Designing and implementing a collaborative teacher professional development model for planning project-based learning in Indian schools

A Thesis

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Declaration

This thesis is a presentation of my original research work. Wherever contributions of others are involved, every effort is made to indicate this clearly, with due reference to the literature, and acknowledgement of collaborative research and discussions.

The work was done under the guidance of Professor Savita Ladage and Professor Sugra Chunawala, at the Tata Institute of Fundamental Research, Mumbai.

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In my capacity as supervisor of the candidate's thesis, I certify that the above statements are true to the best of my knowledge.

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Abstract

For the last two decades, Indian educational policy documents have focused on enhancing quality education in classroom, ensuring students' grade appropriate learning, fostering democratic values, developing 21st century skills, and preparing students for job market(NCERT, 2005; GoI, 2009; NCTE, 2009; MHRD, 2020). The policy suggestions led to many changes in the curriculum materials, assessment methods and implementation of newer pedagogic strategies. One change was the adoption of Continuous Comprehensive Evaluation (CCE). Among the many changes suggested, some are, implementation of project work, subject integration, group work, peer and self-assessment and use of real-world contexts as pedagogical methods to make learning meaningful.

These policy suggestions have increased students' and teachers' burden in terms of increased homework, tests and examinations, and assessment (CBSE, 2010b). Project Based Learning (PBL) has been suggested by researchers around the world to address these concerns and meet the need of 21st century (Barlex, 2006b; Krajcik, McNeill, & Reiser, 2008; Sriram, 2018). In this environment of educational reforms, teachers' role is crucial (Batra, 2014; Batra, Revi, Bazaz, Singh, & Poonacha, 2021; Sarangapani, Thirumalai, Ramanathan, Kumar, & Ramchand, 2021) and there is a need for regular teacher professional development (TPD) both within and outside the school to get acquainted with the new innovative pedagogies and reforms (NCTE, 2009; MHRD, 2020). The educational bodies in the country are aware of the need for TPD but faced with the large numbers of teachers and schools in the Indian context, such programs have been outsourced or follow a cascade model that is not very effective (D. Hayes, 2000; Dichaba, 2013; Sayed & Sarangapani, 2020).

In the light of this background and my reading of literature, including the four major national policy documents, namely: National Curriculum Framework 2005 (NCERT, 2005), Right to Free and Compulsory Education Act 2009 (GoI, 2009), National Curriculum Framework for Teacher Education 2009 (GoI, 2009), and National Education Policy 2020 (MHRD, 2020) along with other relevant literature, such as the associated circulars sent to schools by the Central Board of Secondary Education, (CBSE), and being aware of the massive curriculum development effort at various levels, I identified project based learning (PBL) as a possible curriculum response (Sriram, 2018).

In my work, I have tried to design a model of PBL for implementation in Indian schools and have designed a TPD program implementation to communicate this model to teachers. Prior to the TPD implementation, I attempted to learn about teacher's views

on projects and their practices with reference to project work. My work with teachers follows a deliberative curriculum approach, which tries to integrate contributions of systematic, existentialist, radical, and pragmatic traditions of curriculum making. This approach considers individual's experiences, explores and suggest radical actions, or problem solving based on what works and places the practical art of deliberation at the center (Null, 2011). It engages teachers and researchers in a project of social co-construction of curricula.

I adopted a model of PBL from the five criteria of PBL given by Thomas (2000) namely centrality, existence of a driving question, constructive engagement, autonomy and realism. In addition, four essential elements were derived from the PBL formulation of Waks' (1997) proposal of six elements: (a) Negotiation of the group product, (b) Situation of the group project in a social context, (c) Assessment of incidental learning potential relative to learners' needs, (d) Needs-assessment of background knowledge, (e) Facilitation of project tasks, and (f) Project assessment and learning integration. A CBSE circular (CBSE, 2010b) also helped to identify the major concerns of implementation of projects and pragmatic solutions to address them.

A design based research methodology (Collins, Joseph, & Bielaczyc, 2004) was adopted. First, the model of PBL was shared with teachers and their views on projects and practices of implementing projects in schools were explored through a focused group discussion (FGD) with 10 teachers. Individual teacher interviews were also conducted with four teachers. This baseline information led to structuring a workshop engagement for a larger number of teachers from different school systems and constructing questionnaires to gather teachers' views on projects and project practices.

A total of three workshops were organized with teachers, a few teacher educators, one teacher administrator, and two students of education within a span of 5 months to develop several PBL units for implementation in classrooms. Eighteen participants, including teachers and teacher educators were interviewed, and 13 schools were visited to observe the process, issues and concerns related to the implementation of projects in the schools. Additionally, conversations with two more teachers and one teacher educator over telephone were carried out to know the status of their progress with reference to implementation of projects in their schools.

From the interviews, it was evident that overall, there was an increase in assigning projects and conducting assessment in schools. Both the teachers and students felt burdened due to increase in project work (and number of tests). In the CBSE schools, most of the projects were given as group work and homework assignments and students rarely presented their work in classroom. In the schools that were affiliated to State Board, projects were primarily individual assignments and here too students did not present their work. From the interviews, and questionnaire survey together, it was found that teachers attribute several positive aspects of projects, however, in the interviews teachers also stated that all students were not learning from projects.

Teachers' in the interview had mixed views about different aspects of proposed PBL. All of them stated that self and peer assessment and meaningful group work were not practical. Teachers' views on subjects integration and classroom management was

complex. The idea of subject integration and allotting time for projects in school timetable had mixed views. A few teachers from FGD and three teachers from semi-structured interviews suggested introducing one hour period for project in time table similar to the proposals given in NCF 2005 (NCERT, 2005). But other teachers opposed such modifications. However, all teachers mentioned that to implement the proposed PBL there should be a systemic change.

In the first workshop, teachers suggested that a unit of PBL unit implemented with students in the Indian context be shared with them for greater clarity. A unit was then developed and implemented by the researcher with students (15 students) related to designing and making play items for a playground. This unit and students' productions were shared with teachers in the third workshop of the workshop series for feedback and evaluation.

Teachers' productions in terms of teaching plans made during the three workshops indicated an evolution of their ideas about PBL on five criteria, such as, centrality (the concepts to be used are central to the curriculum), driving question (the PBL should initiate with a question), real world contexts, authentic engagement of students, and student autonomy (ownership of learning). Teachers' ideas about PBL also progressed in relation to integration of subjects, assessment, group work, and classroom management as seen through their teaching plans for PBL. At the same time, the researcher also gained insights while engaging in the workshop, interviewing teachers during the span of engagement, and visiting the schools.

During the three workshop series, teachers also tried out projects in their schools. However, only one teacher could conduct a project including most of the PBL elements. Other teachers while implementing PBL in their own schools included the characteristics of PBL to varying degrees. Teachers tended to continue their existing practices without any major changes.

Conceptualising project based on PBL has the potential to address several suggestions made by the policy documents in Indian context. A wider deliberations is required to understand the PBL pedagogy among teachers and wider community. There is also a need to consolidate diverse efforts related to PBL, assessment, and teaching-learning material and aligning them with TPD programs. The TPD model offered in this study advocates a deliberative approach to curriculum as well as to TPD.

This study demonstrates the possibilities of engaging with teachers around pedagogically relevant issues and devising pragmatic solutions to address policy demands and school realities through a collaboration among teachers and researcher. Researcher's own experience of conducting PBL, sharing the experiences with teachers, and subjecting it for participants' scrutiny opened up possibilities for establishing trust and respect among teachers and researcher.

This study has put forth a model of TPD that provides an integration of content and pedagogical aspects. This model provides a coherent, sustainable, and continuous TPD engagement focusing on teachers practice that provide opportunity to reflect and students' productions as evidence of learning outcomes. It provides a platform for whole

school improvement, facilitate integration of subjects and therefore foster collaboration among teachers, and bring evidence of progress through tangible productions while working on teaching plans and their implementation and students' work.

Chapter 1

Introduction

This thesis *Designing and implementing a collaborative teacher professional development model for planning project-based learning in Indian schools*, is set in the context of educational policies and directives of the last two decades in the Indian context. These policies have suggested projects and other activities as important pedagogic strategies in Indian classrooms, to bring about child centered learning and preparing students for 21st century skills (NCERT, 2005; NCTE, 2009; GoI, 2009; MHRD, 2020). Project based learning (PBL) helps foster democratic values among students and teachers (Apple & Beane, 2006). Globally, PBL is recognised as important pedagogy for inculcating 21st century skills like: creativity, problem solving, critical thinking, reflection, learning to learn, presentation and communication skills, etc. (Barlex, 2006b; Sriram, 2018).

Despite advocacy of PBL at policy level there are challenges of implementing PBL in classroom settings. These challenges are at both philosophical and pragmatic levels. The pedagogy of PBL requires teachers to commit to the constructivist paradigm and increases the burden on teachers for planning teaching, managing and organising learning, and assessing students' learning. If PBL is to be implemented successfully teachers need an orientation to the philosophical background of PBL and solutions to their pragmatic concerns. Teacher professional development (TPD) can play an important role in achieving these goals, but this requires designing TPD so that it is in alignment with the principles of PBL and democratic ethos.

This chapter situates the efforts of the Indian government towards universalising and democratising education and the struggle to implement the national policy suggestions and directives in practice. The Section 1.2 discusses the government's commitment to establishing a democratic ethos in the country through its national education policy directives and also how education can be a vehicle to prepare democratic citizens for the future. Some of the major post-2000 educational policies are summarised in the chapter as well as the curriculum development effort in response to these policy documents. This short review suggests that apart from regular teaching-learning, project work has taken centre stage for diverse innovation initiatives led by the central government. However, the review also suggests that the state of teaching-learning in Indian classrooms does not meet the policy expectations. The chapter ends by a presentation

of the research context, motivation of the current study, a brief outline of the current study and organisation of the thesis.

The following section outlines the wholehearted efforts of the Indian government to democratise and universalise education (Mukhopadhyay, Ramkumar, & Vasavi, 2009). The section mentions the complexities and contradictions in implementing the policy suggestions. Identification of these obstacles opens up possibilities of deliberations in these domains and charting out road maps for appropriate interventions.

1.1 Efforts towards universalisation of education

Government of India's effort to universalise education gained momentum in the 1990's under the flagship project of Sarva Shiksha Abhiyan. A massive structural change was made in terms of creating Block Resource Centres (BRCs), Cluster Resource Centres (CRCs), and District Institutes of Education and Training (DIETs) and a large number of teacher professional development initiatives were undertaken. Attempts were made to encourage the general public to send their children to school with the hope of increasing students' enrollment in schools. The scope of Sarvya Shiksha Abhiyan was widened by constituting a new flagship project Samagra Shiksha Abhiyan in 2018. However, the number of students dropping out from schools continues and is discouraging.

The Indian education policy documents (NCERT, 2005; NCTE, 2009; MHRD, 2020) and Right to Free and Compulsory Education Act (GoI, 2009) of the last two decades clearly articulated the educational trajectory of the country and made it paramount that high quality teaching-learning in classrooms is ensured. The framers of these documents also acknowledged the need of an overhaul in teacher education and placed teacher education at the centre of educational reform (Batra, 2021). The most recent National Education Policy 2020 (MHRD, 2020) too has set ambitious targets and chalked out a detailed stage wise plan to execute its policy directives.

As a result of these policy documents, there has been an increase in the educational vocabulary among the stakeholders of education in India. This is important in light of the fact that Sarangapani (2011), points out that there is an erroneous widespread view that "everyday vocabulary in which education is discussed and personal theories based on personal experience are sufficient for formulating policy and for carrying out research" (p. 70). It therefore becomes critical to take into account how these vocabularies are interpreted in educational contexts by the relevant stakeholders.

Often the policy directives are not implemented as envisioned and there may be many reasons for this state of affairs. In addition, the actionable points derived from the policy documents to be implemented in practice may not find acceptance among the general public and important educational stakeholders. For example, the "no detention" policy derived from the Right to Free and Compulsory Education Act (GoI, 2009) is in alignment with the larger philosophy of the Act and consistent with the ethos of the Constitution of India (GoI, 2007). However, this policy has been widely opposed by teachers, parents, and educational stakeholders, who reasoned that "no detention" will

generate a disinterest among students to study (Sharma, 2016). This opposition reflects the treatment of children as "others" and an obsession with "pedagogic violence" (N. Kumar, 2020).

It is heartening that the Government has made sustained efforts towards transforming pedagogy and the classroom environment into a democratic and inclusive one, and facilitated the universalisation of education. These efforts could get wider acceptance, if the general public also appreciates the democratic ethos behind these efforts. It is notable that, India has a successful parliamentary democracy (Chandra, Mukherjee, & Mukherjee, 2000; Sen, 2005; Guha, 2010) for over more than 70 years and is committed to its constitutional obligation (Austin, 1999). At the same time the general public is perhaps not appreciative of democratic values as manifested by the increased 'public fascination with muscular nationalism' and decreased respect for civic law (Mukherji, 2020). In a similar vein, policies like "no detention" are disregarded on the basis of majoritarian views generated from idiosyncratic experiences and devoid of any scholarly support (Juneja, 2018).

A reason for the non-acceptance of policy directives is the lack of deliberations with teachers and educational stakeholders. Inadequate systemic preparation to implement the suggestions adds further setbacks. For example, when attempts were made for the implementation of Continuous and Comprehensive Evaluation (CCE) it created misunderstandings among stakeholders of education and led to resistance as there was insufficient discussion with stakeholders and systemic unpreparedness to afford its implementation demand (Nawani, 2013; Juneja, 2018).

Batra (2021) proposed a need for re-imagination of the Indian school education curriculum in the post-COVID context. She shows how the pandemic has exposed the fault lines in our society as well as in our education system. Teaching-learning in classrooms and curriculum at large needs deliberation in order to acknowledge and address the socio-economic-environmental crisis of the present and future. She cites inspiration of such curriculum and pedagogical principles from the work and thought of Jyothiba Phule, Rabindranath Tagore, Aurobindo Ghose, M K Gandhi, and B R Ambedkar.

This thesis is situated in the current discourse of educational policy implementation in India. It is important to have democratic deliberations in classrooms using a pedagogy that has the potential to integrate constitutional values (NCTE, 2009; MHRD, 2020). The role of education for nation building and strengthening her participatory democracy is well established in India's policy documents (NCERT, 1971, 2005; NCTE, 2009; MHRD, 2020). The next section presents the role of education in preparing democratic citizens and for strengthening democracy itself. It highlights the current trends of educational reforms and the challenges associated with these educational reforms, and the need for changed perspectives.

1.2 Education and democratic citizenship

For any functional democracy it is important that citizens have the ability and opportunity to take active part in democratic processes and deliberations (Joseph, 2007). It is acknowledged in several policy documents (NCERT, 2005; MHRD, 2020) that maintaining the values enshrined in the preamble of the constitution of India (GoI, 2007) is a prerequisite for real freedom. The University Education Commission 1948-49, Secondary Education Commission 1952-53 (Aggarwal, 1993), Education Commission 1964-66 (NCERT, 1971), National Policy of Education 1986 (NPE 1986) and its modified version in 1992 (MHRD, 1998) categorically elaborate the role of education in developing democratic citizenship and nation building.

The report of the Education Commission 1964-66 (NCERT, 1971) tabled the importance of education for nation building in a democratic set up. Chapter 1 of the report begin with the following words:

> The destiny of India is now being shaped in her classroom. This, we believe, is no mere rhetoric. In a world based on science and technology, it is education that determines the level of prosperity, welfare and security of the people. On the quality and number of persons coming out of our schools and colleges will depend our success in the great enterprise of national reconstruction the principal objectives of which is to raise the standard of living of our people. [p. 3, (NCERT, 1971)]

In the same section, the report mentions that education should be looked at in connection to other aspects of national development rather than considering education in isolation. The report states about education:

> It has to be used as a powerful instrument of social, economic and political change and will, therefore, have to be related to the long-term national aspirations, the programs of national development on which the country is engaged and the difficult short-term problems it is called upon to face. [p. 4, (NCERT, 1971)]

Considerable progress was made in the field of education after the publication of the report of the Education Commission 1964-66 (NCERT, 1971). However, many proposals and suggestions are not yet implemented (Tilak, 2018). A gap in implementation is acknowledged in the National Policy of Education 1986 (MHRD, 1998) and even in the recent National Educational Policy (MHRD, 2020). After more than five decades there are new and constantly emerging issues in education (Batra, 2013).

The National Curriculum Framework (NCF-2005) (NCERT, 2005) identified persisting lacunae in the existing education system that deters the nation from meeting its constitutional obligations. The document has articulated five broad aims of education, so that the process of education be consistent with the constitutional vision. These aims include:

1. Independence of thought and action,
2. Sensitivity to others' well-being and feelings,
3. Learning to respond to new situations in a flexible and creative manner,
4. Predisposition towards participation in democratic processes, and
5. The ability to work towards and contribute to economic processes and social change.

In order to realise the broad aims of education NCF-2005 proposed the following five guiding principles for curriculum development:

1. Connecting knowledge to life outside the school,
2. Ensuring that learning shifts away from rote methods,
3. Enriching the curriculum so that it goes beyond textbooks,
4. Making examinations more flexible and integrating them with classroom life,
5. Nurturing an overriding identity informed by caring concerns within the democratic polity of the country.

Ghosh (2013) notes that education has become a part of the developmental narrative and is often presented as a major socio-political and economic issue in third world countries for the last several decades. At the end of 20th century we have found an emergence of agendas that strive for economic and social development (R. Jha, 2008). The Millennium Development Goals (UN, 2000, 2015a) and later Sustainable Development Goals (UN, 2015b) set by the United Nations are shaping education policies globally and also influencing the vision of India and directing its policies. E.g. the vision articulated in the millennium development charter was echoed in the writing of the former president of India (Kalam & Rajan, 2002). Recently there is a visible focus on enhancing India's performance in attaining the sustainable development goals (RIS, 2016). These agendas of development include the preparation of citizens to develop 21st century skills and universalisation of education (Geisinger, 2016; MHRD, 2020).

National policy documents are emphasising on liberating classroom teaching from examination focused, textbook oriented, and rote learning based activities. These documents also posit education's central role for preparing citizens for democratic citizenship. It is interesting to note that there is a push at the global level to raise the educational level of countries. India's efforts towards ensuring universal education have been consistent and in alignment with the charter of Sustainable Development Goals. National Curriculum Framework 2005 (NCERT, 2005) and National Curriculum Framework of Teacher Education 2009 (NCTE, 2009) laid out comprehensive plans for curriculum reform. National Education Policy 2020 [NEP 2020] (MHRD, 2020) categorically mentions the Sustainable Development Goals (SDGs 2030). However, in a vast and pluralistic country like India it is challenging to meet the targets projected. One of the reasons for these challenges is the lack of coherence in policy suggestions

and its implementations. Policy suggestions and its dictum are often presented as fragmented short term target statements and are indifferent to diversity existing in the educational and social landscape (Batra, 2013, 2020), insensitive to burdened teachers, and rely on prescriptive and top-down approach in education (D. Hayes, 2000).

Interestingly, there is also a rise in treating citizens as human resource or capital. In this narrative, educational discourse is centred around positioning education as an instrument to prepare citizens for better employability and for the nation's economic growth. However, to develop an egalitarian ethos in society the relationship of state and citizen needs to be nurturing each other and realising the potential of the individual (Batra, 2021). This requires the viewing of citizens through the lens of 'human capability' (Sen, 2000). Preparing students as citizens of the future requires nurturing their capabilities (N. Hayes & Filipović, 2018). One of the ways to do this would be to prepare students and teachers to engage in a problem-posing education that allows discourse around social realities (Dewey, 1966; Freire, 2000).

Madan (2019) introduces us with one such social reality of the present time. He observes that during the last 20 years there is a new wave of consumerism with access to Internet and mobile devices available to a large number of citizens. He asserts that it is important to re-discover the role of education in this new situation and posits education as a process that can help individuals reflect on their actions and foster humane values. He situates the role of education in the preface of his book *Education and modernity: Some sociological perspective*:

> ... In a society with increasing hatred between communities, we turn to education as one process which can soothe bruised egos and foster love for humanity. In a time when old occupations are fast disappearing or no longer appear attractive, we expect education to show a path to new ones. When children of farmers move to cities, they may find that the culture and values they were familiar with no longer seem to be of any help to them and we turn again to education to help them learn the newer ways. There are many deep dilemmas that people face today. Increasingly, we find advertisements and consumerism telling us that the meaning of life comes from a new mobile phone or the latest trend in clothes. The desire to buy them motivates people to seek new jobs and even friendships are formed around a shared taste in consumer goods. Education is called upon to take a stand on these new trends as well. [p. 4, (Madan, 2019)]

His view towards education as a lighthouse generates hopes towards education. However, the content and process of education need to be defined. The next section presents an outline of the post 2000 educational policies that are relevant to teaching-learning and teacher professional development. The section also focuses on the elements mentioned in these policy documents to foster democratic ethos in the classroom and preparing students to take active part in the democracy.

1.3 Educational policies post 2000

In the last two decades profound developments in educational policy took place in the country. These include the National Curriculum Framework 2005 and its 21 accompanying position papers (NCERT, 2005), as well as the Right of Children to Free and Compulsory Education Act 2009 (GoI, 2009), the National Curriculum Framework of Teacher Education 2009 (NCTE, 2009), and National Education Policy 2020 (MHRD, 2020). The policies are in continuation of the sustained effort made in the last two decades of the previous century (MHRD, 1998; NCERT, 1988b; GoI, 1993; NCERT, 2000). The recent work and development in education policies are primarily guided by the policies of the last two decades.

The major suggestions made by each of the documents relevant to teaching-learning and Teacher Professional Development (TPD) are briefly summarised in the following sub-sections. The Central Board of Secondary Education (CBSE) circulars play an important role in implementation of policy suggestions in the schools run by the CBSE boards. The respective state boards also follow the CBSE circulars while implementing central government policies and directives. Therefore, relevant CBSE circulars are also cited while presenting the four policies.

1.3.1 National Curriculum Framework 2005

The National Curriculum Framework 2005 is an important document that aims to redesign and restructure the Indian education system. The document outlines the vision, shared goals and fundamental premises of the framers. The emergence of NCF - 2005 predominantly took place through the "process of social deliberation" (NCERT, 2005).

Recommendations for teaching-learning

NCF 2005 recognises that learners actively construct knowledge and concepts by connecting existing ideas with the new ideas based on the learners' own activity and experiences. To construct knowledge from activities, students need to express themselves, handle objects, and explore their natural and social milieu. NCF 2005 noted that the term 'activity' has become a part of the regular vocabulary of most elementary teachers, but is driven by "outcomes" at the end of the lesson. NCF 2005 sought a shift to constructivist and child-centered teaching in Indian classrooms. Productive work has been proposed as one of the effective pedagogic strategies to address educational concerns (NCERT, 2005).

NCF 2005 and the accompanying position papers on Science, Mathematics, and Habitat and Learning (NCERT, 2005, 2006c, 2006b, 2006a) state the importance of hands-on work, making connection with children's real world and adopting 'learning by doing' as pedagogic strategies. These documents emphasized developing students' abilities to

think critically, fostering the spirit of scientific inquiry, democratic decision making, caring for the environment, and suggested project based activities such as, conducting surveys, organizing data and displaying them through exhibitions as important components of pedagogy. These activities would help students know more about the world beyond the textbook content by taking part in projects (NCERT, 2005).

NCF strongly advocated an interdisciplinary approach to school education and expressed the need to reduce the compartmentalisation of subjects in school curriculum. It also suggested that students participate in group activities, and discuss content and issues with peers and teachers. The use of continuous as well as periodic assessment was emphasized as well as, integrating formative and summative assessments of student learning. The importance of self and peer assessments in classroom practices was highlighted (NCERT, 2005).

NCF proposed that the concerns and issues on environment, peace and social justice be addressed in every subject through various activities involving outdoor project work. The position paper of the National Focus Group on Habitat and Learning (NCERT, 2006a) has explicitly mentioned the role and framework for conducting project work for Environmental Education in schools. In the context of environmental education, NCF suggests including activities that will not only enrich our understanding about environment but also enrich the quality of educational experience: (a) locale and time specific observation, (b) careful documentation, and (c) elucidation of the patterns and underlying processes based on comparisons of systems.

The quality documentation of rich environmental knowledge was and is absent in the current scenario. Therefore, documentation of the state of India's environment is viewed as a knowledge generation activity and it was suggested that students be assigned projects to get involved in such knowledge generation, creating a publicly accessible database on the Indian environment. The outcome of the project work would become a valuable educational resource and usable knowledge base for strengthening institutions.

The position paper on teaching of science (NCERT, 2006c) provided an outline of pedagogical strategies for students of upper primary and secondary stages in the following words:

> At the upper primary stage the child should be engaged in learning principles of science through familiar experiences, working with hands to design simple technological units and modules (e.g. designing and making a working model of a windmill to lift weights) and continuing to learn more on environment and health through activities and surveys. Scientific concepts are to be arrived at mainly from activities and experiments... Group activity, discussions with peers and teachers, surveys, organization of data and their display through exhibitions, etc. in schools and neighbourhood are to be an important component of pedagogy...
>
> At the secondary stage the students should be engaged in learning science as a composite discipline, in working with hands and tools to design more advanced technological modules than at the upper primary stage, and

> in activities and analysis on issues surrounding environment and health. Systematic experimentation as a tool to discover/verify theoretical principles, and working on locally significant projects involving science and technology are to be important parts of the curriculum at this stage [p. iv, (NCERT, 2006c)].

The position paper on teaching of science (NCERT, 2006c) even envisioned a paradigm shift in science education by strengthening inquiry skills, language, design and quantitative skills. NCF envisioned a social movement along the lines of Children's Science Congress in order to promote discovery learning across the nation at a later stage throughout South Asia.

Overall, NCF 2005 proposed conducting projects in all the subjects and not limiting projects to subjects like Arts and Crafts. Even in subjects like Arts and Crafts, the document emphasised that the pedagogy of these subjects should be project based. In arts and crafts, teachers could help children over the years to move towards formulating and executing their own art projects independently.

Recommendations for TPD

National Curriculum Framework 2005 (NCERT, 2005) set normative requirements to be addressed in teacher professional development (TPD). It emphasised some dispositions as desirable among teachers. According to the NCF, teachers should:

1. care for children, and love to be with them,
2. understand children within social, cultural and political contexts,
3. be receptive and be constantly learning,
4. view learning as a search for meaning out of personal experience, and knowledge generation as a continuously evolving process of reflective learning,
5. view knowledge not as an external reality embedded in textbooks, but as constructed in the shared context of teaching-learning and personal experience,
6. own responsibility towards society, and work to build a better world,
7. appreciate the potential of productive work and hand-on experience as a pedagogic medium both inside and outside the classroom,
8. analyse the curricular framework, policy implications and texts (p. 108).

NCF 2005 suggested that there needs to be more experiential learning, creating an environment that supports and fosters peer learning and emphasised opportunities for reflection as part of in-service TPD engagements. It also proposed sharing of good practices and/or detailed unit planning rather than merely talking about what to do (NCERT, 2005). Drafting a unit plan and sharing good practices requires a rich teaching context. Emphasis was also placed on bringing diverse disciplinary knowledge

and skills under one problem context. In this context it is to be noted that developing TPD programmes structured around collaborative planning of PBL units and sharing about implementation provide a rich context for reflection.

Implementation of the recommendations and linkages to project work

The Central Board of Secondary Education (CBSE) issued circulars promptly in response to NCF 2005's proposal. These include circulars on life skill education (CBSE, 2005a), alternative to homework (CBSE, 2005b), guidelines to project work on social sciences (CBSE, 2005c, 2006c), including environmental education from Grade 1 to 8 (CBSE, 2005d, 2005g), school based evaluation at secondary stage (CBSE, 2005h), guidelines on continuous and comprehensive evaluation at primary level (CBSE, 2005f), restructuring science practical work (CBSE, 2005e), promoting reading habits as part of CCE in English language (CBSE, 2009c), and fostering students innovation (CBSE, 2006a) etc.

The circular on life skill education (CBSE, 2005a) suggested that life skills could be taught as an independent discipline or integrated with other disciplines. Students could be given "simple studies and projects based on Life Skills", or lectures could be delivered to sensitize students on life skills. The circular on alternatives to home work (CBSE, 2005b), stated that teachers and schools need adequate planning to design "child-friendly activities that would enhance their love for the environment, family and help them to develop as competent citizens of the country". These activities, role-plays or projects could be used for identifying skills and are "a part of co-scholastic activities".

The circular on guidelines to project work in Social Sciences (CBSE, 2005c), outlined a comprehensive plan for conducting and evaluating projects accompanied with a list of project topics. Students of class IX were required to do two projects, and one of them was mandated on Disaster Management, while class X students would do any one project. The circular also provided a format of the project report. Some salient features of the project report provided in the circular are summarised here:

1. project report should be handwritten in 15 to 20 pages, and submitted in "neatly bound simple folder",
2. "credit will be awarded to original drawings, illustrations and creative use of materials",
3. the structure of the report include: (a) Cover page, (b) List of contents, (c) Acknowledgements and preface, (d) Introduction, (e) Chapters with suitable headings, (f) Planning and activities to be done during the project, (g) Conclusions, (h) Bibliography, and (i) Appendix. The photographs and sketches provided in the report should be relevant and labeled.

A few minor changes were made in successive circulars, such as reduction in the number of pages to 12-15, several safeguard provisions that would prevent the project report

from further use (e.g. punching of the completed report) (CBSE, 2006b, 2006c).

It was proposed that the student would select the project topic at the beginning of the new session. "Methodology of study and research work should be completed before the vacation" while during vacation the "project can be systematically organized for presentation and preparation for viva". The second project would be done in school. About 30 periods would be allotted for project work to be carried out by students under the supervision of the teacher (CBSE, 2005c).

CBSE circulars provided an extensive list of themes and a set of topics under each of the themes. The projects would require students to collect information and data through survey and interview, interpret and analyze the data and information, prepare posters, make slogans, perform skits, songs, and debate etc. (CBSE, 2005c, 2006c, 2009b). Interestingly, most of the projects included 'collect information and data' and frequently were the only elements students had to follow while carrying out the projects.

The circular on Environmental Education (EE) (CBSE, 2005d) made EE a compulsory subject from Grade 1 to 8 allotting a minimum of two periods/week. Suggestions included integrating environmental concerns while transacting different disciplines. "Environmental sensitivities as reflected in the prescribed curriculum" would be made a part of the "various co-scholastic activities carried out by the school". The circular on Directives to schools regarding Environmental Education from Classes I – VIII (CBSE, 2005g), suggested carrying out investigations, project work and co-scholastic activities at the upper primary EE curriculum using both process and product evaluation. Every child from the upper primary levels onwards would participate in at least one nature/outdoor field visit experience. The circular suggested maintaining "proper records of learners' progress". The "profiles, so developed, would be utilized for effecting improvement leading to desirable understanding and behavioural actions towards the environment". It recommended that the pedagogy of EE in all the classes will be based on "local contextuality, indigenous knowledge, experiential learning strategies, multi-disciplinary approaches, oriented practical assignments, project based-methods and action" (CBSE, 2005g).

There were other recommendations on reviewing existing teaching-learning in the classroom in the light of NCF 2005. E.g. There was the suggestion of restructuring science practical work (CBSE, 2005e) to enable "learners to pursue the subject with a sense of joy, a spirit of inquiry and a sense of adventure". It identified a casual approach adopted while conducting science practicals in school. In the circular on "promoting reading habits as part of CCE in English Language" (CBSE, 2009c), it was expressed that students' interest in reading has reduced and there was a need to launch reading projects in school.

Implementation of the recommendations on assessment, evaluation, and project work

The circular on assessment (CBSE, 2005h), laid out scheme of assessment for class X. The components of internal evaluation included: (a) Tests (formative and summative) of 10 marks, (b) School and home assignments of 05 marks, and (c) Project work of 05 marks. Formative assessments would include "a variety of oral and written questions for recapitulation, review and diagnostic purposes". The circular cautioned that the purpose of assessment is to "identify learning gaps, deficiency in teaching and to bring improvement in teaching-learning process" rather than assessing the students' learning. Circular added that the unit tests would be written and "a record of at least three unit tests, term tests and half yearly tests should be maintained". Students would be assessed in the unit tests on a five-point rating scale (Excellent - A-5, Very Good - B-4, Good - C-3, Fair - D-2, Unsatisfactory - E-1).

The project evaluation scheme included: (a) Initiative, cooperativeness and participation, (b) Content accuracy and research work, (c) Creativity, originality, (d) Analysis of different situations and different perspectives, and (e) Viva or written test for content assimilation. Each of the aspects carry 1 mark (CBSE, 2005c). Interestingly, later the scheme of assessment was restructured and the number of aspects reduced to four. The modified scheme included: (a) Content accuracy and originality, (b) Presentation and Creativity, (c) Process of project completion (Initiative, cooperativeness, participation and punctuality), and (d) Viva or written test for content assimilation (CBSE, 2006c). The first aspect is allotted 2 marks while the rest are given 1 mark each. In this restructuring some earlier aspects "Analysis of different situations and different perspectives", and "research work" are deleted. Further, two new elements "Presentation" and "punctuality" are added.

It is stated that assignments are to be provided in the form of questions to evaluate "understanding of different concepts". The purpose of internal evaluation is to "destress learning" and make this evaluation "more relevant, useful and enjoyable for the students. The purpose is not to "increase the learning load among the students". Teachers need to refrain from taking "too many tests" and conduct the tests "in stress free, non-threatening environment to help the student in revising learnt concepts". Similarly, the projects should not be "voluminous", but "should be original, creative and innovative" (CBSE, 2005h).

The circular directing guidelines on continuous and comprehensive evaluation at primary level, provided a detailed analytical rubric for evaluation. The rubrics included several elements including activity/projects as one of the elements. It is apparent in the descriptor of the criteria that the activities/projects are limited to products. The highest level for Activity/Project for Grade 3 to 5 describes "Very innovative; collects information, is able to present the work neatly; does reference work". Further, opportunities for including multiple productions while writing descriptors in different levels are inadequately explored. E.g. elements like "Environmental sensitivity", "Group discussion", "Written work" are provided separately (CBSE, 2005f). As a result the descriptors of these elements fail to anchor in a rich and coherent problem context, and remain diffused in isolated actions.

The reform in evaluation got another push when CBSE asked that Comprehensive Continuous Evaluation (CCE) be implemented in all schools that followed the CBSE curriculum (CBSE, 2007). Assessment included both formative and summative assessment. Formative assessment is conceptualised as "a tool used by the teacher to continuously monitor student progress in a non-threatening and supportive environment". There was also repeated mention of diversifying formative assessment. These include paper-pencil test, oral testing, quizzes, conversations, interviews, visual testing, projects, field visits, practicals and assignments (CBSE, 2007, 2009b).

In addition to the scholastic areas, co-scholastic areas like life skills; attitudes & values; participation & achievement in activities involving literary & creative skills, scientific skills, aesthetic skills and performing arts & clubs; and health & physical education were also brought under the ambit of assessment (CBSE, 2009b). Interestingly, several practical initiatives were limited to bringing modification in numerical score to alphabetical grade, deciding the scale, and fixing proportion of marks in the "formative" and "summative" tests (CBSE, 2007, 2009a). In the circular of the assessment scheme in home science (CBSE, 2009b), it was suggested that students would develop informative leaflets, booklets, pamphlets and bookmarks on related topics and display the same on bulletin boards. Informative lecture sessions by experts on related topics (safety, nutrition, apparels etc.) would be organised for students. Interestingly, assessment of most of the tasks were based on theory and limited to report writing.

The evaluation scheme of life skills (CBSE, 2005a) is part of the CCE to be conducted through "team evaluation". It is also highlighted that "students should be graded based on their skills and attitudes while only positive intents of the learners are to be reflected". Circular on alternative to homework suggested to record students' positive behavioural changes as positive inputs in the "school achievement record of the individual learners" and not evaluate these formally (CBSE, 2005b).

1.3.2 Right of Children to Free and Compulsory Education Act 2009

The Right of Children to Free and Compulsory Education Act 2009 [RtE 2009] (GoI, 2009), vide section 8 and section 9, puts an obligation for implementation of the act on the respective appropriate government and local authorities. The sections laid out that the responsible authority needs to ensure that a child belonging to a disadvantaged group is not discriminated against and prevented from pursuing and completing elementary education on any grounds. The authorities must also provide adequate infrastructure at school, ensure good quality elementary education, timely prescription of curriculum and courses of study for elementary education, and provide training facilities for teachers etc.

Chapter IV of the Act sets the responsibilities for school and teachers. Section 16 prohibits schools from holding back a child in any class or from being expelled from school till the completion of elementary education. Section 17 (1), forbids teachers and school from subjecting students to corporal punishment. Section 24 shares the

expectations from teachers. These include conducting and completing the prescribed curriculum within the specified time, assessing the learning abilities of each child and accordingly supplementing additional instructions, holding regular meetings with parents and guardians and appraising them about the regularity in attendance, ability to learn, progress made in learning and any other relevant information about the child.

The Act, vide section 29 (2), listed following aspects "while laying down the curriculum and evaluation procedures":

1. Conformity with the values enshrined in the Constitution.
2. All round development of the child.
3. Building up child's knowledge, potentiality and talent.
4. Development of physical and mental abilities to the fullest extent.
5. Learning through activities, discovery and exploration in a child- friendly and child-centred manner.
6. Medium of instruction shall, as far as practicable, be in child's mother tongue.
7. Making the child free of fear, trauma and anxiety and helping the child to express views freely.
8. Comprehensive and continuous evaluation of child's understanding of knowledge and his or her ability to apply the same.

RtE Act 2009 (GoI, 2009) led to the creation of a new wave of TPD programs across the country. There are several private bodies who are providing TPD programs across the country to both the private and public school systems. However, TPD cannot be a single shot program. Interestingly, the Right to Education Act 2009 (GoI, 2009) itself asked concerned departments to ensure that all the teachers received training within a time bound period. Considering the mammoth number of teachers in Indian schools and situating the complexity of TPD it is worthwhile to explore the situation in detail.

Implementation of the recommendations of RtE Act 2009

The mandate of RtE Act 2009 is reflected in the circular on monitoring and mentoring of CCE implemented by the CBSE. According to the guidelines schools need to keep students' profile and portfolios and marking of the project work as students' record. Teachers are expected to prepare lesson plans, use teaching aids, and plan activities for the formative assessment, and assessment needs to include both scholastic and co–scholastic areas (CBSE, 2010a).

The efforts of implementation of the recommendations of RtE Act 2009, led to dissatisfaction among students, parents, and teachers. CBSE acknowledged the concerns generated in connection to implementation of CCE and also suggested ways to address these concerns. CBSE noted that students had to take "too many tests, assignments, projects, homework and review tests". The projects are given as home work and these

are either done by siblings/parents or even outsourced. There is also a stress on students due to increased "minute microscopic examination of behaviour". It is heartening that the circular clearly laid out what are not CCE practices and suggested practical ways to address the concerns (CBSE, 2010b). Some of these ways are summarised here.

1. Instead of taking daily/weekly assignments teachers need to work in consultation with each other and assign projects/assignments of different subjects at sufficient gaps.
2. Students' self learning and study skills need to be encouraged through in-class activities. Students would be assigned group project to be carried out in school under the supervision of teacher.
3. Teachers need to gather inputs for CCE from the interactive classroom, while engaging students in exploration, experimentation, and experiencing learning.
4. Instead of minutely assessing students' behaviour, schools may provide more opportunities to students in co-scholastic areas and post parents the feedback of their wards.
5. Integrated projects would be given to students, for which the subject teachers need to collaboratively plan, develop, and assess the projects (CBSE, 2010b).

The guidelines of the circular uses the potential of existing structures as pragmatic solutions. The solutions would be classified under four distinct dimensions. These are elaborated below:

1. Classroom management: Teachers need to collaborate for planning projects / assignments of different subjects and place them in timetables with sufficient gaps. More collaboration among teachers would be required for the integrated projects (to plan, develop, and assess the projects). As the projects are to be carried out in the classroom, teachers need to plan the unit in advance. Teachers need to ensure diverse activities and availability of learning resources to encourage students' self learning and study skills. Teachers also need to plan diverse co-scholastic engagement.
2. Group work: It is explicit that students would be engaged in group projects.
3. Assessment: The proposal of gathering inputs for CCE while students engage in exploration, experimentation, and experiencing learning requires teachers to revisit the traditional assessment practices and understand the purpose of assessment. It also requires teachers to devise assessment mechanisms in the co-scholastic areas and give written feedback on students to parents. This demands a good understanding of learning objectives (LOs) by teachers. Using rubrics based on the LOs would help share the feedback with parents as well as with students.
4. Subject integration: It is explicitly mentioned that integrated projects would save time.

1.3.3 National Curriculum Framework of Teacher Education (NCFTE) 2009

National Curriculum Framework for Teacher Education (NCTE, 2009) noted that in response to RtE Act 2009 (GoI, 2009), India has to prepare a large number of "well qualified and professionally trained teachers" [p. 1, (NCTE, 2009)]. The document set a time frame of maximum 10 years to reach universal secondary education. However, the document also acknowledges the "problems of inadequate quality in most secondary schools due to poor infrastructure and insufficient and poorly equipped teachers" [p. 1, (NCTE, 2009)].

The NCFTE 2009 acknowledged that the academic and professional standards of teachers shape the essential learning conditions for achieving educational goals.

> The length of academic preparation, the level and quality of subject matter knowledge, the repertoire of pedagogical skills the teachers possess to meet the needs of diverse learning situations, the degree of commitment to the profession, sensitivity to contemporary issues and problems as also to learners and the level of motivation critically influence the quality of curriculum transaction in the classrooms and thereby pupil learning and the larger processes of social transformation. [pp. 1-2, (NCTE, 2009)]

The framework document noted that "the current system of schooling imposes tremendous burden on our children" (p. 4) and identified two factors responsible for this situation:

> ...incoherent curriculum structure ... often dissociated from the personal and social milieu of children ... the inadequate preparation of teachers who are unable to make connections with children and respond to their needs in imaginative ways. [p. 4, (NCTE, 2009)]

The document noted that current teacher education failed to meet the objectives of both, the NCF 2005 and RtE Act 2009. Referring to NCF 2005, NCFTE 2009 states that, current teacher education:

> ...train teachers to adjust to a system in which education is seen as transmission of information. They take the school curriculum and textbooks as 'given' and train teachers to adjust to the needs of the existing school system..... [p. 12, (NCTE, 2009)]

The document spells out four issues in which teacher education engagement needs to focus on. A brief description of each of the four issues is provided below:

1. Inclusive Education: There are two kinds of exclusion in school. The first kind of exclusion is of the special children and children with learning difficulties. A second kind of exclusion is towards children of socio-economically deprived classes, minority communities, and girls and children with diverse learning needs.
2. Perspectives for Equitable and Sustainable Development: In the present context of ecological crisis, increased commercialised and competitive lifestyle, increased violence and polarisation, it is important that teachers and students develop values for peace, respect the rights of all, and respect and value work. It is also important to change attitude towards consumption patterns and outlook towards natural resources.
3. Role of Community Knowledge in Education: Teachers need to develop capability to identify suitable curriculum content appropriate for local context.
4. Information and Communication Technology (ICT) in schools and e-learning: Teachers need to be empowered to evaluate the use of ICT and engage in judicious use of the same in pedagogy. ICT can be creatively used in both pre- and in-service teacher education (NCTE, 2009).

1.3.4 National Education Policy 2020

The introduction chapter of the National Education Policy 2020 clearly sets the target of high-quality education accessible for all by 2040. However, the policy acknowledges that to achieve the target there need to be major reforms to "bring the highest quality, equity, and integrity into the system, from early childhood care and education through higher education" [p. 3, (MHRD, 2020)]. In the same section, the policy document succinctly articulates its views towards education, pedagogy and their relevance to life. The document states:

> ... with the quickly changing employment landscape and global ecosystem, it is becoming increasingly critical that children ... learn how to learn. Education thus, must move towards less content, and more towards learning about how to think critically and solve problems ... be creative and multidisciplinary ... innovate, adapt, and absorb new material in novel and changing fields. Pedagogy must evolve to make education more experiential, holistic, integrated, inquiry-driven, discovery-oriented, learner-centred, discussion-based, flexible, and, of course, enjoyable... Education must build character, enable learners to be ethical, rational, compassionate, and caring, while at the same time prepare them for gainful, fulfilling employment. (p. 3)

NEP 2020 listed a set of fundamental guiding principles for both the education system and individual institutions. The principles articulated in the NEP 2020 relevant for all education levels are briefly listed below:

1. "recognizing, identifying, and fostering the unique capabilities of each student"

and promoting their holistic development in both academic and non-academic spheres,

2. creating flexibility in system so that learners can choose their "learning trajectories" and thereby choose their "own paths in life according to their talents and interests",
3. reducing water tight separation of disciplines (arts and sciences, curricular and extra-curricular activities, vocational and academic streams, etc.) to "eliminate harmful hierarchies among, and silos between different areas of learning",
4. fostering multidisciplinarity and holistic education,
5. emphasising "conceptual understanding rather than rote learning and learning-for-exams",
6. fostering creativity and critical thinking, ethics and human & constitutional values like empathy, respect for others, cleanliness, courtesy, democratic spirit, spirit of service, respect for public property, scientific temper, liberty, responsibility, pluralism, equality, and justice as well as life skills such as communication, co-operation, collaboration, teamwork, and resilience,
7. "promoting multilingualism and the power of language in teaching and learning", respect for diversity and the local context in the curriculum and policy,
8. focusing on regular formative assessment for learning rather than summative assessment,
9. implementing extensive use of technology in teaching and learning, and
10. continuous professional development, positive working environments and service conditions of teachers.

In order to reduce the learning gap NEP 2022 asked for a shift of classroom transactions towards "competency-based learning and education". And therefore, "the assessment tools were also to be aligned with the learning outcomes, capabilities, and dispositions as specified for each subject of a given class" (p. 12). Assessment would include both self-assessment and peer assessment. Students progress in project-based and inquiry-based learning, quizzes, role plays, group work, portfolios, etc. along with teacher assessment would provide a diverse source of holistic assessment.

The document envisioned that pedagogic focus would be on developing evidence-based thinking, problem solving and logical reasoning, innovativeness, sense of aesthetics and art, gender sensitivity, citizenship skills and values, oral and written communication, ethical and moral reasoning. Curriculum would include digital literacy, coding, and computational thinking, knowledge of fundamental duties, knowledge about India, environmental awareness including water and resource conservation, sanitation and hygiene, current affairs and knowledge of critical issues facing local communities/States/the country/the world, health and nutrition, physical education, fitness, wellness, and sports, and vocational work.

After publication of NEP 2020, CBSE has initiated integrating diverse curriculum areas in school education. Some of these include Art-integrated project for classes

I to X (CBSE, 2020b), Skill courses from classes VI to XI (CBSE, 2022c), and the Atal Tinkering Lab (ATL) (CBSE, 2020c). The skill courses are developed in response to NEP 2020's recommendation of reducing the hard separations between different disciplines. There is an attempt at "mainstreaming all forms of learning and skills... required for particular occupations, through a broad-based education ..." Level wise list of skill courses are also suggested (CBSE, 2022c). Interestingly, a hasty connection is being made with specific skill to a specific job.

Government of India's flagship and highly ambitious project, NIPUN Bharat focuses on developing foundational literacy and numeracy among children. The framework of the NIPUN Bharat is derived from the principle of holistic development of children through competency based education provided in NEP 2020.

The National Education Policy 2020 (MHRD, 2020) envisioned that "teacher education requires multidisciplinary inputs, and education in high-quality content as well as pedagogy" (p. 42). The NEP refers to teacher professional development (TPD) as continuous professional development (CPD) and suggests that teachers will be given:

> 5.15. ... continuous opportunities for self-improvement and to learn the latest innovations and advances in their professions. These will be offered in multiple modes, including in the form of local, regional, state, national, and international workshops as well as online teacher development modules. Platforms (especially online platforms) will be developed so that teachers may share ideas and best practices. Each teacher will be expected to participate in at least 50 hours of CPD opportunities every year for their own professional development, driven by their own interests. CPD opportunities will, in particular, systematically cover the latest pedagogies regarding foundational literacy and numeracy, formative and adaptive assessment of learning outcomes, competency-based learning, and related pedagogies, such as experiential learning, arts-integrated, sports-integrated, and storytelling-based approaches, etc. (p. 22)

It is notable that the content for school leaders includes "leadership and management, as well as content and pedagogy with a focus on preparing and implementing pedagogical plans based on competency-based education" [p. 22, (MHRD, 2020)].

1.4 Curricular material development effort

Several SCERTs of different states and NCERT developed and published textbooks after publication of NCF 2005. Both the NCERT and State board textbooks incorporate projects in almost all school subjects, though these projects are not central to the particular chapter. A set of project books on environmental education, developed by NCERT as co-curricular books for Class VI to X in response to NCF 2005 (NCERT, 2009), integrate topics from several subjects. Since these projects are not mandatory,

and do not count for grades in examinations, they are neither known to all schools, nor implemented.

NCERT prepared syllabus for elementary and high school level (NCERT, 2006d), and a source book on assessment for primary (NCERT, 2008) and upper primary grades (NCERT, 2012) in all subjects. The source books articulated the rationale and context of assessment along with a large number of exemplar citing textbook chapters. NCERT also developed a set of CCE packages for all subjects at primary and upper primary level (NCERT, 2010b). More recently NCERT collated the essence of all the CCE packages and published a similar guidebook on CCE (NCERT, 2019b). All these documents repeatedly referred to project work as an important pedagogy for attaining learning outcomes for integrating assessment of students' learning.

Handbooks on learning outcomes along with suggested pedagogic practices for elementary (NCERT, 2017) & secondary stage (NCERT, 2019c) were also developed. The CBSE has come up with assessment manuals for teachers teaching at Grade IX and X for all subjects. The manuals discuss in detail about formative and summative assessment and ways to grade projects and activities (CBSE, 2009d).

In the relatively recently published handbook for teachers by CBSE, projects are mentioned for diverse purposes. These include use of projects in the context of assessing application skill of classroom learning where teachers can interview students on each project. Project work is mentioned under internal assessment as well as with formative assessment and practicals. Project is thus mentioned in the context of the use of Bloom's taxonomy, in the context of integrating subjects and as one of the elements in students' physical portfolio, and for environmental awareness in the context of teaching topics like disaster management (CBSE, 2019).

Interestingly, the student's physical portfolio mentions other things along with project work. These include classwork, assignments, formative tests, home assignments, journal entries, laboratory work, art work related to integrating art with learning, self-evaluation, peer evaluation, self-reflection, teacher evaluation, presentations, quizzes, blogs, curiosity questions and answers, analysis of newspaper reports related to the topic, awards and certificates, spreadsheets, photographs, etc. (CBSE, 2019).

In response to NEP 2020, there is a sustained effort of developing teacher handbooks and modules. Inclusive education is a crucial and priority area. A handbook of inclusive education emphasises that inclusion can be achieved to a great extent through making regular pedagogical experiences inclusive. A diverse learning experience helps address diverse learning needs and group projects and presentations of work through multiple modes allows students to express in diverse ways (CBSE, 2022c).

CBSE and ThinkTac have prepared practice books on science and mathematics for grade 9 & 10. These problems are real world problems and while engaging in problem solving students need to bring knowledge from diverse disciplines (CBSE, 2022d, 2022f). Competency based "SAFAL" assessment framework for grade 3, 5, and 8 are developed in the area of language, mathematics, EVS & science (CBSE, 2022e). Curriculum books for Grade 6 to 12 in the area of Design thinking and innovation rely on students'

engagement in design projects (CBSE, 2022b).

The Department of School Education compiled a glossary of "educational terminologies / definitions commonly used in school education". Project based learning is included in the glossary along with "child centric pedagogy" a more generic method. PBL is defined as taking place when students work in complex and multifaceted projects, address real world context and encourage "interdisciplinary conversation and group work" (MoE, 2022).

NITI Aayog and CBSE in collaboration with INTEL developed modules containing teaching plans that bring Artificial Intelligence and Internet of Things together. Atal Innovation Mission has conceptualised Atal Tinkering Lab and explicitly mentions its crucial role in "implementing the 'experiential and project-based learning' module in India. The module introduces the projects in alignment with textbook chapters (CBSE, 2022a). There were similar efforts made earlier. E.g. with collaboration and support from INTEL Education, Karnataka Government has come up with a handbook on technology supported project based learning (DSERT, 2006).

It is heartening that the National Education Policy 2020 (NEP 2020) and National Curriculum Framework 2005 (NCF 2005) have suggested a basket of pedagogic elements to be adopted in the classroom and in the curriculum. Both the documents advocated for the use of projects and diverse assessment tools along with regular teaching. The circulars and material development efforts are in alignment with the proposals. It is evident in these efforts that the terms projects and project based learning is often used synonymously. Interestingly, some descriptions of project method / PBL are reduced to simple activities. The project practices noted by CBSE (CBSE, 2010b) indicate larger systemic issues in which projects are assigned to students and carried out by students. This led to a review of the history of project method and the research on project based learning.

1.5 Projects as a part of innovation initiative

Central and State governments as well as other organisations are running programs dedicated to "harness the creative and innovative spirit of school children" (CBSE, 2009c). These initiatives are mostly run by the Department of Science and Technology (DST) of Government of India. E.g. Inspire-Manak Awards (DST, n.d.) and National Children Science Congress catalysed by National Council for Science and Technology Communication (NCSTC). There are other initiatives including the CSIR innovation award for school children (CSIR, nd). All these programs are open to all students and students can conduct projects individually or in groups.

In addition, the Ministry of Environment & Forests, Government of India mandates establishment of Eco-Clubs in schools to constitute a National Green Corps (NGC) aimed at generating awareness of environmental concerns. Similarly, the government encourages schools to run science Clubs. Vigyan Prasar Network (VIPNET), an initiative of Vigyan Prasar under DST coordinates these science clubs. Meaningful engagement of

students in these activities demands carrying out project based learning.

The national policy for promoting innovations in schools posited project and project based learning as the core of establishing culture and innovation in school (MoE, 2022). Similarly, conducting projects in regular classrooms is an important pedagogy in Art integrated learning (NCERT, 2019a), toy-based pedagogy (NCERT, 2022), and joyful learning (CBSE, 2020d).

CBSE developed a handbook on 21st century skills to introduce each of the 21st skills and suggested diverse activities to foster these skills among students (CBSE, 2020a). However, assessing these diverse activities poses challenges (Geisinger, 2016). There is a need to offer a pedagogical approach that would naturally integrate several of the 21st skills in a meaningful whole. Project-Based Learning is advocated as a problem-posing pedagogy to achieve the educational goals of the present time as well as meeting the policy demands (Sriram, 2018).

According to Bell (Bell, 2010), PBL is no longer a supplementary part of the curriculum, instead it is the fundamental part. For Waks (Waks, 1997), the present educational challenge is to "prepare the community as a whole for a democratic shaping of the postindustrial order" (p. 403). And in this context, projects have to be reformulated to meet "Dewey's account of the social significance of learner-directed projects within classrooms and schools as learning communities" (p. 402).

1.6 The state of Indian classroom

Generally the schools and the classrooms in India "socialise children to fit into status quo structures" (D. P. Mehrotra, 2007). From colonial times, the nationalists and educationists expressed their dissatisfaction to the ways dominant schooling runs in our country. And therefore, several of them also instituted alternative schools. Badheka's imaginary but engaging account of school and classroom written in Divaswapna (1990) gives a glimpse of teaching–learning during colonial time.

Report of the National Advisory Committee appointed by the Ministry of Human Resource Development recognised curriculum burden on children (GoI, 1993). The report clearly states that it is not merely the weight of the textbooks students carry but the load of incomprehension that burdens students. The report identified factors that burden students as (a) joyless learning, (b) fearful examination system, (c) textbook as the 'truth' and dominance of textbook and guidebook, (d) language of textbook being alienated from children's life, (e) unorganised and incoherent syllabus, (f) a tendency to teach everything to the students, and (g) burden children from early age.

Kumar (2020) refers to a list of rules mentioned in a curriculum book published in the first decade of 20th century. Some of the rules seems to be sermonising and a project of conditioning. The relics of these rules dominated my childhood too. The first four rules in the book are reproduced below:

1. Study early in the morning; you learn faster.
2. There is no learning without concentration.
3. Till the age of 16, do not act according to your own ideas, obey your parents. When you go to the *pathshala*, obey your *guru*. Always act on what your father, mother, teacher or employer tell you.
4. Education is not acquired in adulthood, so do not waste your boyhood playing.

The dissatisfaction of receiving quality education still exists in post-independent India. After all the efforts in the last 75 years the state education system failed to ensure and provide quality education to most children (Batra et al., 2021). Vittachi, Raghavan, and Raj (2007) listed names of about 150 alternative schools in India in their book *Alternative schooling in India*. According to Mehrotra (2007), the alternative schools are set up for two purposes. One is increasing access of education to all sections of children and therefore "deepening democracy" and second is "developing students' critical and creative faculties." According to her, the mainstream education system is unable to meet both the purposes.

Kumar (2020) makes an interesting argument in the concluding chapter of the book *Lessons from schools: The history of education in Banaras* about not accounting students integral in the adults' mission of educational change. She states:

> ... children are given short shrift, as if they were objects on which any kind of engineering could be carried out by the sheer willpower of adults. Children become the 'Other' of adults, not living beings with interactive and creative energy, but passive objects to be judged according to how they fulfill or 'fail' to fulfill (not consciously sabotage or defeat or adapt in preferred directions) the plans of adult actors. [p. , (N. Kumar, 2020)]

Kumar (2011) noted that government rules of school infrastructure and facilities are only a formality on paper. Even when these facilities exists in school they are not used for the stated purposes. She argues that a relevant educational intervention would be effective only when its technology of education would be taken into consideration. The situation is compounded due to an absence of "narrative of the child" (p. 40) or childhood in modern India.

At least 70 years ago the Secondary Education Commission 1952-53, pointed out several areas of improvement in Indian secondary education. The Commission noted that secondary education does not develop the qualities of discipline, co-operation, and leadership in students. It pointed out that rigid time table, unsuitable textbooks, and pedagogy isolated from life are detrimental for desired learning. In addition, is the examination that does not test the real knowledge of the students (Rai, 1981).

Divorced understanding or even negating the child or childhood ends in an expression of "pedagogic violence" towards children. Children are"stuck in overcrowded classrooms with inadequate light and air, body trapped in synthetic uniforms and badges,

threatened by the ogres of homework and examinations, altogether victim to over disciplining" [p. 45, (N. Kumar, 2011)]. Interestingly, this discipline fails doubly. This "discipline has been sufficient to cause pain at the micro level of everyday life for the children. But ... insufficient to produce the inwardly directed citizen subject of the modern nation state" [p. 46, (N. Kumar, 2011)].

Talib (1998), reported a study conducted with 50 male children of workers in stone quarries, and 12 teachers of the school where the students studied. The students and their families were struggling for subsistence. Most parents were illiterate and unable to provide pedagogic support to their wards. He found that most students were not able to recall the learning from their school. Interestingly, they had developed their "own spaces to retreat from the prescription of pedagogy and school" (p. 203). It was striking that teachers in his study were found dis-empowered to meaningfully engage with other teachers and many of them were alienated from their work. He also noted that the content of teaching was propagating a message of legitimising the status quo, glorifying intelligence over manual work, and valorising children doing domestic work or sacrificing childhood for the survival of the family.

In this study, Talib (1998) shared a heart-wrenching incident of a child named Lalu who dropped out of Class V. The school itself made him believe that he lacked the aptitude for school education. Lalu shared:

> They told me that my head does not contain brain but *bhoosa* [chaff]. They said so because I did not understand the lessons in the class. [p. 200, (Talib, 1998)]

Advani (2004) noted, how English textbooks of a State Board and NCERT in late 90's were domesticated by the goal of preparing ideal citizens for nation by "lecturing on a flat and undifferentiated form of nationalism" (p. 104). Advani concludes that the curriculum and pedagogy dictated by the textbook does not enable students "to acquire English for life or even for success in the examination" (p. 110). The curriculum structure shows mistrust of the education process. In the obsession of establishing a "particular form of nationalist ideology" consideration of "children's interests and learning patterns" (p. 110) are ignored (Advani, 2004).

Mehrotra (2007) shares her reflection on typical Indian classrooms in the following words:

> Many mainstream schools expect standardisation and docile conformity. The atmosphere discourages individual expression and self-directed learning. Teachers, often separated from children by a wide gulf, sit on a pedestal, proclaiming rules, spouting information and evaluating students. Children pursue rigid, examination-oriented syllabi and compete with one another in a relentless race to perform. Camaraderie, cooperation, fun and a love for learning are, unfortunately, casualties. (p. 26)

Interestingly, there is also dissatisfaction expressed by Government reports and policies

that classroom teaching is unsatisfactory (GoI, 1993; DSERT, 2004; NCERT, 2005). Jayalakshmi (2002), expressed concerns two decades ago about a disappointing state of classroom pedagogy:

> Pedagogic practice is still geared towards rote memorization, ignoring (and often at the expense of) meaningful and creative learning activities that lead to the development of the child's cognitive skills, self-confidence and ability to articulate. [p. 1]

Tilak (2018) expressed disappointment at the state of India's education system. According to him, Indian education system is:

> characterised by widespread social, gender, economic and regional inequalities in education, and very low levels of learning at all levels of education. There are problems of inadequate infrastructure and facilities, large number of vacancies of teaching positions resulting in imbalanced pupil-teacher ratios and overcrowded classrooms, and woefully ill-equipped teachers in terms of qualifications, training, knowledge and skills at all levels of education. Outmoded teaching methods, poor quality research in higher education, under-motivated teachers and uninterested students, etc., on the one hand, and inadequate funding, poor supervision and regulation and above all a policy vacuum on the other, are also the features of the present education scene. [pp.xxxi-xxxii, (Tilak, 2018)]

State of the Education Report for India 2021 (Sarangapani et al., 2021) reiterated that Indian classrooms are mostly dominated by teacher centric practices and there is a low to very low provision of school libraries and facilities of ICT in the schools. In this report, the authors tabulated the contrasting characteristics of teacher centric or traditional-formalist pedagogy and progressive pedagogy. It is evident that the latter is desirable in the classrooms. The report does not mention PBL explicitly while characterising progressive pedagogy, however, it is evident that PBL follows most of the characteristics of progressive pedagogy.

Sarangapani (2009) noted that the policy documents highlighted "the problems of the nature of education provided in schools, such as learning based on rote memorisation, examination oriented teaching, poor textbooks and passive, dull classrooms with routinised teaching methods" (p. 43). In the National Policy of Education (NPE) 1986 'quality' of education is associated to learning outcomes in terms of Minimum Level Learning (Sarangapani, 2010). Studies conducted on students' learning levels showed that at a broad level, only half of the students in primary and upper primary grades can successfully perform grade level reading and arithmetic tasks (Mukhopadhyay & Sarangapani, 2018).

National Assessment Survey 2017 (NCERT, 2020) shows that close to half (Grade 3) or more than half of the students' (Grade 5 & 8) learning levels are below grade level. And a more disturbing finding is the proportion of students achieving grade level learning

reduces as one moves to higher grades (51.9% in Grade 3, 47.1% in Grade 5, and 38.7% in Grade 8). It is disheartening that only 13% children develop higher order conceptual understanding while only 15% of children develop problem solving and analytical skills.

Pratham, a non-governmental organisation working in the field of education, conducted a study to evaluate the basic reading and arithmetic levels among students from 2005 onwards. The most recent report of their study *Annual Status of Education Report (Rural) 2022 Provisional* (ASER, 2023) conducted in 2022 and published in January 2023 states:

1. 20.5% of Grade 3 students can read the Grade 2 level text. While 42.8% of the Grade 5 students can read the Grade 2 level text. Close to 70% of the Grade 8 students can read basic texts.
2. 25.9% of Grade 3 students at least can do subtraction. While 25.6% students of Grade 5 can do at least division. 44.7% of Grade 8 students can do basic arithmetic.

Madan, Sarkar and Basu (2012), shared a heart touching observation about their college students. They shared:

> The diverse range of students who we daily met possessed rich inner resources – imagination, curiosity, analytical abilities, information – but we found that their schooling and, possibly, their home environments had managed to systematically stifle their confidence in themselves. They had moved from school to college, but their mental paradigm had not changed. They continued to rely on the teacher for the 'correct' or most authoritative interpretation. They also resisted reading or discussing more than what they thought was absolutely necessary for being successful in examinations. (p. 15)

Overall, Indian classrooms are suffering from a culture of what Freire (2000) referred to as "narrative sickness". The overwhelming pressure of syllabus completion stalks both teachers and students. The situation gets compounded due to inadequate understanding of how children learn and unfamiliarity of designing tasks to make students' learning faster and meaningful.

Other problems are, limited use of resources in pedagogy, considering the textbook and teacher as the sole repository of knowledge (K. Kumar, 2004) and inability to visualise integration in syllabus. Thus concepts and even tasks in the school curriculum and time table are not integrated. This tends to force classrooms to be mostly dominated by prescriptive, unquestioned unidirectional transactions of information from the teacher to the student (NCERT, 2005). Besides, there is little time to make connections between what is learned in the classroom with the world outside the classroom. Reality is negated in favour of a textbook answer (CEE, 1997).

1.7 Research context of the present study

It has been acknowledged for long that schools reproduce inequalities and social injustices through inadequate distribution and silencing (Bourdieu & Passeron, 1990; S. Ball, 2003). As early as 1845, Horace Mann (Mann, 1891) pointed out that there was too much reliance on developing "verbal memory" of the child and little focus on developing thinking and establishing connection to the real world of the child. Moore criticised the focus on providing general education to students and suggested structuring students' learning in response to the concrete social situations that they encounter and will face in future (E. C. Moore, 1915). A similar concern was raised in colonial India by several educationists including Rabindranath Tagore (Bhattacharya, 2013), Gijubhai Badeka (Badheka, 1990), M K Gandhi (Gandhi, 1994) and others.

The educational policy documents of the last several decades repeatedly suggested bringing a paradigm shift in teaching-learning in Indian classrooms and emphasised preparing citizens for a vibrant democracy. The increased effort of the government, both at national and state level is visible in terms of clear policy guidelines followed by material development efforts. The documents advocated child centred pedagogy, and focused on project based learning as an essential pedagogic strategy to teach multiple subjects and for developing 21st century skills.

These efforts however led to overburdening of teachers and students. Even some efforts like CCE were implemented differently as compared to the actual intention (Juneja, 2018). Even after practical suggestions given for reducing the burdens in the classroom, the teaching- learning culture of the schools are dominated by "the culture of performativity" (Juneja, 2018). It is interesting to note that the government's push for progressive and democratic educational practices was resisted in a culture obsessed with disciplining children and ignoring childhood (N. Kumar, 2011).

The dynamic interaction between learners and the education system needs to develop in individuals the capability of engaging with the society at large. Establishing a liberating education in the classroom cannot be formed in isolation. Rather, it requires a systematic curriculum intervention (Apple & Beane, 2006).

As teachers and students are the primary stakeholders in the classroom it is important to engage them in the process of designing a liberating learning experience. The key to the entire educational system is the teacher and it is only through the initiative and innovativeness of the teacher that changes can be brought about in the classroom. The change cannot be through prescriptions (CEE, 1997; NCERT, 2005). Schools as social institutions are accountable to provide a holistic all-round development of children. "This requires adequate space and facilities, time to be spent at school, a sound curriculum, and qualified teachers who can ensure that children have worthwhile learning and development experiences and opportunities." [p. , (Sarangapani, 2009)].

There is a need to work on at least four fronts. First, devising a pedagogic solution for teachers that integrates the diverse work that teachers and students are involved with in a coherent and efficient way. Second, the suggested pedagogic methods need to

result in modules for teachers to use in the classroom. My interactions with teachers suggested that teachers feel the necessity to have some kind of instructional material for them which will address their practical limitations in real classroom teaching. Third, the modules must be developed through a collaborative engagement with teachers to provide ownership to them. Fourth, the engagement with teachers anchored in developing modules needs to offer a model of TPD for engagement that could be organically integrated with in-service TPD engagement. One way to make this engagement collaborative is establishing an ethos of liberating education in the formal education system.

1.8 Motivation for the study

The primary motivation of the present research work is situated in the policy context of the last two decades as discussed earlier. Further motivation came from engaging in graduate courses for my doctorate. I got insights from these graduate courses on how to problematise the issue. I conducted two fieldwork studies in my graduate courses. These two field works provided two distinct kinds of insights. A final motivation came from curriculum development efforts in HBCSE and in other parts of India. The following sub-sections briefly highlight the insights and motivations for the current research.

1.8.1 Influence of graduate course

I was introduced to Paulo Freire's critical pedagogy (Freire, 2000) in one of the graduate courses taken by Prof. Sugra Chunawala. In this course I also read Krishna Kumar's article "Meek dictator" (K. Kumar, 2015). In this article, Krishna Kumar analyses how an oppressive relationship exists among students and teachers. Though teachers are dis-empowered and oppressed in the educational system, in classrooms, teachers dictate the classroom processes and exert oppressive power over "docile children".

These writings gave me a theoretical lens to situate problem posing education as a liberating educational experience for both students and teachers. I am convinced that the present TPD in the Indian context is under strong influence of colonial legacy and there is a need to free it from the power relationship between teacher educators and teachers. Freire's critical pedagogy (Freire, 2000) taught me that a researcher needs to engage in a transformative act along with the teachers and students as colleagues. There is a need to have great faith in teachers' and students' ability and potential to take active part in the journey of change. This gave me hope to explore an engagement with teachers that would help reduce power relationships between different stakeholders and bring real classroom challenges and settings for discussion and review.

In the graduate course I also conducted two projects as fieldwork. One was on studying middle school students' ideas about J C Bose and his contribution to science and society under the supervision of Prof. Sugra Chunawala. The responses from the students

indicated that students have several wrong information about J C Bose and myths related to his work. A similar kind of information and sentiment was also given in the students' textbook (Shome & Chunawala, 2009) and even in the book *Remembering Sir J C Bose* (Gupta, Engineer, & Shepherd, 2009).

In the second study, I had conducted a 8 day (2 hours every day) course on energy and environment for middle school students under the supervision of Late. Prof. Chitra Natarajan. Forty students of grade 8 from three schools attended the course in two batches. It is noteworthy that students meaningfully engaged in group work, survey, activities, and role play. They presented suggestions for alternative energy sources and showed an empathetic attitude towards the people. The findings from the study gave a hope that it is possible to engage students productively through diverse activities and learning can be ensured through group work and structuring the engagement through worksheets, handouts, and audio-visual resources (Shome & Natarajan, 2009; Shome, Patel, & Natarajan, 2009; Shome & Natarajan, 2012; Shome, 2013a).

1.8.2 Curriculum development effort at HBCSE and in India

Curriculum development work carried out at Homi Bhabha Centre for Science Education (HBCSE), Centre for Environment and Education (CEE), National Council of Educational Research and Training (NCERT), Digantar, Eklavya, Pratham, and several other organizations are in alignment with the suggestions of NEP 2020 and NCF 2005. Interestingly, all these efforts remain as alternatives to the national approach.

Besides, educational researchers from around the country have developed modules of investigative tasks that involve student learning through projects at school and post-school levels (Mahajan & Natarajan, 1999; Holbrook, Mukherjee, & Varma, 2000; Pandey, 2001; CEE, n.d.).

Other initiatives that do not refer explicitly to learning through projects, though they are planned for the same, are the Design and Technology Education project among middle school students (Khunyakari, 2008; S. Mehrotra, 2008; Ara, 2013), Homi Bhabha Curriculum for Primary Science (the 'Small Science' series) (Ramadas, 2006; Ramadas & Vijapurkar, 2001), and experiments in Anand Niketan following Gandhi's idea of Basic Education (Gaur, 2018).

1.9 The present study

The present study began with a careful look at the educational policy documents of the last two decades. These documents were also read in alignment with the country's effort to establish democratic ethos in classrooms and prepare students to take part in democratic polity. The setbacks offered to these policy suggestions were also studied in the light of current research work on Indian education and state of teaching-learning in Indian classrooms. I identified that a wholehearted implementation of project based

learning would help implementation of policy directives and will also address the pragmatic concerns of teachers. I also realised that a deliberation has to be established with teachers.

An extensive survey of literature on project based learning and teacher professional development helped in developing a PBL model for Indian context. As a part of deliberations with teachers the study explores how projects are conducted and viewed by teachers. It explores teachers' views on projects through interviews and questionnaire survey. A series of workshops were organised with teachers to design teaching plans on PBL. Teaching plans were developed in groups by the teacher participants that focused on PBL criteria of group work, assessment, subjects integration and classroom management. Teachers presented their work and these plans were assessed by their peers for successful integration of the mentioned aspects. Teachers were expected to implement these plans in their classrooms. I visited the schools on these occasions to gain insights and give feedback on the implementation. I also tried out an exemplar PBL unit with students and shared the details of its planning and implementation with teacher participants. Based on all these engagements a model of TPD was planned and refined.

1.10 Organisation of the thesis

The thesis consists of eight Chapters. Chapter 1 presents an introduction to the topic and details of educational policy documents and their connection with PBL. This chapter also presents my motivation for the work undertaken. Chapter 2 presents a review of literature on teachers' views about teaching-learning, and the role of TPD and PBL in schooling. This chapter provides a model of PBL developed in response to Indian policy documents.

The methodology chapter (Chapter 3) includes the major research questions of the study, the three phases of the study, descriptions of samples, data collection and analysis.

Chapter 4 presents details of teachers' views on projects accessed via a focus group discussion (FGD), interviews and questionnaire. Chapter 5 presents the transaction of a PBL unit with a group of students and the evidence of learning gathered from these engagements.

Chapter 6 presents the structuring of a TPD program for planning PBL projects. This is presented as a narrative of implementation of a TPD and some salient aspects of the engagement. Chapter 7 presents how teachers' project plans and assessment strategies evolved through their collaborative participation in a TPD program. The chapter also presents how teachers implemented projects in their respective schools and their experiences of carrying out projects in school.

Chapter 8 presents salient findings from the study and reports on the use of materials developed in the study to other contexts. The work suggests potential action points

in teacher professional development, role of other stakeholders in implementing policy guidelines and provides suggestions for further study. The chapter also includes reflections of the researcher on limitations of the study and evolution of the researcher while engaged in this work.

Chapter 2

Literature review

The chapter has two major sections; one dealing with project based learning (PBL) and the other focused on teacher professional development (TPD). The section on PBL begins with a brief history on how the project method evolved to PBL. It also presents characteristics of PBL that are described in the literature. The next part reviews the literature that cites evidence for students' learning while engaged with PBL and learning from implementation of PBL in collaborative mode. This literature identifies the challenges related to implementation of PBL in real classroom settings. The section on TPD begins with the role of teachers in curriculum change, role of teachers' beliefs in teaching-learning, nature of teachers' knowledge, how teachers' learn, and teacher' views about project practices, and the status of TPD in Indian context. It also describes the aspects/factors that make TPD effective.

2.1 Project method to Project Based Learning

This section presents some historical aspects related to the introduction of the project method as a pedagogic device at school level. It presents the origins of the project method in the context of educational revival during the 16th century Renaissance and the evolution of Project Based Learning (PBL) to its current form. This is followed by the history of adaptation of project method and its underlying philosophy in Indian classroom pre and post independence. The reference to project method in Indian educational policy documents is studied to trace the history of projects in the Indian context .

2.1.1 Project method: A product of Renaissance

According to Knoll (1997), the project method is a product of the architectural and engineering education movement at the time of Renaissance in the late sixteenth century. By the end of the 18th century, learning by projects also became a part of engineering

education in terms of actual making in "Experimental machines course" (University, 1870, 1873). In 1879, Woodward founded the first Manual Training School (Runkle, 1876; Woodward, 1887; Bennett, 1937) and training in handicrafts was introduced at the secondary school level. The instructions were designed to progress systematically from learning elementary principles to practical applications. Woodward called this pedagogy from "instruction" to "construction" (Woodward, 1887). The students' productions in the project remained as the property of the school (Knoll, 1997). Woodward's approach was soon adopted in elementary schools (Bennett, 1937; Knoll, 1997) and later introduced in agriculture education and other areas of education as well (G. E. Moore, 1988).

2.1.2 Struggle to define project method for school education

William H. Kilpatrick's paper titled,"The Project Method" (Kilpatrick, 1918) is regarded as the "single most dramatic event in the evolution of the movement to reform the curriculum through projects" (Kliebard, 2004)]. Kilpatrick defined the project as a "hearty purposeful act". Whatever the child undertook, as long as it was done "purposefully" (constructing a machine to watching a sunset), it was a project. "Purpose" presupposed freedom of action and could not be dictated (Kilpatrick, 1918). Children who presented a play executed a project, as did those children sitting in the audience, heartily enjoying it (Knoll, 1997).

Kilpatrick's concept is usually illustrated through the "typhoid project," reported by Ellsworth Collings (Collings, 1929). Colling's account was engaging but a product of the author's fictitious story (Knoll, 1996). The work established a different narrative from some contemporary literature (Knoll, 1996), like works of Alice M. Krackowizer (Krackowizer, 1919) and Margaret E. Wells (Wells, 1921). In these writings, project work was viewed from the perspective of planning for teaching. In contrast, Colling's work presented a view about project curriculum in which *the mechanisms of teaching and planning vanished from sight while the 'project curriculum' appeared as the realization of a utopia which could be characterized as 'school without teacher' and 'education without instruction'* [p. 216, (Knoll, 1996)].

In the early 1920s, Kilpatrick's idea of the project attracted the attention of educators. Teachers began to broaden the definition of project and considered it to be a viable "general" method of teaching. However, this "broad definition" faced strong resistance from several educators (Charters, 1923; Knoll, 1997). For example, according to Dewey, the "project" should be a "common enterprise" of teacher and students rather than an "enterprise of the child" alone (Dewey, 1997). He also objected to defining the project as a "purposeful" activity (Knoll, 1997). Dewey (1966), reasoned that while carrying out projects, teachers' support and guidance is required to engage students in a "complete act of thinking".

2.1.3 Discussion on project method post 1960s

During the late 1960s, projects appeared as an alternative pedagogic strategy in the universities of Western Europe. Projects were viewed as a way of learning through inquiry, and promoted for their practical relevance, inter-disciplinarity, and social bearing. The project idea spread quickly from the universities to the schools, and from Western Europe to the rest of the world (Knoll, 1997). Project Based Learning in its present form can also be traced back to problem-based learning emerging in response to the dissatisfaction with the state of medical education. Problem-based learning (PrBL) began with the faculty of medicine at McMaster university in Canada in the mid 1960's and later adopted to different professional degree courses and even extended to school education (Camp, 1996).

Educational reformers of the 1960s combined Dewey's idea of "education for democracy" and Kilpatrick's idea of "hearty purposeful activity," in defining projects. They also broadened the scope of the project including all actions that satisfy the criteria of self-determination and self-satisfying needs (Knoll, 1997). Interestingly, projects were implemented in two modes; on regular school days, a reduced form of project-oriented teaching was used, while specific time periods (e.g. project week) or occasions (e.g. celebration) were fully dedicated to carry out ideal form of projects (Fishman & Martin, 1987). During project weeks, there was complete autonomy for students to plan and present the project. Therefore, any kind of productions prepared by students were accepted as projects.

Since 1980s, substantial effort has been directed toward harmonizing project work with more conventional methods of teaching [Apel and Knoll, 1997 as in (Knoll, 1997)]. A new wave of PBL appeared in this decade (Markham, Larmer, & Ravitz, 2003; Knoll, 1997). The renewed pedagogic innovation in the form of problem and project based learning was propagated by two primary contemporary developments. The first was the research on learning theories during the period of 1960s and after (Ausubel, Novak, & Hanesian, 1978; Bruner, 1959, 1961; Rogers, 1994) and the philosophical ideas and research of Piaget (1954) which were inspired by Dewey (1910). The second development stemmed from the need to adapt to a new century in the school system. PBL was an attempt to create new instructional practices that reflected the environment in which children live and learn (Waks, 1997). The definition of PBL has changed over time as the education system has been evolving. The most important recent shift in education has been towards increased emphasis on standards, clear outcomes, and accountability (Markham et al., 2003).

Michael Knoll (1997), has summarised the present models of project method in the following words:

> The two basic models of the project method still used today were already developed in the 19th century. According to the older model (e.g., Woodward), students first learn, in a course of instruction, the skills and knowledge that they then apply independently and creatively in the practical project. According to the more recent model (e.g., Richards), the

> project is moved from the end of the unit to the center of teaching, in accordance with the fundamental idea of the new psychology that "natural wholes" must be the subject of learning if valuable interests and insights are to be developed. Here, the course of instruction does not precede the project, but is integrated into it [Online, (Knoll, 1997)].

2.1.4 Project method in Indian context

Alice B Van Doren (1930) edited a book titled "Projects in Indian Education" almost a century ago. The foreword of the book was written by Kilpatrick and the authors of the book chapters have drawn their inspirations primarily from Kilpatrick and Dewey. The introduction of this book provides a definition of project:

> ...Project Method does not connote the use of any fixed form of teaching, or even the doing of a piece of work described in a syllabus. It means rather the spontaneous development of forms suited to local conditions and needs, and hence never quite the same in any two situations. By Project Teaching we mean the use in education of "purposeful activity" – of purposing, planning, execution and judging by the children themselves, while the teacher acts sometimes as leader, but more often as an older, wiser friend and guide. [p.2, (Doren, 1930)]

The book (Doren, 1930) made realistic proposals to teachers to begin using project method in the classroom through gradually establishing the norms of the project. The proposals are enumerated below:

1. Project is context dependent and therefore the projects suggested in the books are mere examples and not to be followed "blindly". Ideally, project "arises through child–purposing or even through teacher-purposing".
2. Projects can be gradually introduced in the school. E.g. first project would start with one period a week with most "lively and energetic class in the school." And later the duration can be extended. Similarly, "wholeheartedness" of the students would increase over time.
3. There would be two types of projects: major and minor. Major projects are extended over a duration of half year or even one year and the major project, "serves as a centre to which much of the formal school teaching is related". In contrast, minor projects are short duration projects ranging from a day to a month.
4. Projects need not be connected with syllabus unless they naturally connect.
5. The book categorically mentions that there should be no cost incurred to the projects and available materials should be used. However, it also accepts that urban schools have access to greater wealth for projects than rural schools.

6. There should be training of teachers on project method. This should be followed by regular short term training and regular supervision and extending required support to the teachers.

The projects suggested in this book (Doren, 1930) are rich in terms of meaningfully engaging students in learning. Interestingly, these projects did not provide a structure of the project, in terms of a project format, nor did it introduce assessment and learning objectives (Markham et al., 2003).

It is also interesting to note that as a reaction to colonial oppression several educational thinkers like Rabindranath Tagore, Gijubhai Badheka and Mahatma Gandhi made efforts to revive Indian education. There were differences and several commonalities in their approaches. The key idea in all these approaches was to make the educational experience meaningful to students and to focus on activity as a central aspect for organising learning experiences.

Tagore was moved by seeing the misery of the poor peasants. He thought of education and local self-reliance/self-governance as instruments of welfare. He realised that oppressive relationships can be overcome when people "discover the bond that holds them together as society" [p. 605, (N. Jha, 1994)]. For Tagore, the basic objective of national education was to promote creativity, freedom, joy and develop an awareness of the country's cultural heritage. His idea of the education system was based on the notion of universalism, which was in contrast to nationalism, commercialism, and imperialism. For him, students needed to gather knowledge from direct sources and through their independent effort. Tagore's experiment in Sriniketan was a holistic approach towards improving rural life and included work education in the curriculum.

Badheka's pedagogical approach and commitment to Montessori Method is well described in Divasvapna (Badheka, 1990). This fictional book provides a vivid description of how learning can be grounded in students' every day life, how content could be presented in integrated and thematic form, and students can learn content and concepts of different subjects while engaging in diverse learning experiences like story telling, dramatisation, play, and other activities. The book also highlights a teacher's role as a reflective practitioner engaged in constant deliberations with multiple stakeholders and the oppressive system in which the teacher and school operate.

Gandhi proposed Nai Talim (Basic Education) as a pedagogic strategy in the Harijan published in July 1937 (Sethi, 2007). In Nai Talim, students had to engage in some form of productive work relevant to students' surroundings. Gandhi thought that such an approach would connect the hands and minds of children and thus make the village economy vibrant and self-reliant (Gandhi, 1994). The plan was discussed in Wardha Congress and was famously named as the Wardha scheme of education or Basic Education. Basic education outlined a pedagogy for students keeping productive work as its core.

Gandhi envisioned that this productive work would help students connect to their real lives and selling the products made by students would meet the cost of education. Additionally, engaging in manual work would help the village economy survive, preventing

heavy industrial capitalist invasion in village markets, and would develop dignity of labour among students (Rai, 1981; HTS, 1938). In this scheme 5.5 hours were allotted for study. The time table allotted for Basic crafts was 3 hours 20 minutes (HTS, 1938). For different reasons, the pedagogy of Basic Education remained limited to a handful of schools in India (ISD, 2003).

In post-independent India, several commission reports and policy documents on school education prepared by the Government of India proposed the inclusion of work experience in the school curriculum. The Education Commission (1964-66) suggested introducing work experience in education (NCERT, 1971). The Iswar Bhai Patel Committee suggested including "Socially useful productive work and community service" (SUPW) as integral to school curriculum. Schools adopted SUPW, however, these were short lived and half-hearted (ISD, 2003).

The major education commission reports and curriculum frameworks prior to the National Curriculum Framework (NCF), 2005, such as, report of the Secondary Education Commission (GoI, 1953), Education Commission of 1964–66 (NCERT, 1971), and the National Curriculum Frameworks (NCERT, 1975, 1988b, 2000) did mention use of project/project methods for teaching of subjects. However, the mention was only at a few places and for one or two subjects. Interestingly, the policy documents mentioned project method along with activities and the same is evident in the textbooks prepared by governmental bodies.

Projects have been prominently mentioned in the NCF 2005 (NCERT, 2005) along with diverse activities and for all subjects. National Education Policy 2020 (MHRD, 2020) has highlighted projects as a central pedagogy and an essential element for multiple subjects. For example, NCERT textbook of Computer Science, Informatics practice, and Computer and Communications of Class XII (NCERT, 2021) have devoted a chapter titled Project Based Learning. All the chapters have a similar format: (a) Introduction to PBL, (b) Modular approach to Project, (c) Team work, and (d) Exemplar projects. Most of the project ideas are given in the form of Problem Context and have shared a set of expectations from students. However, adequate presentation of PBL consistent with vast literature has not been included in the discussion. Thus, the presentation of PBL presented in the books has overlooked the crucial role of teachers in structuring PBL.

In the Indian context, there are a number of schools, primarily alternative schools that anchor their pedagogy in diverse activities. Such activities are life centric and authentic. The students mostly work in groups, carrying out productive work in a fear free environment. Schools do not carry out traditional assessment instead assessment is interwoven in the students' work. Students learn content and concepts while engaging in the diverse activities (Taleemnet, 2006). The pedagogy offered in these schools do not refer to PBL explicitly. However, their diverse pedagogic elements and school norms like flexible time table, activity based engagement, students autonomy, commitment to child centred pedagogy are conducive for PBL. One interesting characteristic of these schools is they operate as a community.

However, there is less documentation available for the implemented project practices

in India. One good example is by a school of the Krishnamurti Foundation India. The school has shared learning from a project carried out by students of Class VIII (KFI, 1995). In this case, teachers did extensive planning for the project. The efforts included modification of the school time table, discussion with students and parents, permission from management (Principal), inviting and involving resource persons and teachers engaged with conduct of similar projects from other school systems etc. Teachers aligned the concepts and skills of other subjects with the learning outcomes and student engagements planned in this social science related project. The project was aimed at building a connection of the school with the outside world. Students carried out the projects along with teachers, documented their work, and presented the work to a wider audience. The report acknowledged that students built a better connection with the outside world and learned multiple concepts while engaging in diverse activities of the project.

It will be interesting to look at scenarios related to B.Ed. courses in India as it caters to teacher education. In fact, several textbooks (Aggarwal, 2010) published for and used in B.Ed courses provide detailed accounts of project method that cite Dewey, Kilpatrick, and Stevenson frequently in the introduction section. However, the elaboration of projects given in these texts are mostly guided by Kilpatrick's project idea. The examples of projects do not elaborate the required characteristics, but present simple examples, like "Pageant on the life of Lord Buddha" or "Village survey" [p. 243, (Aggarwal, 2010)]. Therefore, translating the generalised principles of PBL is difficult for teachers as it demands drawing knowledge of multiple domains including content knowledge, perspective on how children learn, and pedagogical content knowledge (Capps, Crawford, & Constas, 2012; Juuti et al., 2021). As a result, the project practices are generally not implemented in regular schools in a meaningful manner.

2.2 Project Based Learning (PBL)

There is a long standing tradition in schools for "doing projects," incorporating "hands-on" activities, developing interdisciplinary themes, conducting field trips, and implementing laboratory investigations (Thomas, 2000). Such widespread degeneration of the word "project" and "project method" poses multiple challenges to initiate a conversation on the topic with a consensual meaning. This is a similar situation to one that existed a century ago, e.g. Stevenson (1922) reported that the term "project" had wide usage in agricultural education, teaching home economics, administration, trades and industry. He observed there were multiple definitions for the term projects that indicated widespread interest, but did not indicate any striking agreement or uniformity of views.

Overall, there is a lack of a universally accepted model or theory of PBL. Thus, it makes it difficult to evaluate and compare the variety of practices in different PBL program (Thomas, 2000). There are similarities between models referred to as Project-Based Learning and models referred to with other labels, for example, "discovery learning" and "problem-based learning". The literature related to problem based and project based learning shows that these phrases are often used interchangeably (Markham et

al., 2003) and they have more similarities than differences (Savery, 2019).

Stevenson (1922) has analysed the characteristics of projects in terms of four pairs of aims related to teaching: a) reasoning vs. memory of information, b) conduct vs. information for its own shake, c) natural setting for learning vs. artificial setting for learning, d) the priority of the problem vs. the priority of principles. He has characterised projects as a combination of the first terms of these four pairs.

Prince and Felder (2007) noted that in project-based learning, students mainly apply previously acquired knowledge and the final production is the central focus of the assignment. By contrast, in problem-based learning students don't possess the previous knowledge and the process involved in the learning is more important than the final product. However, this distinguishing character is contradictory to centrality criteria of PBL mentioned in literature (Thomas, 2000).

Based on a qualitative review of the literature, Helle, Tynj*älä*, Lonka, and Olkinuora (2006) state that the construction of a concrete artifact is one of the main distinguishing feature of project-based as compared to problem-based learning. Other authors mention authenticity, constructivism, and the importance of learning "new basic skills" as characters of PBL (Diehl, Grobe, Lopez, & Cabral, 1999). Howard defined PBL as "an instructional technique in which meaningful tasks, often in the form of problems, serve as the context and stimulus for knowledge building and critical thinking" [p. 348, (Howard, 2002)].

From an extensive literature review, Thomas (2000) characterises projects in PBL in the following words:

> Projects are complex tasks, based on challenging questions or problems, that involve students in design, problem-solving, decision making, or investigative activities; give students the opportunity to work relatively autonomously over extended periods of time; and culminate in realistic products or presentations... (Projects) include authentic content, authentic assessment, teacher facilitation but not direction, explicit educational goals, ... cooperative learning, reflection, and incorporation of adult skills.

Ladewski, Krajcik, and Harvey (1994), Marx, Blumenfeld, Krajcik, & Soloway (1997) and Krajcik, Blumenfeld, Marx, Bass, Fredricks, and Soloway (1998) mention five features of project based learning as described below. In their opinion, these features follow the constructivist theory of learning (Krajcik, Blumenfeld, Marx, & Soloway, 1994). These five features are:

1. having a driving question, encompassing worthwhile content that is meaningful and anchored in an authentic real-world problem that organizes concepts and principles and drives activities,
2. investigations including asking questions, making predictions, gathering and interpreting data, and making real world recommendation,

3. creation of artifacts allowing students to learn concepts, apply information, and represent knowledge,
4. collaboration among students, teachers, and others in the community of the larger society in discourse about the problem and in collaboration as a community of inquiry, and
5. use of cognitive and technological tools.

Larmer, Mergendoller, and Boss (2015) noted that planning a the project begins with the intended learning outcomes in mind. A standard project would follow seven key design elements while implementing. These include: (a) a challenging problem or question, (b) sustained inquiry, (c) authenticity, (d) student voice and choice, (e) reflection, (f) critique and revision, and (g) a public product (p. 37). One effective idea would be coming up with a set of demarcating criteria for a pedagogy to be PBL rather than defining PBL. These demarcating criteria would not define PBL but provide an evaluative scale for the educators and help identify what is not PBL.

2.2.1 PBL characteristics

Thomas (Thomas, 2000) came up with a useful set of five criteria to differentiate PBL from other similar pedagogic methods. These include (a) centrality, (b) existence of a driving question, (c) constructive investigation, (d) autonomy, and (e) realism. This study had adapted the idea of PBL put forward by Thomas (2000) to integrate pedagogic elements delineated in NCF 2005. A brief elaboration of each of the criteria is given below.

Centrality: Projects are central to the curriculum. The project is to be considered as part of the curriculum itself and as part of the central teaching strategy and not supplementary to the curriculum. Students encounter and learn the central concepts of the discipline while engaging in the projects (Thomas, 2000). PBL projects should start with learning objectives which should be in alignment with the conceptualised project. However, it requires forward and backward thinking to establish alignment between learning objectives and the anticipated learning from projects. Equally important are the social skills as well as subject specific procedural skills in PBL.

In Indian context, one can say that while doing the projects, students will learn the concepts, content and skills prescribed in the syllabus and help achieve the curriculum goals. In this study, the centrality criterion is interpreted in terms of addressing curricular and textbook topics from different subjects for a given Class. This is practical for the context of most current Indian classrooms and teachers, dictated by covering textbook topics in limited time and also meets the requirement of Continuous and Comprehensive Evaluation (CCE).

Projects that do not satisfy centrality criteria require students to (a) apply knowledge gathered from lecture notes, (b) carry out additional practices, (c) construct new concepts, but outside the syllabus or curriculum, (d) engage students in some activi-

ties without aligning learning goals addressing the curriculum and syllabus (Thomas, 2000).

Existence of a driving question: PBL projects are focused on questions or problems that "drive" students to encounter and struggle with the central concepts and principles of a discipline (Thomas, 2000). Format of the problem dictates the nature of students' engagement in problem solving and constructive engagement from this engagement (Gijselaers, 1996). There would be four types of driving questions:

1. abstract, conceptual: answered by conceptual analysis and logical arguments,
2. concrete: answered mainly by the analysis of empirical evidences,
3. problem solving: answered by offering a reasonable solution, and
4. design challenge: answered by creating and/or executing a design that best addresses the problem at hand.

Students' engagement with the project largely depends on a clear goal. It is important to bring alignment in activities and the underlying conceptual knowledge set for the students to learn (Barron et al., 1998). The driving question (Blumenfeld et al., 1991) or an ill-defined problem (Stepien & Gallagher, 1993) sets the goal for students and provides them the prestigious role of a problem solver. The driving question organizes activities around planning and carrying out investigations (Krajcik et al., 1994).

Therefore, a project topic in the form of a phrase, a word, or an instructional statement is not PBL. Krajcik and his colleagues (Krajcik et al., 1994; Marx et al., 1997) defined following four characteristics of good questions or problems:

1. Feasible: The questions are accessible to students in such a way that students can design and perform investigations to answer the question or problem.
2. Worthwhile: The question or problem contains rich subject content, relates to what experts really do, and can be broken down into smaller questions. The problem or question is consistent with existing curriculum framework and while exploring the driving question students learn and achieve curricular goal.
3. Contextualized: The questions or problems are related to the real world and are important.
4. Meaningful: The questions are interesting and exciting to learners. Driving questions need to encompass real world problems to make learning meaningful and motivating for students. This would help students to take ownership of the questions and to thoughtfully pursue answers to them.

Some examples of driving questions are:

1. "What makes a kite aerodynamic?" (Meyer, Turner, & Spencer, 1997).

2. "Will breathing the air in my city make me sick?" (Marx et al., 1997).
3. "How do I stay on my skateboard?" (Marx et al., 1997).
4. "Where does all our garbage go?" (Krajcik et al., 1998).
5. "Water, water everywhere! Is there enough to drink?" (Krajcik et al., 1998).

Putting emphasis on problematising content helps students "elicit their curiosities and sense-making skills" and provides opportunities for productive engagement (Hiebert et al., 1996). This in turn facilitates teachers to encourage students' questions, proposals, and poses challenges in the problem context (Hiebert et al., 1996; Lemke, 1990; Warren & Rosebery, 1996). When learning environments clearly communicate the open ended nature of the question to the students a productive disciplinary engagement is possible (Cazden, 1988; Lemke, 1990; Mehan, 1979; Stein, Grover, & Henningsen, 1996). If students fail to appreciate the open-ended nature they would look for the right answer and wait for the green signal from the teacher (Engle & Conant, 2002).

The questions should be open-ended with multiple possible answers (Krajcik et al., 1994). Some authors referred to the use of provocative or interesting problem context before asking a driving question. A problem would be closed or solved for an expert in a discipline, but open from the perspective of students interpreting them, using their available knowledge and resources (Hiebert et al., 1996; Henningsen & Stein, 1997). Problems may be presented to students by their teachers (Barron et al., 1998; Hatano & Inagaki, 1991; Lampert, 1990a, 1990b) or emerge in the course of student activity (O'Connor, Godfrey, & Moses, 1996; Warren & Rosebery, 1996; Krajcik et al., 1994). In a study with middle school students in an Indian context, researchers found that students spontaneously ask investigatable science questions while they are exposed to authentic context (Singh, Shaikh, & Haydock, 2019).

Existence of driving questions is recognised in the study as a novel and difficult idea. It was retained as a useful motivation for teachers to engage students in investigation. However, teachers could also interpret it in terms of a problem context. For instance, it could be design based problem solving where students could meet a societal need by designing and making suitable artifacts (Khunyakari, 2008; Ara, 2013).

Constructive engagement: Projects engage students in investigations that lead to constructing new knowledge rather than simply applying knowledge or performing a routine task. PBL projects may be built around thematic units or the intersection of topics from two or more disciplines, but that is not sufficient to define a project (Thomas, 2000). The questions that students pursue, as well as the activities, products, and performances that occupy their time, must be "orchestrated in the service of an important intellectual purpose" (Blumenfeld et al., 1991; Bereiter & Scardamalia, 1987). Students need to engage in 'problematic' activities so that learners carry out 'relatively complicated and extensive thinking' [p. 404, (Waks, 1997)]. Therefore, straightforward service projects such as cleaning school playground, planting a garden, or cleaning a stream bed are projects, but may not be PBL projects (Thomas, 2000).

In this study, constructive engagement is ensured by aligning the learning outcomes (LO) and assessment while planning the activities and engagements planned to carry

out these projects. These learning outcomes include those prescribed by NCERT as well as the 21st century skills. It is emphasised that the amount of time and effort required to complete a PBL project needs to be commensurable in terms of number and depth of LOs learned by all the students.

Autonomy: PBL projects incorporate a good deal of student autonomy, choice, unsupervised work time, and responsibility. They are student-driven, to a significant degree, in terms of planning and conducting investigations, formulating question(s), and even in developing assessment plans (Thomas, 2000). In PBL the teacher acts as a cognitive coach who models, coaches, guides and encourages independence in goal setting and decision making and promotes reflection (Howard, 2002).

PBL projects are primarily not, teacher-led, scripted, or packaged. Laboratory exercises and instructional booklets are not examples of PBL, even if they are problem-focused and central to the curriculum. PBL projects do not end up at a predetermined outcome or take predetermined paths (Thomas, 2000).

The nature of autonomy given in a classroom influences students' engagement. Students have autonomy if they have an active role in defining, addressing and resolving given problems, in presenting their contributions to the external community, and positioning themselves as producers of knowledge (Cobb, Gravemeijer, Yackel, McClain, & Whitenack, 1997; Lampert, 1990a; Stipek et al., 1998; O'Connor & Michaels, 1996; Wertsch & Toma, 1995; Schwartz, 1999; Lamon et al., 1996; Lehrer, Carpenter, Schauble, & Putz, 2000; Magnusson & Palinscar, 1995; Scardamalia, Bereiter, & Lamon, 1999). Student autonomy encourages engagement in the task (Turner et al., 1998; Engle & Conant, 2002).

It was considered important that in the Indian context, students have autonomy to design, execute and evaluate their work. Teachers could give them task descriptions but not provide prescriptive steps on how to finish the work. Ideas of peer and self-assessment by students were added to indicate explicitly their ownership of the project. A dimension of students' autonomy includes providing opportunities to the students to take ownership of their learning. For teachers, there is a tension of deciding the degree of autonomy that students should have. Students need to take responsibility for their work and in the process, they need to justify their steps or plan of work and this would be important feedback for teachers.

Realism: The current school education system often isolates learning within the formal setting from the world outside. PBL projects are realistic and address real-life challenges. Due to its focus on the solving of real life problems, PBL helps learners to become autonomous (Bell, 2010). During the planning of the PBL (Thomas, 2000), the criteria of realism can be satisfied if one or more aspects listed are taken care of - authentic context, involvement of real world problem, the products that are produced, authentic assessment or the criteria for judging the products or performances, urge for practical solutions, the tasks and roles the students play, the collaborators who work with students on the project, etc.

In PBL, students are expected to work in collaboration with other students in small

groups. Collaborative decision making and problem solving is necessary as teams work on projects in which they discuss, consult, collaborate and solve problems to create a product (Waks, 1997; Thomas, 2000; Markham et al., 2003; Larmer et al., 2015). PBL typically culminates with a presentation to an audience other than the teacher and classmates, and often includes a finished product. According to Waks (1997), the learning group needs to participate in the larger social life beyond the classroom. Projects need to be embedded in 'a predictable cycle of practice' that 'culminates in performance before outsiders' [p. 403, (Waks, 1997)]. This generally makes the work more authentic for the students, who in turn, put more effort and enthusiasm into their work (Thomas, 2000; Markham et al., 2003; Larmer et al., 2015).

Besides the real world connection and judgment in the context of the real world task that Thomas' (Thomas, 2000) criterion requires, the aspect of authentic assessment was explicitly added. In this, students are asked to perform real-world tasks that demonstrate meaningful application of essential knowledge and skills. For authentic assessment, the learning project and its product should also be authentic (Waks, 1997). An emphasise was also given on assigning service projects considering the context of Indian reality.

2.2.2 Deriving four principles for PBL planning and implementation

The PBL characteristics elaborated in the previous section provide a comprehensive nature of PBL pedagogy. These characteristics could work as a checklist to evaluate a given pedagogy as PBL. Simultaneously, it was important that the project proposal of the study address the pragmatic concern of the teachers and students while carrying out projects. The CBSE Circular (CBSE, 2010b) while advocating the idea of integrating projects as integral part of regular timetable, suggested that the following four aspects be considered: (a) subject integration, (b) assessment and learning, (c) group work and learning, and (d) management of time and resources as discussed in the Section 1.3.2.

The guidelines regarding assessment (See Section 1.3.1) and curricular materials developed (See Section 1.4) related to projects, CCE, and formative assessment direct attention to aligning the assessment practices to facilitate learning and evaluate teaching and not for grading students. Understanding assessment is an important aspect for project implementation. Another theoretical proposal that provided valuable inputs was by Waks (1997). It was more comprehensive in nature and suggested that the following six elements needs to be satisfied while devising the project method: (a) Negotiation of the group product, (b) Situation of the group project in a social context, (c) Assessment of incidental learning potential relative to learners' needs, (d) Needs-assessment of background knowledge, (e) Facilitation of project tasks, and (f) Project assessment and learning integration.

The first two elements proposed by Waks (1997) are directly derived from Dewey's social significance of learning. The first element focuses on the significance of group work

in a project and how a product in the project is a culmination of collectively negotiated work of individuals, aimed at accomplishing the collective goal. Additionally, the group work also facilitates other elements to be satisfied. The third element focuses on ensuring learning of students while engaging in projects and that even the incidental learning needs to be anticipated. Therefore, the second element integrates the realism criteria of Thomas and connects with authentic audiences in particular and the third element is similar to constructive engagement criteria of Thomas (2000). The fourth and fifth elements focus on planning projects along with students and structuring the learning experience. These include assessment of students' learning. However, a major goal is to manage the project and take it to its culmination while ensuring students' learning. So, these two elements together address classroom management. The sixth element mandates self and peer assessment in the project and teachers as facilitators to create the environment to reflect. Thus this element clearly focuses on the importance of assessment in social settings.

Subject integration

PBL is interdisciplinary in nature (Habók & Nagy, 2016). However, there are several difficulties in aligning projects with the content in the syllabus or curriculum (textbooks in Indian context) (Krajcik et al., 2008). It is heartening that projects can take advantage of the repetitions of the content in the textbooks of different subjects (NCERT, 2006d). The thematic approach followed in the NCERT syllabus makes it easy to find content of the same theme in different subjects. If the project is chosen to address a common topic, it will help teachers present a holistic picture to the students. Moreover, when teachers from multiple subjects come together, the time allotted to teach the topics separately will be saved. Thus, the time could be used fruitfully to guide students, give them inputs, conduct assessment, and for teachers' own academic preparation. Multiple learning objectives from different subjects can be incorporated by mapping across the year long curriculum (Petrosino, 2004). The approach of subject integration may enable students to perceive connections between the topics, subjects and their everyday lives, making learning more meaningful and relevant (Beane, 1995; Kaskey-Roush, 2008).

Assessment and learning

Assessment is shaped by the power relationships in the classroom, just as all activities are shaped by social relationships (Foucault, 1977). For instance, loosely defined continuous informal assessment of students as suggested in NCF 2005 can become an "instrument of surveillance" as indicated by Hargreaves' terms (Gipps, 1999, p. 362). It would be useful to conceptualise assessment from a socio-cultural perspective. An interpretive approach, as discussed by Gipps (Gipps, 1999), may help in understanding and planning assessment by accessing the meanings and values that teachers and students assign to assessment in the context of working on projects.

Assessment is perceived as both of and for learning (Black & Wiliam, 1998). Peer as-

sessment provides a non-threatening environment for students and the mutual feedback can help teachers gain rich insights of students' learning and needs for support. Self and peer assessments allow students to become more critical towards their work, as students develop a better understanding of their work and become more responsible and able to set their own targets (Black & Wiliam, 1998; McLaren & Stables, 2008; Lindsay & Clarke, 2001; Nicol & MacFarlane-Dick, 2006). PBL also offers opportunities to evaluate 21st century skills (Bell, 2010; Habók & Nagy, 2016).

It is crucial that the students should reflect on what worked and what didn't work, individually and collectively. Students could reflect upon (a) what background knowledge was used, (b) what background knowledge was not used, (c) what incidental learning took place, (d) how incidental learning took place and applied in the productive work, (e) how the project group cooperated, (f) how relations with persons external to the group were managed, (g) what standard of quality was achieved in the product, and (h) what societal impact the product had (Waks, 1997).

Teachers have to extend timely guidance to the students and provide inputs to them on how they could improve. Assessment needs to be constructive and respectful to the students. And mere criticism or provision of a single mark or grade would not be helpful. In PBL teachers could look at the variety of productions involved in a project and decide what would be assessed and how. These student productions could include working models, diagrams or drawings, writing in a worksheet, and the student presentations in front of the class etc. Teachers could inform students about the productions they have to make and how these would be assessed. These attempts would integrate both formative and summative assessment aligned with the learning goal. Assessment should include content, concepts, and skills. Skills could be drawn upon from different domains rather than being limited to physical or motor skills, social skills or soft skills.

NCF suggests inviting experts as well as all interested citizens to assess the quality of such projects. Interested individuals or groups can put up their results and set up a self-correcting system. For knowledge based areas of curriculum, assessment may be based more on tests, examinations and project reports along with self-assessment (NCERT, 2005).

Group work and learning

Learning is conceptualised as a social process along the lines suggested by Rogoff (Rogoff, 2003). From the socio-cultural perspective, group work provides a cognitive advantage of better development of concepts and problem solving skills. It may prepare students to participate in a community of inquirers along with their teachers, and inculcate democratic values in them (E. G. Cohen, 1994; Echeverria & Hannam, 2013). Group work (consisting of 3 or 4 students) among students with diverse backgrounds, helps in integration and inclusivity especially in heterogeneous classrooms where there are students with disadvantaged backgrounds. Thus, it is important to formulate such groups in the classroom. Such group work also facilitates effective peer evaluation (Oakley, Felder, Brent, & Elhajj, 2004).

According to Waks (1997), to ensure social significance of learning, cooperation is central in the project method. The learning group would collectively negotiate a common project with a common product, and express collectively the productive goals of the individuals in the group.

NCF 2005 suggests projects and activities in groups to be conducted at middle and high school levels. The projects can be given to a mixed group that includes students from different classes and genders. This kind of grouping for conducting activities would help provide "pedagogically feasible" and "sound curriculum" to the multi-grade schools. Girls and boys both should be given field-based projects (NCERT, 2005).

Management of classroom and resources

The planning and implementation of a project is a highly time consuming activity and requires great attention and careful planning (Habók & Nagy, 2016). Inquiry learning requires scaffolding at multiple levels and stages and the role of teacher as "tutor" is crucial for effective problem based learning (Gijselaers, 1996). Hmelo-Silver, Duncan, and Chinn (2007) noted three areas in PBL that require structure and scaffolding: (a) making disciplinary thinking and strategies explicit, (b) embedding expert guidance, and (c) structuring complex tasks or reducing cognitive load.

Through effective grouping, subject integration, and planned self and peer assessment, teachers can save time and resources. However, schools need to schedule suitable chunks of time for conducting projects (NCERT, 2005). It is also important to arrange for material and academic resources for students, and to reduce cost by adequate planning.

While carrying out projects and even when planning the project, a teacher needs to plan learning activities as per the learning levels of each student and also plan peer learning and prepare direct enrichment support to individual students. The teacher and students together need to plan projects in totality including: (a) sequencing the project tasks, (b) time periods for planning, (c) making and evaluating proposals, (d) productive behaviour, (e) interim assessment, completion, terminal assessment, (d) presentation to audiences. The teacher needs to facilitate students in all areas and sometimes prepare materials beforehand. Teachers also need to facilitate self-assessment activities of the students (Waks, 1997).

NCF 2005 recommended adequate time in the school time table to arrange different kinds of activities, such as project work and outdoor excursions to natural and heritage sites. The recommendation suggests that the school timetable be allowed to have a period of an hour, or one and a half hours for conducting activities such as craft or art work, projects, and lab work. Such lengths of time are also essential for undertaking cross-subject integrated learning, and for effective group work. Morning assembly time can be utilized to share interesting findings from projects done by students with the whole school. On a weekly basis teachers should get at least two/three hours to take stock of learning, to work out details of activities and projects proposed, and to plan lessons. Excursions and field trips and projects that two or more classes can go to or work on together can be planned. At initial stages, teachers need to establish the

classroom culture for activities. It also requires forming rules to use and allocating space and resources (NCERT, 2005).

2.3 Research on effectiveness of PBL in students' learning

Several research studies have mentioned the effectiveness of PBL in students' learning (Scott, 1994; Barron et al., 1998; Thomas, 2000; Ross & Lowther, 2003; Barlex, 2006b). According to Cross and McCormick (1986) [as cited in (Barlex, 2006b)] PBL serves several positive outcomes. By engaging in PBL, students develop skills of problem solving, applying knowledge and group work. PBL allows students to use or cultivate both divergent and convergent thinking and by putting the onus on students it helps develop self-discipline and a sense of responsibility.

Implementation of PBL has been found to improve school climate, students' attitude towards learning, performance and work habits, students' problem-solving abilities, self esteem and motivation (Thomas, 2000; Ross & Lowther, 2003), critical thinking and collaborative skills (Scott, 1994), design proficiency, controlled experimentation, measuring skill, and the ability of students to generate their own questions to guide their scientific inquiry (Barron et al., 1998).

According to Barlex (2006b), PBL tasks are situated in the real world context and therefore can provide a relevant educational experience as well as a chance to discover the interdisciplinary linkages in real situations. The other outcomes include enhancing the skills of listening, talking, discussing, analysing, communicating, identifying problems, planning tasks, taking corrective measures, as well as solutions. Problem solving tasks in a social setting naturally push students to use creative and critical thinking, engage in negotiation and conflict resolution.

According to Knoll, PBL helps students retain a deeper knowledge of the subjects they are studying. PBL also helps develop students' independence, sense of responsibility, social and democratic behaviour and polish their organizational and research skills, and become better communicators (Knoll, 1997). Other teaching methods might individually or separately provide learning opportunities in each of the domains or learning aspects, however, project work integrates all these into a single purposeful engagement for a student (Barlex, 2006b).

Project work involves five categories of learning viz. Knowing, understanding, skills, attitudes, and values. Black and Harrison propose the idea that task-action-capability depend on three related features [Black and Harrison, 1985 as in (Barlex, 2006b)]:

1. Resources of knowledge, skill and experience which can be drawn upon, consciously or subconsciously, when involved in active tasks.
2. Capability to perform, to originate, to get things done, to make and stand by

decisions.

3. Awareness, perception and understanding needed for making balanced and effective value judgements. (p. 125)

There is rich research globally on project-based science which have explored approaches addressing various pedagogical goals, by embedding science learning in investigations of meaningful real-world problems (Moss, Abrams, & Kull, 1998; Polman, 2000; Kanter, 2010; Juuti et al., 2021). Project-based science helps students develop explanations of scientific phenomenon that signifies important disciplinary understanding and comprehension of core scientific ideas as represented by science standards. It can build connections between students' scientific knowledge and their understanding of everyday experiences (Krajcik et al., 2008; Kolodner et al., 2003). In addition, students get the opportunity to apply their understanding in solving novel problems (Bransford, Brown, & Cocking, 1999) and take ownership of their own learning (Ladewski et al., 1994).

However, there are studies that also report that completion of a task in a project does not guarantee students' meaningful science learning. Sherin, Edelson, and Brown (2006) reported a project in which students analyzed climate data to prepare briefings about the causes of global warming and ways to mitigate it. The findings of the study suggest that after completion of the task, the students held a naive understanding of the nature of light and the structure of the earth-sun system and could not use this knowledge in their briefings. Likewise, Petrosino [1998, as cited in (Kanter, 2010)] found that students completed the making and launching of model rockets but without learning about experimentation and measurement sufficiently to evaluate functional demand of rockets made.

Interestingly, in a relatively recent study Chen and Yang (2019) reported an encouraging finding related to the effectiveness of PBL. They conducted a meta-analysis of the last 20 years of research to find out the effect on academic achievement of PBL over traditional instruction. Their study found that as compared to earlier years of implementation of PBL, the effectiveness of PBL has increased in recent years. In their opinion, the number of studies related to PBL implementation in classrooms as well as relevant resources have increased over time. The larger number of studies and greater access to resources, has helped in enhancing understanding of PBL among teachers that has empowered them to conduct effective PBL in the classroom (Chen & Yang, 2019).

Duke, Halvorsen, Strachan, Kim and Konstantopoulos (2021) reported encouraging findings from their study with 48 teachers teaching social studies in second grade. Equal number of teachers were divided into experimental and comparison (control) groups. Teachers of the experimental group received three hours initial professional learning workshop, follow-up support through webinars and coaching. They were also provided four project-based units containing detailed plans for 80 sessions. The comparison group of teachers followed their regular practice. Teaching by teachers in both groups was observed by researchers. It was observed that students of teachers in the experimental group outperformed in the measures of social studies and informational

reading as compared to students who were taught by teachers from the comparison group .

2.3.1 Learning from collaborative PBL implementation

Regarding collaboration in PBL an important study was reported by Schauble, Glaser, Richard, Schulze, and John (1995) which explored sixth grade students understanding about the goals and strategies of scientific experimentation and whether the understanding could be deepened by engaging them in an extended inquiry task in a problem solving context. The researchers collaborated with five teachers and developed a unit that was carried out by the teachers. With the support and coaching from the research staff, the teachers carried out the unit in their respective classrooms for a 2 to 3 week period. From the interview data of the selected students, researchers concluded that such exercise allowed students to meaningfully engage in reasoning about relevant scientific concepts, and the nature of experimentation.

Researchers observed that guiding students in a complex and extended sequence of activities demands a strong and flexible understanding of subject matter and sensitiveness to students' conceptual understanding. Teachers carrying out this kind of activity for the first time naturally find this role unfamiliar and uncomfortable. While conducting such a unit, teachers had to handle several pedagogic tensions, like negotiating a balance between encouraging students to perform and to reflect about their performance, maintaining a balance between working productively with students' background knowledge and focusing on the task at hand. It was also difficult to engage students in a project over a long duration of time. While framing the problem context and associated activity, teachers themselves present the entire exercise as a competition rather than an investigation to develop understanding about the principle or content intended to learn from the whole exercise (Schauble et al., 1995).

Toolin (2004) in his study reported several factors that influence teachers' implementation of project-based approaches in their classrooms. Six teachers, reported in the study, were different from each other in terms of educational qualification, subject specialisation, teaching experience, classes taught, number of project-based learning workshops attended, opportunity to collaborate and co-teach with other teachers and pedagogical orientation.

Two of the six teachers did not implement PBL in their respective classrooms. Both of them were first year teachers, with no formal degree in education. Both of them had minimal participation in the project-based learning workshops, and no opportunities to co-teach with other science teachers. On the contrary, another first year teacher, with student teaching being his only prior teaching experience, followed a project-based approach and reported the results. Although, the teacher did not have an opportunity to co-teach with other science teachers, he did have a master's degree and attended all the project-based learning workshops. School philosophy and guidelines and teachers' own commitment also influenced one teacher's implementation of project-based learning.

It was also observed that initially two teachers had resisted the idea of implementing project-based learning on the grounds of time constraints. Both of them followed a traditional teaching approach in their classrooms. However, a new school policy on collaboration led one teacher to collaborate with museum educators who helped her implement PBL. The other teacher had reservations for implementing PBL due to her concern of time management and syllabus completion. According to her, students need to learn the language and vocabulary of the subject before they engage in authentic projects and inquiry. However, it seems that the discussion and sharing among teachers and the planning and practice of PBL inspired her to design and implement PBL in her classroom.

Thus, teachers implementation of PBL depends on the pre-service and in-service professional development experiences teachers receive, a formal education background, interest to attend teachers workshop on PBL and longer teaching experiences. Novice teachers with little to no formal education background seem less able to focus and learn inquiry approaches like PBL and are more concerned with the daily routine and classroom management issues. To implement PBL in respective classrooms, teachers must be provided external support in terms of time, adequate staff, equipment, and adequate funding (Toolin, 2004).

2.4 PBL implementation: Challenges and response

The real school setting poses restrictions on adopting inquiry learning (Lakkala, Lallimo, & Hakkarainen, 2005). There are several difficulties and challenges in implementing and conducting PBL with middle and high school students and there would be several tensions in carrying out PBL with students, such as: (a) alignment of concepts, contents, skills needed for and learned through PBL and learning goals prescribed in syllabus, (b) limiting the scope of work and suspending the work that does not address the learning goals, (c) sequence of concepts, contents, and skills appearing in project and in the syllabus content or textbook chapters, (d) balancing breadth and depth covered in PBL and the broad coverage demanded by syllabus, (e) time invested in PBL and the time required to cover the syllabus in an academic year, and (f) balancing result of PBL and the process of engagement (Krajcik et al., 2008).

Rigid school timetable combined with concerns for safety results in classroom teaching that is rushed and regimented and confined within classroom boundaries (Anastopoulou et al., 2012). Crawford (2000) presented a detailed study of a teacher conducting PBL with students of grade 9 to 12. Teacher was teaching Ecology using a set of real world problems in the surrounding area. Crawford concluded that teachers' involvement in inquiry learning is very intense and teachers had to model multiple roles during the engagement and therefore more demanding for teachers than engaged in traditional teaching (Crawford, 2000).

Kanter (2010) mentions that there are three design challenges in ensuring students' meaningful understanding in Project Based Science. These include viz. a) creating the demand for unfamiliar content, b) applying all the content, and c) applying all the

content in time as well as identifying general curriculum design approaches to resolve these.

Hammer (1997) noted that teachers face conflicting situations regarding the degree of structuring in the course of PBL. Teachers deal with the tension that occurs between emphasising among process or product, breadth or depth, and reasoning or answers. Perception towards course content also influences teacher acceptance and success in the pedagogy. E.g. according to the traditional view, course content is the established body of knowledge. On the other hand, according to the inquiry oriented view, the content of the course is not something fixed rather it evolves through engagement in the inquiry (Hammer, 1997).

Aldabbus (2018), reported a study of applying PBL in some primary schools in Bahrain. Less than one third of the participants implemented PBL and the following challenges surfaced while implementing PBL:

1. some teachers were reluctant and not confident enough to use PBL,
2. most pre-service teachers faced difficulties in managing their classroom time as projects took more time than expected,
3. teachers faced difficulties in deciding the topic or unit for PBL,
4. teachers faced difficulties designing valid and reliable assessment tools,
5. students lacked the necessary skills of collaboration,
6. some schools cited constraints like time and financial support, and
7. some schools did not welcome the noisy classrooms and engagement.

However, several of the challenges can be solved by empowering teachers with appropriate school initiatives (Achilles & Hoover, 1996; Barron et al., 1998; Barron, 2000; Krajcik et al., 1998; Edelson, Gordin, & Pea, 1999; Thomas, 2000; Krajcik et al., 2008; Wurdinger & Rudolph, 2009). It is possible to structure a PBL unit with students to ensure the learning of syllabus concepts, content and skills (Kanter, 2010) and incorporating aspects of self and peer evaluation. Teachers need to internalise the potential of such structured tasks in students' learning. One of the crucial aspects of this realisation lies in differentiating traditional or conventional projects from the PBL approach.

The work presented in the thesis involves designing and implementing a model for Teacher Professional development (TPD) for planning PBL in an Indian context. Thus, after going through PBL and related aspects in considerable detail, it is equally important to look at research related to TPD and other important associated aspects. The next section presents discussion about the same.

2.5 Research regarding effectiveness of TPD

Teacher professional development (TPD) programs have the potential to impact teacher belief systems, teaching practices, and student learning (Lumpe, Czerniak, Haney, & Beltyukova, 2012). Overall, due to the enhanced significance of school accountability, there is an increased emphasis placed on the role of the teacher, the role of professional development, and theoretical connections between teacher beliefs and classroom action.

There can be multiple interpretations of the phrase *effectiveness of TPD engagements*. The interpretations could be situated in particular political, economic, social, and cultural contexts. However, the primary goals of TPD should be congruent with the goal of establishing just, democratic, and egalitarian society. From an extensive survey of literature, Guskey (2003) concluded that, the research literature failed to provide a definite answer on the question on what makes TPD effective.

It is important to look at different features that have been proposed for an effective TPD program or staff development program. There are similarities and differences among the features proposed by different researchers.

Little (1988) listed five features for effective staff development program: (a) ensures collaboration adequate to produce shared understanding, shared investment, thoughtful development, and a fair, rigorous test of selected ideas; (b) requires collective participation in training and implementation; (c) focus on crucial problems of curriculum and instruction; (d) adequate and extended interactions to ensure progressive gains in knowledge, skill, and confidence; and (e) consistent with and contributes to professional habits, norms of collegiality and experimentation.

Abdal-Haqq (1996) listed an extensive set of attributes for effective professional development. Such a TPD: (a) is ongoing, (b) includes training, practice, and feedback; opportunities for individual reflection and group inquiry into practice, and coaching or other follow-up procedures; (c) is school based and embedded in teacher work, (d) is collaborative, providing opportunities for teachers to interact with peers, (e) focuses on student learning, which should, in part, guide assessment of its effectiveness, (f) encourages and supports school-based and teacher initiatives, (g) is rooted in the knowledge base for teaching (h) incorporates constructivist approaches to teaching and learning, (i) recognizes teachers as professionals and adult learners (j) provides adequate time and follow-up support and (k) is accessible and inclusive.

Based on the literature, Ball (1996) suggests the inclusion of content knowledge, knowledge of students, provision of time for learning, and opportunity to reflect in a meaningful TPD engagement as important additional aspects for fruitful TPD engagements. In this context, it is necessary to address the elements for meaningful teaching in the classroom. The extent of translation of learning from such engagements into classroom practices is related to the context of teachers' classroom and school. Interestingly, Ball also argues that teachers learning in a professional development depends on his/her"prior beliefs and experience".

Putnam and Borko (1997) presented their understanding from existing literature in the form of four "mantras" or "truisms": (a) Teachers should be treated as active learners who construct their own understanding, (b) Teachers should be empowered and treated as professionals, (c) Teacher education must be situated in classroom practice, and (d) Teacher educators should treat teachers as they expect teachers to treat students. They also have pointed out "hidden complexities and potential problems" associated with such statements.

Darling-Hammond and Richardson (2009) while summarizing research on effective teacher professional development, cited that, effective TPD engagement should contain the following seven elements. It: (a) deepens teachers' knowledge of content and how to teach it to students, (b) helps teachers understand how students learn specific content, (c) provides opportunities for active, hands-on learning, (d) enables teachers to acquire new knowledge, apply it to practice, and reflect on the results with colleagues, (e) is part of a school reform effort that links curriculum, assessment, and standards to professional learning, (f) is collaborative and collegial, and (g) is intensive and sustained over time.

In a detailed analysis of 25 teacher professional development programs, Blank, de las Alas, and Smith (2008) found that programs that demonstrated positive impacts on student outcomes, included features such as (a) duration over 50 hours or more of professional development, (b) continuous coaching and mentoring for teachers, (c) alignment with the curriculum, and (d) ongoing teacher collaboration.

From statistical analysis of a large scale sample of mathematics and science teachers, Garet, Porter, Desimone, Birman, and Yoon (2001), identified three core features that have significant positive effect on teachers self-reported enrichment of knowledge and skills and change in classroom practices. The core features include: (a) focus on content to be dealt in the classroom, (b) presence of active learning experiences during the professional development engagements, and (c) coherence of the learning during the professional engagement to the teachers' professional needs. Later, Desimone (2009) added two more features in this model: (a) occurs over a long duration, and (b) collective participation by educators in their professional learning. The presence of these features in a sustained manner in TPD would improve teachers' knowledge, skills, beliefs, and attitudes. These in turn would bring change in teachers' practices and thereby increase student learning. However, the trajectory would be realised only when it is complemented by a supportive school system which includes curriculum, leadership, and policy (Garet et al., 2001; Desimone, 2009).

Guskey (2002) proposed a similar model where effective professional development would lead to improved professional practices, which would in turn lead to improvements in student learning. While both Desimone (2009) and Guskey (2002) cite the importance of teacher beliefs and attitudes in the professional development process. Desimone (2009) includes these affective variables as part of the development process where Guskey (2002) lists them as outcomes after student learning.

Loucks-Horsley, Love, Stiles, Mundry, and Hewson (2003) proposed a professional development model for science and mathematics teachers in which they contend that

teachers' environmental context and beliefs directly impact goals and plans, ultimately leading to specific actions in the classroom. Actions, depending on their effectiveness, may assist or deter student learning. They noted that self-reflection by teachers provides a feedback loop for goal modification. For example, one cannot simply give quality science curriculum materials to a teacher and expect quality science instruction. Their model supports Haney and Lumpe's (1995) contention that science teachers' beliefs must be identified and clarified prior to and during professional development activities.

The report of the National Academies of Sciences, Engineering and Medicine (2015) listed four most effective features of TPD programs:

1. active participation of teachers who engage in the analysis of examples of effective instruction and the analysis of student work,
2. a content focus,
3. alignment with district policies and practices, and
4. sufficient duration to allow repeated practice and/or reflection on classroom experiences.

The outcome of the TPD engagement could be visualised in terms of teachers engagement in professional development activities (Lieberman, 1994). And as a result schools are transformed into communities of learners (McLaughlin & Zarrow, 2001) or professional communities (King & Newmann, 2000). It is important to view a teacher as a reflective practitioner (Lieberman, 1994). Therefore, the role of TPD is to support teachers with adequate resources, so that they can build new pedagogical theories and practices (Darling-Hammond & McLaughlin, 1995) and in turn help develop their expertise in the field (Dadds, 2001). In this context teacher educators and teachers participate in a collaborative process (Darling-Hammond & McLaughlin, 1995) rather than a prescriptive relation.

2.6 Role of teachers' beliefs in teaching-learning

Researchers concur that tacitly held personal beliefs of teachers about teaching and learning influence their teaching practices, teaching of content and interactions with pupils (Kagan, 1992; Pajares, 1992). One of the ways to understand teachers' practices is to explore their beliefs (Pajares, 1992). Beliefs are known to be resistant to change (Kagan, 1992), and are influenced by a variety of factors including the teachers disciplinary background or subculture of their subjects (disciplines), their classroom experiences, opportunities for reflection and social background (Fang, 1996; Markic & Eilks, 2012; Pajares, 1992).

However, teachers' beliefs about teaching do not always play a functional role in planning their classroom teaching (Eley, 2006). Teachers' practices in the classroom may not conform to their beliefs (Fang, 1996), as practices are influenced by multiple external factors in complex ways.

Teachers play a significant role in conceptualising how the given policy and curricular demands can be pragmatically transformed for their classrooms and school culture (Guskey, 2002). However, their actualisation of the intended curriculum is determined by their knowledge, belief, desire and authentic experiences in a particular socio-cultural context (Krüger, Won, & Treagust, 2013; Lam & Lidstone, 2007). Teachers' beliefs and practices interact dialectically. Hence in teacher development, change in practice may lead to change in belief, and not necessarily the other way (Guskey, 2002).

In a post-NCF 2005 study of two Indian teachers, Nargund-Joshi and co-workers reported that though teachers were able to articulate the curriculum goals, their classroom practices were not aligned with these goals (Nargund-Joshi, Rogers, & Akerson, 2011). However, teachers' actual classroom practices are not always accessible to researchers. Besides, reports on project practices may not reflect teachers' intentions for engaging in such practices. One way to address this problem may be to simulate practice through a narrative (mei Chan, 2012). A discourse that begins with a narrative at an individual level has the potential to realise transformative actions in practice (Freire, 2000).

2.7 Nature of teachers' knowledge

Teachers' knowledge and thinking is complex (Pajares, 1992). They construct their knowledge about teaching-learning in dynamic and complex ways. They derive their knowledge about teaching-learning from the knowledge in related domains like student behavior and learning, subject-matter difficulty, multiple perspectives, and educational context into their pedagogy and thinking (L. M. Anderson, 2001; A. F. Ball, 2009; Chiodo & Brown, 2007; Hashweh, 2003; Joram & Gabriele, 1998; Nettle, 1998). The teachers' personal experience and prior knowledge influences their learning in professional development programs (Kagan, 1992).

It is not always possible for teachers to articulate their thinking in the form of "overt propositions" [p. 6, (Manouchehri & Goodman, 2000)]. Due to the tacit nature of teachers' knowledge and beliefs, they are only accessible in the practice of teaching (Pajares, 1992). Teachers' descriptions of their teaching practices may be ambiguous, while articulation, separated from teachers' actions, may not represent teachers' authentic voices (Briscoe, 1993; Munby, 1986).

The ultimate success of any proposed changes relies on the way teachers respond to such changes. This is true for the pedagogic changes proposed in the National Curriculum Framework 2005 (NCERT, 2005) too. Teachers' understanding of the proposed changes is instrumental to translate the reform proposals into actual teaching action in classrooms. However, these calls for change result in several teacher concerns, like lack of clarity on what is expected from teachers, and when the proposed changes challenge their existing beliefs. The envisioned shift in teaching-learning practices cannot be realized unless teachers understand what these imply, and more importantly, feel empowered to change (NCERT, 2006c).

Therefore, teacher empowerment cannot be achieved by prescribing a list of pedagogic strategies, such as, learning by doing, hands on learning, inquiry based teaching or project method. One way is that teacher educators and researchers discuss the possible strategy to bring changes with the teachers so that all collaborators listen to each others' voices (Batra, 2005). In this context, promoting new pedagogical approaches in the classroom will be ineffective without continuing professional development programs for teachers. It is important such programs integrate the relevant research and theoretical underpinnings of the proposed approaches (Burton & Bartlett, 2006).

Each school has its own organisational culture (Darling-Hammond, 1993) and instructional program (Jita & Mokhele, 2008). The organisational culture depends on multiple factors (King & Newmann, 2000). Therefore, teachers from similar school contexts may show similarity in teaching-learning practices and practice related views (Aun, Tiong, Kum, & Ang, 2004). However, primarily teachers have diverse views on teaching-learning and its goals, at least in part based on their varied academic, professional and social backgrounds both as individuals and based on the communities they belong to. Communities use several tools for communication among their members. The meanings and usage of these tools are characteristics of the community. Teachers, teacher-educators, researchers, and policy makers form different communities in terms of their respective professional experiences. They use different vocabulary as well as the same vocabulary with different meanings. Sometimes, teachers' develop practice that matches with the learning theory proposed by the experts, but they are not recognised by the teacher educators due to teachers' lack of adequate vocabulary (Kagan & Warren, 1992).

When NCF, 2005 (NCERT, 2005) asked for a paradigm shift in classroom teaching, several of the common terms used by both the communities became in-commensurable. If these reform terms are not articulated in detail to the teachers, they would interpret the reform terms based on their prior experience and understanding, and would hence be considerably different from the intended meaning of the policy terms.

Therefore, the roots of the divide in teachers' beliefs and their practice need not be the result of the teacher's pragmatic response to the policy suggestion alone, but could also arise from an issue of meaning making. However, meaning and action are in a dialectical relationship. And therefore, they must be discussed together. Hence it is important in teacher professional development to articulate both the meaning and practices (teaching action) in connection to each other before introducing new meaning or suggested practice. The authentic meaning associated with an action can be derived only in connection to the action in the context.

In the context of coming up with a deliberative curriculum approach and pivoting Project Based Learning as a curriculum response, it is important to explore teachers' views, voices, and practices about the associated ideas. Teachers' ideas about projects and assessment are based on a complex interaction between their concepts of learning and philosophical understanding of education. Their conduct of projects also depends on their knowledge of content and pedagogy. Development and implementation of project-based unit for schools requires engaging with teachers' knowledge and actual classroom situation along with the research literature (Kolodner et al., 2003).

2.8 Teachers' views about project practices

A century ago, Stevenson (1922) cited while elaborating teachers' diverse views on projects.

> in many sections where teachers talk of projects there seems to be a lack of understanding of the plan and a lack of unity in the definition of the term. According to some teachers any effort toward giving their work a practical turn is termed as projects. Others have used the word in lieu of 'practicum', so that simple laboratory exercises are spoken of as projects. [p. 2; (Stevenson, 1922)]

Dogan, Batdi, and Yildirim (2011) conducted a study regarding the views of Turkish primary school science teachers about the issues related to practice of PBL. They report that the teachers attributed several positive aspects to PBL. Teachers of different subjects worked together on projects, and found that the funds and library resources were adequate. They were, however, confused about the adequacy and arrangement of computers and material resources in their schools. When asked about students' practices and preferences, the teachers responded that students communicated, worked in groups, effectively used educational technology and engaged in creative activity. Their individual academic differences caused no problem in PBL. They were unsure about students making efficient use of resources and whether they could learn on their own.

In another study researchers found that high school teachers allowed students to decide project topics. Both teachers and students from the schools faces difficulties at different stages of conducting projects. Students faces difficulties in data collection, doing research, planning project, document the results. Some schools face budgetary constraints in planning and conducting projects. In order to address the challenges teachers and students suggested "elective lessons aiming to teach executing a project work", "collaboration with universities" and "forming science clubs at schools" (Tural, Y$\ddot{I}$g$\ddot{I}$t, & Alev, 2009).

Habók and Nagy (2016) conducted a questionnaire survey with 109 teachers, of which 32 were lower primary teachers, 42 upper primary teachers, and 35 vocational or vocational secondary school teachers. The study presented some interesting findings. It was found that more than a third of the teachers' use PBL along with other methods. Interestingly, most teachers of all the three categories assign importance to motivating students (63 %). They also showed adherence to transmission of values (40 %) and forming personality (34 %). Expert teachers showed greater adherence to forming personality (45 %) than the less experienced teachers. It is interesting to note that, only 10% of the teachers or less found themselves in the role of teacher, evaluators, or supervisor of the students in PBL. Close to a quarter of teachers mentioned about educational planning in the PBL. Most of the teachers of all categories (more than 60 %) attributed a successful PBL to greater degree of student activity. Interestingly, only less than 5 % of the secondary teachers associated 'good marks and good evaluation of students' with a successful PBL.

In Indian context, Pandey (2001) mentions initiatives like Uttarakhand Environmental Education Centre (UEEC) which work with local experienced school teachers in developing environmental education modules for schools in Uttarakhand. UEEC conducted several workshops with the teachers but the outcome of the exercise was unsatisfactory. According to Pandey, teachers' perception is shaped by mass media and standardised textbooks that do not correspond with the reality of rural Uttarakhand context. Moreover, most of the teachers and principals had inadequate understanding of basic ecological concepts (Pandey, 2001). The course was then redesigned and relaunched in the year 1992 and was implemented at grade 6 to 10 in all the schools of state. The course requires five short (40 minutes) and one long class period (3 hours) and the exercises are seasonally oriented. At the end of each year, students showcase their activities carried out over the years with plausible practical implications, to parents and local people. Other activities in the program include songs, poetry recitals, and debates about ecological themes (Pandey, 2001).

The few reports prior to the commencement of National Curriculum Framework (NCF), 2005 (NCERT, 2005) related to Indian teachers' views on projects have focused on the limitations of teachers in implementing environmental projects outside the regular school curriculum (CEE, 1997). But the new curriculum has explicit recommendations for teachers to carry out projects in every subject as part of the curriculum. This policy can have an influence on the nature and structure of projects in school, which has not been studied.

2.9 Status of TPD in Indian context

The state of teacher education in India is still under the "colonial framing, institutional structures and practices" (p. 11) and the situation is more or less "stagnant" (p. 11) since independence (Batra et al., 2021). Report of Justice Verma Commission on teaching education categorically mentions that pre-service teacher education does not prepare teachers to address the reality of classrooms. Teacher education is mostly offered through sub-standard private institutions. Interestingly, pedagogy and curriculum offered in most public institutions are largely outdated (GoI, 2012).

A recent study conducted by Azim Premji Foundation on 35 private Teacher Education Institutions in 5 states (Research Group, 2021) reported a woeful situation and confirms the concerns mentioned in the report of Justice Verma Commission (GoI, 2012). The study reported that the majority of the institutes do not meet the minimum standard of infrastructure, adequate number of faculty, and indulge in widespread corruption. The institutes encourage students to get a degree on a mere exchange of money (Research Group, 2021) .

One dominant character in Indian education is its changing landscape and articulation of a need for teacher education in government reports and documents (NCTE, 1998, 1997). Improvement of the public education system has now become a part of regular discourse in both government and non-government platforms. These discourses are increasingly focusing on teacher professional development (TPD). The translation of

these discourses in TPD is evident across the nation (Batra et al., 2021; Sarangapani et al., 2021).

According to Batra (2014), implementation of RtE Act 2009 (GoI, 2009) focuses on standardisation, teacher accountability and learning outcomes, while NCF 2005 (NCERT, 2005) and NCFTE 2009 (NCTE, 2009) affirm the "central role of teachers as agents of social transformation" (p. S7). A report on *Restructuring and Reorganization of the Centrally Sponsored Scheme on Teacher Education: Guidelines for Implementation* by Department of School Education and Literacy, MHRD, Government of India asserts that:

> Connecting knowledge to life outside the school and enriching the curriculum by making it less textbook-centered are two important concerns of the NCF. In order to help children move away from rote learning, teachers will need to be prepared to give children the opportunity to derive meaning from what they read, see, hear and experience. This is possible only when teachers are able to play an active role in the design of learning materials, and have the knowledge and skills to organize meaningful learning experiences and to use evaluation as means to improve their own performance. For this to happen, the teacher needs several support mechanisms, including a pool of learning resources to choose from, the skills to identify developmentally appropriate text materials, a critical and analytic mind and the opportunity to engage children with learning resources outside the classroom. [p.4, (DSEL, 2012)]

There are several training programs organised for teachers on different topics at different points of time. These include training on pedagogy and content, teaching through drama, establishing science centre in school and others (DSERT, 2004). However, there is concern about the effectiveness of such training programs in making any significant change in classroom teaching-learning and preparing teachers to meet new challenges (Jayalakshmi, 2002). It has been noted that teachers generally ignore the training modules that they are uncomfortable with. The trainers in such training programs are often not competent to engage with teachers in participatory modes (DSERT, 2004).

There are classroom realities like multigrade teaching which poses challenges even for trained teachers (DSERT, 2004) in ensuring the learning level of all children. There are intense efforts to make resources handy to teachers and development of science kits for primary (NCERT, 1988a) and upper primary grades (NCERT, 2010a). Studies on assessment are taken up at national level (Pandit, Chandrasekhar, & Sreekanth, 2004).

A study conducted by Azim Premji Foundation with 322 teachers from 27 districts in 5 states (Research Group, 2021) explored the concerns raised by the report of the Kasturirangan Committee for the Draft National Education Policy 2019. The findings of concern related to in service teacher professional development are summarised below:

1. In most cases, structured training calendar is not shared with teachers in advance by senior functionaries.

2. Most teachers expressed that senior functionaries did not assess teachers' professional development needs.
3. Most in-service training programs are often stand alone or lack logical linkages with other such in-service training programs and are devoid of follow-up support by senior functionaries at the school level.
4. Most teachers find it difficult to connect learning from the in-service training to their classroom practices.
5. Most of the schools are not visited by block level functionaries in the duration of 1.5 years. Further, the visits when done are primarily in an "inspection mode" and do not focus on mentoring support(Research Group, 2021).

National Assessment Survey 2017 (NCERT, 2020) identified nine aspects that have positive association with high performing states. These aspects include: (a) Teachers' high expectation of students' achievement, (b) Teacher's understanding of curricular goals, (c) Teachers' job satisfaction, (d) Monitoring of the schools by the Department of Education, (e) Schools having a library, (f) School's participation in literary activities and school fairs, (g) Students attending pre-primary schools, (h) Students' understanding of 'what teacher says, (g) Student participation in classroom activities, and (h) Student attendance.

Sarangapani, Mukhopadhyay, Parul, and Jain (2018) noted that for the last two decades, there is a growth in the perception that government school teachers are not capable of ensuring learning outcomes. Interestingly, the solutions that are suggested or implemented at the bureaucratic level do not include teachers in the process of change and in fact, demand more control over teachers.

> It is commonplace to come across bureaucrats asking for solutions to ensure attendance or increase accountability and for a demand of quality interventions that are teacher-proofed or can micro-manage teachers and, as if therefore, can enhance learning outcomes in students. [p. 124, (Sarangapani et al., 2018)]

Batra (2014) made an interesting observation of dominant lenses used in teacher professional development:

> Nationwide programmes to universalise elementary education have focused on 'training' teachers to perform and become accountable and not on changing the ways in which teachers are prepared and supported, reminiscent of the Fordist discourse on factory workers in the early twentieth century. (p. S8)

State of the Education Report for India 2021 (Sarangapani et al., 2021) recognises that there is a lack of qualified teachers in school. The report put forth following recommendations in the line of TPD.

1. Improve the terms of employment of teachers in both public and private schools.
2. Increase the number of teachers and improve working conditions in north-eastern states, rural areas and 'aspirational districts'.
3. Recognize teachers as frontline workers.
4. Increase the number of physical education, music, art, vocational education, early childhood and special education teachers.
5. Value the professional autonomy of teachers.
6. Build teachers' career pathways.
7. Restructure pre-service professional development and strengthen curricular and pedagogical reform.
8. Support communities of practice.
9. Provide teachers with meaningful ICT training.
10. Develop teaching governance through consultative processes, based on mutual accountability.

According to Sarangapani and her colleagues, delivering quality education for all, needs to be primarily based on quality of teaching, teachers, and teachers' education (Sarangapani et al., 2021). Thus, it is essential to focus on teachers and teaching on a priority basis. The Government of India launched the Scheme of Pandit Madan Mohan Malaviya National Mission on Teachers & Teaching (PMMMNMTT) in 2014. This mission brings diverse public institutions of teacher education under one thread and makes a coherent effort of collating all the diverse work on teaching and teacher education under one platform. The mission goal stated two major domains:

1. Programmatic and scheme based interventions: pre-service & in-service training through existing and new institutional structures, new academic programmes & courses, strengthening post-graduate and doctoral programmes, pre-scheduling year long training calendars, online training; and
2. Project based activities: ICT based training, training of Mathematics, Science, Language teachers for schools, Core science & engineering courses in technical education, general courses in social sciences, humanities and vocational courses. (GoI, Online)

The National Council of Education and Training had come up with LINDICS and PINDICS about a decade ago. The learning indicators and performance indicators were given to schools for self evaluation of teachers and shared at cluster and block level. NCERT modified the PINDICS further and developed Teacher's Self Assessment Rubrics (TSAR) for teachers of all levels (NCERT, 2019d). It is envisioned that the practice of self assessment would help identify teachers' strengths and weaknesses and help evolve them as reflective practitioners (NCERT, 2019d; Sarangapani et al., 2021). TSAR includes six performance standards: (a) Designing learning experiences, (b) Knowledge and understanding of the subject matter, (c) Strategies for facilitating

learning, (d) Interpersonal relationships, (e) Professional development, and (f) School development (NCERT, 2019d).

National University of Educational Planning and Administration has developed a comprehensive school evaluation framework, where schools have to respond to self evaluation rubric on seven domains. These include: (a) Teaching-learning and assessment, (b) Learners' progress, attainment, and development, (c) Managing teacher performance and professional development, (d) School leadership and management, (e) Inclusion, health, and safety, (f) Productive community participation, and (g) Enabling resources of school: Availability, adequacy, and usability (NUEPA, 2015).

The gigantic task of TPD in the Indian context demands huge amounts of resources in terms of money, human resource and time. The current study is of direct relevance to teachers. A research project conducted at University and College level about teachers' education must include current needs of teachers and should be consistent with the suggestions presented in the policy documents. There are several state and central government initiatives for TPD. The frequency and intensity of TPD programs have increased over the last 10 years. Therefore, it is important for teacher educators to be informed about research on effectiveness of TPD engagements in order to structure these engagements effectively.

2.10 Summary

This chapter presented some of the literature reviewed for the study. It has presented the history, origin and definitions of the term project and project based learning including the Indian context. Additionally, it has tried to capture studies related to aspects such as characteristics of PBL, principles for PBL planning, implementation of PBL in classrooms and associated challenges, effectiveness of PBL w.r.t. students' learning and TPD and its effectiveness, nature of teachers' knowledge , teachers views' about project practices and status of TPDs in Indian context. The study presented in the thesis has its thrust on placing PBL in the Indian context and to develop a TPD model for the same.

The word project or project method are familiar words in the Indian educational policy documents and to the teaching community. However, there are a variety of manifestations of project practices in Indian classrooms. Therefore, it is important to revisit the history of project method as a pedagogy for school education and its manifestation as project based learning (PBL) over time.

Literature documenting efforts carried out in India as well as around the world suggests that PBL can be an effective curriculum approach to address the challenges of education, meeting the policy requirements, and educating future citizens (Sriram, 2018).

Any curriculum intervention to be effective must build an ownership among teachers and empower both the students and teachers. There is a danger that new ideas for

pedagogical approaches in the classroom are often promoted, sometimes by government agencies, without the detailed research and theoretical underpinning relating to it being considered with due diligence (Burton & Bartlett, 2006). Therefore, the present study was designed to evolve through a deliberation with teachers. The motivation of carrying out the research came from a need to develop a curriculum response to policy suggestions and meet the pragmatic challenges of teachers and students in the process of teaching and learning. This study led to the development of a model of PBL that could address the recommendations of the policy and the concerns of implementation.

Chapter 3

Methodology

The study has followed a deliberative curriculum approach (Null, 2011). From the review of literature (See Chapter 2) and reading through policy documents (NCERT, 2005; MHRD, 2020) it was seen that project-based-learning (PBL) could be a possible response to some of the concerns regarding Indian classrooms. The characteristics of PBL were elaborated upon in Chapter 2 and these were presented to teachers to get their inputs and to refine the same and get additional insights into designing a teacher professional development engagement. The study followed a design research methodology (Collins et al., 2004) and was aimed at designing a model of teacher professional development (TPD) in the Indian context. The study proposed that while participating in the TPD engagement, the teacher participants would collaboratively plan teaching units for middle and high school students and implement these plans in their classroom. Thus the pedagogic recommendations of NCF 2005 (NCERT, 2005) and National Education Policy 2020 (MHRD, 2020) would be ensured in classroom teaching and would also address teachers' current concerns of conducting projects following post-NCF 2005 circulars of CBSE. In this context a PBL workshop series was organised to facilitate collaboration among teachers, teacher educators and researcher.

Since a school works as a community, teachers, school administrators and teacher educators share an equal stake while implementing new pedagogical approaches. Hence the workshop was planned to include teachers, teacher educators, and teacher administrators, so that such inclusion could result in a shared meaning on PBL that would empower teachers and other stakeholders to implement PBL units better in their respective schools. The experiences gathered from the implementation of PBL units in these schools would also help identify factors responsible for shaping the nature of projects in PBL and to suggest how different factors influence the elements of PBL.

The following sections present the research questions, theoretical framework, research design and phases of the study, as well as details of the participants in the study, the data collection and analysis, and finally ethical considerations of the study.

3.1 Research questions

The study was guided by the following research questions:

1. What are teachers' views about and practices of projects in teaching-learning, and the challenges they face in implementing projects? What are the teachers' views towards addressing subject integration, assessment practices, group work for learning, and management of resources in designing projects in their own teaching context?
2. How do project plans and assessment strategies of teachers evolve through their engagement in a TPD program? What challenges do teachers face while generating teaching units on PBL projects and while implementing these?

The first research question is addressed in Chapter 4, while the second research question is addressed in Chapter 7.

3.2 Theoretical framework of research

PBL is a way of encouraging students' engagement and addressing the contextualisation of student inquiry (Blumenfeld et al., 1991) and is consistent with the constructivist paradigm of learning (Krajcik et al., 1994). According to van Rooij (2009), PBL follows cognitive theories like *situated learning* (Lave & Wenger, 1991) and *cognitive apprenticeship* (Collins, Brown, & Newman, 1989).

Several factors are associated with school improvement and educational reforms. School constraints and teachers' competencies alone, taken in isolation, do not determine quality of education and mode of teaching-learning. These are shaped in the socio-economic and politico-cultural landscape (Prawat, 1992; Price & McConney, 2013). Any attempt to improve teachers' practices must take into account the school context as well as the social context beyond the physical periphery of school (Lam & Lidstone, 2007). Thus, the social constructivist paradigm (Rogoff, 2003; Bruner, 1983; Vygotsky, 1986, 1978) is useful for formulating PBL and for designing and implementing teacher professional development (TPD) engagements.

The following sub-sections introduce an outline of the theoretical lenses used in the study and how these have informed the study. The theoretical lenses include *social-constructivism*, *situated learning*, *cognitive apprenticeship*, and *critical pedagogy*.

3.2.1 Social-constructivism

Rogoff starts the first chapter in her book *The cultural nature of human development* with the following words:

> Human development is a cultural process. As a biological species, humans are defined in terms of our cultural participation. We are prepared by both our cultural and biological heritage to use language and other cultural tools and to learn from each other. Using such means as language and literacy, we can collectively remember events that we have not personally experienced — becoming involved vicariously in other people's experience over many generations. [p.3, (Rogoff, 2003)]

The implication of looking at human development as a cultural process is situating learning of students as well as teachers in social engagement. In such engagements, language and other cultural tools are used in diverse ways both in terms of modes and means. The purpose of these engagements is to learn from the experiences of others and thus reduce time and effort required to actually go through the same experience.

According to social-constructivism, reality is constructed through shared human social activity. Members of a community create the properties of the world, and the meaning of the properties are a product of shared and negotiated understanding among the members of the community (Kukla, 2000). Thus knowledge is a human creation, constructed by social and cultural means (Prawat & Floden, 1994). Individuals construct meaning and understanding by means of interactions in society and with their environment mediated by cultural tools such as language (Vygotsky, 1978).

This study recognises that teachers' interpretation of the curriculum and anticipated outcomes is shaped by their knowledge about teaching-learning, about students, and their own professional experiences (Manouchehri & Goodman, 2000). I am committed to the world view that reality does not exist independent of human interpretation. We reach a reasonable agreement on any reality through a process of negotiation among different personal realities constructed by individuals. So meaning making is a collective endeavor situated in a particular social, cultural, and historical context (Simon & Schifter, 1991). As a tool, language plays a crucial role in cognitive functioning. According to Vygotsky (1978), for young children, speech or language and actions are inseparable and this is the characteristic difference between humans and other animals.

The social-constructivist framework provides a democratic base to co-create a shared vision and reality. In the study, teachers' individual experiences were heard through interviews and via a questionnaire. The engagements with teachers in the series of workshops and later visits to the schools of the participant teachers were designed in a way that could support expression of personal realities.

This framework considers social interaction and dialogue as fundamental to cognitive and intellectual growth.Vygotsky's notion of the Zone of Proximal Development (ZPD) provides an optimistic scenario of learning. It describes the difference between what an individual can learn independently and the potential of learning of the same individual with support of more able peers (Vygotsky, 1978; Daniels, 2005). Interestingly, "able peer" can be anyone for any individual for different tasks and performance. This possibility of learning can be harnessed through ensuring sustained group work situated in a social setting among individuals of diverse abilities and proficiency in a problem rich context. Vygotsky's view on ZPD also implies assessing students progress during

the course of engagement and the focus of assessment being both on the process as well as intermediate products (Daniels, 2005).

In a formal classroom setting, a teacher is accountable for ensuring the learning of every individual. Therefore, the social setting of classrooms needs to maximise the learning of every individual taking advantage of Vygotsky's notion of ZPD. According to Bruner, teachers need to encourage students to discover principles for themselves, and there should be an active dialogic engagement among the teacher and students (Bruner, 1983). In PBL, students carry out a problem solving task situated in a real world context. This real world context provides multiple scaffolds for students. While working in groups, students can receive adequate scaffolding from teachers as well as from students who may be more able. A similar learning situation was created in the series of workshops with teachers in this study.

3.2.2 Situated learning

From the perspective of 'situated learning', learning takes place in social situations. The term social situation refers to situations where more than one individual interacts in versatile ways and this interaction encourages learning of one or more individuals to take place (Lave & Wenger, 1991). Lave and Wenger (1991) proposed "situated learning" while elaborating legitimate peripheral learning in the "communities of practices" citing five studies of apprenticeship. They however did not include such learning situations in the context of classroom teaching-learning in schools (Lave & Wenger, 1991). Here, I have borrowed the ideas where experts create a conducive environment for novices by providing space and legitimacy to approach proximity and carry out tasks without fear of failure.

Learning and cognition are fundamentally situated. "The activity in which knowledge is developed and deployed...is an integral part of what is learned. Situations might be said to co-produce knowledge through activity" [p.32, (Brown, Collins, & Duguid, 1989)]. As an extension of this position, it can be said that knowledge can not be separated from the activity. Brown and co-authors (1989), brought out some crucial aspects while considering knowledge is situated in activity. In this framework conceptual knowledge can be treated as a "set of tools". And learning happens through enculturation in the respective activity.

In PBL, a teacher (expert) presents a complex authentic problem context to students who form a community of inquirers or problem solvers. Students also possess expertise in multiple areas and hence there are more-able peers for some activities. Students who take on a peripheral role at initial stages for any given task may ideally take more ownership at later stages. As the proposed PBL in school settings draws multiple capabilities in one authentic problem context, the model ensures that each student takes both the peripheral and central role depending on the tasks at initial stage.

The teacher's role is to ensure that every student becomes more-able while performing the task. And as per the proposed PBL this can be done in three ways. First,

the teacher herself positions herself as an expert particularly in posing problem context, analysing the problem and deriving shorter tasks in alignment with larger tasks, distributing work in the community, setting expectations from all including rules and norms, establishing a culture in the community of learners capable of self and peer evaluation, responding to unexpected problems, commitment to democratic values, and demonstrating academic integrity.

Second, the teacher helps adequate grouping of the students to ensure diversity and degree of expertise. Third, the teacher needs to establish an assessment culture focused on improving the outcome of the task or performance situated in the capability of the student. More specifically, the assessment practice in the entire PBL engagement should highlight good practices, elaborate the evaluation indicators, suggest ways to improve performance, chart the support required from the community, and actions to be taken by the individual.

A similar framework is visualised in this study for the TPD too. The teacher is replaced by the researcher and students replaced by the participant teachers. The authentic problem context is the preparation of a teaching plan based on the proposed PBL model. The participants engage in preparing the plan in a workshop mode outside school but transact these plans in their real school settings. The feedback to be given to the participants is in the form of sharing exemplar PBL units for evaluation. An assessment culture could be demonstrated through evaluation of the teaching plans for their potential in aligning with the criteria set for the proposed PBL.

3.2.3 Cognitive apprenticeship

According to Brown and co-authors (1989), "Cognitive apprenticeship methods try to enculturation students into authentic practices through activity and social interaction in a way similar to that evident–and evidently successful–in craft apprenticeship" (p. 37). According to this approach, students are given problem solving tasks along with required cognitive tools and are provided opportunities to engage in a culture of the practice in which the task is situated. Solutions of the problem are many and evolve in action by the class or community and not dictated by the teacher. Khunyakari (2008), attributes Cognitive apprenticeship (CA) in the following words:

> Unlike traditional apprenticeship, CA employs a sequence of tasks that takes into account the changing demands of learning. Besides, it aims for generalising knowledge so that it can be used in many different settings.

Similarly, in this study in the series of workshops with teacher participants it was planned that I and the teachers would work together to develop teaching plans. It was understood that there is no single correct teaching plan rather there are several teaching plans. Preparing a teaching plan (or a lesson plan) is a regular practice of teachers, and in these workshops teachers were expected to work together as part of a community of reflective teachers preparing teaching plans. The cognitive tools required

for preparing the teaching plans and resource rich environment was to be provided in terms of lead talks, informed discussions, exemplar modules, textbooks, rubrics etc. It was hoped that the learning from this exercise would be generalisable while making teaching plans and assessment on other topics.

3.2.4 Critical pedagogy

According to Freire (2000), the aim of education is not the transfer of a body of knowledge, but the engagement of the learner in authentic problem contexts that are meaningful to them. In such an engagement, the learner becomes a creator of knowledge, rather than being a consumer of knowledge.

In my work engagement with students and teachers for the last several years I have observed a prescriptive relationship in the context of teaching-learning. A large number of teachers feel discomfited when a facilitator of a session seeks answers from the participant teachers. Similarly, most students and parents do not attribute classroom engagement as teaching unless students are given a set of written question-answers by the teacher. Even copying textbook content is valued much more than investigating germination of seeds or recording the temperature of one's surroundings on a daily basis. I hear a common voice from teachers, while conducting workshops or facilitating discussion sessions:

> If we are here to answer our own questions and hear each other, why are we in the workshop? What is our learning then? You must say what is the correct answer. We can discuss later.

A similar discomfort is expressed by students. After a long session of 1.5 hours, students inquired, "So far we have done activities and discussion, but when will you teach us?" This I hear mostly on the first day of my visits in State Government Schools. Interestingly, the students least able to read and write prefer most to copy the content written on the board or from the textbook. I find these cases in conformity with the situation mentioned by Freire (2000) in his classic work *Pedagogy of the oppressed*. He points out "prescription" as one of the basic elements of the relationship between oppressor and oppressed.

I have also worked as a school principal for more than 4.5 years in a school situated in the Garwal region of Uttarakhand. Here a democratic culture was established in the school by sharing a common working space. This included planning together by teachers and students, taking responsibility for cleaning the classrooms and school ground, eating together during mid-day meals, farming in the garden, painting the boundary walls, managing waste, solving problems, making models, constructing meaning of a poem, and interpreting a historical event etc. I found that it is possible to minimize the prescriptive relationship while engaging in such engagements. I have seen students taking ownership of their work, taking part enthusiastically in problem solving, working together and sharing in the hard work and joy of others and helping each other in learning.

The students of the school viewed examinations and assessments as engagements to achieve learning goals and find out new areas to work on. Teachers viewed the results of the assessments as a resource to know more about students' learning and how to make teaching and school culture better. So, the exercise of assessment as well as formal structure of examination can become engagements for learning and gaining insights on teaching-learning.

From my personal experience of working with educational functionaries, teachers and students, I find hope in Freire's (2000) approach of positing education as a liberating force. How PBL can be conceptualised as a liberating pedagogy and bring it in alignment with the curriculum suggestions is elaborated in the chapter *Literature review*.

The following sections elaborate how such a liberating experience is also realised in designing TPD. In this study, the workshop engagements, school visits, and teacher conferences provided ample opportunities to the participants to share their views, voice their concerns, and I was often in the position of a proposer or moderator during the discussions. The school visits helped explore the tensions existing in the curriculum implementation and the challenges that appeared during the engagement aided reflection.

In the study, I have developed reading resources considering the classroom reality, prepared two blog spaces for teachers to share and discuss and maintained communication over phone and emails. The discussions made with teacher participants were focused on understanding the reality and experience of teachers in PBL implementation. I also carried out a PBL unit with students and presented the findings to the teacher participants for evaluation. This was my attempt to get first hand experience of PBL implementation and also to reduce the prescriptive relationship between me and the teachers.

3.3 Research design of the study

The theoretical lenses guided me to adopt the *deliberative curriculum approach* (Null, 2011) to propose PBL as a curriculum response to teachers. Similarly, *Design Research Methodology* (Collins et al., 2004) was followed to address the evolving nature of the engagement with teachers and stakeholders. The following sections briefly present how these two approaches shaped the study.

3.3.1 Deliberative curriculum approach

According to Poonam Batra (2015) and Mary Ann Chacko (2015) there is an increasing focus on positing deliberative agendas while developing curricula for the Indian education system. One dominant idea emerging from their writings is that the process of deliberation in curriculum making started in India from pre-colonial times. However, these deliberations did not always include all the stakeholders. Krishna Kumar's work

in the last three decades gave an impetus for advocating deliberations in the process of curriculum making. (Chacko, 2015; Batra, 2015).

Pinar noted responses of Chacko on Krishna Kumar's view in the light of Schwab in his edited book *Curriculum in India: Narratives, Debates, and a Deliberative Agenda* as below:

> Kumar identified a "fracture between the discourse of those who are involved in the everyday life of schools – the teacher, teacher trainer, and parents – and those of the educational planners and administrators".
>
> ... "Both Kumar and Schwab insist that choice and action in the field of curriculum should be driven not only by theories but by an intimate knowledge of the curriculum as lived in a particular time and place. However their vision for the field of curriculum is not satisfied with theoretical eclecticism and an intimate knowledge of classrooms but calls for 'deliberation' as a necessary method for the practice of curriculum." [p. 185-186; (Pinar, 2015)]

Interestingly, most of these engagements were part of making policies and curriculum frameworks at larger levels and this act of deliberation had to start from the stakeholders much closer to the classroom. This indicates a vision and commitment to establish a dialogue with different stakeholders working at different levels and aiming to reach a more liberating experience of curriculum making. My engagement with teacher participants during the study can be best described in the following words:

> In Schwab's hands, deliberation is a deeply human activity that accepts the fact that curriculum making takes place within an imperfect world. There will never be a perfect curriculum or a perfect teacher. That does not mean, however, that teachers and curriculum makers cease to strive toward perfection [p. 168, (Null, 2011)].

According to Null (2011), the deliberative curriculum approach brings together contributions of systematic, existentialist, radical, and pragmatic traditions of curriculum making. This approach and process considers individual experiences, explores, and suggests radical action, or problem solving based on what works and places the practical art of deliberation at the center. This approach leads to "the formation of school subjects and curriculum content that rests on a deliberative understanding of education and curriculum content, going beyond a view of school subjects as distinctive and prescribed purpose-built enterprises" [p.n.d. (Englund, 2015)]. The proposal of PBL in this study was derived while working within a deliberative framework and has been presented in detail in Chapter 2.

Inspired by this deliberative approach, I have first prepared a proposal of PBL as a curriculum response, shared this with teachers, presented the idea to educational researchers, and presented this proposal to a group of teachers and teacher educators

in a series of workshops. A sustained dialogue was maintained through several school visits. In the school visits, I had several rounds of conversations with participant teachers, their colleagues, and students.

I also tried out a PBL unit with students and presented the unit to teachers for their review. Teacher participants and I discussed how, why, and what to teach in classrooms that makes a balance of policy demands, our vision of education situated in preparing future citizens, and our classroom realities. The diverse realities presented by the participants representing diverse socio-cultural and educational backgrounds was used as an opportunity to engage in search of pragmatic solutions to achieve common goals.

3.3.2 Design based research methodology

The study began with identifying critical elements of design based research and finding out how these elements interact and are addressed (Collins et al., 2004). Design based research is situated in real educational contexts, focuses on the design and testing of a significant intervention, uses mixed methods, involves multiple iterations & a collaborative partnership with the researcher and practitioners, leading to a design principle and an impact on practice (Barab & Squire, 2004; Collins et al., 2004; T. Anderson & Shattuck, 2012).

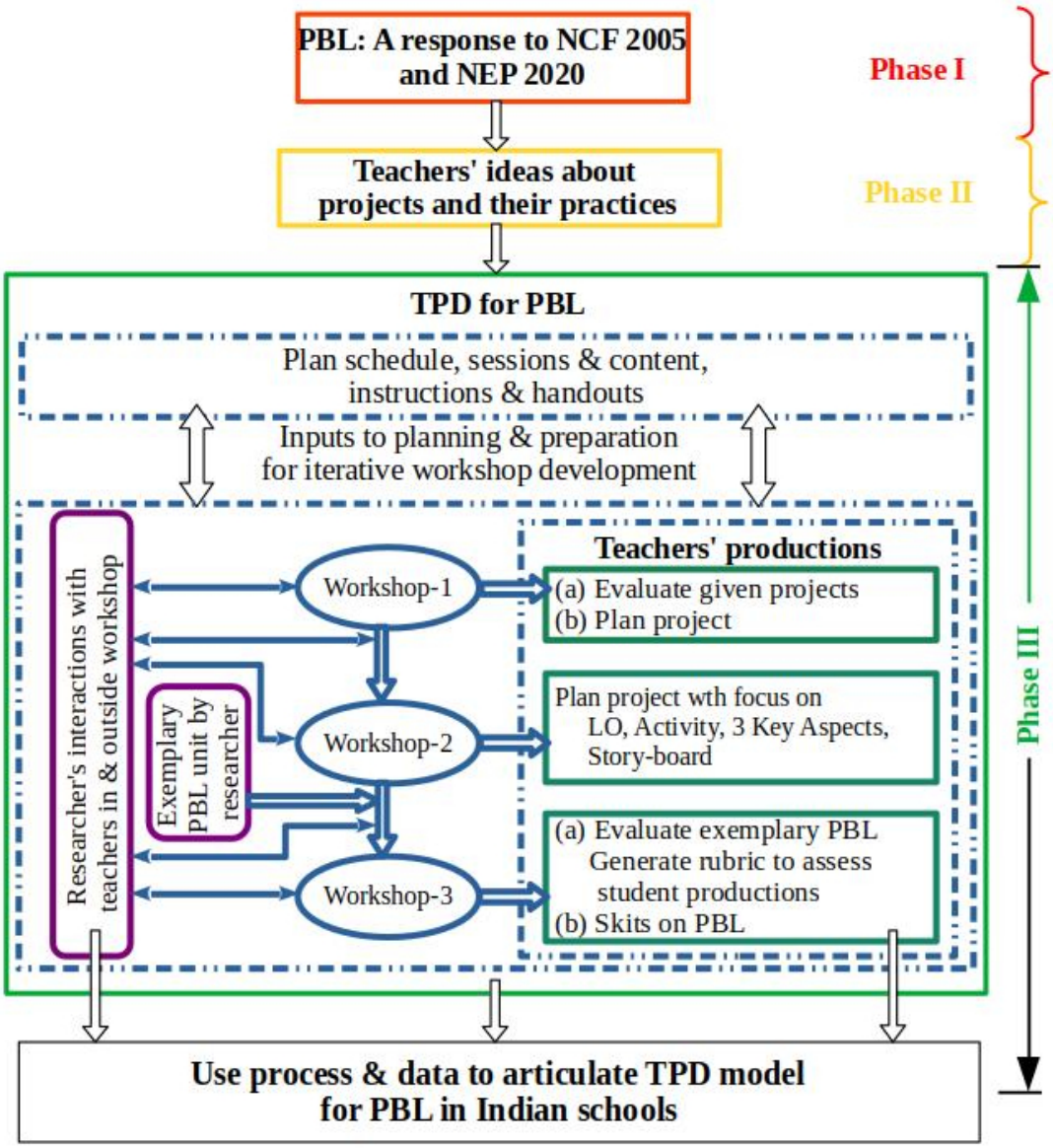
Following Krajcik and his co-workers (Krajcik et al., 1994), I have collaborated with workshop participants to plan and implement teaching units on PBL, provided a platform to articulate and share participants' practices, critiqued and reflected on projects, those conducted by the participants as well as researcher. Like in the work of Desimone (2009), the PBL planning was based on textbook content, and the workshop was structured to provide an active learning environment through several open ended tasks, justification and argumentation, making tangible productions like filling worksheets, presentations, enacting skits, etc.

I have designed the engagement with the participants over a duration spanning more than five months, and attempted to address teachers' professional needs. The details of each phase are described in the following sub-sections. The study used: interpretive analysis of relevant documents; case study and descriptive analysis of surveys through semi-structured interviews and questionnaires; and descriptive analysis of written and oral productions to study evolution in a process.

3.4 Phases of the study

The study was conducted in three broad phases as shown in Figure 3.1. Teachers' views on projects and their project practices were explored in every phase of the study and incorporated as an integral part of TPD (Haney & Lumpe, 1995; Loucks-Horsley et al., 2003; R. S. Kumar & Subramaniam, 2013).

Figure 3.1: Research design of the study.



Note:

1. NCF 2005: National Curriculum Framework 2005;
2. NEP 2020: National Education Policy 2020;
3. LO: Learning Objectives;
4. TPD: Teacher Professional Development;
5. 3 key Aspects: Subject integration, Classroom management, and Assessment. Group work is included in Classroom management.
6. Researcher's interaction with teachers in and outside workshops include both online and face to face mode. Face to face mode includes school visits.

3.4.1 Phase I

In Phase I, a variety of curricular and policy documents were studied to find the role of projects in the current Indian education system. This study led to a suitable interpretation and elaboration of the five criteria of PBL given by Thomas (Thomas, 2000) for the Indian context, such that they would remain congruent with recent policy recommendations and be implementable by teachers. The documents and literature used in this phase included:

1. National Curriculum Framework 2005 (NCERT, 2005), Right to Free and Compulsory Education Act 2009 (GoI, 2009), National Curriculum Framework for Teacher Education 2009 (NCTE, 2009), and National Education Policy 2020 (MHRD, 2020).
2. The middle and high school syllabi, textbooks, project and assessment modules published by the National Council of Educational Research and Training (NCERT), Central Board of Secondary Education, Government of India, as well as the Maharashtra State Bureau of Textbook Production.
3. The circulars relevant to projects and assessment that were sent to schools periodically by the Central Board of Secondary Education (CBSE) (CBSE, n.d.).
4. Proceedings of the biennially held National Science Teachers' Congress (2009 and 2011) (NCSTC, 2010, 2012).

At the end of Phase I, a model of PBL along with some broad criteria for the Indian context was developed on the basis of the PBL conceptualization of Thomas (Thomas, 2000). This was then used in Phase II for designing interview protocol for Focused Group Discussion (FGD), survey tools – for semi-structured interviews and questionnaire surveys of teachers.

3.4.2 Phase II

Having reliable ideas about teachers' views and studying these views in relation to teachers' teaching practices are important in implementing any new policy. Interviews, questionnaires, case studies and oral histories, are appropriate methods for such research (Pajares, 1992). The research design of Phase II has focused on this aspect of learning about teachers' views.

The research design in Phase II included three distinct stages, having an iterative process of knowledge construction for the researcher. The knowledge constructed in these stages helped shape the content, process, and design of the engagement with teachers. Overall these stages explored teachers' views and experiences about conducting projects, their satisfaction as well as discontent with the way projects have been introduced and carried out in school, and presenting my conceptualisation of projects and teachers' response to the same. The following subsections provide brief details of each of the three stages.

Stage 1: Focus group discussion (FGD) with teachers

In Stage 1, a focus group discussion with ten teachers of one school was conducted. A FGD typically brings together eight to ten people for a face-to-face discussion on a particular topic (Edmunds, 1999). The reasons for conducting the FGD, the tool used, a description of the school, preparation for FGD and proceedings are presented below under separate headings.

Reasons for conducting FGD: There are at least five reasons to conduct FGD. First, it enabled me to begin in a very open-ended manner by asking how teachers conduct projects in their school. The responses gave ideas of what these teachers think about existing projects and provided information about their own practices of projects. Secondly, the open-ended questions gave an opportunity to follow up with more targeted questions depending on the teacher's answers.

Thirdly, success of PBL implementation depends on the approach of the whole school and not only on the individual teachers' perspective. Therefore, a FGD would probably provide a better picture of the school as a whole. Fourthly, certain teachers and/or certain critical points might be presented only in a large group (though the opposite is also possible in rare situations). Finally, the discussion helped in framing the teachers' and students' questionnaire used at the later stage (Creswell, 2002).

Tool used in this stage: A semi-structured interview protocol was used as given in Table 3.1.

Table 3.1: Interview protocol of the Focused Group Discussion.

Sr. no.	Questions
1	Tell us about your school. How many grades do you teach? How many students do you have in each class? What are the students' social and economic background?
2	You conduct projects with students. Will you elaborate how you do projects with students?
3	Who are the teachers carrying out projects? Are these group projects or individual projects? Who assigns projects to the students? How are academic resources collected? What is the role of teachers in projects? What is the role of students?
4	Do you conduct projects with all students in a class? Do you conduct projects for all grades?
5	In what way projects as a teaching method is different from traditional way of teaching?
6	From the point of view of students' learning, how is the project method? Is it less or more effective with respect to traditional method?
7	What are the challenges in conducting projects or what caution one should take in conducting projects?
8	How do you evaluate students' learning in the projects?

Preparation for FGD and proceedings: On the day of the interview, I met the Vice Principal and introduced my research work, and situated the need of FGD with teachers. The consent form was shared with the Vice Principal for her reference and to

get signature from the Principal. Then I went into a classroom where the participant teachers were already waiting.

I and the participating teachers welcomed each other. Initially, teachers sat on the school desks arranged in rows and columns, but the sitting arrangement was changed and made circular to increase informality and to be able to see each other while talking. The FGD began with me introducing the nature of the research work and the role of teachers' views about projects and their importance in learning at school levels. Teachers were informed that their names would be kept anonymous and not reported in publication. Permission was also taken to record the discussion both in audio and video modes.

The discussion was for almost 2 hours. The location of FGD afforded authenticity. There was some occasional noise in the background as the school was located near railway tracks. I attempted to ensure that all members had the opportunity to participate in the discussion. However, during the initial 50 minutes, two teachers dominated the discussion. In the remaining time other teachers also pitched in. However, some teachers were not vocal.

I moderated the discussion. While the overall structure of the discussion was shared with the teachers, there were no ground rules for discussion (eg. turn-taking, not dominating the discussion, not interrupting). An attempt was made to ask each question clearly, prior to facilitating the discussion and then to reflect back to the group a summary of what was said (Drew, Hardman, & Hosp, 2008).

Stage 2: Individual semi-structured interviews with four teachers

In Stage 2, individual semi-structured interviews were conducted with four teachers from three schools. The aim of the interviews was exploratory, descriptive as well as explanatory (Yin, 2003). The reasons for conducting the semi-structured interviews, the tool used, a description of the representing schools, preparation for the interviews and proceedings are presented below under separate headings.

Reasons for conducting semi-structured interviews: FGD was conducted with a group of teachers from a single school that followed the Maharashtra State Board curriculum. The policy directives to implement NCF 2005 were more prominent in CBSE Board schools and CBSE had circulated a series of circulars during pre- and post-NCF 2005 context that have referred to project work. NCERT textbooks and syllabus were prepared in close collaboration with the framers of the NCF 2005. Both CBSE and NCERT had also come up with assessment manuals, project books, teachers' handbooks, and started orienting teachers on pedagogy proposed in NCF-2005. Therefore, it was considered worthwhile to know the practices of teachers in these schools too.

The teachers participating in FGD had provided projects to the students in their classroom, however, none of them had guided students in group projects for exhibition. During FGD, participants shared that teachers guide students in the science projects prepared for National Children Science Congress or for exhibition purposes. It is most

likely that in these projects teachers guide students towards an authentic problem situation. It was also considered important to explore all the aspects of the proposed PBL in detail through an in-depth interview of individual teachers, where teacher and researcher could engage in discourse on the potential of PBL.

Tool used in this stage: A semi-structured interview protocol with open ended questions (L. Cohen, Manion, & Morrison, 2007) was used in these interviews. The interview protocol captured: (a) teachers' practices of school projects, (b) students' learning from the projects, (c) the challenges teachers face while conducting project, (d) students', parents' and schools' views towards projects, (e) teachers' views towards the practice of projects relating to the four aspects – subject integration, assessment, group work and learning, and management of resources, and (f) kind of teacher support and systemic changes required while adopting the proposed model of PBL.

The discourse promoted in the study was aimed at encouraging the teachers to reflect on their pedagogic practices of projects. At the end of the interviews all the participants were also asked about the nature of support required by teachers to adopt PBL pedagogy in the classroom.

Preparation for the semi-structured interviews and proceedings: Two of the participants (AB and AM) were approached for interviews when they visited the Homi Bhabha Centre for Science Education (HBCSE) and these interviews were audio and video recorded. The other two participants (DB and CS) were interviewed in their schools and were only audio-recorded.

All the participants were informed about the purpose of the interview and their consent for the interviews and recording the conversation was obtained. In the interviews I looked for the occurrence of any of the aspects mentioned in the tool, even if they appeared in different sequences, frequency and depth of elaboration in each teacher's interview. When a teacher did not refer to an aspect at all, I provided cues to elicit ideas on that aspect. The duration of the interview with AM was 30 minutes, the least, and with AB was 55 minutes, the longest. The interview with DB and CS was around 50 minutes each.

At the end of the interview, each teacher was informed of the series of workshops being planned, in which teachers in collaboration with me would develop projects and conduct them in their respective schools. The teachers were informed that school management would be approached and their cooperation would be sought.

Stage 3: Exploring workshop participants' views on projects through questionnaire

In Stage 3, workshop participants' views on projects and their project practices were explored through a questionnaire. The reasons for conducting the survey, the tool used, a description of the representing schools, a description on how the tool was administered is presented below under separate headings.

Reasons for conducting the questionnaire survey: To develop an effective professional development model it is important to know the initial views of the participants. This helps design appropriate interventions that address and leverage the views of the individual participants. Further, responses from a large number of teachers can be gathered in a short time duration. The survey would also make it possible to explore any association of pattern of responses on a large number of indicators to the type of school system.

Tool used in this stage: A questionnaire was framed based on (a) the insights from focused group and individual teacher interviews, (b) an analysis of NCERT and Maharashtra State Board textbooks at the middle and high school levels with respect to projects and activities, and (c) informal interactions with teachers and students during science exhibitions and teacher conferences.

The questions were mostly open-ended and sought free responses (Littledyke, 1997). The questionnaire (see Appendix A) was validated by three experts. All the items having unresolved disagreement with any one of the experts were removed.

The final questionnaire contained seven open ended questions, one question with 24 statements that had Likert type choices, and one close ended question. Four open ended questions and the 24 statements were aimed at exploring teachers' views of and ideas about the project. The remaining questions were aimed at exploring teachers' actual practice of projects. In addition the questionnaire contained two separate sections to know teachers' personal information and their expectations from the workshop.

Administration of the tool: The questionnaire was administered to the teachers who participated on the first day of the series of PBL workshops. The motivation behind the formulation of the questionnaire was explained by me and was printed on the first page of the questionnaire itself. Participants were requested to write their own thoughts freely regarding their expectations from the workshop. Teachers on an average took around an hour (Range: 55 minute to 1 hour 15 minute) to fill the questionnaire.

3.4.3 Phase III

In Phase III an iterative model of TPD was developed that consisted of three stages. These stages are separated in terms of mode and purpose of engagement with the same or different group of participants. The participants of stage 1 and 2 include teachers, however, stage 3 included students. A short description of each of these stages are presented below.

Stage 1: Workshop series

The stage 1 included a series of three workshops organized over a period of five months. Teacher participants collaboratively generated project plans in alignment with the proposed model of PBL. The elements of the engagements are presented in Figure 3.1.

During the workshops, participants generated plans of projects guided by worksheets and presented them. The analysis of participants' productions, their feedback and inputs from each workshop and school visit helped to plan and restructure the workshop that followed.

Stage 2: School visits

The second stage included school visits made to schools of the participant teachers. The school visits were conducted between the first and second workshops and also after the third workshop of the workshop series. During the visits, I conducted interviews of participant teachers, their colleagues, and select students of the school. These visits were also made to gather an understanding of school culture and teachers' life in school. A major discussion agenda of the visits focused on how participant teachers were translating PBL units in their schools.

Stage 3: Developing a PBL unit and transacting it with students

In the third stage, I developed a PBL unit and tried it out among grade 6 students. The motivation of this work, objective of the study, research questions, and a brief description of the development and transaction of the PBL unit are presented under the following heads.

Motivation of developing and transacting a PBL unit with students: There were two-fold motivations for this study. The first motivation came from the participant teachers' demand of viewing a PBL unit that had been transacted with students. The second motivation came from my own felt need of developing and trying out such units. I wanted to see what are the teaching-learning aspects associated with developing and transacting a PBL unit. I also felt that there were no PBL story boards, learning trajectories, and student productions available at one place.

I thought that first hand experience of developing and transacting PBL unit will provide the required resources for teachers and valuable insights on implementation aspects of PBL to me.

Objective of the study: The guiding objectives of the study included, gathering evidences of students' learning through student productions in PBL tasks and developing suitable assessment rubrics to help evaluate students' learning through PBL.

About the development and transaction of the PBL unit: I extensively surveyed the literature relevant to the planned workshop and made a tentative outline of the sessions and developed a script of the entire workshop. All the managerial and logistic tasks like intimating students and their parents, taking permission from appropriate authorities, arranging rooms, etc, were completed.

A workshop was conducted with students who worked in groups to design and make

models of items for a playground space shown to them. The play items were aimed at serving the young children of the locality. Each group of students would make an item model and all the models would be placed on a scale model of the playground. A case study framework and qualitative research principles were used to record and reflect upon as much evidence of learning as possible.

The idea of the playground space unit was adapted from Malcolm's (Malcolm, 1994) story of a similar unit, which illustrated how learning objectives of concepts and procedures in science and mathematics are met when students engage in planning and designing a playground. The workshop was planned with PBL pedagogy (Thomas, 2000) in mind to include several issues relevant to learning concepts, procedures, and designing. The story board, students' productions and log of events were outcomes of the engagement, and these were then used as an exemplary PBL unit for teacher participants to engage with in the third workshop.

3.5 Participants

The sections which follow provide information about the sample/s (schools, teachers and students) who participated in the study at different stages and phases.

3.5.1 Participants of FGD

The FGD was held in the teachers' school so that they would feel comfortable and this would ensure authentic responses. The school is operated by a trust, and the medium of instruction (teaching-learning) is Marathi. The school follows the syllabus of the Maharashtra State Board. It is a well reputed school in the locality, and has sessions from pre-primary to grade 10, with five divisions in all the standards from grade 1 to 4, six divisions in grade 5, and 7 divisions from grade 6 to 10. The average number of students in each division is 65. The parents are mostly working class and from the middle income group. At least 25% of the parents have professional qualification while the rest have educational qualification till standard 12 or less.

Seven teachers, three DEd Interns (student teacher) participated in the FGD. The details of the participants are given in the Table 3.2.

There were 4 female and 6 male participants from the school who took part in the FGD. One of the female participants was a lab assistant, while three male and three female participants were teaching Mathematics and Science at high school level. One male participant was teaching English and History at grade 5 to 8, while two other male teachers were teaching English and Geography at the same level. All of them were proficient in Marathi, the state language. The interview was conducted in both Marathi and Hindi.

Table 3.2: Participants of the Focused Group Discussion

Sr. no.	Designation / Code	Sex	Subjects taught	Class teaching
1	Teacher / B	Male	Sc., Math	9, 10
2	Teacher / C	Female	Sc., Math	8, 9, 10
3	Teacher / D	Female	Lab assistant	Integrated section
4	Teacher / E	Female	Sc., Math	8, 9, 10
5	Teacher / F	Female	Sc., Math	9, 10
6	Teacher / G	Male	Sc., Math	8, 9, 10
7	Teacher / H	Male	Sc., Math	9, 10
8	DEd Interns / I	Male	Math, English, History	5 to 8
9	DEd Interns / J	Male	English, Geography	5 to 8
10	DEd Interns / K	Male	English, Geography	5 to 8

3.5.2 Participants of individual semi-structured interviews in Phase II - Stage 2

Four teachers (all female) AB, AM, CS and DB from three different English medium schools affiliated to two different education boards participated in the interviews. Details of the participating teachers and their respective schools are given in Table 3.3.

Table 3.3: Participants of the individual semi-structured interviews (Phase 2 - Stage 2)

Name (age)	Qualifications	Experience (in years)	School Board / Management	Class size (level)
AB (61)	MSc (Zoology), BEd	30 (retired)	Maharashtra State Board / Private	70-80 (VII to IX)
AM (25)	MSc (Physics), BEd	2	CBSE / Private, missionary	40 (VIII to X)
DB (45)	MSc (Chemistry), BEd	18	CBSE / Government	40-45 (VIII to X)
CS (50)	BA (Social studies), BEd	20	CBSE / Government	40-45 (VIII to X)

The medium of instruction in AB's school was Marathi. The school was run by a trust, and followed the Maharashtra State Board curriculum. In terms of the nature of administration, parents' occupation and teachers' profile, this school was similar to the school where I conducted the FGD. It differed primarily in two aspects. First, the number of students in each class was a little higher (70-80 students), and the number of divisions for each class/grade was fewer.

AM worked in a private school run by a Catholic Educational Trust. The medium of instruction was English and it was affiliated to the Central Board of Secondary Education (CBSE). The class size was 40 and the school had only one division in every grade. Parents were educated, mostly middle class and held salaried jobs or good

business.

DB and CS were in one school, which followed the CBSE curriculum and was run by an autonomous Educational Society within a department under the Central Government. The class size was 40-45 and there were two divisions in each grade. The medium of instruction was both English and Hindi. All the parents were working in a Research Establishment but at various capacities. At least half of the students' parents were engaged in research laboratories.

While projects were mandated by CBSE circulars as part of formative assessment, they were mandatory only for the school leaving year in the State Board affiliated schools. Hence, it was harder to find teachers in the State Board affiliated schools who conducted projects on a regular basis.

AB, though recently retired, had been requested by the school administration to continue teaching in the same school. She had taught general science (integrated physics, chemistry and biology) and mathematics. AM had been teaching science and had also worked in the physics laboratories of two research institutions for three years. Teacher DB was considered a good and experienced science teacher. CS, a colleague of DB, taught history, geography and Hindi at the middle school level.

3.5.3 Participants of questionnaire survey in Phase II - Stage 3

The 34 participants of the workshop, comprising 30 females (25 teachers, four teacher educators, one teacher administrator) and four males (three teachers and one teacher educator), completed the questionnaire. All had teaching experience at middle and/or high school levels, and were associated with schools with either English, Hindi (National language) or Marathi (Maharashtra State language) as the medium of instruction. They represented 22 schools from nine organizations with different organisational structures and socio-economic profiles of students as well as teachers.

The information about the school context was derived from talking to the heads of the schools, the participants and by visiting the school websites, wherever available. The school organisations had different stakeholders and they varied in terms of their management, access to government/public funding, student-teacher ratio, teachers' academic profile, and teachers' age and experiences. The organizations can be classified into five broad categories; a) semi-government (A), b) completely government (B, F, I), c) NGO (C), d) NGOs running government schools (E, G, H), and e) completely private organization which do not follow any particular board syllabus (D).

Most of the practicing teachers had either a Diploma (Dip.Ed.) or a degree (B.Ed., M.Ed.) in education. They were teaching different subjects in school: languages, art and craft, social studies (history, geography, civics), science (biology, chemistry, physics) or mathematics. Half of the participating teachers were 35 years of age or less and almost half of the teachers had 10 or more years of experience. All the participants

were referred to as teachers during the interactions and in this thesis.

Participants' hobbies and passions were varied: from a passion for singing and listening to music, dancing and even teaching. A few participants said they loved interacting with children, learning languages and logic, reading books, playing chess, drawing, art and craft, poetry, and so on. There were some who liked cooking, watching movies or cartoons on TV, or choreographing dances. Besides their leisure interests, participants indicated their willingness or ability to work collaboratively in groups, referring to their qualification and content knowledge, and their pride in their profession, that is teaching. Half the participants referred to interest in teaching or were passionate about their teaching profession. Over half the teachers referred to the subject they taught, but only 3 teachers mentioned that having depth of content knowledge was important to their profession and only 2 participants mentioned teaching different subjects.

3.5.4 Participants of the workshop series in Phase III - Stage 1

There were 43 participants who attended at least one of the three workshops and in the first workshop there were 34 participants. Twenty two participants attended all the three workshops, but a few dropped after the first workshop, while a few more joined in the second workshop.

All participants had teaching experience at middle and/or high school levels, and were associated with schools that had either English, Hindi (National language), Marathi (Maharashtra State language) or Gujarati (Gujarat State language) as the medium of instruction. The participants represented 24 schools from 12 organizations with different organisational structures and socio-economic profiles of students as well as teachers. A summary of participants' details is given in Table 3.4.

The sources of information about the schools were similar to those outlined in Phase II - Stage 3. One organisation (J) in the category of "NGOs running government schools" and a PhD student from a prestigious Central University joined the second workshop.

The participants worked in groups. In the first workshop two school systems each formed five member groups. The remaining three groups were constituted by participants from different school systems. There was a group formed by participants from a Marathi medium school. A group was formed by 2 school systems (NGO's) who had English as the medium of instruction, and the participants were all (6 teachers) females of almost the same age (range, 20 – 35 years; average, 24.5 years). Two participants from a school support group from outside Maharashtra, who had Hindi as the medium of instruction joined the three teachers from a Marathi medium. This group was the most heterogeneous in terms of language, school board, subject specialisation of participants, and their exposure to educational research. The details of the groups are given in Table 3.5.

The participants' profiles on the other parameters were more or less the same as Phase

Table 3.4: Institutional profile of participants attending the workshop.

Sr. No.	**Institution type**	**Designation**	**Male**	**Female**	**Workshops attended**
1	I	Teacher	0	7	5 attended all, 1 attended first two, and 1 only first
2	E	Teacher Educator	0	1	Attended all
3	E	Teacher	0	4	3 attended all, 1 attended only first
4	A	Teacher Educator	1	1	Attended all
5	A	Teacher	0	5	2 attended all, 2 attended II, 1 attended III
6	G	Teacher	1	1	Attended first
7	F	Teacher	1	3	2 attended all, 1 attended I and III, male teacher attended first
8	F	Teacher Administrator	0	1	Attended all
9	H	Teacher	0	4	Attended all
10	D	Teacher	0	2	Attended all
11	C	Teacher Educator	0	2	Attended first
12	B	Teacher	1	2	Attended first two
13	BEd College	Student	0	1	Attended first two
14	J	Teacher Educator	1	3	Attended II
15	University	PhD Scholar	0	1	Attended II
16	Total	–	5	38	–

Table 3.5: Groups, their members in the three workshops

Sr. No.	**Groups and their members in Workshop 1**	**Groups and their members in Workshop 2**	**Groups and their members in Workshop 3**
1.	Raigad (SU-A, BH-A, SH-A, AD-A, AN-E, PR-E)	Mrudgandha (BH-A, AD-A, AR-A) Raigad (SU-A, SH-A, CH-A)	Raigad (SU-A, SH-A, BH-A, AD-A, VE-A)
2.	Innovation (PR-C, SH-C, TA-C, PR-E, SH-E)	Innovation (PR-C, SH-C, TA-C)	
3.	Desire (SU-C, MA-C, RA-C, NA-C, SH-C, RO-C, SS-C)	Daffodils (MA-C, RA-C, RO-C) Indradhanush (SU-C, NA-C, SH-C)	Desire (SU-C, MA-C, RA-C, NA-C, RO-C)
4.	Umeed (BI-A, SA-A, PR-A, ZA-A, VA-S, JU-S)	Ummed (PR-A, ZA-A, VA-S)	Ummed (PR-A, ZA-A, VA-S) Achievers (BI-A, SA-A, JU-S)
5.	Angan (DY-M, KA-M, VI-M, NA-M, AR-M)	Angan (KA-M, NA-M, AR-M) Team XI (DY-M, SE, RA-G)	Angan (DY-M, KA-M, NA-M, AR-M)
6.	Gulmohar (ME-A, UM-A, VE-A, VI-A, VA-A)	Gulmohar (ME-A, UM-A, VA-A)	Gulmohar (ME-A, UM-A, VI-A, VA-A)
7.		Gyanghar (SH-G, DI-G, PA-G)	
Total	34	30	24

II - Stage 3.

3.5.5 Participants of the school visits in Phase III - Stage 2

After each workshop, I visited several schools who had been represented in the workshops. Details of these visits are presented in the Table 3.6.

Totally 13 schools of the 7 school systems were visited to support the teachers for PBL implementation and for a follow up. Five schools from school system I, two schools from school system F, and one school each from school system A, B, E, G, and H were visited. During these visits, I interacted with a total of 21 teachers who had participated in the workshops.

Table 3.6: Details of school visits.

Sr. No.	School System	Name of the school	Teachers involved	Time of visit and frequency
1	I	I-B	SU-C	After W3 (1)
2	I	I-A	MA-C	After W3 (1)
3	I	I-M	RA-C	After W1 (1), W2(2), W3 (2)
4	I	I-K	NA-C	After W1 (3), W2(2), W3 (1)
5	I	I-P	RO-C	After W3 (1)
6	E	E-M	KA-M, NA-M, AR-M	After W1 (3), W2(2), W3 (1)
7	A	A-G	SU-A, SH-A, BH-A	After W1 (3), W2(1)
8	A	A-D	AD-A	After W1 (2), W2(1)
9	G	G-E	AN-E, PR-E	After W1 (2)
10	F	AE1	UM-A	After W1 (3), W2 (1)
11	F	AE4	VI-A	After W1 (3)
12	H	H-S	PR-A, ZA-A	After W3 (1)
13	B	B-C	SH-C, TA-C, PR-C	After W1 (3), W2 (1)

3.5.6 Participant students who were involved in the PBL unit in Phase III - Stage 3

I approached a neighbouring English medium school run by an independent Central Government department, that follows the CBSE curriculum and requested the principal if students of Grade 6 would volunteer for a workshop. A total of 20 students were selected through application to participate in the workshop. Fifteen (15) students (6 boys and 9 girls) registered on the first day and were present on all 5 days. The mean age of the participants was 11.2 years and the ages ranged from 10 to 12 years.

Students worked in 3-member single sex groups (2 boys groups, 3 girls groups). Single sex groups were preferred as it was found in an earlier study that such groups showed greater intra-group interaction than mixed groups did (S. Mehrotra, 2008).

3.6 Data and analysis

This qualitative study has used multiple methods in its design across the three Phases. It has attempted to uncover the inner experiences and participants' views and practices of PBL as it was assumed that meanings are situated in teachers' world. There was a humanistic bent towards the entire engagement that helped build trust in the self and helped to see the value in the work that is produced (Corbin & Strauss, 2008). The following subsections present brief descriptions of data collection and analysis of data made in different phases and stages.

3.6.1 Phase I

In Phase I, interpretive analysis of relevant policy and curricular documents for specific aspects like projects, activities and assessment (CCE) was done. The four policy documents (NCERT, 2005; GoI, 2009; NCTE, 2009; MHRD, 2020) were read multiple times. Along with these, textbooks published by NCERT and Maharashtra State Textbook Bureau, the CBSE circulars and other curricular material were also read. Informal conversation with teachers and colleagues indicated that there is an increased focus on CCE, project practices, and activities in school. This guided the reading of the documents and I focused on how the project and CCE are presented in these documents. The relevant portion of the four major documents were copied and other documents were summarised.

The CBSE circular on pragmatic solutions given for reducing the burdensome aspect on project and criteria of PBL helped develop a framework to categories the proposals of PBL, activities, CCE, and other curricular areas. The proposed solution of reducing the burden on teachers and students due to new policy directives requires a collaborative engagement of researcher and teacher. Therefore, literature on TPD and aspects of TPD in the policy documents were also searched for.

3.6.2 Phase II: Stage 1 & 2

In the FGD and individual interviews, teachers were asked to describe (Eley, 2006) their conduct of projects. Responses through FGD and interviews were audio and/or video recorded after obtaining permissions from participants. The records were transcribed verbatim by me and extensive notes were taken during the interviews. These transcripts helped categorise the responses under different headings to primarily identify ideas related to the four major aspects outlined earlier (subject integration, assessment, group work and classroom management). Segments of utterances were chosen as the units of analysis. The emergent patterns were then shared and discussed with the supervisor and disagreements were resolved and the classification into aspects was finalised.

3.6.3 Phase II: Stage 3

The analysis of responses received from questionnaire survey was done separately for teachers' views about projects and their practices. In response to the open ended questions, teachers sometimes wrote whole sentences and sometimes wrote only phrases or just a word. Hence the units of analysis in the free responses were sentences, phrases or words. The words and phrases were counted together, compound sentences were divided into simple sentences and then each was counted. In some cases two sentences were coded as one as they made sense only when taken together. In some cases, a phrase or sentence had multiple ideas each part of which was coded separately. The latter sentences or phrases were associated with multiple codes.

In response to the four open-ended questions, teachers gave a total of 233 words and phrases, and 304 sentences including compound sentences. Among all these, 13 sentences, and 5 phrases and words were not coded as they merely repeated the statement in the question or were unrelated to projects. From the total of 537 units given by teachers, 688 coded units emerged.

Final coding scheme evolved after several iterations. Ten categories are found to be relatively independent to each other and are discussed below:

1. **Characterising projects:** These include the description(s) or characteristics of project method which refer to a name e.g. "learning by doing" or kind of pedagogy e.g. "open ended enquiry" or qualify the project method e.g. "innovative".
2. **Content covered:** These include the mention of content in terms of topics or themes covered or addressed in the project. Teachers' mention of general and specific content is coded separately.
3. **Quality and ease of teaching-learning:** These include responses that state that a) it is easy to teach through project, b) students easily learn in projects, c) students learn better through projects, d) project work enhances students knowledge, concepts, skills etc., and e) project work enriches teacher too.
4. **Role of teachers:** This includes a mention by the teacher on his/her role in helping students' learning and structuring and managing projects.
5. **Students' tasks:** This category includes the mention of student tasks in projects in terms of a) specific name of the tasks or students' productions, b) students' cognitive engagement excluding application aspects, c) students' application of information, knowledge, concepts, and skills, and d) students' managerial engagement with the task.
6. **Collaboration, communication and community aspects:** These include the responses that refer to aspects of a) collaboration and group work, b) communication aspects, and c) community aspects.
7. **Students' feelings and views towards projects:** These include the responses that refer to the affective domain in the context of students and projects.
8. **Students' autonomy:** Responses that mention students' ownership in the project in terms of learning, planning, and doing the projects.
9. **Assessment of students learning:** Responses referring to assessment of students learning or grading.
10. **Role of policy and school guideline:** Responses that include the role of policy and school guidelines like participating in science exhibitions.

Responses on the Likert Type scale were simply tabulated and percentage of responses were calculated. Teachers' responses on project practices were first tabulated and later categorised on the basis of proposed PBL criteria after several iterations.

3.6.4 Phase III: Stage 1

Participants' productions during and between workshops were in the form of write-ups, completed worksheets and online communication. Data was also collected in the form of audio and video recordings of discussions, presentations and interviews of teachers between workshops, and researcher's observation notes. The audio recordings were transcribed verbatim. The recorded conversation and videos were heard several times and some emerging points were identified and the notes were edited accordingly. The text from the recordings and written responses were analysed for the five criteria of PBL adapted from Thomas (Thomas, 2000), along with three key aspects that emerged during the first workshop. The change in nature and frequency of references to these aspects in these productions were also analysed to infer the evolution of participants through the TPD engagements.

3.6.5 Phase III: Stage 2

Researcher's observation note, audio records of conversation with teachers and students, students' productions available at the time of school observation or shared by teachers over email consisted the major sources of data. One teacher (MA-C) sent her project format by a postal letter after the first workshop and I visited her school. Another teacher (VA-S) shared her project implementation over email after the first workshop, however, I was unable to visit her school. The analysis of the data was done similar to the approach adopted in the previous stage.

3.6.6 Phase III: Stage 3

The major sources of data in Stage 3 of Phase III are the researchers' field notes and students' productions. Researchers' notes were written independently by me and an observer. I had requested colleagues in my department to observe the proceedings and write notes of their observations. Three other observers also made notes and shared these in a Google document. Some notes were short and delayed. Most notes were written within a period of less than three hours after each activity and the delayed notes were often written 24 hours to 7 days later. There was more than 95% agreement between the researcher and the observer notes. The differences were resolved through discussion.

Students' productions were maintained in group portfolios and were an important source of data. Each portfolio included the following productions: personal information sheet, playground measurements, a 10 items list, 5 favourite items list with justification, design exploration, technical drawing, plan of action, materials list, evaluation sheets and a write-up on the making experience.

3.6.7 Ethical considerations of the study

Some ethical considerations that were observed are enumerated below.

1. A brief description and nature of work was explained to the school authority, such as the Principal, management committee etc.
2. Parental consent was taken before the involvement of the students in the project.
3. Attempt was made to ensure the safety of the participant students during the project activity through supervision and providing support while students were engaged in cutting and drilling objects in the project.
4. The names of the participating schools or participants were not mentioned in any published articles or papers that contain analysis of the work. Every effort has been made to keep the data anonymous to the people outside the research group.
5. The video and audio data taken during the study are heard only by me and my supervisors. The visuals taken during the study in the form of photographs were used in limited platforms.

Chapter 4

Teachers' views on and practices of projects

This chapter presents the findings from the studies carried out with teachers to know about their views and practices of projects. These studies were carried out in three distinct stages and learning from each stage informed the next stage. As discussed earlier, a focus group discussion (FGD) was organised in the first stage with teachers of one school. In the second stage, four individual semi-structured interviews were conducted and the findings from this study have already been published at different platforms (Shome & Natarajan, 2013a, 2013b; Shome, 2013b). The last stage included a survey of views of teachers who participated in the first workshop of the workshop series.

Learning from these stages helped develop materials and also to structure the content of the sessions in the workshop series. Specific materials were prepared for the areas that were suggested by teachers. The discussion and findings from these stages gave an idea about teachers' views about projects and their practices of projects in the respective schools and representing school boards. This helped organise discussions, cite appropriate examples and more importantly understand the content and context of teachers communication in Phase III. These learning also helped design specific kinds of interventions during the workshop and were useful in providing feedback and inputs during school visits.

The following sections introduce learning from each of the stages. Each of the sections first introduces the findings in terms of teachers' responses, then presents an analysis of the responses and finally shares the insights gathered.

4.1 Learning from the FGD

In this section, the teachers' responses in the FGD are presented in two parts. The first part covers the teachers' responses about the practice of projects, while the second

part is related to the teachers' responses about the proposed model of PBL, which was shared by the researcher with them. This section also presents the analysis of the responses in the context of NCF 2005 (NCERT, 2005), NEP 2020 (MHRD, 2020), and Upper Primary and High School Textbooks of Maharashtra State Textbook Bureau.

4.1.1 Practice of projects

Teachers shared that there are primarily two kinds of projects carried out in schools. The characteristics of the projects that were highlighted are presented in the Table 4.1. Type I projects are conducted with students of classes from 5 to 8 while Type II projects are conducted with students of classes 9 and 10. The details of both types of projects are given below. The current section also covers teachers' views regarding students' constructive engagements in projects, resources used in projects, support provided to students, and finally challenges associated with conducting the projects.

Table 4.1: Types of projects and their characteristics.

Types of projects	**Class**	**Group or individual**	**Subjects dealt with**	**Subjects integrated**
Type 1	Grade 5 to 8	Group or individual	Marathi, history, geography, mathematics, or science	No
Type 2	Grade 9 & 10	Individual	Environmental studies (EVS)	No

Type I projects

Teachers stated that students are given both groups (consisting 5 - 10 students) and individual project work. Students are generally assigned group projects in the beginning of the academic year, while individual projects are assigned half-yearly. Themes are drawn from the textbooks and are mostly taken from the lead activities/projects given at the end of the exercises in the books. The topic/themes could include, accounts of historical places, historic events (e.g. Dandi March), biographies of personalities or national leaders, types of leaves and related botanical details (venation, root systems etc.), study of polynomials, triangles (types of triangles), how day and night occur, census reports, and analysis of select textbook photographs etc.

The themes are selected by the subject teachers and a student has a choice to select from these themes as per her/his interest. Subject teachers help the individual class teachers by suggesting several ideas of project themes or topics. Ideas for projects are also contributed by parents during the parent teacher meet in the beginning of the academic year (during June-July). Teachers noted that sometimes students' ideas are too ambitious to execute, and some ideas are ignored due to technical difficulties. Hence, teacher guidance in selecting project topics is important.

Teachers opined that themes from mathematics, science and geography were most preferred for projects as there are possibilities of constructing working models in these subjects. Such projects often receive greater appreciation in project competitions too.

Teachers E and F felt that for these subjects, there is a possibility of merging 2 to 3 group projects into a single good project especially for science exhibitions. Thus, it was apparent that the choice and process of group project activity is driven primarily by science exhibitions or competitions.

Teachers mentioned that the project activity generally starts with an idea from the teacher followed by students' activities that involve collecting information and getting teacher approval from time-to-time. Students showed their rough sketch /draft and proceeded ahead only with the teacher's "green signal". Teachers justified this process by saying that it prevented loss of time and money as the making of charts and booklets involved both these resources. Teachers also mentioned that a lot of inputs came from parents.

The project productions depended on whether these were group or individual projects. In individual projects students make charts, write essays or prepare booklets. In group projects, students generally make working models or demonstrations or 3-D models. In science, the focus of projects is generally on making working models. Teacher E mentioned a term "corner projects" which involves students making charts and displaying them on classroom walls. The themes of these corner projects are textbook based and usually involve writing mathematical tables and formulae, definitions in science or rules of English grammar, etc.

Teachers were able to recount some examples of group projects: (a) A visit to Sanjay Gandhi National Park and study of different kinds of plants and animals; (b) Study of medicinal plants; (c) Study of rice varieties where students had detailed information of 32 rice varieties grown; (d) Thermo-glue, etc. In fact, they mentioned that the thermo-glue project was selected at the State level project exhibition. It is interesting to note that teachers also shared that these projects carry 10 marks and are assigned as homework activity. It was unclear how such diverse project tasks assigned to students are assessed using a single overall score.

Type II projects

These are the Environmental Studies (EVS) projects assigned to individual students of Class 9. These projects are called "Area Study". Teachers said that these are typically short projects, such as a report of a visit to a place by students. This could be either a historic place or even a report on a picnic. SCERT provides guidelines for conducting and reporting the projects, which are submitted in the form of descriptive essays. The guidelines for writing the visit reports include; an introduction and historical account, maps and geographical details of the place, details of the flora and fauna, interesting activities at the place, such as bee culture etc. The writing activities are usually conducted by the students during the vacations after the first term.

The evaluation of these projects is based only on the submitted student report, no oral or formal presentations are made. These reports are marked by the class teacher and then converted into grades. When I was conducting this study, EVS was a subject whose grades were generally not included in the total grades, but it was assessed

like some other subjects such as social service (samaj seva), personality development (vyaktimatva vikas), or arts (kala).

EVS had a theoretical component for 60 marks. The remaining 40 marks were reserved for the project work. The total of these two components (theory and project) was converted into grades following the guidelines set by the State Board. The teachers could not recollect the exact scheme for converting the marks into grades, but said that nobody fails in this subject. The projects submitted by the students are examined by an external examiner in class 10 and the grades bear his/her signature. Teachers also stated that there are project books available in the market produced by private publishers and students use these to organize their report in the given format.

Students' constructive engagements in the projects

Teachers had a mixed response towards effectiveness of the projects in terms of students' learning and benefits. On the positive side, teachers noted several beneficial outcomes of project work. They felt that during project work students do engage in gathering information from sources such as library, Internet, and newspapers. Project work also affords enhanced interactions among students. A science and mathematics teacher, F, shared her experience with a trigonometry project where a comparatively shy and silent student seemingly uninterested in mathematics appeared highly motivated when engaging in a project activity. Teachers mentioned that some of the projects prepared in science subjects are "very good" and are sent to science exhibitions, while some of the products generated from projects, particularly the charts, are used as teaching aids,

Some teachers however responded that projects don't contribute much to the learning of students. As example, two female teachers teaching science and mathematics at Grade 9 and 10, shared their experience of some students who reproduced their reports from the earlier project reports. They stated that there is also a widespread culture of blindly copying each other's work. Interestingly, all the teachers agreed that the current format of project assignments did not benefit most of the students.

Resources used in project

The teachers said that they appreciate and encourage use of less expensive, recyclable and easily available materials for making models, especially because children can get these materials themselves. Teacher H, mentioned that projects using such materials are usually appreciated in science exhibitions and this was the reason why teachers encouraged use of such materials.

Support provided to the students during the project

Teachers mentioned that students are expected to bring the completed projects (done as homework) to the school after the first semester break. However, teachers can be approached for guidance as and when required, in fact during the vacation period teachers can be contacted over telephone.

In group projects, there may be differences among members of a group. In such cases, teachers stated that they intervene and distribute the tasks among group members and provide orientation and give feedback at several points in the development of the project. This also becomes a means to ensure that each member in a group contributes to the project. This justification came from all teachers except teachers I, J and K who were D.Ed. interns (student teachers).

Difficulties and challenges associated with projects

Certain problems related to project activity were also presented by teachers. Teacher F, believed that there is a 'rat race' for marks which burdens the students a great deal. Thus, the time constraint influenced the students' involvement in the project. Besides, students' engagement in projects was compromised as they had to spend time doing homework related to other school subjects. Other teachers supported this response.

4.1.2 Teachers' responses to the proposed model of PBL

During the conversation, teachers were probed for possibilities of modifications and improvements in the proposed format of the projects. The aim was to explore teachers' views about the different elements of the proposed PBL. These responses are discussed below.

Potential of the projects in enhancing students' learning

When asked if the teachers themselves support and encourage the idea of doing projects, a number of ideas surfaced. Some of these include, working in groups enhances student rapport, their ability to work as a group, develop a scientific temper, increases intelligence and enjoyment, encourages creativity, provides a way for expressing and sharing ideas among students as well as promoting self-study. Teacher F, felt that the projects should be 'application based' in order to contribute to students' learning, and teacher, G, expressed that students would benefit if the project themes are taken from the prescribed textbooks.

Even though teachers stated that the existing format of projects do not add much learning to most of the students, they preferred retaining these projects as part of the school curriculum at least till class 8 for two main reasons. Firstly, the project

marks help in increasing a student's overall score in the respective subject. This fact motivates the students to submit the project work. Secondly, the projects prepare students for a subjective way of answering questions, a necessary skill for board exams. Teacher H, justified his position stating that the questions asked in examination for class 8 were objective type whereas in class 9th and 10th examination, students are asked subjective questions.

Possibility of teacher collaboration

Teachers reported that they don't collaborate with other teachers in project work. When they were probed on a hypothetical situation wherein teachers teaching different subjects could come together and decide to cover some portion of their subjects through a common project, almost all teachers overruled this suggestion. Teachers, B, C and D were of the opinion that such projects can be done provided they were longitudinal in nature and spread over 2-3 years. Teacher I, J and K favoured the idea that such a thing could occur at the college level.

Possibility of subject integration

Teachers noted that projects assigned so far did not require subject integration. However, there are possibilities to integrate two or more subjects. According to a science and mathematics teacher (F), science and geography can be done together and at the most science and mathematics could be combined. However, she argued that projects in language needed to focus on grammar or vocabulary and therefore could not be integrated with other subjects. When I inquired whether science and history could be integrated, teacher F vehemently opposed the idea. However, teacher H also teaching science and mathematics stated that it was possible to do so to some extent, like writing names of the scientists, year of birth, their contribution etc. Listening to teacher H, teacher F and a few other teachers agreed to the same. They stated that it is an opportunity to know the history of science and scientists while integrating science and history projects. Teacher E opined that the combination of history and science is possible, however, she felt that it would be a forced combination. In fact, she expressed that all teachers during their B. Ed. courses are encouraged towards drawing 'all correlations' across subject areas.

Participants also highlighted a concern of having less number of project topics in certain subjects, e.g. mathematics and geometry. The only two sub-topics that were given for project assignments were types of triangles and types of sides and angles. Teachers suggested a way to resolve this issue by repeating the topics in different years.

Time management

According to teachers, there is not enough space in the time table to conduct projects. Teacher B and H, opined that if the time allocated for other subjects such as social service and personality development was reduced within the time-table, it was possible to dedicate more time in school for projects. In their opinion, these subjects were of less relevance or less significant to them.

Teacher A suggested that the existing time duration for class periods from 30 minutes be changed to one hour. However, other teachers were opposed to the idea. One of the reasons for the opposition was that it creates a psychological burden on the child to "listen to one teacher continuously", especially when students are not interested in a particular subject. Besides, Teacher G said that it would be difficult to cover the entire syllabus in the modified time-table. Apart from time constraints, teachers also cited difficulties of managing individuals and the number of projects as well as dealing with parents and their complaints.

4.1.3 Analysis of responses and learning for the next stage

The responses by teachers provided insights on the existing project practices and teachers' views on projects in the school context. Teachers' responses on the proposed aspects of projects gave some nuanced understanding about the reality of school context.

It was evident that teachers assign projects to the students and the projects are mostly given as homework. These projects are generally taken from the textbook, and could be limited to preparing charts. Making working models for exhibition purposes are highly preferred projects especially in the science domain as this could lead to winning prizes in competitions. Teachers indicated that support was provided seldom to the students regarding doing projects. Teachers themselves noted that most students did not learn much from the current format of project assignment. It was evident the projects were not used in the classroom for teaching-learning and the learning from conducting these projects was not shared in the classroom. Therefore, these projects do not follow the criteria of centrality and constructive engagement. These projects are also not orchestrated around a driving question or problem context.

Some teachers noted that there were students who learned from the projects. They further mentioned that this learning was with reference to skills of gathering information and also about group work. Some teachers expressed that students could learn some important skills and abilities like group work, scientific temper, intelligence, creativity, presentation skill etc. while engaging in projects. Interestingly, despite agreeing on the learning potential of project assignments, teachers preferred to keep projects out of the school time table citing pragmatic limitations like constraints of time.

Teachers stated that students engaged in project compromise time spent on other subjects. Such statements clearly indicated the fact that a lower position was given to projects. Improving grades due to the project was highlighted the most by the teachers.

Teachers showed preferences to mathematics, science, geography, and environmental studies for conducting projects. The rationale for such a preference was based on the fact that such projects present greater opportunity of making a working model. The purpose of projects seemed to be driven by a need for winning awards. Interestingly, these projects often did not emerge from the deliberations in the classroom or regular project based pedagogic approach in school. Some of the projects prepared by interested students or able students under parents guidance were those primarily selected for presentation in exhibitions or competitions.

Students autonomy and authentic engagements was not the prominent point highlighted in the responses by teachers regarding projects. In individual projects, students had to do very simple tasks in a prescriptive manner. Teachers agreed that largely parents support the students to complete the projects. It was heartening that students have more autonomy while carrying out group projects. Students of only a few selected projects get the opportunity to present their work to the wider community i.e. to the authentic audience. However, other elements of authentic engagement like authentic problem context and purpose, authentic assessment, and collaborative group work are generally absent in these project practices.

Teachers mentioned that obtaining material resources for conducting projects is not a challenge. This was surprising, but it indicated that schools might not engage with material arrangement for projects and probably it was the responsibility of students and parents. Teachers' role in distributing tasks among students also seemed similar to the managerial support to the students rather than as a cognitive mentor.

Teachers argued that projects need to be "application based" and topics of the projects should be from textbooks. The first suggestion has potential to partially satisfy at least two criteria of proposed PBL like 'constructive engagement' and 'authentic context'. Similarly, the second suggestion satisfies the criteria of centrality. Teachers do follow this approach while they select project topics from the textbook. However, these projects were not integrated as resources for classroom learning except using charts as teaching-learning materials. Also, there was a lack of clarity on the term "application based" project.

Teachers' advocacy for retaining projects for merely getting higher scores shows a narrowness in the assessment culture of the education system. This showed an influence of external factors or a dominant social force that prefers "performativity" over meaningful learning. In a similar fashion, retaining projects in order to practice writing long answers is again a reflection of assessment in upper primary classes. The fear of high stake examinations haunts teachers to such a degree that they prefer to continue project pedagogy in the current format to give students practice of writing or mostly copying long answers at the cost of uncertain learning.

Teachers denied the possibility of teacher collaboration, and the possibility of subject integration was limited to a few subjects. Even teachers' professional experiences in B.Ed seems to be ineffective in this case. Visualising possibilities of subject integration depends on how teachers view subjects and the content of subjects and teaching background. Understanding of subjects as well as how they are taught in school has

an influence on how project opportunities are explored.

Teachers were not ready to replace the time allotted for major subjects with the project work. One teacher suggested extending the class period duration from 30 minutes to 1 hour. This proposal is consistent with the time duration proposed by NCF 2005 for conducting projects. However, the concern was raised by other teachers against this proposal. They felt that students would find it monotonous to listen to the teachers for an hour. Such arguments indicate that teacher talk dominates in classrooms and probably teachers do not engage in diverse activities (including project work) with students. Teachers were worried about the time required to assess many projects, indicating a need for planning assessment and group work in a way that would address the concern of time constraints of teachers. Policies do suggest the adoption of peer & self assessment, not yet practiced in school.

In this discussion with teachers, all elements and aspects of the proposed model of PBL could not be explored. Those aspects that were explored could not be discussed in considerable detail. e.g. how to make group work and assessment more effective could not be adequately explored. The sacrosanct time table seemed to be a hurdle and no modifications seemed to be possible in it according to teachers.

4.2 Learning from individual semi-structured interviews with four teachers

The learning from FGD discussed in the previous section led to a more in depth study on teachers project practices and views towards the proposed model of PBL in the individual semi-structured interview mode. This section presents a short descriptive sketch of the teachers' responses about their project practices; views on projects, the four aspects of PBL proposed to them, and implementability of the proposed PBL in the school. Additionally, the discussion about their responses in the light of existing literature on PBL and related domains and the takeaways are also discussed below.

4.2.1 Teachers' project practices

Regarding project practices, teacher AB mentioned that she conducted projects primarily for two different purposes. In Maharashtra State Board, it was mandatory for every student to submit a project report in the final school year. To meet this goal, AB said she suggested a few project topics in class, and students chose a topic but AB expected the students to work without her help. The second motivation for AB's project practice came from science exhibitions. She guided one project each year among a group of 4 to 5 students selected by her and mentored it for participating in the competitive science exhibitions. These projects were meant to motivate students to solve real world problems in innovative ways. Following her school guidelines, teacher AM periodically conducted and graded her middle school students on six projects each

year. Each time she assigned a project to the whole class on the chapter content to be addressed during a specific period, on which students had to work individually and submit reports. The projects mostly involved collecting information or samples and presenting them neatly, for example, in a scrap-book format.

Like AM, teachers DB and CS too had to conduct projects as part of formative assessment guidelines, however, they were assigning projects and activities more frequently. For both DB and CS, projects were short activities and largely involved collecting information. They both conducted weekly as well as longer term (2-3 months) projects. Teacher DB stated that she made a detailed lesson plan with her colleague one or two months ahead of teaching a lesson, which included activities and projects.

4.2.2 Teachers' views on projects and proposed aspects of PBL

Teachers' views on projects and their responses to the suggested changes in project practices in terms of the four aspects viz. subject integration, assessment and learning, group work and learning and management are presented here.

Subject Integration

Teachers AB, CS and DB felt that it was possible to conduct projects that integrated topics from different subjects. Teacher CS recalled an instance, where she gave a project topic from the Hindi (language) lesson that she had chosen because the topic was common for Hindi, Geography and History. However, she accepted that most of her projects were on one topic. Teacher DB had integrated content from physics, chemistry and biology in several of her high school level science projects and AB though had not conducted subject integrated projects, she could cite several examples of such projects:

> ... you took battle of Plassey, you went to 1857 ... in history ... geographical feature of that time is represented in geography project ... renaissance during 1857 ... what discoveries in science took place ... English can be included ... Language will come ... specially the great literature that was there at that time.

She also thought that these were better than projects based on a single subject. She raised the concern that it was difficult to teach all topics in a subject through projects, and impossible for teachers to provide adequate guidance to students for doing these kinds of projects. Teacher DB too cited an example of a project integrating different subjects:

> We can develop a project on global warming where we can take up science, social science, and some calculations from mathematics ... English ... Hindi

> is always there. Language they need... to write or execute the process. So all subjects can be integrated.

On the other hand, teacher AM felt that subject integration was not possible in projects. All her projects were about collecting information and pasting these on charts or books. She felt that ensuring better learning through practical experiences in science was more important than subject integration. She mentioned that science teachers worked with geography teachers in preparing a working model of a volcano for science exhibitions. However, this model making activity did not seem to contribute to learning either the science or geography of volcanoes, though the teacher did not refer to this problem.

Teachers in the study gave primary importance to textbook content, but believed that all students did not learn the required textbook content by doing projects. Three of the teachers cited multiple examples of project topics that could integrate more than one school subject. They also agreed to the proposed aspect of subject integration.

Assessment

The four teachers differed about the practice of assessment, its goals, as well as the learning associated with projects. All four of them assessed only students' final productions in projects. Teachers CS and DB referred to better learning through projects, while AM referred to students gaining practical knowledge in science. In the projects aimed at exhibitions that teacher AB conducted, she focused either on the functioning of the model or on the conclusions of investigations rather than any topics in the syllabus.

Though they had different learning goals for projects, the assessment criteria by teachers CS and AM were similar. Their criteria included "quantity and correctness of information", as well as "neatness, attractiveness, systematic (presentation)". Students were not informed about these criteria used to evaluate their projects. The emphasis on aesthetic criteria meant that students with similar levels of conceptual understanding may get different project grades because of aesthetic differences. Teacher DB and AB used criteria like students answering questions related to their own projects, and the teachers' overall evaluation of students' productions. It was interesting to note that all the teachers were aware that parents and elders often did the projects for most students. However, they felt that they could do nothing about these practices.

The teachers did not have difficulty in assessment of projects, though they found it time consuming. Teacher AB believed that teachers having long and varied experiences in assessing students, were "expert" at quickly assessing each student's contributions in a project. Teachers DB and CS felt that the CBSE mandates on assessment posed a challenge for teachers like them. They had to strike a balance between the traditional written test and multiple forms and modes of assessment in projects, activities, observation of students' behaviour and attitudes, etc. They had to assess individual students, even though project reports were sometimes submitted in groups.

Teacher DB did not perceive subject integrated projects as a possible solution to the frequent assessments, and multiple projects on disconnected topics that she was already engaged in. In response to the researcher's proposal of embedding written assignments within projects, teacher DB felt that this would create more assessment work for her and if they are not assessed, parents would be unhappy.

Even those teachers, who had explicit assessment criteria, did not feel it necessary to communicate this to their students. They felt it was sufficient to just assign tasks to students. All the teachers also stated that students could not be assessed while the project was in progress. According to AB, this was difficult because students were often involved in off-task activities. According to all the four teachers, self and peer assessments by students were neither reliable nor helpful. They felt that students favoured themselves and their friends.

When explicitly asked about the benefit of providing feedback to students during their project work, all except teacher CS supported this. Teacher CS perceived that giving "feedback" would give away the correct answer or expected result of the project. Hence she feared that all students would generate similar products and reports. Besides, this would interfere with one of the perceived goals of assessment, namely, to differentiate students' performance. On the other hand, she happily recalled her earlier experience with her Class VI students, who came up with "wonderful projects" after she had given them "some inputs."

All the teachers except AB planned their projects based on the textbook topics they had to cover, though they did not use projects as a primary pedagogic strategy for student learning. Teacher AB had a more complex view. She felt that students learned minimally from the whole class projects that she assigned to satisfy the examination requirements. She conceded that the students she selected and guided for project exhibitions learned a lot, though she did not care whether it was related to textbook topics.

All the teachers opined that all students would not learn by doing projects. However, they justified their opinions in different ways. Teacher AM stated that not all students were able to work on their own to collect information or bring appropriate samples. Teachers DB and CS, however, pointed out that most students went to private coaching classes and hence did not find the time after school hours to complete all the different projects assigned to them. Thus, it sometimes led to situations where parents played a major role in completion of their projects. In such situations, students lost the learning opportunities integral to the projects. Most students in a class did not even make the effort to collect information. According to teacher DB, these students were "very lazy" and they wanted their teachers to provide all the answers. All the teachers felt that there were a few students in each class who were sufficiently interested to complete their own projects.

Teacher AB's projects did not call for reading of textbooks or other related materials by students. According to her, an "average child" (implying an average performer in academics) would not learn through projects, as they would not understand what was required to be learned in the topic unless s/he read textbooks. Following her arguments

she suggested that learning could be supported and assessed among students, who perform above average, by providing worksheets at the end of each project. Her idea was that worksheets would set learning goals for students, and help them work towards these goals. Teacher AB's ideas of a project and her concerns were evident in her statement:

> Suppose you are taking chemical reactions and their types ... if you just show in the laboratory has different reactions ... displacement reaction ... combination reaction ... your project-based learning completed? You said ... so you learn now. ... Children will not read this ... Otherwise you have to deal ... really with a group of students who are little above (average) ... You will finish the project and provide the worksheet ... They should answer the worksheet.

Although policy recommendations required teachers to conduct multiple forms and modes of assessment, teachers limited their assessment to grading students' final productions. The learning goal was either not stated or restricted to a few. Teachers rarely used any assessment criteria to assess her students and when used, they were not shared with the students. Sometimes, the assessment criterion was not aligned with the learning goals stated by the teachers. All the four teachers did not find any need to share the assessment criteria with their students.

Teachers' views on peer and self-assessment did not match with the recommendations of NCF 2005 (NCERT, 2005). They viewed self and peer assessment, in their classes of over 40 students, to be impractical and unreliable, as students were not "mature" enough to grade "impartially."

Group work

In response to teachers' problems of projects not benefiting all students, and not finding time to help all students, the researcher proposed that students could work in groups, each including students of different abilities. Though teacher AB agreed that in such groups all students would learn by helping each other, she continued to feel that teachers did not have the time to provide the necessary guidance to keep students focused on project related tasks. Teacher AM had never thought of conducting group projects, but doubted the possibility of grading individual students when they had worked in groups.

Although teacher CS shared her happy experiences about doing group work with students, she was unhappy about students in a group receiving the same grade despite contributing to a different extent and in different ways. Because of this, some students did not prefer group projects, especially those who sincerely contributed to projects, or those who were competitive. Teacher DB always conducted her projects in groups. She found that only about a fourth of the students were able to complete the tasks on their own. She felt that group work would be beneficial for students from a "higher" socio-economic background:

> Here we have variety of children, some are from very high class background, the parents are not only socially but even economically higher... so they are able to do better than other(s). We have to think about others.

The teachers felt that group work was not practical among their students. And they reasoned that teachers' lack of time, students belonging to diverse socio-economic strata in their classrooms, and students' lack of interest pose challenges to students working in groups. Teachers were also unsure about the learning from projects by all students.

Classroom management

Teachers found time a major constraint in conducting projects. Other management issues included disinterest of parents and students in doing projects, large class size, and limited access to library. No teacher mentioned the constraints of resources - laboratory material, stationary material etc. For teacher AB, it was important to provide a (physical) space for students to exhibit their products, consistent with her goals of participating in exhibitions.

Teachers DB and CS felt that by including activities as they normally did, they were able to cover the topic in less time than they did with routine chalk and talk. Teacher DB needed two consecutive class periods to present and discuss the activities and projects. Both the teachers felt that students were often unable to complete their tasks in the school and were too burdened with private tuition to do projects outside school hours.

However, in response to the new proposal for projects that integrated topics from different subjects, and involved extended work in groups by students, including assessment, both DB and CS felt that such projects could be conducted at best once or twice a year. Teacher CS found it very difficult to assess projects in addition to the every day assignments. Teachers DB and AB pointed out that there was insufficient time during school hours to bring together teachers from different subjects to plan, guide and assess projects including topics across subjects. These teachers taught for an average of 36 periods (each of 35 minutes) of a total of 50 school periods per week. This context of work was captured in teacher AB's statement:

> Teacher has lots of work ... preparing question papers and checking answer sheets ... Complete the course ... control the class ... these fifty students are behaving differently ... Moreover, each day someone (teacher) is absent ... attending (to) that class.

Teachers DB and CS stated that parents perceived projects as a waste of time, and time away from studying. They argued that there was an increase in the number of projects as a consequence of the new policy of continuous and comprehensive evaluation (CCE). They felt that parents, who were not yet familiar with the requirements of CCE, were burdened by projects, and considered it an extra effort for the students.

On the other hand, teachers AB and AM observed that parents were happy with students doing projects. Early in the interview, teacher AB had stated that it was difficult to implement projects for the whole class (50 to 80 students) having varied student performances and interests. Those students, who were interested in projects, preferred doing activities to reading the textbook, and made models and other products outside school hours, with help from parents or friends.

Although teachers did not agree to many of the aspects of the proposed PBL model, three of them asked for a systemic change to make the proposal functioning. Teachers did not feel empowered to bring about changes in classrooms needed to implement the NCF 2005 suggestions. The tensions between addressing policy requirements within the systemic and social constraints, may be resolved by enabling the sharing of the educational goals and expectations among all its stakeholders, especially, school management, teachers, researchers, and policy makers. Teachers' resistance to projects is due to its inherent contradictions.

Implementability of the proposed project model

Towards the end of the interviews, teachers were asked their views on conducting projects as suggested by the researcher. Teacher AM, whose projects merely involved information collection, saw little scope for altering her views during the interview, and remained negative to the proposed changes. The views of teachers AB, DB and CS evolved as the interview progressed, though each to a different degree on the four aspects. They became more positive towards changing their practices to integrate some of the aspects in conducting projects, though they were negative about, and their views remained unchanged, on including peer and self assessment in projects. They sought modifications of the existing systems in schools and policy, like providing support to teachers, changing the existing assessment policy, and school management of scheduling and intake.

Teachers AB and CS expressed that they needed guidance in developing and conducting projects, largely in terms of academic inputs. Teachers AM and DB did not seek such support, and DB was more confident of conducting projects. Teacher CS expressed a need for guidance and support only in the initial years. Teacher AB, on the other hand, was unsure whether just a series of collaborative workshops with teachers in developing PBL modules would ensure their implementation in classrooms.

Teacher AB stated that, given the present policies on projects and assessment, implementation of the researcher's proposed PBL model would require continuing support and efforts as teachers did not have the time to invest in it. According to her, teachers would follow the project method, even without external support, only if there were policy pressures to conduct projects with assessment at the middle and lower classes. Such pressures did not exist in her school board. When asked how teachers would then find the time for doing projects, teacher AB responded:

That (the) department will think how to do what ... One 10 marks ... unit

> test (can be) discarded. That unit test ... will be on the projects. Then you need not prepare so many question papers ... check so many answer sheets ... it's project ... Then teachers will enjoy.

Teacher DB seemed to converge on the view that she already had the aspects proposed by the researcher in her plan of projects. However, in order to implement the aspects as the researcher wanted, she suggested system changes:

> Whatever, you are saying is possible only if we change the system ... and we have children from same background. In this type of learning ... if parents and teachers contribute equally for the development of the child ... I alone cannot change the system. You alone cannot change the system. We need some(one) ... from outside ... from inside ... from them (parents) ... from everywhere.

The systemic changes that the teacher needed involved (a) parents and teachers working together, (b) homogeneous classes – students from the same (preferably upper) socio-economic background, (c) adequate library facility, and (d) school scheduling that allowed time for students to use the library and for teachers of different subjects to work together.

4.2.3 Discussion

Teachers AM, DB and CS conducted projects in their respective schools because of the mandate of the new CBSE policy. The mandate states that projects must be part of formative assessment, but the number and frequency of projects is not prescribed. Besides, assessment practices are decided by schools or school systems, and teachers of different subjects have limited flexibility to interpret these practices. Hence, the number of projects conducted by teachers interviewed differed. While AM conducted a project per unit-test exam and the parents did not complain, teachers DB and CS assigned multiple projects and activities for each test much to the dislike of the parents and even the teachers found it a burden.

Though teachers AM and CS were from different schools and taught different subjects, they both used similar criteria of correctness and aesthetics to assess projects. The assessment of teacher DB was different from that of her colleague, CS. Teachers AB, AM and DB, though teaching science, viewed projects as serving different purposes. The differences may, at least partly, arise from the perceived expectations of the school from the teacher. While teacher AB's school relied on her to guide students on award winning projects for local and national competitions, the other teachers were expected to improve their students' scholastic performance in school and board examinations. Even so, the stated purpose of projects as articulated by teachers AM and DB were largely similar, but they structured their projects and assessment differently.

The interviews indicated that the term project had become a part of teachers' everyday vocabulary, though their ideas of what constituted a project differed from the policies as well as each other. This phenomenon is reported by Furtak and Alonzo (2010), who state that teachers enacting an inquiry-based unit among third graders used terms such as, hands-on, discovery, exploratory, etc., without their meanings reflecting in their teaching practices. For instance, since the requirement of projects was difficult to meet within school time, the teachers gave projects as home assignments, or reduced projects to simple short duration activities. Besides, the teachers had not read the policy documents, and they knew only fragments of what these contained.

When teachers hold sets of conflicting and complex beliefs, one or the other set of beliefs tends to dominate their actual practices, with apparent inconsistency between stated practices and their own description of those practices (Bryan, 2003). A study by Achilles and Hoover (1996) found that students were unable to work in collaborative groups on problem based learning, as they possibly lacked the needed social skills. The teachers interviewed by me also felt that group work was not practical among their students. Similarly Scott (1994), in her experiences of implementing projects, found that students were initially involved in non-academic conflicts, and that the teacher had to put in the effort to support students in learning to collaborate and collaborating to learn. This was reflected by teacher AB, who recognised that to achieve effective group work, the teacher had to provide guidance, for which she did not have the time. The difficulty with collaboration appeared in different ways, for example, in the view of teacher DB, having students belonging to diverse socio-economic strata was detrimental to group work. Assessment issues, as in the case of teacher AM and students' lack of interest, as in the case of CS were also cited as reasons for not engaging in group work.

Teachers' views on peer and self-assessment were not in agreement with the recommendations of NCF 2005 (NCERT, 2005). They viewed self and peer assessment, in their classes of over 40 students, to be impractical and unreliable, as students were not "mature" enough to grade "impartially." Research studies of design and technology projects with fewer middle school students from similar contexts showed that groups of students, even with different abilities, learned to work together effectively through engaging in complex projects involving multiple tasks (Khunyakari, Mehrotra, Chunawala, & Natarajan, 2007; S. Mehrotra, Khunyakari, Natarajan, & Chunawala, 2009). The studies also referred to impartial self and peer assessment of products by students.

All the teachers mentioned different goals of doing projects. They used projects either as a motivator before teaching a topic or lesson (Ladewski et al., 1994), or as one of the exercises to be done after completing textbook content. Each project had to result in a collection, report or model and the assessments mentioned were related to giving marks or grades to students based either on their submissions, or on oral presentations, or both. Teachers CS and AM had explicit criteria for evaluating students' projects. However, these were neither shared with the students, nor were the criteria in tune with their stated goals. For instance, though teachers, other than AB, stated that projects and activities were done to develop students' conceptual knowledge, their projects largely involved information collection and presentation in written reports, and did not promote students' conceptual understanding. Besides, their assessment focused on

correctness of information and aesthetics.

Marx and co-workers (Marx et al., 1997), reporting on the implementation issues in project-based science among middle school students, noted that teachers had difficulty in designing assessment to measure students' conceptual understanding, as they limited the productions to public performance and written reports that did not always require such understanding. Although projects provide opportunities for multiple ways of assessing the process (Barron et al., 1998), the four teachers felt that it was unimportant and impossible to assess the process of students' engagements in projects. In fact, the suggestion of communicating assessment criteria explicitly to their students was also not approved of by all the four teachers. Thus the common knowledge among educational researchers regarding assessment was not yet a part of the teachers' understanding (Grant, 2011).

In their study of PBL practices in projects conducted by researchers among middle school students, Barron and co-workers (Barron et al., 1998) reported that students at all ability levels showed learning gains on skills and concepts. The teachers in the current study were unsure about the benefits of projects to students of different abilities, and at best perceived it as motivating. For instance, teacher AB cited two examples of how students, who had been low achievers, improved their performance after participating in projects. Yet she argued that low achievers would not learn unless they read and projects may not require reading and hence students would not learn through projects. The other teachers too felt that high performers did better projects.

Based on PBL literature, Krajcik and co-workers (Krajcik et al., 2008) summarised that there was a tension in aligning the standards (in the Indian context, the syllabus) and designing project-based science pedagogy. These tensions include selecting content, coverage of content, and deriving generalised knowledge from the task context in PBL. Teachers in the current study gave primary importance to textbook content, and believed that all students did not learn the required textbook content by doing projects.

Regarding subject integration, all four teachers could identify project contexts that could draw content from multiple subjects. Although teacher AB cited multiple examples, these did not address syllabus content. This was possibly because, unlike teachers DB and CS, she was unfamiliar with the syllabus of other subjects. Teacher DB, who had never conducted similar projects at the middle school, was not confident that subject-integrated projects at middle school were possible. In a similar vein, Krajcik and co-workers (Krajcik et al., 2008), have found that middle school students were unable to systematically collect data, or draw inferences based on the data.

Resources are known to pose constraints for conducting projects. Blumenfeld and co-workers (Blumenfeld, Krajcik, Marx, & Soloway, 1994) referred to the challenges faced by teachers while conducting projects in terms of time, laboratory and library facilities, and large class size with diverse composition. Teacher AB mentioned large class size as a constraint, while for DB it was lack of library facility. Time was the most critical resource constraint for all the four teachers. However, each teacher needed time for a different purpose. Teacher DB wanted time for teachers of different subjects to plan

together, while CS needed time for assessing the work of a large number of students. Teacher AB stated that students needed guidance while conducting projects, and it was difficult for teachers to manage this time. Teachers reported that the inflexible school schedule could not accommodate conducting projects, nor could their students find the time to work on projects outside school hours. A class session of half an hour was insufficient to conduct projects during school hours. Scott (Scott, 1994) has also cited these time constraints while describing her own experiences of conducting projects.

The four teachers in the study responded in different ways to the researcher's proposal of collaboratively conducting projects using the four aspects. Teacher CS was the only one who felt that the proposal might work in her school. However, she and her colleague DB felt that projects including the suggested aspects could be conducted only once or twice a year. At the other end of the spectrum, teacher AM saw no need for such efforts, as she was content with her practices. The others had concerns that evolved through the interview and resulted in their suggestions for change in school policies and mandates.

4.2.4 Insights and takeaways for the next stage

The participants chosen in the study were from different school settings and teaching backgrounds. Yet, the findings of the study can not be generalised to all teachers considering the diversity of teachers and teaching context in India. However, many other teachers in similar school settings may share several of their ideas and views.

Significantly, the study indicated that teachers did not feel empowered to bring about changes in classrooms needed to implement the NCF 2005 suggestions. It also highlighted, through teachers' voices, the nature of changes in the school and a larger educational system that teachers would have liked in order to conduct projects as suggested. For instance, while teachers agreed that teachers and researchers needed to collaborate to implement the new policy suggestions, they pointed to several systemic constraints to the success of the researchers' proposal.

All the teachers' views reflect the challenges of maintaining a balance between assessment policies and addressing the required syllabus topics within a fixed school schedule (Blumenfeld et al., 1994; Krajcik et al., 1998; Marx et al., 1997; Scott, 1994). Teachers (DB and AB) echoed that they could not change their project practices in isolation from the larger school culture and policy issues that shaped examinations and assessment (Prawat, 1992; Price & McConney, 2013), and that there must be a systemic change, rather than only changing teacher practices (Lam & Lidstone, 2007).

National Education Policy 2020 (MHRD, 2020) proposes minimum 50 hours of engagement in continuous professional development (CPD) of in-service teachers. This suggests that teachers should be able to share ideas and best pedagogical practices in different forums at local to international levels. The policies suggest that the CPD engagements should offer opportunities to learn formative and adaptive assessment of learning outcomes and competency based learning and related pedagogies, such as

experiential learning. A similar approach is also suggested for school leaders. The policies recognise a need of reducing teachers' burden from non-academic work, increasing library and other resources in school, and having a choice of diverse textbooks.

These findings led to the organisation of a series of workshops for teachers in Phase 3, so that the suggested deliberation among teachers, teacher educators and researchers could begin.

4.3 Exploring teachers' views about and practices of projects through questionnaire survey

The last stage of Phase 2 explored 34 teachers' views (from 9 school systems) about and practices of projects through a written questionnaire survey. The details of the tool and participants are presented in Section 3.5.3. The findings from the survey are presented under two major heads: Teachers views about projects and teacher practice of projects. Teachers' views about projects are further divided in two categories according to the type of questions used to explore their views.

4.3.1 Teachers' views about projects from four open ended questions

The responses of teachers on views about projects could be grouped largely under ten categories (Given in Table 4.2). The table also gives the proportion of total responses in each category. The pattern of responses given by each teacher was noted, and the average responses in each category per teacher in each of the nine school systems was also analysed.

More than a fourth of all responses (27% of all responses, N=688) referred to students' tasks, which included making models, and to students' engagement in applying knowledge. However only a little over a tenth of the responses (12%) explicitly associated projects with "learning by doing", "activity based", or "hands on learning". It appears that though products and student activity are intimately connected with projects, learning through them is less connected to these activities. Yet, over a fifth (22%) of the responses associated projects with better learning and overall development of students or with ease of teaching difficult concepts. Considering that teachers chose to conduct projects only on very few topics, perhaps, they chose topics and projects on the basis of their explicit potential for student activity or with ease of teaching and learning in mind. It is evident that teachers gave considerable weight to affective elements (11% of responses) like fun and enjoyment.

Though only a tenth of the responses referred to group or team work, the responses came from most of the teachers. Only 4% of the responses referred to students selecting and conducting project tasks or learning on their own. Despite assessment being an

Table 4.2: Pattern of teachers' views about projects. N=688

Sr. no	**Category**	**%**	**Sample responses**
1	Students' tasks	27	making models, doing practical activities, field work, innovation
2	Quality & ease of teaching-learning	22	effective, enriching, good teaching aid, teach lessons in a concrete way, reduces time spent by teachers in explaining difficult topics
3	Characterising projects	12	constructive, practical, non-textual, innovative, caters to multiple intelligence
4	Students' feelings & attitudes towards projects	11	tension/stress free learning, fun
5	Collaboration, communication & community aspects	10	team work, building team spirit, co-ordination, cooperation
6	Content covered	7	study of birds, environmental science, maths puzzles, study of living and non-living
7	Students' autonomy	4	self-learning process, students come up with own ideas, learn at their own pace
8	Role of teachers	4	time management, planning and preparation
9	Assessment of students' learning	2	tool to assess and observe students' level of understanding
10	Role of policy & school guideline	1	Curriculum

issue of frequent discussions and after recent circulars on continuous and comprehensive evaluation have brought assessment to the foreground, very few responses (2%) referred to it. Together with low association of learning with projects, this was an important finding that needed attention. Those who did mention assessment issues, viewed it as an alternative to "paper/pencil tests" suitable for those students who are not good at "paper/pencil tests".

Participants' responses received under each of the ten categories mentioned in Table 4.2 are discussed below.

Characterising projects

Teachers find projects to be constructive, practical, non-textual, and innovative teaching that involves open-ended enquiry, learning by doing, child-centred and activity based learning. They also mentioned that projects are different from the monotonous way of traditional teaching and learning. According to some teachers, projects cater to multiple intelligence. At least one teacher from each of the school systems mentioned at least one of the aspects from this category.

Content covered

Seventy seven percent of the teachers from all the school systems referred to content, textbook content, students learning textbook content by doing projects and or specific topics addressed in the projects. These responses formed about 7% of the total responses. Close to 9% (2% of the responses) teachers mentioned the specific topic on which they assigned the projects. These included projects on study of birds, environmental science, maths puzzles, study of living and non-living things, human heart diagram poster.

Quality and ease of teaching-learning

The responses in this category form the second largest contributor (22%) to the total responses. Ninety seven percent of the teachers gave responses in this category, which includes five subcategories. This category had teacher statements such as, projects make teaching easy (3%), projects enhance students' knowledge, concepts, skills, attitude etc. (10%), it is easy to learn for students through projects (2%), students learn better in projects (6%), by conducting projects teachers enrich themselves (1%).

Eighty percent of the teachers from all the school systems stated that projects enhance students' knowledge, concepts, skills, attitude etc. which consists of 10% of the total responses. Sixty two percent of teachers, from eight school systems, stated that students learn better in projects (6%). Therefore, more than half the teachers tended to associate projects with students' understanding of a concept or topic and felt that projects lead to better understanding or clarity. Forty four percent of teachers, from seven school systems, stated that projects make teaching easy for teachers (3%). Teachers mentioned that projects are effective, enriching, and good teaching aids, which help teach the lessons in a concrete way and which reduces the time spent by the teachers in explaining difficult areas.

A smaller number of teachers (35%), from eight school systems stated that it is easy for students to learn in projects (2%). Teachers stated that projects provided a different view of the same concept. Some teachers wrote that projects provided hands-on experience to students, and thus enhanced their understanding. One teacher mentioned that even a slow learner can understand the concept through a project. Only 15% teachers, from five school systems, stated that teachers were also enriched by projects (1%). Some teachers felt that conducting projects provided a learning experience to teachers and one teacher stated that projects make a teacher into a learner and a learner into a teacher.

Role of teachers

Less than a third of the teachers (32%) from six school systems mentioned their role in projects and this constituted less than 4% of the responses. Around 15% teachers

from four school systems mentioned that their role was to help students learn through projects (less than 1% of the total responses). Teachers from two school systems mentioned that their role involved structuring and managing projects and managing resources.

Students' tasks

All the teachers from all the school systems responded to this category and it was the largest (27%) response category. Most of the teachers (91%) from all the school systems mentioned about students' tasks and productions in the project (largest subcategory (15%). Slightly fewer teachers (82%) mentioned students' cognitive engagement with tasks or activities in projects and 38% teachers associated projects to the application of information, knowledge, concepts, and skill. Teachers associated creativity, out of box thinking, innovation, or imagination with projects. Teachers also associated projects with applying knowledge, theory, ideas, and skills.

Collaboration, communication and community aspects

Seventy one percent teachers from eight school systems associated projects with collaboration, communication and/or community aspects (10% of the total responses). Fifty percent of the teachers mentioned communication in the context of conducting projects and an equal percentage of teachers mentioned aspects of collaboration and group or team work too. Projects were thought to require as well as result in improved co-ordination, cooperation and interaction, building relationships, and closeness with peer groups, and making adjustments. However, community aspects were mentioned least, by only 12% teachers (less than one percent of the responses).

Students' feelings and attitudes towards projects

Seventy nine percent of teachers from all the school systems referred to students' feelings and attitudes towards projects (eleven percent of the total responses). These teachers mentioned that projects increased students' interest and enthusiasm in that subject and students felt more active and excited to be involved in projects. Teachers reported that projects were enjoyable for students and that projects helped in removing stage fright, allowed students to open up and even introverted students could speak up during projects.

Students' autonomy

Forty seven percent of teachers from all the school systems referred to students as autonomous learners in projects (four percent of the total responses). These teachers acknowledged that students planned and did projects independently. Projects were

seen as a self-learning process, where students learned on their own about what they had found interesting. Teachers also mentioned that projects provide opportunities for students to come up with their own ideas and learn at their own pace.

Assessment of students learning

Considering the importance of assessment through the school year, it is interesting that only about two percent of the responses referred to assessment of students' learning, grading in terms of summative assessment, or teachers' assessment. Twenty nine percent of the teachers from eight school systems mentioned projects as a tool to assess and observe students' level of understanding in a different way (as compared to regular tests). It was considered a particularly good tool to assess students who were not good with paper/pen tests. In fact a teacher wrote that projects helped to evaluate teaching strategies, incorporate feedback and inform about students' needs. When assessment was mentioned teachers associated projects with scoring, success, and rewards.

Role of policy and school guideline

Eighteen percent of the teachers, from four school systems mentioned the role of school and the policy in relation to conducting projects, though these responses contributed to less than one percent of the responses.

4.3.2 Responses to statements about projects in Likert type scale

Analysis of the responses to statements about projects presented in a Likert scale, provided several interesting insights. While there seems to be consensus on some statements, teachers were divided on many others.

Almost all (91%) of the teachers felt that students learned a lot from projects, and teachers agreed that projects enriched students' understanding of textbook content (88%). Though over half (53%) the teachers felt that doing projects reduced the time available to teach textbook content, a fourth of the teachers disagreed with this, and an equal number were unsure. All teachers except one agreed that projects could be done in subjects other than science too.

A majority of the teachers (38%) were unsure whether all textbook topics could be taught through projects, while a third agreed that projects could be used to teach all textbook topics, and the rest (26%) disagreed. Teachers were divided on whether a working model should be included in projects with a majority agreeing (44%) and a slightly fewer number of teachers (38%) disagreeing. Most teachers (79%) thought that projects helped students prepare for examinations better, while almost a similar number (73%) agreed that they improved students' performance in all subjects. When

asked if students' understanding of concepts could be assessed through projects, three fourths (74%) agreed.

Most teachers (76%) felt that students enjoyed doing projects, and felt that it was not an extra burden on students (79%). None of the teachers agreed that project work was a burden on students, though about a fifth were unsure about this. More than half the teachers (56%) disagreed that only high performers will do projects well, consistent with a majority of teachers (62%) agreeing that projects are suitable for all students. Only a fifth (21%) of the teachers felt that students could conduct projects without adult help, while most either thought they needed adult help (44%) or were unsure about it.

None of the teachers agreed that projects were burdensome to themselves, though 15% were unsure. Interestingly, a sixth (15%) of the teachers agreed that only some teachers could do projects, while a fifth (21%) were unsure about this. A third of the teachers agreed that projects were time consuming, and an equal number disagreed with this. Three fourths of the teachers agreed that the school administration was supportive of conducting projects. Most teachers (62%) were unsure about whether parents felt that doing projects was a waste of students' time. Over a third (38%) of the teachers felt that projects were suitable only for a small class size, while an equal number disagreed with this.

Slightly less than half (47%) of the teachers did not think that an equipped school laboratory was a requirement for conducting projects, and an almost equal number (44%) thought otherwise. Half the teachers agreed that conducting projects required funds for resources, while almost a quarter (26%) disagreed. Half of the teachers agreed that teachers lacked guidance materials, like instruction manuals, to conduct projects, while a fifth disagreed.

The average responses per teacher on some categories, like assessment and management, were relatively higher from teachers in certain school settings. This may guide structuring interactions in developing projects for those school settings.

4.3.3 Teachers project practices

Teachers' project practices are analysed in the light of the criteria to be satisfied by practices for project-based learning and are summarised below.

Only two projects' titles suggested driving questions being posed to the students. The projects were all varied in their form and scope. Some projects mentioned a broad theme, and also the focused questions which guided the scope of students' tasks. For example, the project title, "The work of social reformer", was a very broad theme, but to focus students' activities they also posed two guiding questions: a) How did the social reformers of India help Indian society? and b) How did they change people's thinking? On the other hand, some projects started with a broad theme like "Origami", "Survey of the people living in your building", but failed to define the task to limit

the breadth and depth of student activities. Some projects had titles that did not suggest any clear activity, like “Scientific toy house”, “Magic pipe”, and “Creativity in science”.

Most of the projects were intended to collect more information and present them both in written or oral formats. Over a third of the teachers (38%) reported conducting projects among groups of students. A similar number of teachers mentioned that they faced difficulties while conducting projects. Most of the difficulties cited pertained to time constraints. Three teachers from three school settings reported constraints of resources. Interestingly, two of the schools were catering to students from very low economic strata. The third category of the school was funded by a central government undertaking autonomous body (I). In one project, students visited the Bank to know about different accounts. According to the teacher, students were not able to answer the questions asked by bank staff. The project evidently lacked prior planning.

According to the teachers they have provided guidance to the students and the focus of guidance was diverse. Interestingly, most teachers from school setting (I) did not mention their specific role. Teachers from other school systems mentioned their role as involving helping students to collect information, providing information, helping students to understand, providing materials for presentation, observing students’ progress, helping make models, explaining the topic, helping students to plan and help students in choosing the topic of the project.

It was evident from the teachers’ reported practices that most of the assessment was limited to evaluating final productions and no feedback for improvement was given. Interestingly, most of the projects did not delineate the learning goal and corresponding assessment criteria and standard. Most of the assessment criteria mentioned by the teachers did not match with the stated learning goal.

4.3.4 Discussions

Teachers rightly associated projects with “learning by doing”, activity based, or hands on learning. According to them, projects were “different” from the traditional teaching-learning. It was not recognised explicitly that care needed to be taken to engage students in constructive investigation so that learning by doing could be achieved.

Many participants held the opinion that students understood, learned or gained knowledge in projects. Teachers thought that projects provided multiple perspectives of a concept and led to better understanding of the concepts taught in class. Projects were perceived to help the overall development of students. Teachers claimed that students understood better through projects and it was an easier way to teach, which required less time to explain difficult concepts. This would lead us to expect that the teacher would conduct projects regularly in her/his classrooms to teach all topics, especially since the teachers also stated that students found projects interesting, enjoyable.

Several teachers saw projects as a research or a problem solving activity which has

multiple research components. Some teachers found projects to be the doing of practical activities, making models or other products or involved field work. These responses were from most of the organisations (except H), indicating respondents preference to adhere to a particular view.

Most teachers also rightly associated projects with group or team-work where students interact, coordinate and cooperate among their peers. However, it is important to explore to what extent the fruits of group work and discussions are exploited in the classroom. Whether students collaborate with peers or merely divide their tasks? Whether students engage in quality discussion or simply communicate managerial problems or share facts among their peers?

Some teachers consider projects as an opportunity to apply known knowledge. This can be considered as a simple exercise. However, in contrast, some teachers view projects as a vehicle to convert theoretical knowledge developed in the classroom context to knowledge applicable to the wider context of real-life. In that case, the project is not a mere exercise, but a tool for situating knowledge in the rich context of real life.

Student autonomy is an important aspect in project-based learning. Teachers share the view that in projects students learn on their own or with their own pace. Teachers also acknowledge the importance of teacher guidance. It is crucial to identify what teachers consider as teacher guidance or what they consider as "own learning" by students. It is also important to recognize that both the extremes could be detrimental.

The much discussed topic of assessment in the recent Indian policy document appears least in the responses. Most of the respondents looked at projects as an assessment tool for students, and one respondent viewed projects as a tool to evaluate teaching itself. Projects are also viewed as an alternative to "paper/pencil tests" for those who are not good at "paper/pencil tests."

4.4 Conclusion

This chapter presents the teachers' views collected from three stages using three different modes and tools. I first explored with the help of FGD, the state of project practices and general views about projects from 10 teachers of a reputed semi-government school that follows Maharashtra State Board curriculum. In the second stage, I conducted individual semi-structured interviews of 4 teachers from three school settings that were following either the Maharashtra State Board curriculum or the CBSE curriculum. The study in the last stage explores views of 34 participant teachers about projects. These teachers were from 22 schools, run by nine school systems that followed the same two boards of education mentioned above.

The studies conducted at three different stages initiated deliberations about the proposed PBL among the researchers and teachers. While going through the stages, I gained insights on existing project practices, the vocabulary associated with projects, the status of assessment of projects, parental expectations (as perceived by teachers),

teachers' response to the four aspects of proposed model of PBL, teachers' pragmatic concerns, and possibilities to engage in deliberations with teachers and stakeholders.

The stages helped me to focus on major aspects and this understanding evolved over time. Listening to teachers during the first two stages made me become more humble and understanding of the classroom realities and educational context in which teachers operate.

It was found that frequency of project work increased in schools irrespective of boards and school systems in response to post-NCF 2005 circulars. The state boards seem to assign less number of projects in an academic year (one or two projects) and prefer to allot a general score for the project assignment against the total score of 10. State board textbooks included a large number of projects and activities in every subject. However, teachers preferred students to make working models and prepare charts. Working models are valued for presentation on exhibition day or science exhibition to the external audience. Select charts are pasted on the walls of the classroom and used as TLM. Teachers have made charts in their BEd training and are aware of these activities. Only a few project ideas were chosen from the textbook and assigned as homework. The schools which follow CBSE board assign project assignments more frequently and for all subjects. They too follow the textbook ideas and prefer the projects to be limited to collecting information, writing on charts or making a flip book and assigned as homework. Teachers of both the school boards knew that most students get a lot of support from others while completing their projects. Interestingly, teachers participating in the FGD and semi-structured interview still wanted to retain the projects as home work.

The tendency to use textbook activities as projects makes it easy to satisfy the criteria of centrality in PBL. However, keeping them as homework loses the opportunity of making a project a classroom pedagogy. So, it is important to make it explicit that the textbook also contains projects which can engage students in higher order skills and help students learn the concepts better. Importantly, the nature of productions could also be diverse.

Even though teachers associated learning with project work, when probed further teachers were not confident about relying on projects to use them pedagogically. In this aspect teachers' held a complex view about projects. Teachers' responses imply that students who carry out projects learn from projects and thus projects are intrinsically associated with learning. However, teachers themselves accept that projects don't contribute much to the learning of most students.

The challenge is probably compounded as teachers select simple tasks as projects and students' learning is narrowly defined. E.g. copying a mathematical table, or pasting different kinds of spices on a chart paper does not engage students in deeper learning and lacks authentic context. It is important to prepare examples of projects that would satisfy both the criteria of centrality and constructive engagements.

For projects to be a part of school pedagogy there is a need to re-imagine the time table, resources, provisions of library internet and other facilities. The existing time-table is

not conducive for conducting projects in school. Though some teachers proposed the use of block periods or extending the duration of 30 minutes to 1 hour, this requires a whole school approach and re-defining the subject based approach in the school time table.

Projects offer opportunities of subject integration, and most teachers agreed to this aspect. Some teachers however did not see such possibilities. It is evident that due to subject based approach and lack of collaboration among teachers in most of the schools, teachers seem to be unaware of common topics and themes existing across different subjects. Projects that bring content, concepts, and skills from diverse subjects for longer duration would address the issues of subject integration. However, teachers are yet to appreciate this possibility.

In FGD and semi-structured interviews it was evident that there is scope of aligning assessment culture in the school (score driven) with the policy directives (learning driven). Even though there have been efforts made at different levels and a large number of discussions have happened in the respective school system, there seems to be a need for further deliberations in the areas of assessment. Some of these areas include formative assessment, authentic assessment, self- and peer evaluation, need of giving feedback to the students, assessment criteria, learning objectives, indicators of achieving learning objectives, and sharing assessment criteria and learning objectives with students etc.

According to teachers, projects have increased the assessment burden for them. There is a need to develop mechanisms so that assessment burden can be reduced while designing appropriate projects. Effective group work can enhance students' learning and help reduce teachers' burden. However, teachers seem to be reluctant to rely on group work in classrooms as part of PBL pedagogy or otherwise.

Teachers used relevant vocabulary while characterizing projects and their practices. However, teachers' elaboration of these practices demands a consensus view and requires deliberations with researchers and within the teacher community. In the questionnaire survey, teachers' wholehearted appreciation of projects but relegating these to homework assignments indicates a deeper struggle for teachers to implement projects in school as regular pedagogy. In certain school systems some aspects were found dominant.

It is evident that teachers give considerable weight to affective elements like fun and enjoyment, and cognitive elements like innovative and creativeness in the context of projects. Teachers also consider projects as an easy way of teaching as well as learning. Surprisingly, teachers do not replace their traditional approach of teaching with projects. Teachers do mention learning by doing but little indication has been made to assess the learning. In summary, the findings reveal a multidimensional nature of teachers' views and it requires further deliberations with teachers. A series of workshops with teachers and teacher educators, and school visits were planned for this.

Chapter 5

Development and implementation of PBL unit

This chapter primarily summarises proceedings of a PBL unit with playground as central theme conducted with students of Grade 6 and learning from such an engagement. The PBL unit involved designing and constructing play item models for a park. Students visited the place, did measurements, and based on instructions planned, designed and constructed models of play items. Students evaluated their work based on the assessment format provided to them. Students learning from this engagement and insights on assessment and evaluation were analysed based on students' productions.

In Chapter 3, the Section 3.4.3, titled 'Developing a PBL unit and transacting it with students', presents the necessary details about how this PBL unit was designed and developed by the researcher. The playground model, central theme of the PBL unit, allowed the placement of the fabricated items by each group of students. In other words, the final product included the items designed and fabricated by each group that participated in the study.

Student productions made individually and in groups formed the students' portfolio. These portfolios, instructions shared with students, session proceedings, and researchers' notes were resources which were then used with participant teachers in the third workshop of the study. The following sections present this process of developing and transacting the PBL unit by the researcher and learning from this engagement.

5.1 Transaction of PBL unit

As mentioned in the chapter on methodology, a workshop for students was scheduled during the short mid-term school vacation. The workshop was conducted over five consecutive days and each day the sessions were for four hours, that is from 9:30 am to 1:00 pm. Tasks for each day were as given in Table 5.1. An account of the workshop proceedings is presented in the following subsections.

Table 5.1: Schedule of tasks for each day of the "making a playground model."

Day	**Tasks**
Day 1	Fill personal information sheet, form groups Discuss playground context Measure and map playground space List 10 playground items Resource: pictures/ videos of playground List and justify 5 favourite Items Design brief, scaling discussion
Day 2	Design exploration Resource: Exposure to technical drawings Complete design drawing, technical drawing
Day 3	Resource: Learning to plan - Making a firki (toy pinwheel) Plan to make and distribute work List materials with quantity and tools Presentation of design and discussion
Day 4	Make Item model
Day 5	Complete making Place items on playground model Evaluation of products (a) independently and (b) as part of group

On the first day of the workshop, each student was given a personal data sheet where they filled in personal details and details about the nature of their father's and mother's work and their favourite subject. They were asked to write a few things about themselves, their hobbies, a project that they would like to do, whether and what things they would like to make, and what the word "design" meant to them. The last two questions were intended to probe their pre-existing knowledge and inclination for designing and making. An unfilled personal information sheet is given in the Appendix B. Students were also asked to form groups of 3 members each, and 2 groups of boys, and 3 of girls were formed. The students made the grouping choices themselves.

5.1.1 Contextualising leisure activity

The researcher (myself) and the group of observers introduced themselves and conducted an ice-breaking session with students to make them comfortable. Students were asked what games/ sport they liked to play and the name of their favourite player. They were also asked how they spent their holidays/ leisure time. Responses included cycling, drawing, badminton, football, cricket, and learning English words. I then asked students what games/sports they had liked when they were younger. Students tended to repeat the same game/ sport as earlier. The idea of playground items was introduced by asking, "What do you see in parks?" The responses included swing, slide, see-saw, giant wheel, merry-go-round, dashing cars. The word "park" also elicited responses like pond, plants, fountain, insects, birds, flowers, water park, children and statue.

5.1.2 Measurement of playground

I introduced the first task in the activity of measuring the playground and asked the students how they would go about measuring the playground? Students' responses included use of measuring tape, foot-ruler, by counting steps, measuring the length of a (wood) log first and using it as a unit or using a "big thin wire" (I suggested a long thick rope). One student suggested measuring the length, breadth and area. I pointed out that the area is calculated using length and breadth. One team for measurement was formed composed of one member from each of the 5 groups. The other two members in each team were asked to make a list of items which they would like to place in their playground.

All the students were taken to the ground. The measurement group was asked to further divide into two groups. There was a natural division with one group consisting of 2 boys and another consisting of 3 girls. Each group measured the ground independently and was assisted by me from time to time. The measuring devices made available were a long roll of jute rope, short (less than 1m) sticks, a tailor's flexible measuring tape (1.5 m), two metal tapes of 3m (with the girls) and the other with boys of 5m.

In the beginning, both groups started measuring the ground with the help of the metal measuring tapes. They were asked to suggest another way to measure and then students pointed to the rope. The groups made 3m, 6m, 9m markings (by placing knots) on the rope and used this for measuring shorter or longer sides. No group paid any attention to errors in measurement. The boys managed to measure the length of the plot faster, but failed to count a 5m length on one side. They also preferred to store the data in their memory and were reluctant to record it. Even after realising what went wrong (missing 5m) they did not bother to record the corrected measurement on the sheet. When asked to fill the sheet, one of the boys approximately calculated the length to be 36m. The girls were slower in doing measurement and clumsier, but were more meticulous in recording the data. It appeared that the students did not understand the implications of wrong or incorrect measurements.

5.1.3 Selecting 10 items for the playground

Students were told that they needed to list 10 possible items suitable for the playground area. It was communicated that ultimately they have to select only one item from their list. However, these students thought that all the 10 possible items needed to be placed on the playground and were in doubt about how to do so. It appeared that perhaps they had never carried out an activity on similar lines. Thus, even though the idea that they would be designing and making a playground and how to go about it was told to them, they had not fully internalised it appropriately.

Another issue was that students listed all possible things connected to the playground/park (like flowers, gardens, statues, trees, club houses, etc.) rather than focusing on play items. The terms park and playground were used interchangeably by students and this may have played a role in their responses. Parks also have children's play sections,

with several playground items. Playgrounds in urban areas with young children's play items are often a part of children's parks.

Students were also shown pictures of playground items and videos of a few innovative low-budget playgrounds in an Indian school setting. After watching a video that indicated a merry-go-round, one student raised safety issues and said that it could be dangerous for very young children. The group wise listings of ten items are given in Table 5.2.

Table 5.2: Groups and their chosen play items.

Group Name (Initials)	**Boys/ Girls**	**10 Play Item chosen**	**5 Play Item chosen**	**Play Item chosen**
Forest Fighters (FF)	Boys	Swing, Slides, See saw, Benches, Gandhiji's statue with fountain, Flower bed, Plants, Trees, Forest fighters club	Combined fun, Merry go round, Trampoline, Sand box, Club	Ultimate combination
Tremendous Three (TT)	Boys	Swing, Slide, See-saw, Monkey bars, Bench, Fountain, Pond, Flower bed, Plants, Guest house, Statues	Swing, Slide, Bench, Fountain, Pond	Slide
Super Dupers (SD)	Girls	Swing, Slide, Monkey Bar, Dashing Rollers, Merry go round, Water slide, See saw, Fountain, Statue, Swimming pool, Seats, Dustbins	Swing, Slide, Monkey Bar, Dashing Rollers, Merry go round	Dashing rollers
Three Champions (TC)	Girls	Slide, Merry go round, see saw, Monkey bars, Dashing car, Swing, Different types of plants & flowers, Fountain, Ponds & Lakes, Different sculptures and statues	Slide, Merry go round, see saw, Monkey bars, Dashing car, Swing.	Monkey bars
WinX Club (WC)	Girls	See-saw, Slide, Swing, Merry-go-round, Sand pit, A big circle in which flowers, aquarium and bird cages are fitted, House for indoor games, Ice cream shop, Plants & grass, Small Fountain, Flower bed, Seat	Slide, Swing, Merry-go-round, See-saw, Sand pit, Seat	Merry-go-round

Once students listed 10 or more items, they were asked to choose 5 play items from their list along with justifications for the selection. I communicated that the main criteria for selection should be that children could play with these items. However, 3 groups of students selected items like flower bed, bench/seat, fountain and pond. Their justifications were primarily based on safety issues. Table 5.2 shows the list of 5 selected items by each group. I was in conversation with the groups while they were selecting these 5 items and mentioned to the students that while selecting the items they should avoid repetition across groups. To help in the selection I wrote the items

chosen by each group on a board.

Though I was implementing the plan in a stepwise manner, it was evident that students were confused about the design briefing given to them. The confusion was about various things they were expected to do. In fact, while listing, justifying and sketching the 5 favourite items, several groups were working with sketches of the whole playground and placing all their items on it. They had to be reminded that each group would eventually make only one item from the list of 5 items. The final selected items by each group are given in Table 5.2.

5.1.4 Choice of scale

The scale is an important parameter for making or constructing models. I introduced the idea that a scale had to be decided for making a model of the playground. The choice of scale was important for making the model of the items. One student suggested a scaling down to 1/4. I calculated that the 30 meter length of the playground would be 7.5m and this would not even fit in the class. The student then quickly suggested a 1/6 scale, while another student suggested 1/10. I remarked that it would be easy to calculate the sizes and dimensions with a factor of 1/10. In addition, I demonstrated how one had to move the decimal point one place to the left to go from actual size to the model size. I asked what would be the sides of the playground and the students suggested 3m and 1.5m.

5.1.5 Design exploration

An overview of the plan of the workshop including students' roles and the activity itself in the form of a Dashboard was put up on the wall of the room, which was a day-wise plan of action always visible to students. It helped students to realise their current position and allowed them to allocate remaining time to achieve their goals as suggested in the plan. In other words, the displayed plan helped students to track their progress.

Students were asked to explore making their play item by drawing it. This was an attempt to represent the actual model on a piece of paper. However, prior to making a technical drawing of the play item model for the playground, a scaffolded task was given to students. This task involved drawing of a mug, an item that is familiar to all students and drawing its technical drawing is relatively easy. It is important that students do the scaffolded task as such an engagement is likely to help students to transfer their learning to the main task. The researcher decided to conduct the scaffolded task rather than giving them a set of oral instructions about how to draw technical drawings. The next subsection presents the details about students' engagement with the scaffolded task.

5.1.6 Exposure to technical drawing: drawing a mug

Students were told that representing shape and size were most important in the case of technical drawing. Size could be shown with the help of leaders and arrows, dot and dash lines to show axis, dotted line to show hollowness and cross to show centre. Also the concept of inner and outer diameter were discussed.

Students found it difficult to draw a mug even after exposure to the technical drawing provided. The most difficult aspect of the drawing was deciding the views. Students often were inclined towards drawing perspective rather than the top and side views of the object. The side view was often a mixture of side and top views for the mug, which has a circular cross section. It is also an indication of interference from the stereotypical drawing of glasses, mugs, etc. Another difficulty was deciding where to use dashed or solid lines. Several groups had difficulties regarding drawing of leaders, arrows and writing dimensions and units. They drew arrows without leaders and wrote dimensions outside the arrows line, and so on. These examples can be seen throughout the mug drawings and also in students' attempts at drawing the technical drawing of their play item models. Technical drawings of a mug made by the members of Tremendous Three and Forest Fighters are shown in the Figure 5.1 and Figure 5.2 respectively.

Figure 5.1: Technical drawing of a mug made by the members of Tremendous Three.

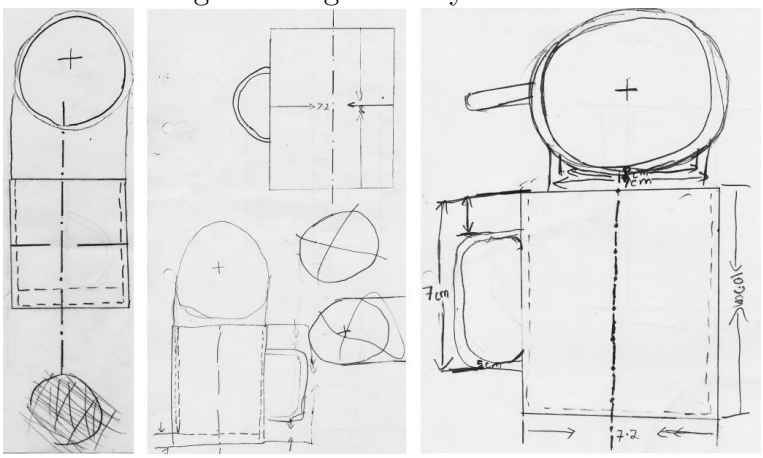
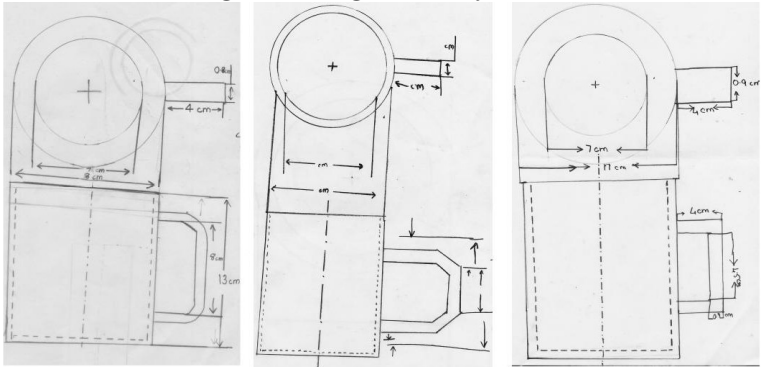


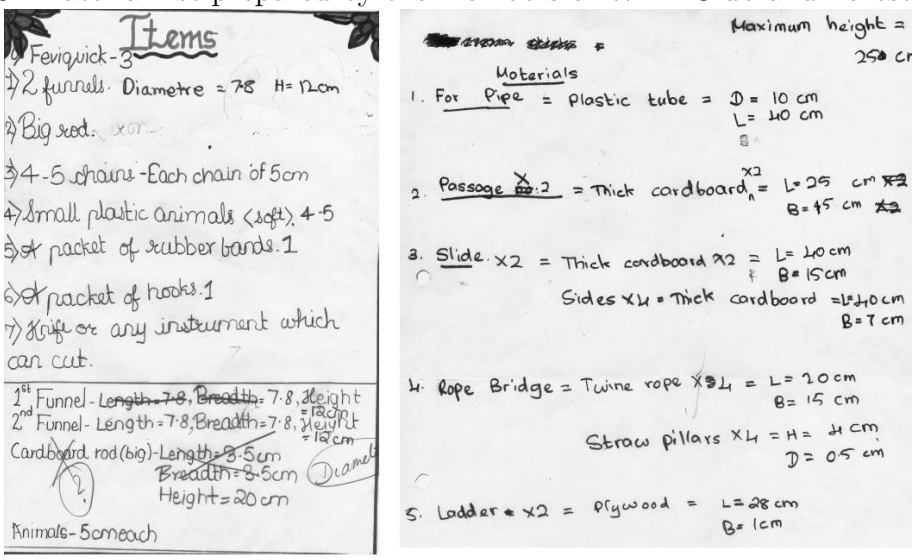
Figure 5.2: Technical drawing of a mug made by the members of Forest Fighters.



5.1.7 Listing materials and tools for making

Each team focused on their technical drawing and made a list of materials required to make the model. They were told to mention length, breadth, height, inner and outer diameter (wherever needed) for the required materials. Later it was found that some of the lists were incomplete. Students had to redo some work to give dimensions of the materials that they needed. So though the materials were supposed to be given on Day 3, students had to work one more day to finalise their designs, make technical drawings and then plan their actions before they could finalise their materials in detail. Hence making was moved to Day 4. Two samples of the material list prepared by Groups WinX and Forest Fighters are given in Figure 5.3.

Figure 5.3: Material list prepared by the members of Winx Club and Forest Fighters.



Prepared by WinX Club

Prepared by Forest Fighters

The planning phase for making the item model for the playground also had a scaffolded task like in the case for the technical drawing. As students were unaware of how to do planning and distribute the work in the group, it was important to give the scaffolded task.

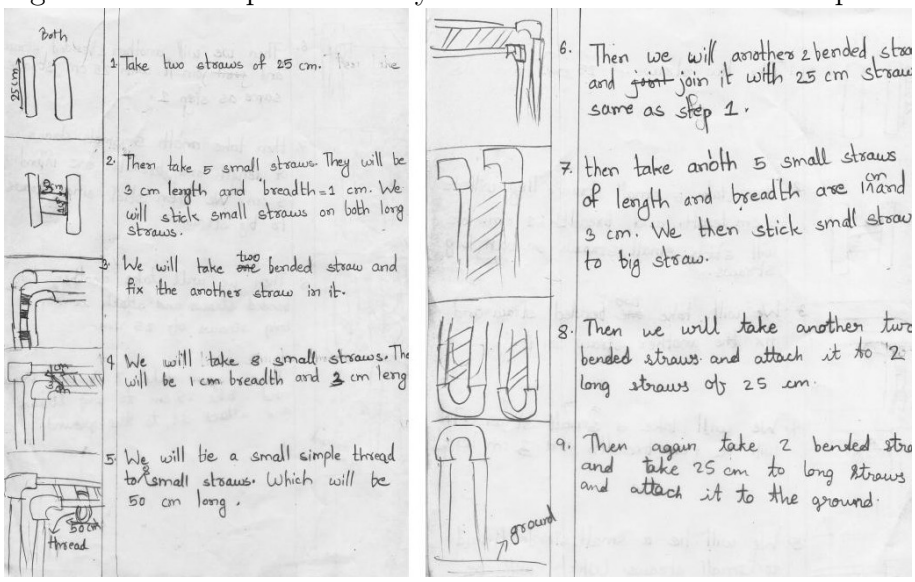
5.1.8 Learning to plan: Making a firki

All the groups read the plan of action for making a firki (toy pinwheel) and found it relatively easy to make it. Group Winx showed aesthetic skills by decorating their firki. Making of a firki using the given plan gave students a sense of what exactly they have to do to write a plan of action, and who would do what in making their model.

5.1.9 Work Plan and work distribution

Each group then wrote a plan of work to be done with work distribution. One group, Super Duper, followed the instructions and picked up the concept of plan very fast and wrote it systematically showing diagrams and work distribution. For group WinX Club, two members were engaged with writing, while the third member was assigned the task of drawing for their plan of action. One of the groups, Three Champion's work plan is shown in Figure 5.4.

Figure 5.4: Work plan made by the members of Three Champions.



5.1.10 Presentation of design and plan

All members of the groups were expected to take part in the presentations. Thus, the entire group had to come to the front together and state: (a) group name, (b) names of group members, (c) play item chosen for making, (d) actual size of the play item, (e) its design, and (f) process and steps of making (Materials, tools, steps of doing work, work distribution).

During presentations, often students discussed the fixing/ joining of parts and safety issues. The group Forest Fighters, group WinX Club particularly drew attention to safety issues. Organization skill was noticed in the group Super Duper. In a few cases, the presenters got help from the audience to resolve their confusions. The group Three Champion did not have their plan ready and were busy with their work even while other groups were presenting.

Table 5.3: Materials list prepared by the groups.

Group Name (Initials)	**Boys/ Girls**	**Materials listed**
Forest Fighters (FF)	Boys	For pipe, Plastic tube (D=10 cm, L=40 cm); Passage x 2 = Thick cardboard x 2 (L=25 cm, B=15 cm); Side x 2 = Thick cardboard x 2 (L=40 cm, B=15 cm), Thick cardboard x 4 (L=40 cm, B=7 cm); Rope bridge = Twine rope x 4 (L=20 cm, B=15 cm) & Straw pillars x 4 (H=4 cm, D=0.5 cm); Ladder x 2 = Plywood (L=28 cm, B=1 cm); Swing x 2 = Thick cardboard x 2 (L=55 cm, B=3 cm), Twine rope x 4 (L=21 cm); Monkey bars = rubber tube (which can be bend) x 2 (l=30 cm, d=3 cm); Steps = plywood x 15 (l=15 cm, b=1 cm); Circular slide = tube which can bend (l = 50 cm, B = 10 cm); glue-stick, sticking-tape, paint, scissors, hacksaw; ice cream sticks = 30; modelling clay = red colour, brown colour, 1 pack; Thread = 1 & 1/2 m; Pillars x 12 = pencils x 12 (H=25 cm, d $\leq$ 1 cm); Pillars x 10 = pencils x 10 (H= 4 cm, d $\leq$ 1 cm)
Tremendous Three (TT)	Boys	25 cm straws (4), straws (4) for steps, cardboard (b=7 cm, L=10 cm) for platform, cardboard (L = 8 cm, b = 12 cm), wood / cardboard pillars (4) (L=20 cm, d = 3 cm), Gum (1), Paper (2) blank, Card board (2) for slide (B = 5 cm, L = 7 cm), Pillars for slide (4) (1, h = 10 cm, D = 3 cm; 2, h = 5 cm, D = 3 cm
Super Dupers (SD)	Girls	One aluminium rod (46 cm), transparent plastic tube (2m), straw (19 cm, 15 pieces +), Bamboo like stick (40 cm, 2 pieces), thread, gum, and one stitching needle
Three Champions (TC)	Girls	Bent straw = 10 (tall), straw = 30, simple thread = 40 cm, Scissor = 1, sticking-tape = 1
WinX Club (WC)	Girls	glue-stick - 3, 2 funnels, Diameter = 7.8, H = 12 cm, Big rod, 4 - 5 chain - Each chain of 5 cm, Small plastic animals (soft) 4 - 5, A packet of rubber bands - 1, A packet of hooks - 1, Knife or any instrument which can cut

5.1.11 Making an item model

The detailed list of the materials requested by different groups for making the play item is given in Table 5.3. The required materials and tools were made available to the students. Some interesting observations regarding the model making of each group are presented below.

Super Duper: The group marked the stick with pencil so that holes can be made later to put threads in them. They also marked straws, transparent plastic pipe, and the aluminium rod. After making the marks they approached me to cut the aluminium rod and make holes using a drill. I provided the help and also demonstrated how to cut and use the drill. It was pointed out that while drilling it is important to make the holes diametrical. One student said that we have to draw a straight line and holes along that line. Students also used the drill to make some holes and learned to use the drill bit for making tiny holes on parallel bars of their Dashing Rollers.

It was observed that the group divided the small tasks for the bigger task. For example, one member was cutting the threads of various lengths and the other two were putting threads in the straws. Thus, the task of putting threads was divided among members as two smaller tasks. However, when a small task was done by only one member completely, the group was made aware of it before the work began.

Any disputes like mismatch in measurement or difficulties like falling of straws from the table, uncut threads, were accepted openly, and resolved through action. Consultation with the researcher (me) and sometimes actual help from me (e.g. for cutting and drilling) was useful in solving difficulties. For example, one student was trying to fix the aluminium rod with card paper using gum and the paper kept falling off. I suggested another gum/glue stick but keeping the paper upright was a problem because of the weight of the aluminium rod. I proposed and also tried two three ways to hold the aluminium rod and paper before the glue dried. Finally the two were kept on a piece of folded cloth, and students did the same when they found the idea working.

The group changed the thread to copper wire without exploring the different kinds of thread or other flexible materials. One student was holding the drilling machine pointing the tip towards herself and I pointed out the safety issues involved in holding the tip of the drill.

Three champions: I observed that this group did not progress and when I joined the group for discussion, a sense of frustration among the members was evident. Interestingly, this group was the least articulate of all the groups. It was observed that the group faced several difficulties in fixing the materials in the play item. Some of these difficulties were:

1. The platform used was of thermocol and since the straws were repeatedly inserted the holes became bigger and could no longer hold the straws.
2. The holes made in the straws to put smaller straws in were neither aligned nor uniform. A clear sign of disappointment and frustration was observed on the

faces of the student, as also in their conversation.

I asked them to explain what they are going to do. The group indicated that they had problems with cutting the straws. I suggested that all holes be aligned in a straight line and holes on both the straws should be identical. I also demonstrated how to do this by cutting the straws. The group had not realised just using straws was not sufficient to make the sturdy ladder. So the researcher suggested the use of sticking-tape and provided help in placing the tape and finally after some struggles, the ladder of one side was prepared. I asked several questions from time to time for clarification but it was apparent that the students were not able to visualise the final outcome.

There was good teamwork in the group for making a 'Monkeybar'. Their actual model appeared different from their sketch of the model. The primary reason for the same was the group had not explored their design sufficiently and thought of all the joints and spaces, especially the space between two ladders. The selected material also posed a challenge as the material properties were not anticipated by the students. Their use of units of measurement was another problem as they used feet as a unit for dimension instead of centimeter or meter.

WinX Club: WinX never thought of how the Merry-Go-Round would rotate. When they were asked to think about it, they couldn't come up with a satisfying solution. They were ready with their model but did not show inclination to try to find a solution to make the Merry-Go-Round mobile and dynamic. They preferred to wait for someone to come and help them find a solution to overcome their problem, instead of trying their hands on some of their unexplored ideas. This group also faced difficulties reaching a consensus on the number of rides (animals) to be placed (four or five) in the model.

Tremendous Three: One member was working on the ladder all the time according to their work distribution. Again the unit of measurement was feet and not centimeter or meter, in the beginning. However, at a later stage they moved to the SI system. The group changed the plan of two spiral slides to one spiral slide and their dimensions changed considerably. This change happened primarily due to at least three reasons: (a) lack of visualisation of how two slides would bend in three dimensional space, (b) lack of flexibility of the materials to bend, and (c) finally a limited object manipulation skill.

Forest Fighters: This group needed a great deal of assistance. They explored different materials to fix parts of the play item model, for example, extra wooden rods were tied parallel at the bottom, to support the aluminium pillars, wooden blocks were placed to keep aluminium pillars in place. They made changes in the model during the middle stages of making, using aluminium rods instead of pencils. They also made changes in length as the crossed bar was tied with thread in the middle for added stability. The slide was made from cardboard, while its side rails for preventing falls were made from wood strips. The slide was thus unstable and difficult to support. They realised that the slide should be heavy and side supports should be lighter. They had several components in one play item that made it complex. Probably, due to such a complex situation, members deviated from their planned work distribution.

5.1.12 The final day: Summing up of the work

On the last day, students came much earlier to complete their model and placed it on their playground plan. To make things easier for them plywood (with space marked and allotted for all five playground items) was kept ready. In the beginning of the day, Forest Fighters (FF) had many things to work on. Three Champions (TC) seemed to be in control. WinX Club (WIN) had to put their animal rides on their item. Super Dupers (SD) needed to put all the threads with rollers in their Dashing Rollers. Tremendous Three (TT) had to make only the slide part of their spiral slide. Three Champs (TC) had to fix bars on their monkey bars. Once students finished their work they were asked to prepare a write up on the product and carry out self and peer evaluation of the play items. A brief description of the two tasks are given below:

Write-up on product: Each group was asked to write about their model and what they felt about their making activity. However, the way they wrote the procedure of making the model indicated that they did not understand what was expected in the write-up. A sample of the write-up is given in the Appendix C.

Evaluating items: Each group was given an assessment sheet. The members of the group sat in front of the playground model and evaluated all the items. One group member wrote "yes", "no" instead of rating them in terms of the given scale on the given criteria and had to rewrite with scale values. A sample of the filled assessment format is given in the Appendix D. All the groups compiled their work in the group portfolios and submitted them to the researcher. At the end, the participants were told the exhibition dates and time.

5.1.13 Exhibition

An exhibition of the students' work was held in the researcher's own institute. The exhibit of the playground with models of playground items by all the participating groups was on display. Parents and teachers of the participating students of the workshop were invited to visit this exhibition. Eleven students along with their parents visited the exhibition. One of the students had brought his grandmother, while the other students were accompanied by their parents and siblings.

There was a sense of curiosity among the parents, regarding the exhibition. Parents finally could see all the work done by students. The compiled portfolios and all the other work done in the span of five days was on display. The exhibition depicted the plans - how students managed to map the actual area and came up with a list of playground items. The work for each group was depicted in chronological order. Some glimpses of parents' reactions are given below:

V's parents: The parents of V were the first visitors to the exhibition and took active interest in the work. They were interested more in how their child's group fared. V's father was interested to know which model was the best among the lot. I responded that the activity was not meant as a competition but an opportunity for students to

materialize their ideas by working in collaboration and learning in that process.

R's father: R's father was quite surprised that his ward had contributed to the making of Ultimate Combination.

S1's parents: S1 came with his parents and grandmother. He explained in detail how he and his group made the Ultimate Combination. His mother was happy to see what S1 had done in five days and thanked everyone for a wonderful exhibition.

S2's parents: S2's parents were very interested in learning outcomes of the workshop and found this activity invaluable especially in the area of behaviour of students in a group. They were interested in knowing how this kind of activity could help in students' overall progress and what else could be done in order to facilitate learning in this kind of group activity. They wanted more such activities to be conducted and were interested in a follow up activity.

5.2 Aligning activities with LO's and subject content

The activities planned in the workshop were aligned with learning objectives (LO's) delineated in NCERT curriculum and relevant content in the textbook chapters. The mapping is given in Table 5.4.

5.3 Analysis

This section presents the students' learning in the domain of measurement and estimation first. Then aspects such as analysis of design evolution in terms of students' identifying problems and developing strategies to fix them, insights on the nature of social and interpersonal engagements of the students during the designing, presentation and making and evidence of empathy and aesthetic arguments used by students are discussed. Students' presentations and their responses to evaluation sheets were analysed for their ability to critique their own and others' work. Insights on assessment and evaluation are also discussed.

5.3.1 Learning in measurement and estimation

Learning in measurement and estimation is discussed in the context of students' use of tools and strategies for measuring and mapping playground, tool handling and object manipulation, design, scaling, and unit conversions, estimation of lengths using body parts and familiar objects and measurement accuracy while making. Each of these aspects are presented below under separate heads.

Table 5.4: Mapping activities and LOs

Sr. No.	**Activity**	**LOs & Textbook content**
1	Contextualising leisure activity areas including playgrounds	Setting democratic values.
2	Visit to allotted land, see space available, measure dimension, map the space	Measuring dimension; calculating perimeter and area; drawing map; using instruments (Science, Ch. 10 - Motion and measurement of distances; Mathematics, Ch. 15 - Practical Geometry, Ch. 7 - Fractions, Ch. 8 - Decimals, Ch. 10 - Mensuration; Geography, Ch. 4 - Maps).
3	List/ draw/ sketch playground items	Drawing skills, ratio and proportion.
4	Discuss, select 5 items with justification to accommodate in the space available	Negotiation skills, value judgements, analytical reasoning, area manipulation, tessellation (Mathematics, Ch. 13 - Symmetry)
5	Negotiating 5 items and choose one to include in playground	Team skills – cooperation and prioritising conflict resolution, decision making in /for a large group
6	Group selects one of the items.	Decision making in /for a large group, application of ideas and relevant arguments.
7	Sketch of item	Visualisation, ratio proportion, art (sketching skills)
8	Design of model, technical drawing with dimensions, list/ quantity of resources and costing, plan of making, work distribution	Drawing to scale, recognising constraints, creating and evaluating options, understanding stability and strength in relation to balance, shape, etc. knowledge of materials to be used in model (Science, Ch. 4 - Sorting materials into groups, Mathematics, Ch. 10 - Mensuration)
9	Present the design to the whole class.	Presentation skills: Communication – listening, understanding, responding
10	Model making and evaluation of models	Construction skills; limitations of modelling and scaling; raw materials to be used in model (Science, Ch. 3 - Fibre to fabric, Ch. 4 - Sorting materials into groups)
11	Evaluation/ assessment and reflection (Evaluate product independently and as part of playground)	Ability to engage in Self and Peer Evaluation, ability to evaluate
12	Communicate product making experience	Ability to reflect, writing skill

Tools and strategies for measuring and mapping playground

In this challenging measurement context, students used a variety of tools to measure the dimensions of the playground site. It included a 3m tape, long rope with knots at fixed lengths of 15m and sticks of known length. Some students also used strategies to minimise error and remove parallax.

When all the dimensions were transferred to the site map on paper, a discrepancy was found in the length of two parallel sides. This led students to measure the two sides again, more systematically this time. They became more careful in holding the tip of the rope, marking the right place and placing the rope from the same marking. They called out the length readings and collaboratively added the lengths to ensure peer checks.

The skills to choose appropriate tools were enhanced, for example, using measuring tape for curved surfaces (Group WC), strategy of taking reading by minimising zero error (Groups FF, SD, WC), holding measuring tape straight over an uneven surface (Groups FF, TC, SD, WC). Students correctly marked the materials for cutting, making holes etc. (Groups TC, SD) and there was strong evidence about students' improved skills over the time.

Tool handling and object manipulation skill

Students were working with unfamiliar or rarely used tools. Use of hack-saw (Group FF), Drill (Group SD) was completely new to students. Group discussion (Groups SD, FF) and performance (Groups FF, TC) revealed their improved skill in using tools and understanding safety issues. Students developed several strategies to handle materials and objects and use tools towards making their designed item.

Stability of the model was not addressed by many students which created problems while making their model. V asked his team-mates, "can straw be sturdy (as a support)?", "What can we do for (to increase) safety?", "Don't you think that slide supporter or hand-holder (railing) is needed?" Overall, material selection for the model was generally done appropriately.

Design, scaling and unit conversions

In order to make item models that would all be placed on the same playground model, groups had to make them to the same scale. Students first suggested a scaling factor of 1/4. The calculation resulted in too large a model. This led to suggestions of 1/6 and 1/10. The last was chosen for ease of calculations. Thus, scaling provided a context for thinking about proportionality. Scaling and conversion also afforded opportunities for peer learning within groups, as able members helped those who struggled to convert different units. One student in the group (TT) was struggling with conversion from inch to centimetre, and I asked another group member to discuss with him and clarify

his understanding on how to convert inches to centimetre. When one of the students asked, "How many cm makes one foot?"a student answered 15 cm corresponds to 1/2 foot. V realized 25 cm couldn't be the height of a child in the model. Ultimately the model had to be scaled down.

Estimations of lengths using body parts and familiar objects

A group (FF) struggled to determine the length of an inclined ladder to reach the given height (25 cm) of slide. They initially supposed the length to be equal to the height and realised their error on actually placing a scale in position. They solved the problem by placing 2 rulers to represent height and hypotenuse (ladder) at a convenient inclination. They then read the ladder length from the scale.

During designing and making models, group members had lots of disagreements about the estimated dimensions of different components. They readily used scale or measuring tape to resolve the disagreements. Sometimes they used a combination of actual measurement and estimation. For example, to estimate the height of the room wall, they measured the height of one of their group members with a measuring tape, and then estimated the height of the wall as 2.5 times of the member (Group FF).

Measurement accuracy in making

The context of making, which involved assembly of closely fitting components, demanded accuracy in measurement of components. Students were seen to improve in the trials while marking and cutting component parts. For instance, the design conceptualised for dashing rollers (SD) required the group to make equidistant holes on a stick with a circular cross-section. The holes also had to be diametrical and parallel. Initially students made equidistant markings on the stick, but ignored the latter aspects. This posed an assembly challenge. To ensure that the holes are parallel to each other, they drew a line along the length of the stick and then marked equidistant points.

A similar challenge was faced by the group making the monkey bars, where the rungs of the ladder had to be fixed. Students struggled with getting the parallel rungs on two straws with striations along its length, until they were guided to see the need for joining the rung to the same striation mark along the length of the straw. The nature of the cut was also modified to strengthen the straw rather than weaken it. In this struggle the group ended up with a different shape than they planned before making. The sketch of the model and the photograph of the actual model is shown in Figure 5.5.

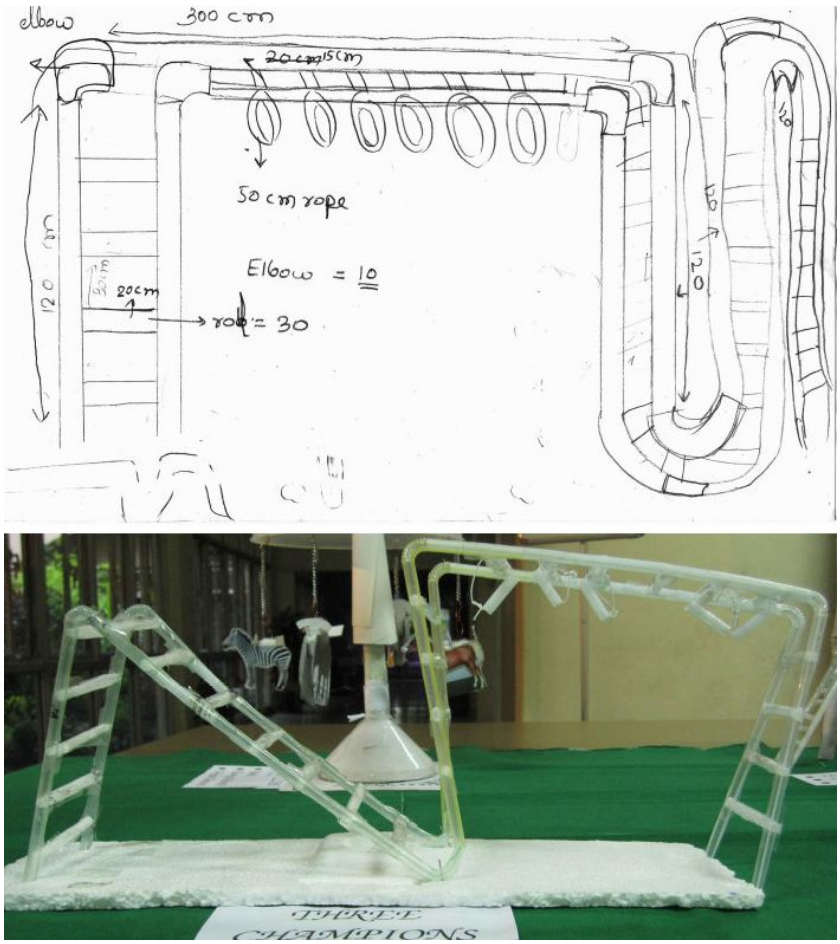


Figure 5.5: Comparison of sketch of the play item and actual model made by the members of Three Champions.

5.3.2 Design evolution: Identifying problems and fixing them

Design evolution took place in two interdependent areas. One was the evolution of design in the area of material selection, shape, and structural aspect. The other area involved assemblies and joints, stability and strength. Both these areas are presented below under two separate heads.

Material, shape and structural evolution

There is evidence of evolution of design ideas first through explorations, then while making technical drawings, while planning to make and notably while making the model. Annotations and labels in exploration sketches show that designs evolved with respect to materials used, dimensional suitability, structural aspects of making and safety issues.

Another point to be noted was related to proportional reasoning. Group Dashing rollers (SD) first designed its length as 5m with roller rods placed at 10 cm distance. They

calculated that this would need too many rods and hence reduced the length. Another group (TC) designed the distance between their ladders in Monkey bars as 20cm (2 cm in model), but realised that this was insufficient space for children to climb and changed their design (Figure 5.5). In making the model, some students realised that the smaller components in the proposed design will be too small to make and show in the model (Group TC, Monkey Bars). The distances between two consecutive stairs in the ladder were too small to place them. They had to negotiate in that situation. So, length and width was decided by proportional reasoning.

The easy to visualise Dashing rollers (SD) was the least explored while complex and creative items like "Ultimate combination" (FF) and intertwining slides (TT) or groups that had disagreements about their model as was the case with (WC) who made the merry-go-round explored various aspects of their items. The material to be used for the rope bridge in model "Ultimate combination" (FF) varied from paper/ cardboard strips, jute cloth to layers of bandage gauze.

During the making, students had to negotiate with their design plan due to several reasons like joining and fixing (FF, SD), inappropriate choice of material and limited manipulation of material (TC), making dynamic movable parts (WC), discarding the element due to structural incompatibility (TT) and replacing or changing design plan. To overcome this they had to bring structural changes.

Assemblies and joints, stability and strength

Critical problems were faced by all groups related to joining component parts and ensuring stability and strength in the model. The rubric developed and used by me for evaluating the play item models included these aspects and is given in Table 5.5.

Assemblies and joints were explored by most groups (FF, WC, TT, TC) extensively. The group making Ultimate combination (FF) faced challenges with making stable supports for their platforms that would support slides, rope bridge, and swings. They used several techniques to strengthen their joints: tied the crossovers of crossed vertical supports with strings, reinforced with sticking-tape, used additional wires and wooden rods for stability as well as flat wooden slats with slots and glue to hold the supports of the structure in place.

The assembly of the pole with the carousel posed a challenge while assembling the Merry-go-round (WC), some of which the group members were unable to solve on their own. The choice of inverted plastic funnels for carousel and base, and a hollow plastic tube for the pole limited the joining options at both ends of the pole. The plastic tube kept slipping off the funnel and was steadied with cardboard, which was insufficient to bear the load of the pole and carousel. The rotation of the carousel on the pole was a problem that group members were unable to solve on their own. They were provided a sharp conical paper structure as pivot for the rotation.

Joint or clamps to the monkey bars structure were explored in detail to arrive at a safe design. One group (TT) changed their design of the item in a major way as they

Table 5.5: Part of the rubric corresponding to assessment of playground item (product).

Criteria	**Limited**	**Developing**	**Proficient**
Material strength, flexibility, durability	Less than half the materials chosen were strong or durable; flexibility/ stiffness not suitably chosen	Mostly strong, and durable; flexibility and stiffness mostly chosen correctly	Strong and durable; flexibility suitably chosen
Stability	Very unstable; joints improper; easily topples on playground area.	Fairly stable by itself; joints made but may become loose with use; but cannot take load (specified no. dolls 50 gm each)	Stable by itself; well designed joints; Can take load (specified no. dolls 50 gm each)
Proportion	Parts are not in proportion	Most parts in correct proportion	All parts in correct proportion.
Working model	Static and dynamic parts, dynamic parts not moving	Only static parts; or some of the dynamic parts moving	Moving dynamic parts, moving correctly

discovered several problems with their original design of two intertwining slides. They struggled with visualising the curvature of the slides, and with materials that would enable them to make the curved model. While trying with paper strips, they also discovered that the vertical height between the slides at the position of crossing was too little to allow for a child's size. They changed their design by joining their two curved slides into a single curved slide.

5.3.3 Evolution of ideas in design exploration

Three of the groups (TC, TT, WC) tried to show the outline of the item model after visualizing the actual item whereas the other two groups tried to show minute details of the model. Some of them were successful in sketching 3D objects on 2D paper using cylindrical structures. But initially all of them found it very hard to imagine and to capture the model on a plane.

There is evidence of gradual progression in design exploration (Groups FF, WC, TC). Multiple exploration with static nature (Group TT) and virtually no exploration (Group SD) were also observed. Naturally the exploration was higher in complex and innovative models (FF) and also where members had disagreements (WC) and active participation in visualization (TC). The simplicity of components and the familiarity of action strategies with familiar real life work (putting thread in soft bamboo stick analogous to stitching) lead to better visualization and communication among members and lead to less exploration in the design sketch (SD). Incorporating how to make aspects like fixing and joining of two components (FF), appropriateness of materials used (WC), dimensional suitability for safe use (FF, TT, TC), structural aspects in making (TT) and for safety (WC) etc. brought more complexity and lead to more design exploration.

The design exploration by Tremendous Three is shown in Figure 5.6.

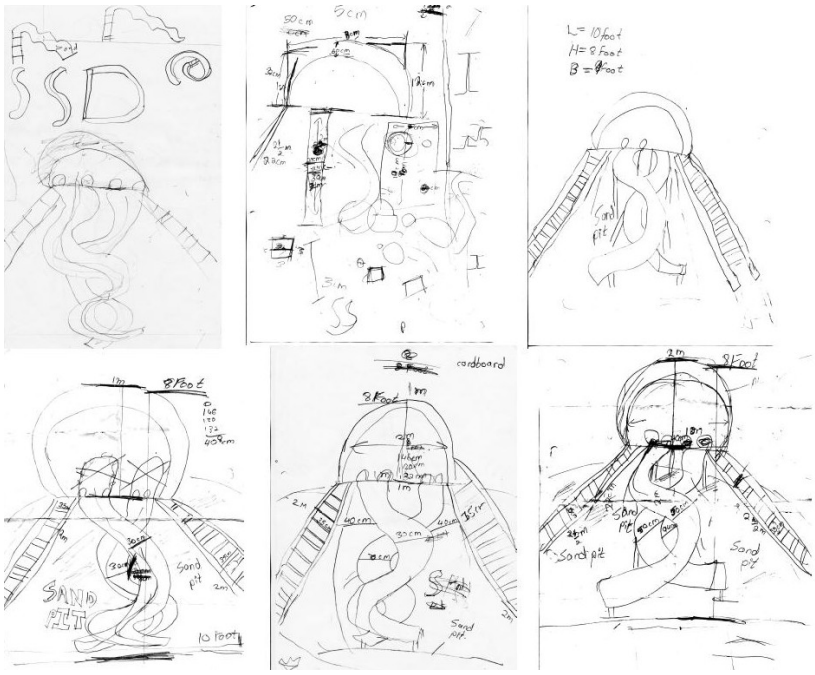


Figure 5.6: Design explored by the members of Tremendous Three.

Technical drawings: Visualisation and representations

Students explored various components in their conceptualised design in great detail. Group FF explored each of the components in their conceptualised design in great detail. The evidence for this comes from a circle around each of the components with a tick over it (explorations) and details of each in the technical drawing. Group TC too explored clamps, bends, joints, pillars and rungs each in great detail in their technical drawings.

It is heartening to find that all groups showed dimensions using arrows and leaders in their technical drawing. However, it was clear that some students were still struggling with the concept of scaling for all items and even for all segments. One probable reason may be that students (even grown ups) go first by intuition and checking is done only if problems arise (like insufficiency of page, visible discrepancy among two known sizes, incompatibility in two sections of the same drawing) etc. The components of an item that can be broken down into known geometrical figures have been shown better in technical drawing (WC, TC).

All the groups used annotations and labels in their drawings. Based on the general observations a rubric for evaluating technical drawings was developed as in Table 5.6. The play item models can be categorised in three ways, viz. a) structural components unchanged, but different materials used (Group SD) b) Modification of shape, or reducing structural components, unable to make according to the drawing (Group TC,

TT) c) structural components are the same with different joining, cutting, pasting etc. (Group WC, FF).

The groups Tremendous Three and WinX Club, were less collaborative. TT required guidance to represent their technical drawing, which initially they were drawing as cylinders and then corrected to rectangles and circles showing axes in each of the shapes. Group TC showed the dimensions of their model in their rough sketch and elaborated it in their technical drawing showing circles, rectangles, and axes. FF was facing the challenge of integrating four items but they were very confident about their plans. They corrected their drawing many times to arrive at the final representation. Super Duper (SD) members were more cautious about safety issues. One member of the group had a clear picture about the item because she had seen the item which others had not. The groups quickly understood technical drawings in the authentic context of making their item drawing and they gave a detailed list of materials along with the technical drawing.

Figure 5.7 shows the technical drawing prepared by group Super Duper using little exploration. In contrast another group Forest Fighter made several explorations while making the technical drawing shown in Figure 5.8

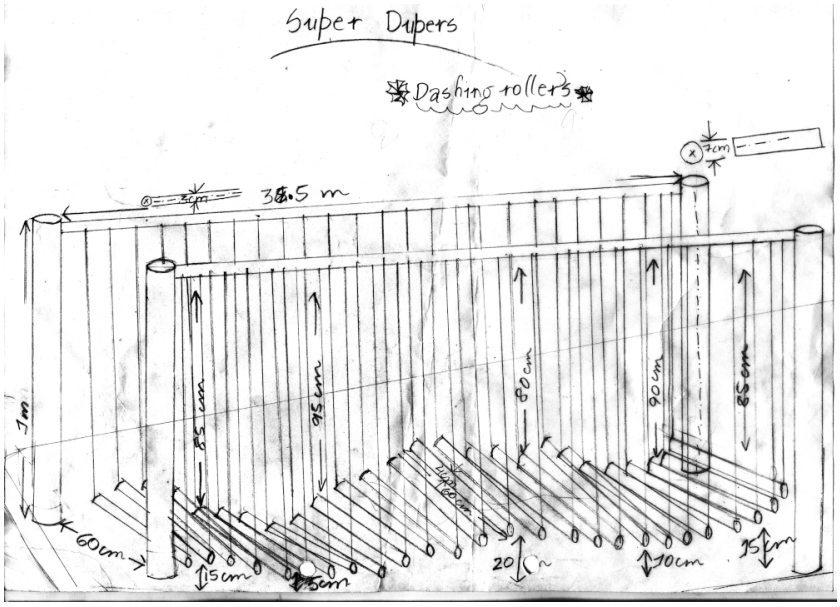


Figure 5.7: Technical Drawing by group Super Duper.

Group WinX dealt with the question of using tape and scale i.e. where one should use the scale and where one should use tape. They were worried about locating the centre of the circle, and diameter. I asked them about the chord of the circle and brought their attention towards the longest chord of the circle. Students drew the circle on a piece of paper and started searching for the longest chord by placing the scale at different points. In the process they realised that the intersection of two diameters could give the centre of the circle. But they had to face one more question which was whether the length of all the diameters were of the same size or not. I showed them how to get the centre of a circle by paper folding method. Then they took the measurement of two diameters and concluded that all diameters have the same length.

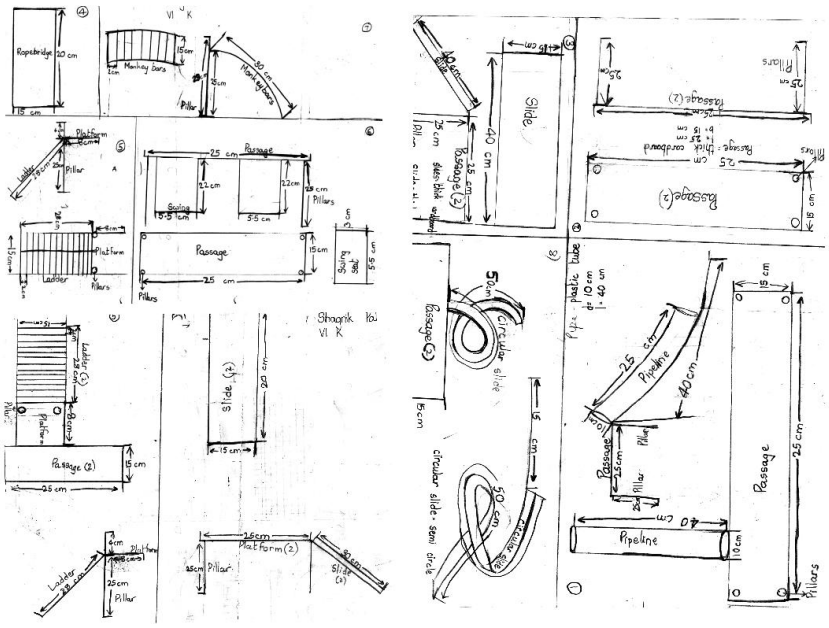


Figure 5.8: Technical Drawing by group Forest Fighter.

5.3.4 Social and interpersonal engagements

The social and interpersonal engagements are discussed under following headings:

Collaborative work: Students helped each other in clarifying and understanding concepts, ideas, plans, using tools (shared by all groups) etc. to reach the goal. Despite conflicts in sharing work, the groups appreciated the value of mixed abilities and the need of working together to accomplish tasks (WC). During the task. members of a group provided valuable and unique contribution and mutual respect built up in the group. One member taught unit conversion to another student, in turn the second student raised critical questions on technical aspects (TT).

Resource sharing: Students shared tools and bigger objects like drill, hack-saw, paper puncher across the groups whenever required and were willing to give extra materials to other groups. Realisation of the fact that they often needed materials that they had not listed, but was available with another group, helped them to appreciate the benefits of resource sharing.

Work distribution: Students distributed the work and mentioned this in the plan. There was a detailed work distribution in group FF. However, during making, students had to make dynamic changes of roles as per the need and shared their work. Most striking role change was observed in group SD, where they divided bigger tasks into smaller components and distributed among members, viz. one member was cutting the threads and the other two were putting the threads in the straw.

Responses to presentation: Overall, students were attentive while others were presenting. Most questions asked related to safety and suitability issues, while there

Table 5.6: Part of the rubric corresponding to assessing technical drawing.

Criteria	**Limited**	**Developing**	**Proficient**
Technical details of item	Leaders, arrows not used; all dimensions not mentioned; axis if needed not shown	Leaders, arrows shown for most parts; dimensions are mentioned for most parts; axis where needed is indicated	Leaders, arrows shown correctly; dimensions for all parts; axis indicated wherever needed
Views	Only one view, that too insufficient to show all parts	Multiple views drawn or perspective, showing most parts	All needed views drawn
Labels	No labels	A few labels for views, materials, etc.	Extensive labels, annotations for views, materials.

Table 5.7: Evidence of negotiation.

Sr. No.	**Name of group**	**List of 5 items (play / non-play items)**	**Evidence of negotiation**
1	Forest fighter (FF)	(4/1)	2 new and 1 modified item, 1 discarded
2	Super duper (SD)	(5/0)	2 play items discarded
3	Three champions (TC)	(6/0)	all 6 play items
4	Tremendous three (TT)	(2/3)	play items discarded
5	WinX club (WC)	(5/1)	Selected all 5

were also some questions on clarifying technical details: “How will you fix it?”, “How will this rotate?”, “Is this material strong enough to hold?” Such questions helped students elaborate understanding.

Negotiation of selecting play items: There is evidence of negotiation in choosing play items from the list of ten to list of five (except TC). Table 5.7 shows evidence of negotiation made by different groups.

5.3.5 Considerations of empathy and aesthetics

Most groups included considerations of aesthetics, safety and suitability for special children while designing their item. Emphasis of these aspects in students’ item lists indicates that these values are important for students. To make the list of 5 play items, TT discarded 2 play items from the list of 10 and kept three non-play items a) Bench b) Fountain c) Pond. The explanation by the group (TT) members showed their holistic and empathetic considerations for making the park are given in Table 5.8.

The designers of the Merry-go-round (WC) elaborately explored having a belt attached to the seat for safety reasons. Where there were chances of users falling to the ground, designs included a sand pit (SD, TT, TC, FF), and had railings or boards to prevent

Table 5.8: Evidences of empathy and aesthetic considerations by Group TT.

Sr. No.	**Name of item**	**Explanation given**	**Concern expressed**
1	Bench	This item should be in the playground because old people will be resting on this	Concern for old people (Empathy)
2	Fountain	This item will attract people's attention towards the park	Concern for attracting people (Advertising)
3	Pond	This item will look beautiful in the park	Concern for aesthetic (Aesthetics)

Table 5.9: Self and peer evaluation of model play items "Is model proportionate in dimensions?"

Name of the assessor group	**FF**	**TT**	**SD**	**TC**	**WC**
FF	No	Yes	Yes	No	No
TT	Yes	No	No	Yes	No
SD	Yes	No	No	No	No
TC	Yes	Yes	No	No	Yes
WC	Yes	Yes	Yes	No	Yes

accidental fall from heights (TT, FF). Even during the presentation of design and making plans, most questions asked by peers referred to safety and aesthetic issues. These aspects are a part of the three scale analytical assessment rubric.

5.3.6 Critical appraisal of models: Self and peer evaluation

Students evaluated their own model as well as others' using a given worksheet that included criteria related to salient issues, such as: dimensional proportionality of model; scaling; suitability of materials used; and stability, sturdiness, strength, safety, ease of use and aesthetics. It also included positive aspects of the model, or indicated problems in the model, and suggestions for improvements. All the groups rated at least one other group on one or more criteria more than they rated themselves, reflecting their critical thinking.

Students peer and self evaluation on the criteria "Is model proportionate in dimensions" is presented in Table 5.9.

Some salient points observed in their assessment on "Is model proportionate in dimensions?" are listed below:

1. Out of a total of five groups, four groups assessed Forest Fighter's model proportionate to dimension. However, the group itself did not find their model proportionate.

Table 5.10: Self and peer evaluation of model play items based on Stability.

Name of the assessor group	**Score of FF**	**Score of TT**	**Score of SD**	**Score of TC**	**Score of WC**
FF	5	3	3	5	5
TT	5	3	3	3	3
SD	3	3	3	5	3
TC	5	5	5	5	5
WC	5	1	3	1	5

Table 5.11: Self and peer evaluation of model play items based on Safety.

Name of the assessor group	**Score of FF**	**Score of TT**	**Score of SD**	**Score of TC**	**Score of WC**
FF	5	5	5	3	5
TT	3	5	3	3	5
SD	3	3	5	5	3
TC	3	3	5	3	3
WC	3	3	3	3	3

2. Forest Fighter was critical of their own model regarding proportionality on dimension. They found two other groups' models proportionate, namely Tremendous Three and Super Duper.
3. Forest Fighters, Tremendous Three, Super Duper, Three Champion assessed their own model as not proportionate while assessing at least one other group's model as proportionate.
4. WinX Club assessed their own model proportionate, and also judged three other groups as proportionate.

Students peer and self evaluation on the criteria "Stability" is presented in and "Safety" is presented in Table 5.10 and Table 5.11 respectively.

Some salient points observed in their assessment on Stability are listed below:

1. Three groups assessed Forest Fighter's model as stable, as did Forest Fighters themselves. FF also gave the highest score to two more groups Three Champions and WinX Club.
2. Three Champions gave the highest score (5) to all groups including themselves.
3. Two groups, Tremendous Three and Super Duper scored themselves lower than one other group.
4. WinX Club scored themselves highest along with Forest Fighters.

Some salient points observed in the assessment of groups regarding safety are listed below:

Table 5.12: Analysis of total score received by each group

	FF	**TT**	**SD**	**TC**	**WC**
Total score received by a group	120	102	104	98	114
Total score given by self	28	22	22	20	26
Total score given by peer	92	80	82	78	88
Ratio of total score given by Peer to the Self (Peer/ Self)	3.3	3.6	3.7	3.9	3.4
Total percentage score (of maximum possible)	80	68	69.3	65.3	76
Total percentage score given by Self (of maximum possible)	93.3	73.3	73.3	66.7	86.7
Total percentage score given by Peer (of maximum possible)	76.7	66.7	68.3	65	73.3
Total score given to peer	94	80	78	92	76
Percentage score given to peer	78.3	66.7	65	76.7	63.3

1. Only one group gave a moderate score (3) to Forest Fighter, who were rated by others and themselves as high (5).
2. WinX Club gave a moderate score (3) to all others groups as well as to their own model.

An interesting pattern is observed when the total scores of the groups received from self and peer assessment are compared together. The total scores received by each group are presented in the Table 5.12

Some salient points observed in the overall assessment are:

1. There were only three scores (1, 3, and 5) to grade these play items. Students mostly used 3 & 5. From the score received from diverse elements, it is possible to aggregate the scores and order the performance of different groups.
2. The ranking of the models indicating performance of groups exhibited a stable order if total percentage, or peer assessment or self assessment is taken as reference. Thus, using peer assessment and self assessment did not upset the order.
3. Three groups Forest Fighters, Tremendous Three, and Three Champion gave either equal or more score to their peers than what they received from peers. Interestingly, Forest Fighter was the highest scorer and Three Champion the lowest scorer and both gave higher scores to their peers.
4. When the percentage score given to self and to peers is compared, only one group Three Champion (the lowest scorer) gave a lower percentage score to self (66.7%) than to peer (76.7%).

The richness of the students' understanding of others' work is evident while recording the critique of the item models. The critique given on the play item model prepared by Forest Fighters is given in Table 5.13. Forest Fighters mentioned a positive aspect of

Table 5.13: Critiques by all the groups on the item Ultimate combination by FF

Name of the group	**Positive aspects**	**Negative aspects**	**Tips for improvements**
FF	Combination of many things and takes less space	No accessories for disabled children	Using things for differently able children
TT	Fun	Has not very much safety	Including safety
SD	Children can exercise in many ways	Swings can fall easily because they are not tied correctly	The passage is not safe
TC	Joining the straws	None	By making rope way proper
WC	Children have ultimate enjoyment	(Its) passage and rope bridge are not safe	The rope bridge should be more safe

their play item is that it combined many things within a small space. This is explicitly resonated by group SD, while TT and WC echoed the word of Forest Fighters "fun to its user". Forest Fighters used this phrase several times during their presentation and conversation on their play item model. TC faced difficulties joining the straws and they appreciated the way FF joined the straws and did not mention any negative aspects of the play item model. FF themselves accepted that their play item did not include accessories for differently abled children while other three groups raised safety aspects for play items made by FF. Two of the groups identified swings, passage, and ropeway required attention to safety. Similar suggestions for improvement also show a consensus among at least one other group.

5.3.7 Insights on Assessment and Evaluation

There are several challenges in assessing design and making tasks. Focusing on processes for the whole class could be impractical, while focusing on product is insufficient to appreciate the richness of the design tasks. However, assessment of a planned sequence of productions will give evidence of processes, which can be tracked in successive productions. The assessment will include the evolution of the product in a dynamic context. My assessment included making students' articulation explicit in the context of presentations and self and peer evaluation. The assessment rubrics served as a progress indicator for both students and me. These were not meant to grade students, but as a guide to students' learning, and to help structuring the teaching-learning sequence.

Students' assessment of their own model and comparing with others' created an environment for them to reflect and aspire to improve further. This context can be used to help students appreciate multiple skills and varied abilities among them. However, when students work in groups, assessing individual learning and performance is difficult

within the format discussed here. The possible solution may lie in using the assessment rubric to provide feedback that will help set individual attainment goals. The rubric developed is specific to the PBL activity that requires design and making. It is not generalisable to all PBL activities of this kind, though some aspects may be common across all design and make tasks.

5.4 Conclusion

In this study, Grade 6 students carried out several activities as part of their engagement in designing and making a model of a playground on a plot of available land. These activities have been analysed along with students' productions to gain insights on students' learning in and through the PBL activity. Several assessment rubrics were also developed to record and facilitate learning.

A technological practice environment is created in which students can learn technological concepts and processes while developing solutions to meet real needs or opportunities (Drain, 2010). This approach is Project Based Learning (Barlex, 2006a) and satisfies the five criteria of PBL given by Thomas (Thomas, 2000), viz. centrality, existence of driving questions, constructive investigations, autonomy, and realism. For the PBL unit to be tried with students, I set the context through a discussion of experiences of play spaces followed by a visit to a playground site, giving due importance to students' ideas. After the making activity, students evaluated their own as well as others' models. These activities provided a sense of authenticity and realism to the whole work. The design brief served as the driving question, without a prescriptive script. The activity was novel for the students, engaged them in constructive investigation and displayed evidence of their learning of new knowledge and skills. Students' tangible productions in response to the demand of the tasks made this activity a PBL unit. The centrality criterion was addressed by including multiple concepts and learning objectives from students textbooks of grade VI.

All the children of this sample had prior exposure to parks and playgrounds. The PBL activity as mentioned above was contextualised. Students carried out actual site measurement and were provided with all the materials they needed as well as help if required. During the planning and designing, students were encouraged to relate the tasks to their daily experiences and feelings. Students were provided opportunities to talk to their peers both in structured and non-structured setting (S. Mehrotra, 2008).

Students were informed that their design would be evaluated by the concerned authority of the institute for a possible implementation. Students were asked to present their play item models to the class and evaluate their model as well as others' models. I had to intervene in the critical parts of the activity, especially when students required assistance to complete the task within the given time or when it appeared that students were deviating from their actual task or lacking interest and enthusiasm in their work.

Students became more confident about using new tools though they were far from experts. Mapping the playground provided opportunities for using measuring tools

and measuring skills. Estimation skills, scaling and measurement accuracy were tested throughout the design and making tasks. Students used their body parts and familiar objects for estimating dimensions of their conceptualised play item.

Students' designs evolved from exploration through technical drawing, planning to make and even while making. They identified design problems and developed strategies to fix them. Students' social and interpersonal engagements were studied both during their informal interactions while designing and making and during their presentations and responses to others' presentations. Empathy with differently abled persons, concern for safety and attention to aesthetics were seen in many of their productions and interactions. Students' queries on peer presentations largely involved questions of safety, material use and stability. Students' responses while evaluating showed their ability to critique their own and others' work in a fair and just manner.

Developing assessment rubrics for the tasks poses several challenges, especially if the activity is a group activity. A three scale analytical rubric was developed having a number of criteria. These criteria were based on evidence of students' learning in their productions. While this rubric helped in tracking the progress of groups through their successive productions, it was not possible to use the rubric for tracking progress of individuals. It is hoped that discussing the performance with the students will serve to set standards for individuals to achieve.

The tasks and activities assigned to students during the course of this engagement were also mapped with LOs from syllabus and content from the textbooks of different subjects. Students' learning of content knowledge and attainment of learning objectives were not evaluated with evidence of learning but shows a promise in this direction. The self and peer evaluation conducted by students recorded in the evaluation sheet shows that students' evaluation can be reliable, authentic, and reflective if they are provided adequate opportunity. This evidence shows the promise of policy suggestions to implement in the classroom.

The insights gained from the study were documented in the form of researcher's log and proceedings. These documents along with students' portfolios were shared with teacher participants of the third workshop of the teacher workshop series for developing assessment rubrics.

Chapter 6

Development and implementation of TPD model for PBL

The chapter describes the preparation and transaction of a design based research model of Teacher Professional Development (TPD) that evolved with the engagement of participant teachers. There were three distinct phases of the engagement. A schematic diagram of the three phases of the TPD engagement is presented in Figure 3.1 in Chapter 3.

Section – 6.1 provides a brief description of the TPD engagements, while section – 6.2 presents a narrative of the planning and preparation of TPD engagements. The sections – 6.4 to 6.7 – discuss the engagements with teacher participants and the sequence of workshops designed for PBL over a period of five months.

Teacher participants collaboratively generated iterative project plans in alignment with principles of the proposed model of Project Based Learning (PBL) while engaging with the researcher. The engagement was centered around a series of three workshops. The sessions of the workshops are listed in Table 6.1. School visits and feedback from participants during and outside the workshops are discussed in relation to their influence on iterative development of the TPD model. The communication made over asynchronous modes and platforms to facilitate such communication are also discussed. Four short duration workshops were also organised to test the effectiveness of the content and process developed in the workshop series. These provided a wider audience to the participants of workshop series to share their PBL practice and learning from it. A brief account of these workshops is also presented in the last section.

Section – 6.10 presents the learning from the TPD engagement that forms a basis for evolution of the TPD model presented in Section – 6.11. The final Section – 6.12 highlights some unresolved dimensions of TPD engagement in the current study and points out the potential of resolving these concerns through existing institutional mechanisms that are in place.

6.1 Design of the TPD engagement

I critically looked at the major educational policy documents of the last two decades which have shaped the current educational scenario of the country. These included the National Curriculum Framework 2005 (NCERT, 2005), Right to Free and Compulsory Education Act (GoI, 2009), National Curriculum Framework for Teacher Education (NCTE, 2009), and National Education Policy 2020 (MHRD, 2020). The relevant circulars issued by Central Board of Secondary Secondary Education (CBSE) and curricular materials developed by CBSE, National Council of Educational Research and Training (NCERT), and Ministry of Human Resource Development (MHRD) in response to these policy documents were also looked at. I also scrutinised the primary to high school textbooks published by NCERT and Maharashtra State Textbook Bureau.

An important plan of the government is to provide quality education to every child of the country (GoI, 2009) and prepare them to take active part in the democratic polity and nation building activities (MHRD, 2020). This ambition demands a shift towards providing a liberating educational experience to every child. On the contrary, the situation on the ground reflects increased burden on teachers and students in the form of conducting frequent assessments, carrying out projects and activities after enforcement of the suggestions given in NCF 2005 and RtE 2009, resulting in the fact that teachers work under a very tight schedule.

I felt that reading these resources and literature is important for planning engagement with teachers. The reading of these documents, circulars, and curriculum development efforts indicated a common thread for unifying pedagogy, as PBL. A detailed outline of deriving PBL as a possible response to diverse policy suggestions is presented in Chapter 1. From an extensive survey of literature (Ref. Chapter 2) a model of PBL was formulated as Phase I of the study.

This model required scrutiny from practicing teachers, particularly, important was how teachers view projects and the related four aspects proposed. I thought that the model could be deliberated among the teachers of one school in focused group discussion (FGD) mode. While individual teachers may have differences, it was expected that in the FGD, the participants would respond as a community while negotiating their individual differences. This was important as PBL and similar pedagogic strategies require a whole school approach. In addition, I would gain insights of the diverse vocabulary used by teachers in teaching practice and what interpretations they make towards the proposed PBL.

The major insights from FGD was how projects are implemented and carried out in a school where practice of projects for all students is not mandatory. The model was then introduced to teachers conducting projects on a regular basis, during individual semi-structured interviews. These interviews were useful in exploring teachers' individual understanding, challenges, views and vision. The interaction with teachers helped in exploring the meanings situated in teachers' respective context. At the same time, these provided important insights about the school systems the teachers represent.

The learning from FGD and semi-structured interviews provided insights in the proposed model of PBL. The learning largely informed the content and approach of Workshops on PBL for teachers and generating items of a survey questionnaire for teachers. This questionnaire was administered to the participants of the first workshop. One FGD, four individual semi-structured interviews, and a questionnaire survey together form Phase II of the study.

A series of three workshops were planned and conducted with teachers. These workshops were planned as TPD engagement and the content and process of the workshops were drafted and executed by the researcher. This version of the TPD engagement was then shared with three experts in educational research. For the first and second workshop, content was created as well as collated from existing literature and the content used in the third workshop was mostly derived from the school visits, teachers' PBL plans and a PBL unit conducted by researchers. Teachers' productions were used as content in all the three workshops. The learning from each workshop helped create and select resources for the next workshop.

The responses gathered through the survey questionnaire helped me understand teachers' initial views about projects and their practice. The items of the questionnaire were mostly open-ended and thus in order to understand the teachers' responses, it needed some interpretation. This process provided an opportunity to reflect on my own ideas.

I visited schools of most of the teachers, discussed with them about their project practices and learning from the workshops, observed their classroom teaching, conversed with other teachers and students, conducted semi-structured interviews and attended their students' project presentations. In a few schools, semi-structured interviews and questionnaire surveys were carried out with students. The student views gathered from the interviews and surveys were presented to the teachers during the workshop series.

A PBL unit was planned and transacted with students. The students' productions generated from the transaction of PBL and researcher's log were provided to participants of the third workshop. This helped participants to evaluate actual students' productions and a prototypical PBL unit. It also provided some concrete examples of different PBL criteria to teachers. Along with school visits, I used online communications, such as, emails, online documents and blog spaces. Telephonic communications were also maintained with teachers.

A part of the productions of the workshop series were compiled and published as a technical report and distributed to all the participants. The PBL unit transacted with students formed an exemplar for use in the successive workshops. After the workshop series, four single-shot workshops were conducted to try out the content and process developed in the workshop series. Teachers from the workshop series shared their understanding and implementation of PBL and acted as resource persons in these workshops.

6.2 Planning and preparation of TPD engagements

Planning and preparation of this study for exploratory research purposes was carried out outside the regular institutional mechanism for TPD in place. The regular institutional mechanism of TPD is conducted at District Institute of Educational Training (DIET), Block Resource Centre (BRC), and Cluster Resource Centre (CRC) under the mandate of DIET and State level Institutes like State Council of Educational Research and Training (SCERT) or State Institute of Educational Management and Training (SIEMAT).

Planning and preparation are crucial aspects of any TPD engagement. There are two primary purposes of elaboration of these aspects. First,is to acknowledge the diversity of work involved in TPD engagement. The second is allocating space and time for such engagement and advocating required institutional mechanisms to meet these requirements. This section presents a short sketch of the planning and preparation carried out in this study and how some of its learning can be extended to general TPD engagements. Planning included work related to both non-academic as well as academic dimensions.

The academic preparation for the entire engagement included at least three elements: (a) building a community of practitioners and collaboratively planning the process and content of the engagement, (b) literature survey and review, and (c) planning and conducting teacher and student interviews. The element of *literature survey and review* is already presented in Chapter 2, while *planning and conducting teacher and student interviews* are presented in Chapter 3.

Building a community of practitioners is a crucial aspect of establishing deliberative practices among teacher educators. The research project was initiated by me along with my supervisor. However, to add richness to the project, a dynamic research group was formed that consisted of resource persons with expertise in science education, design and technology education, gender and socio-scientific issues as well as other interested persons. The resource persons with expertise in design and technology education were familiar with the pedagogy of PBL. However, none of them had explicitly focused on the pedagogy of PBL in their research.

This research group participated in several meetings for planning and discussions, both in person and over several asynchronous modes. The asynchronous modes include communication through emails and online shared documents. Through these meetings, the process and content of the engagement was discussed, reviewed, edited, developed, and collated from available sources. The content of the TPD engagement facilitated by the research group can be classified into four categories: (a) announcement brochure (Appendix E), application form, schedule (Appendix F), and covering letter, (b) session plan, (c) reading materials, and (d) worksheets and survey sheets.

The announcement brochure was reviewed by two experts. The announcement of the workshops contained a day wise schedule of all the three workshops and changes were made to the schedule to incorporate the learning and the needs arising from the

engagements. A detailed session plan was prepared for every workshop. The first draft of the session plans were developed by the researcher and was shared with the research team for review and feedback. The session plans for the second and third workshop as well as for the short duration workshops were shared with some selected teacher participants.

The reading materials were of two kinds, published papers and handouts. Handouts were provided to teachers in all the workshops. Some of the handouts were from existing literature and resources. These included a set of rubrics from the "Project Based Learning Handbook" (Markham et al., 2003). The rubrics were used as examples and worksheets in the workshop sessions. Some other reading materials/handouts were either edited or written by me or the research group. These materials covered educational ideas of Gandhi and Tagore, and ideas of assessment, subject integration, and classroom management. It was strongly felt after the first workshop that participants needed to be provided with content suitable for the Indian context and the concerns relevant to the Indian school situations. Further, the language of the write-ups needed to be appropriate for Indian teachers. Therefore, papers were provided only in the first workshop of the series of three workshops. Handout materials evolved over time and were also used in the successive one-shot PBL workshops with different groups of teachers.

Handouts of slides presented during the workshop were also added in the dockets of handouts. Presentation slides prepared covered six topics: (a) introduction to PBL, (b) plan of PBL workshop and the engagement with the teachers, (c) problem context and PBL, (d) assessment, (e) students' ideas of PBL, and (f) an overview of PBL unit transacted with students. Each short duration workshop included all these topics, however, the slides were presented in summarised form.

Worksheets were developed for participants to work in groups. Survey sheets on "Ideas of Projects" were developed and administered to all the teachers of the first workshop. A detailed description of the development of the tool is given in Chapter 3.

6.3 Structuring TPD workshops

As mentioned earlier, there were two types of workshops. One was a series of three workshops and the other were multiple shorter duration workshops. The series of three workshops is more crucial, the shorter duration workshops had diverse purposes, such as, (a) providing a wider platform for teachers who participated in the series of three workshops to showcase their practices and learning, (b) introducing PBL to a wider group of teachers, (c) trials of materials developed in the series of three workshops, and (d) verifying some of the ideas and perceptions that emerged from engaging in the series of three workshops.

This section presents a description of the structure of the series of three workshops and provides an overview of (a) inviting participants to the series of TPD Workshops, and (b) schedule of the workshop.

6.3.1 Inviting participants to the series of TPD Workshops

The announcements of the workshop series were made through several modes: (a) publishing on the researcher's institute's website, (b) postal communication to a group of known teachers/schools, (c) communication by email, and (d) personal communication. The invitation was open for teachers and teacher educators working preferably in middle and high school levels. However, care was taken to have a diverse group of participants, for example, choosing participants from different school systems, having different kinds of school experiences, teaching different subjects, etc. I made several follow-up visits and sent communications to the respective authorities of participating schools to send their teachers in the second and third workshops.

6.3.2 Schedule of the workshop

The final schedule of events in the workshop series is presented in Table 6.1.

6.4 First workshop: Introduction to planning PBL

The first workshop primarily dealt with introducing teachers to the idea of PBL and developing a PBL plan for implementation in their respective schools. It was structured to include interactive enrichment sessions, teachers' activities and presentations. The main objectives of the sessions were to allow teachers to articulate their ideas about PBL, discuss their concerns about conducting PBL, share ideas and strategies to address some of the concerns through planning PBL projects, engage in planning projects on the lines of PBL suitable for their schools and develop insights about the challenges and possibilities in the exercise.

The first day began with registration of all participants. Like the community of researchers, a community of teachers is equally important so as to initiate and sustain the culture of deliberations. Therefore, one of the objectives of the workshop series was to build a community of teachers, who will support each other, and will enhance capability to conduct PBL in schools. Hence the first session was structured to give an opportunity to every participant to introduce themselves, stressing that all participants are important, and diversity of professional and personal interests are an asset in the teaching-learning profession. The researcher and resource persons positioned themselves as collaborators of the teachers.

The proceedings for the day are described below.

Table 6.1: TPD workshop schedule.

Day	**Workshop 1: Introduction to planning PBL 7-10 July 2010**	**Workshop 2: Planning PBL focusing on 3 key aspects 22-23 October 2010**	**Workshop 3: Consolidating PBL ideas 9-11 December 2010**
1	*Registration* *Introduction:* Knowing each other *Responding Questionnaire:* Ideas on projects and project practices *Lead talk:* Introduction to PBL *Sharing:* The plan of workshop and norms of group work *Group work:* Reading of research papers *Present:* On Readings	*Discuss:* Introduction to the Plan of Workshop 2 *Group work:* Plan project – Focusing on Learning Objectives and Sequencing activities *Group work:* Expert group sessions on 3 key aspects – Assessment, Subject integration, Classroom management *Present:* Plan with 3 key aspects	*Discussion:* Introduction to the plan and scope of Workshop 3 *Lead talk:* Student's views on projects *Discussion:* Introduction to the PBL unit *Group work:* Constructing assessment rubrics for student portfolios *Present:* On rubrics *Discuss:* Plan BASE workshop
2	*Group work:* Is this a PBL project? *Lead talk:* Contextualising PBL for Indian classroom & strategies for implementation *Group work:* Plan & structure project *Present:* Project plan	*Discuss:* Unresolved tension in relation to 3 key aspects *Group work:* Plan projects *Group work:* Poster making *Present:* Poster *Summary:* Learning and plan for next engagement	*Group work:* Review of example PBL unit *Present:* Review of PBL unit *Present:* Teachers' PBL practice *Group work:* Plan for role-play on PBL *Discussion: Plan for teacher workshop*
3	*Discuss:* Introduction to different types of constructivist pedagogy *Lead talk:* Assessment *Group work:* Activity on planning projects including assessment strategies *Discuss:* Driving question and project plan *Present:* Revised project plan		*Group work:* Skit practice, enactment & discussions *Present:* Revised project with assessment plan Summary & feedback
4	*Discuss:* Develop analytical rubric, integration in PBL *Group work:* Finalising project plan *Present:* Revised assessment plan Summary, feedback, & plan for follow up		

Collecting ideas about project and project practices

The details of administering the questionnaire are provided in Chapter 3 and a detailed analysis of the responses is provided in Chapter 4. Once the teachers completed the questionnaire, each of the teachers was given a docket containing the reading materials (see Appendix G) and worksheets. Individual teachers were given the complete docket so that teachers could carry it to their respective schools and read during their free time. This session lasted for an hour

Lead talk: Introduction to PBL

The talk was aimed at initiating a discussion on projects and PBL with the teachers. In the talk, project ideas suggested and practices reported by the teachers were used as resources to build PBL ideas. The talk touched upon a short introduction of projects in school with a special reference to John Dewey's idea of conducting projects in school. Then a short account of three Indian educational thinkers, viz. Swami Vivekananda, Mahatma Gandhi, and Rabindranath Tagore's ideas were presented as a motivation to project method in school.

The next point of discussion was contrasting the conduct of traditional projects to the characteristics of PBL projects (Thomas, 2000). While discussing types of projects, teachers' examples were used as resources. It was also mentioned that all projects were not PBL projects. Several examples of projects, different types of pedagogic strategies, and recent initiatives in India, involving the Kendriya Vidyalaya Sangatan's (KVS's) initiative of PBL were also presented to the teachers. This was connected with detailed elaboration of five characteristics of PBL projects (Thomas, 2000) and proposed model of PBL mentioned in Chapter 2. The duration of this sesssion was 1.5. hours

Sharing the plan of the workshop & setting the stage for group sessions

It was communicated to the participants that they were expected to plan projects during the workshop and conduct these in their respective classrooms. The implementation of projects would help both the teachers as well as researcher understand real teaching-learning issues in implementing PBL at school level. Participants were requested to come up with at least three to four ideas of projects. The expected duration for each project was three to four months. The teachers would implement their plans in their school and communicate the experience to all the participants in the next workshop. This would help the community of participating teachers in the workshop to learn from each other.

Teachers were also requested to suggest suitable dates for the second workshop to be held for two days (in September). If projects were being scheduled to be conducted in schools, the researcher wished to visit the schools and help in the planning and implementation of the projects. In the third workshop in December, the group could

evaluate the project implementation. The tentative schedule of the workshop series and further plan was also elaborated to the participants.

Participants were informed that most of the work in the workshop would be group work, and hence participants were requested to form groups. Each group could name itself and was provided a cardboard box to keep all their productions in, e.g. write-ups, worksheets, and feedback sheets.

Reading of research papers and presentation of readings

Each group of participants was assigned a paper to read and prepare a presentation based on a set of guiding questions. These readings and questions are given in the box in Appendix G. I requested teachers to first read and understand the papers and then respond to the relevant guiding questions. Participants could also refer to a few copies of English dictionaries provided. All groups felt the need to refer to these dictionaries while reading the papers, indicating the interest of the participants in reading as well as the language gap that existed between research papers and teachers' everyday language use.

I along with two resource persons attended to the queries raised by the groups and engaged in clarifying ideas expressed in the papers. Given that each group had to present the content of the paper assigned to them, it was interesting to note that most questions of the participants were primarily related to what to present and how. Teachers were requested to present the readings according to the given points: (a) Group name, (b) Presenter(s)' name/s, (c) Paper title and authors, (d) Key findings, and (e) Relevant guiding questions and group's responses to them. All the groups read the papers and prepared their presentations and this entire session of reading, understanding and presenting papers lasted for 3 hours

The proceedings for day 2 of the first workshop are discussed below. For the list of sessions and their duration conducted on this day, refer to Table 6.1.

Contextualising PBL

On the first day, the lead talk introduced the characteristics of PBL and contrasted it with usual project practices in the schools. The discussions and presentations indicated that participants were finding it difficult to make the connections between the PBL issues and concerns, as expressed in the literature, and their own project practices. Therefore, it was planned to include more specific context rich situations on the second day.

Group work: Is this a PBL project?

In the first session, each group was given two examples of projects. These projects are given in Appendix H. Each project satisfied the different PBL criteria to different extents. Care was taken to put some of teachers' existing practices in the project samples. Teachers had to evaluate whether each project was a PBL project or not. To help in the evaluation of the project, teachers were also given an analytical rubric including the five PBL criteria with descriptors.

It was clarified to the teachers that they had to first evaluate the given projects in terms of the five PBL criteria (Thomas, 2000) and then decide whether they considered the given project to be a PBL project. Teachers had to fill up a form indicating their decision. The rubric with the five criteria and descriptors is included as Table H.1 in Appendix H. Teachers also were asked to suggest modifications to the projects that would satisfy the PBL criteria better.

Lead talk: Contextualising PBL for Indian classroom & strategies for implementation

The talk consisted of five major aspects: (a) discussion on PBL criteria, (b) developing PBL project ideas, (c) types of driving questions, (d) teachers' role in PBL implementation, and (e) perceived tensions in planning and conducting PBL projects. All the aspects were discussed with the help of several examples drawn from contexts familiar to the participants and citing examples from textbooks of Maharashtra Board and NCERT. Opportunities were provided for teachers to raise questions and express their ideas and views about the different aspects of PBL projects and share them with their peers. The discussions gave insights about teachers' conceptual understanding, as well as their non-academic concerns, and how these shaped their views about implementing PBL.

Group work: Plan and structure project

Each group of participants was asked to write down the plan of a project that they would conduct with their students. A *Project Planning Format* as in Appendix I was provided as a guideline so that they could write their ideas in the format, and present their written responses in the following session. Several sets of middle and high school textbooks of Maharashtra State Board and NCERT were kept at a common place and each group was requested to consult the books if required. It was seen that all the groups referred to the textbooks in planning projects.

It was hoped that participants would use the given format throughout the workshop series to guide their project planning. However, this format evolved into different activity sheets after the first workshop.

Presentation: Plan of project

Once teachers completed the write-up they presented their project plans to all the participants. Each group was asked to present their ideas under five heads: (a) Title and theme of the project, (b) Subjects addressed, (c) Problem context and driving question, (d) Concepts and contents that could be addressed in the project, and skills to be developed in the project, and (e) Products and assessment of the learning.

All participants actively took part in the discussions that followed every presentation, which included clarification requests and feedback from others, and short discussions. There was a congenial atmosphere where participants' ideas were appreciated and feedback was provided and received sportingly.

Day 3 began with introduction to assessment. The description of what was achieved during different sessions on day 3 is presented below

Discussion: Introduction to different types of constructivist pedagogy

There were some challenges observed in the previous sessions. Almost all the groups were confused about structuring a driving question. At one stage, participants questioned the need of having a driving question. Some of them even challenged the researcher to structure the driving questions for them. To address this challenge, I decided to hold a discussion with specific examples and the day began with this session. I used the topics, themes, and problem contexts developed by the groups and showed their potential to structure suitable driving questions.

In this session, participants were introduced to methods such as project based, activity based, inquiry based, and discovery based learning. The session made an attempt to explore participants' ideas and make them explicit and discuss them in detail. Teachers were aware of the term inquiry based teaching-learning and not the other teaching-learning methods.

From the beginning of the workshop, some of the participants requested a session to introduce different types of constructivist teaching-learning methods and their similarities and differences. The discussion with teachers during the lead talk on the second day and the findings from the questionnaire survey responses revealed that participants did not share the same views about different activity based and constructivist teaching-learning methods. Therefore, the first session on the third day was altered to address this aspect and the lead talk on assessment was shifted to the next session. The other sessions were accordingly rescheduled.

Lead talk: Assessment

In the beginning of the lead talk, participants were given three research papers on assessment (See Appendix G) and a set of exemplar rubrics from a standard PBL

Handbook (Markham et al., 2003).

The talk on assessment discussed the differences between associated ideas like assessment and evaluation. Clarification was provided on purpose and forms of assessment, assessment tools, definition of rubric, differences between holistic and analytic rubrics, features of a rubric, steps of designing a rubric, issues of validity and reliability in assessment, principles of assessment. It was observed that teachers were concerned about assessment, however, they had incomplete understanding about assessment. It was discussed in the talk that formative assessment was also known as assessment for learning, and that assessment and evaluation was a continuous process.

Group work: Activity on planning projects including assessment strategies

In this session, participants were requested to continue the activity *project planning* that they had started on the previous day and finalise their project plan including the aspects of assessment. The task required participants to select the learning goals they were going to assess, select the productions to assess the stated learning goals, and prepare a holistic rubric to assess the respective students' productions.

Discussion: Driving questions and project plan

From the presentations of the previous day on *project planning* it was observed that almost all the participants faced several difficulties while drafting their project plans. Participants reported that they had faced difficulties in posing problem context, framing a driving question, and deciding assessment criteria. In addition while planning the projects, participants failed to align several components of the projects, e.g. aligning stated learning goal to the productions and corresponding assessment criteria and aligning driving question to the planned tasks and productions.

It was interesting that one of the groups (Desire) started complaining that it was very difficult for them to again work on the project plan. However, I observed that there were several opportunities to include PBL elements and modify the project plans in all groups. Therefore, it was decided that a whole class discussion on structuring projects in connection to their project plans would be helpful for teachers to reflect on as well as improve their plan.

Taking the help of specific examples from the project plan prepared by the participants, the following major issues were discussed: a) role of driving question, b) steps to construct driving question, and c) aligning driving question to the learning goal. The discussion included steps to decide learning goals, tasks, and productions, aligning productions to the learning goal, delineating criteria to assess particular productions and communicating the assessment criteria as well as assessment scheme to the students.

There was a long discussion on the requirements of driving question, nature of driving question and difficulties in framing of driving question. In this context, I discussed

with the teachers, by taking examples of driving questions and problem contexts from the project plans made by all the groups and showed how putting problem context was insufficient to guide students activity. Therefore, a driving question at the end of problem context was essential. Similarly, just a driving question without any context would not provide enough motivation. I pointed out that although some groups faced difficulties in framing driving questions, they had created a relevant problem context. While presenting the rich problem context the teacher or students could generate a driving question. For some groups, I helped in modifying their driving question.

During the presentation session, all the groups were asked to present only the assessment scheme they made for the project plan. While planning for the assessment, it was observed that groups also revised their original plans.

There were four major sessions on the last day. The first session was dedicated to discussions on developing assessment rubrics. In the second session, teachers were engaged in group work to complete their project plan with detailed assessment. Participant teachers presented their project plan in the third session. The last session summarized the workshop and feedback was sought and received from the participants. The deliberations of the different sessions on day four of the first workshop are presented below.

Discussion on developing assessment rubrics and project plan

In this session, ways to develop assessment rubrics were discussed. This included five aspects: (a) different components of an analytical assessment rubric, (b) uses of rubrics in PBL context, (c) advantages of using analytical rubrics, (d) aligning content, concepts, and skills to the assessment tool and criteria, and (e) use of rubrics along with an existing standard scoring system.

Group work on finalising project plans and presentation

After the discussion on preparing rubrics and aspects of assessment in PBL, participants were asked to complete their project plan with adequate assessment components. After drafting the project plan, the participants presented their plan.

Summary, feedback, and plan for follow up action

At the end, all the sessions were summarised. All the participants and their respective organisations were thanked, and participants feedback was sought. Participants shared oral feedback in the session and they were requested to share their feedback in writing too.

6.5 Learning from the first workshop

The interaction with school systems and the participants provided insights on at least three aspects: (a) the factors that influence teachers' participation in voluntary TPD engagement, (b) inputs for TPD planning, and (c) evolution of participants' views about projects. The first two aspects are discussed in the following sections while the third aspect is presented in Chapter 7.

6.5.1 Factors influencing participation in TPD workshops

When contacted personally, school authorities — principals, headmasters, school system chairperson or secretary — gave a variety of reasons for their inability to depute teachers to the workshop series. The reasons included the following:

Tight teaching schedules: The tight schedule of teachers' does not permit them to leave their regular class for four consecutive working days, as required in the first workshop of the series.

Substitute teacher unavailable: The school did not have enough teachers to provide a substitute teacher to the participant teacher's class.

Preference for off-school period: Some suggested that similar workshops during the school vacation period, on holidays only or weekends, would be useful.

Personal commitments: A principal expressed inability of teachers to participate in workshops even on weekends as they had to fulfill their personal (not professional) commitments then.

Approvals from higher authorities: The schools run by the State government and some private schools affiliated to the State Board required that the researcher first obtain approvals from the concerned government educational authorities before approaching the school.

Other workshops to attend: Two schools mentioned that their teachers had to participate in workshops organized by the State Education Department during the vacation. Hence they would not be able to participate in the workshops even if these were held during the vacation.

Also, the participation of teachers in the workshop was not steady, and there were irregularities in teachers' attendance. Teachers have busy teaching schedules and also there are insufficient number of teachers in the school. At the same time, sending teachers to such types of workshops is subject to approval / direction from higher authorities.

6.5.2 Inputs for TPD planning

During the feedback sessions of the first workshop and through written communication from teachers, I got a glimpse of teachers' perspective towards the workshop. Seven participants representing five groups, six school/organisation systems, and seven schools/organisations shared their feedback on the workshop. Two teachers sent the feedback on the next day, and other teachers sent their feedback within the next 7 to 20 days. All the teachers found the workshop *good* and interactive. Teacher (VA-S) expressed that they enjoyed the workshop particularly the first three days of the workshop. They (PR-A) felt that the idea was *easily and conveniently* presented. She also expressed that, she liked the idea of PBL and had already requested her organisation's concerned authority to implement it in their school.

Teachers (VA-S, SU-A) appreciated the work of the researcher and resource persons. They (VA-S) found the researcher and resource persons hard working and enthusiastic and appreciated the teamwork and hospitality of the researcher and resource persons. The workshop was a learning experience (VI-A, SU-A, NA-C) and helped teachers (VA-S) to learn the difference between *just a project and project based learning*. The resource persons observed that the workshop had exposed teachers to relevant activities however they felt that the workshop did not discuss sufficiently on contrasting PBL and other projects. Hence, future workshops must include this component in more detail.

The members of the research group noted that the sessions of the workshops had addressed the aspects of collaborative work, planning, assessment and implementation in PBL. Teachers (UM-A) found the elements of the workshop, like working in groups, presentations by the participants, and providing feedback interesting. The teachers liked the example of PBL conducted in an Indian context for each subject, and specially appreciated inclusion of social studies and language. The encouraging comments of a teacher participant (VA-S) are given below:

> "You had well planned the things because I know how much hard work goes in even when I prepare for just a 40 min lecture. And you had kept us occupied for so many hours.
> ... Though not directly intended by you, but my indirect observation of the team spirit shown by you all throughout the session, keeping all egos aside, no superior-inferior attitude, being there for each other also encouraged me to work even better for my Umeed team."

While engaging in the first workshop, most participants realized that at least in some ways PBL was different from their project practices so far and that their project practices did not incorporate all PBL aspects. In the activity: "Is this a PBL project", participants could recognise projects that satisfy PBL criteria. Teachers could intuitively decide whether a project was in alignment with PBL or not. However, this intuitive understanding was not sufficient to enable them to structure projects aligned with PBL.

It was also observed that teachers did not appreciate the nature of differences between traditional projects and project based learning. Teachers seemed to associate PBL to only their prior experience of dealing with school science projects. At the same time, it was realised that there was a need of contextualising content and sharing an exemplar PBL project with the participants. The modifications carried out based on the learning while engaging in the first workshop are briefly described under separate heads.

Better contextualisation

Overall, it was observed that, participants had faced difficulties in reading and comprehending the research papers. Teachers (eg. VA-S) found the activity of reviewing research papers difficult. She rightly pointed out that the research papers cited were about science and mathematics projects.

Similarly, the worksheet with project planning formats was directly taken from PBL handbook and was more suitable for USA context. Teachers found it difficult to organise project planning in this format and kept most of the sections blank. Therefore, a fresh set of modified worksheets were given to participants. The planning task was divided into three distinct but related stages, which would engage participants first to plan a project with the learning goals in mind, then plan suitable activities aligned with their learning goals, followed by structuring the PBL as a sequence of activities in a coherent way.

Increased focus on LOs, content, concepts, and skills

In the session, teachers expressed that they were introduced to learning objectives, and the content, concepts, and skills required for PBL for the first time or these had not been presented in such detail earlier. It was observed that participants were confused about selecting content from school subjects and corresponding learning goals in a coherent way, integrating them in a project theme, structuring and sequencing the tasks in order to address the learning goals, deciding what students would generate as productions, and assessing these productions for the corresponding learning goals. They also had difficulties in choosing appropriate criteria with adequate descriptors. Three new worksheets were planned to focus on LO's, content, concepts, and skills as well as their inter-relations better.

Giving less importance to framing driving questions

Framing driving question was a contentious topic in the first workshop. One teacher (PR-E) expressed that their difficulties in framing driving questions had not been resolved in the workshop. Considerable time was spent on discussion about the driving question and problem context. In fact, the researcher noted that there was presence of suitable context for contextualising the problem and also potential to construct good

driving questions. However, the participants disregarded these aspects. Therefore, in the second and third workshops, framing of driving questions was made optional.

Elaborating unfamiliar and ambiguous terms

It was observed that while discussing PBL and planning PBL units, several unfamiliar terms such as authentic, real world, driving question, problem context, portfolio appeared in the discussion. Meaning of some of the terms like formative assessment, summative assessment, CCE, group work, subject integration, resources, expressed by the participants differed from the literature. So, it was planned to use relevant handouts written in the context of Indian classroom and teachers' every day concerns. Based on these resources, discussions were conducted to develop a consensus meaning.

Relating assessment more with PBL

It is heartening that, a teacher (VI-A) mentioned that teachers had doubts on how to comply with the recent policy demands for conducting continuous and comprehensive evaluation in the schools. Such doubts were most prominent for formative assessment. According to her the workshop had shed some light on the topics that teachers were struggling with in terms of making sense. Teachers also felt that they needed support so as to build more confidence w.r.t. assessment and use of rubrics in assessment.

Teacher (PR-E) felt that the session on assessment could have been more related to PBL. I also realised that discussion on assessment was not always situated in the PBL context. Teachers lacked a coherent understanding of formative and summative assessment and how these could be naturally integrated within PBL practices. Considering all these aspects, the second workshop was restructured to focus on some of the key aspects relevant to successful implementation of PBL in Indian contexts. These were subject integration, assessment, and classroom management. The aspect of group work was addressed in the discussions of both assessment and classroom management. A new set of handouts suitable for Indian context were developed. Research papers and other relevant handouts on all these three aspects were either collated or prepared.

Need of presenting an exemplary PBL practice

It was assumed while planning the workshop series that participants would bring diverse project plans for discussion in the workshop. However, during the first workshop sessions, it was realised that the idea of PBL needs to be anchored in actual PBL practice in the Indian context. Additionally, the teachers also demanded for such examples.

Bringing clarity in instruction and balanced attention

Teachers suggested in their written feedback that instructions during the task had to be clearer. They communicated that researchers did not give equal time to every group for presentation and feedback. One teacher (PR-A) suggested that the presentations should have included more visuals (and less theory) to retain interest throughout the presentation. Teachers (VA-S) also felt that the session did not have flexibility to move around or break the monotony of sitting in one place for long periods of time. The following workshops included aspects of diverse work, reduced theory and included more worksheet based work, reduced long discussion sessions, and increased scope for lots of movement of the participants (during poster making and role-play).

I gained insights on other aspects too. For example, a teacher (NA-C) said that PBL was effective for student learning. However, she felt that it would not be practised in schools unless there was a reduction in the teaching burden on the teachers. If PBL was to be made mandatory, then teachers should be provided professional development sessions to educate them on PBL pedagogy.

Most groups felt that the docket of reading materials Could have been given to them before the workshop. Their perception was they would have got time to read it which would have prepared them better for the workshop. It was observed that teachers could not read one single article after the third workshop. Teachers' busy time schedule often hampers such engagement and anotehr factor for the same could be the difficulty level of readings.

6.5.3 School visits and teachers' project implementations after workshop 1

After the first workshop, I visited nine schools of six school systems and met with the participants, their colleagues, the school principals and students. I also conducted semi-structured interviews and discussions with some teachers.

The teachers' communications between the first and second workshops indicated that seven teachers implemented projects in their school. Four teachers implemented the project individually whereas two teachers paired themselves. The remaining one teacher implemented the project in collaboration with two others who had not participated in the first workshop participants (as a triad). The projects were conducted in six schools that belonged to four different school systems. However, only one teacher shared her write-up on her conduct of the project and responded to my query. Participants from another school conducted discussions with me prior to implementation of the project. I was able to observe the teachers' actual project implementation partially only for one teacher. Other teachers did not inform in advance when they would be conducting their project.

One teacher (VI-A) reported that carrying out the projects with her students reduced her teaching burden. However, the project activity resulted in a lot of noise and thus,

disturbance for other classes. This issue, that is, handling the class, was included and covered in a session on classroom management planned for the second workshop. Another teacher (VA-S) reflected on her project practice and felt that she could have prepared her students better before the presentation by providing feedback. She also mentioned that she found it difficult to assess her students by using the rubric while they were presenting. She further stated that her experiences would help her while conducting projects in future. She was from a school that seemed to allow greater freedom to their students and teachers in planning teaching-learning.

The school visits provided insights into the nature of teachers' difficulties in implementing projects aligned with PBL in their school context. School visits provided insights on students' and teachers' views about the project, school infrastructure, availability of resources in school, and general pedagogy adopted in the school. These insights were used as inputs for planning future interactions. From the several school visits, it was felt that there were still lacunae in understanding PBL as a pedagogy, that would address the teachers concerns arisen from recent policy changes. The findings from the school visits are discussed while analysing teachers' responses and practice in the Chapter 7.

6.6 Second workshop: PBL strategy with 3 key aspects

The focus of the second workshop was on developing project plans based on learning objectives in terms of content, concepts, and skills given in textbooks and in syllabus. Teacher participants also had to present their work in a poster presentation mode. On the first day, participants prepared teaching units following PBL criteria focusing on learning objectives and sequencing activities. These teaching units were presented in the last session of the day. The list of sessions on the first day and their duration are given below:

Introduction to the plan of workshop 2

Participants were informed that they had to plan at least one project so that the project could be implemented in their school and the help from the researcher was assured. In fact, this was the focus of the second workshop. The difference between content and concepts were clarified with textbook examples. The participants had to work in groups and there were two kinds of groups: *home groups* and *expert groups*. Each participant was part of one home group and one expert group. Each home group had three members. One member from each home group was part of either of the three expert groups: assessment, subject integration and classroom management. Hence every expert group consisted of a member from each home group. The participants could form groups based on participants of different or same subjects depending on their interest. Participants could focus on multiple subjects or multiple topics from the same subjects.

Planning projects: Focusing on learning objectives

In the second session, participants were asked to focus on integrating learning objectives in their projects. Guided by a worksheet, the home groups first had to decide the learning goals and list potential projects to address the stated learning goals. The activity also included listing a number of topics from one or more subjects that they would address by conducting the project. Additionally, they had to list the major concepts and skills that their students would learn through their planned project.

Planning projects: Sequencing activities

Two more worksheets guided participants to plan activities that students would engage in. They had to list the activities in sequence, provide a brief description of each activity, decide whether the activities would be assigned to a group of students or individuals and plan students' output or productions from each activity. They also had to ensure that the listed concepts and skills would be assessed through the planned productions. Overall, participants had to decide a learning goal in terms of content, concepts, and skills and list some potential projects that could be planned. They were expected to note their plan in a worksheet.

Expert group discussions

After the second activity, the ten groups split and regrouped into three expert groups. Participants were requested to form three groups each on classroom management, assessment, and subject integration. Each group was moderated by one or two resource persons (including the researcher). Each member of the group was given a set of reading materials and handouts and was introduced with the goal of the particular session. Participants had to discuss their concerns on the particular area in connection to the project planned for its implementation in their respective schools. They were requested to note their consolidated group discussion in a handout provided to them. The proceedings of each of the expert session are given below:

1. Classroom management: The group was given a paper by (Malcolm, 1994), handouts on classroom management, and assessment rubrics. During the session, some of the teachers asked for clarifications from the readings given to them. For example, a teacher (ME-A) asked for clarification on grouping strategies given in the handout [p. 118, (Markham et al., 2003)]. The expert group on classroom management discussed issues in the formation of student groups, strategies for ensuring group work, setting each student's accountability in a group, deciding tasks for individual students and groups, planning meetings with students, and planning instructions to students.
2. Assessment: The group was provided with a set of Rubrics and handouts of assessment. They generated the assessment rubric including criteria for continuous

assessment, meaningful assessment of each student's contribution to collaborative group work, and assessment of student productions in the project.

3. Subject Integration: The group studied different approaches to integrate content from different subjects, like multi-disciplinary approaches, trans-disciplinary approaches, etc. from the handouts provided to them. They also referred to textbooks published by NCERT and Maharashtra Textbook Bureau.

The second day of the workshop focused on developing a full-fledged project plan along with the three aspects of classroom management, assessment and subject integration. The discussions in the expert sessions held on the earlier day were taken as the basis of the introductory session on the second day.

Addressing the unresolved tension

In the expert sessions, teachers raised several concerns that they thought needed to be resolved in order to implement the projects meaningfully in their respective schools. In this session, the concerns were addressed through discussion. It was emphasised that it was important to communicate the plan of assessment as well as projects in the form of a storyboard to the students.

Plan projects, prepare poster and present

After the discussion, teachers were engaged in making the plan of projects and started preparing for the poster session. Participants were provided a worksheet and requested to prepare a plan of projects that they had initiated the earlier day. The plan of projects was expected to include: (a) problem statement or question(s) for the projects, (b) board and standard, (c) activity title, (d) activity description including product, (e) individual or group projects, (f) learning objectives in terms of content, concept, and skill, (g) assessment criteria / rubric, (h) management notes, and (i) subject integration.

In addition to the project plan each group had to prepare a storyboard for students to display in the class. Then the project plan and storyboard would be presented in the form of a poster. Teachers presented their posters in a poster session with the audience both from the workshop as well as members who had not participated in the workshop.

Summary: Learning and plan for next engagement

All the learning and concerns were summarised for the participants. There was also an announcement made regarding the forthcoming school visits and upcoming workshops. Tentative dates suitable for conducting workshop 3 were also discussed. The possibility of online blog spaces was discussed as a means to sustain the discussion among the researcher, resource persons and teachers. Some teachers (e.g. RA-C) said that while

it was a useful experience to prepare the project plan, its validity and refinement will be based on its implementation in the classroom. However, the teacher further stated that teachers generally were too preoccupied to do so.

6.6.1 Insights from Second Workshop

In the second workshop participants had engaged in project planning groups and expert groups with three key aspects of PBL implementation: subject integration, assessment and classroom management. They had then planned their projects with a focus on these three aspects.

Teachers' project plans in the second workshop showed improvement with respect to several of the categories discussed above. However, deciding what could be accomplished by students on their own with moderate effort and meaningful engagement was difficult, and where they would need guidance and assistance, was unresolved. This was worsened by the fact that the participants interpreted scaffolding, assisting or guiding students, as giving the solution to the problem.

Most groups did not explicitly mention that they would communicate their expectations of task completion, the expected productions and assessment criteria to the students. This may arise at least partly from teachers' beliefs about their students' prior knowledge and abilities, and from their own eagerness to ensure that the projects are completed satisfactorily by all students. This may also explain why teachers tended to overly prescribe the tasks while planning projects, and still felt that there was student autonomy in their project. They did not recognize that fragmenting tasks and prescribing steps without communicating their expectations is likely to make students wait for instructions and hence become dependent on teachers for every step of the project. Some groups interpreted student autonomy as students doing everything on their own. Most groups doubted the reliability of using self and peer assessment as a legitimate assessment practice in their regular teaching practice.

Several participants expressed their suspicion on the effectiveness of using assessment rubrics. Yet, all the groups developed some criteria to assess the corresponding productions. The levels for each criterion were often just whole number marks. Such levels without clearly stated descriptors convey no information about the performance of the students. It appeared that they had insufficient time to generate meaningful levels and descriptors for each criterion in the rubric.

It was heartening to note that almost all the plans could be modified in structure to generate a coherent set of activities suitable for PBL. Participants in the workshop expressed a need for an example of PBL in the Indian context, to help them understand PBL. Several of the problems observed in the participants' project plans and discussed above could possibly be addressed with an example or two. The videos of such practices in Indian context would have been ideal but were not available then. Thus, it was important to maintain written records for a project that is conducted with students, in alignment with PBL pedagogy. Such a project was done with students by me and

proceedings were recorded in terms of students' written productions, the artifacts made by them, still pictures of their presentations, written logs of planning and conduct of the project, and resource persons' observation notes. This part of the research study is published as conference proceedings (Shome, Shastri, Khunyakari, & Natarajan, 2011). Details of this PBL unit are presented in Chapter 5.

A number of school visits were also made. The findings are presented in the Chapter 7.

6.7 Third Workshop: Consolidating ideas of PBL

The third workshop helped consolidate and share the participants' understanding of PBL, their practice and struggle of conducting PBL, researcher's practice of a PBL unit with students, and learning from the engagements over the duration of workshop series. The workshop provided opportunities to the participants to critique the PBL unit developed and transacted by researchers, to know about students' views and attitude towards projects, and finally present their understanding of PBL in the form of a skit.

The researcher and participants also planned to take the learning forward in other short duration PBL workshops to be held for other teachers. Brief description of the day wise proceedings are presented in the following sections.

Portfolio assessment

The first day of the workshop was primarily focused on two aspects. The first was sharing the findings from the 'survey of students' views on projects' and the other was introducing portfolio assessment to the teachers.

Plan and scope of the workshop

Participants were informed that a PBL unit had been implemented with students of sixth standard. A summary of the PBL unit was shared with the teachers and they were told that they would be given the students' productions and researcher's log with details of the workshop proceedings. Using the same, the participants had to develop rubrics to assess the productions. In addition, they also had to review the PBL unit and its transaction. Additionally, the participants had to perform a skit on what is PBL. The plan for a two day workshop to be held with teachers from different schools of Mumbai also needed to be worked out. Presentations by teachers who conducted projects in their schools were also to be part of the workshop.

Students' views on projects

During the school visits, the researcher had interviewed some teachers and their students and observed teachers' implementation of projects. It led to recognizing the importance of teachers' knowledge regarding their own students' ideas about school projects. It was practically useful for a teacher to know what students think and such awareness enriches teachers' own ideas. It is also an ethical demand of the research design, that the data collected from students must serve a useful purpose for the students directly or indirectly. A presentation on students' views on projects was made based on data gathered from four school systems. The names of the school system were kept confidential while presenting the students' views. The findings presented were:

Most students associated projects with learning, fun, and group work. They mentioned that the project helped them to understand better. These ideas matched with teachers' views about projects. Interestingly, students of one of the schools stated that projects should be done in order to learn and understand. They also stated that projects should not be assigned frequently, and needed guidance from elders. These views were echoed in teachers' views and concerns expressed during the semi-structured interviews with two of the teachers from the same school system.

In semi-structured interviews conducted with students from two school systems (AE1, IK), students stated that their teachers assigned project topics to groups of students. The group size in one school (AE1) was three to four, while in the other (IK) it was between six and nine. Students were helped by their family members for the work done at homes. Students from one of the schools (AE1) liked to do projects and claimed that they learned a lot through doing projects. While a teacher of the other school claimed that her students learned from projects working in groups, her students did not support this view. They mentioned that there was very little clarity about assessment of projects. The detailed analysis of students' responses is not included in this study.

Introduction to the PBL unit

Participants were introduced to the PBL unit conducted with students. Researcher logs and students' productions were distributed to each group. The motivation, planning, proceedings, and relevant details associated with the development and implementation of PBL unit were shared.

Constructing rubric on students' portfolios and presentation of rubrics

Each group was provided with two portfolios, the researcher's log, and storyboard. The storyboard is given in Appendix J. All the groups were asked to generate analytical rubrics for the nine productions of students, one rubric per production. The instruction sheet provided to the participant groups to guide assessment of students' productions is given in the box shown in Appendix K. Teachers then presented their assessment

rubric.

Planning Bombay Association for Science Education (BASE) Workshop

A plan to hold a workshop for teachers of Bombay Association for Science Education (BASE) was shared with the participants. They were told that those teachers who had conducted projects in their schools as a part of TPD engagements could share their experience at the BASE workshop and act as co-facilitators in the sessions on planning PBL projects.

On the second day, participants critiqued the PBL unit transacted by the researcher, planned a role-play to present their understanding on PBL, discussed session plan for a shorter workshop with teachers, and presented their learning from implementation of projects.

Review of example PBL unit and presentation

In the first session, teachers were asked to critique the researcher's PBL practice on the basis of three primary questions: 1) What did you like most?, 2) Where do you suggest improvements? and 3) What can be done in your school? Each group written the aspects they liked, suggested improvements, and how they will implement the PBL in school.

In the next session, titled as presentation of teachers' practice, all the groups presented their findings from the review. Teachers from four school systems (A, D, E, and F) presented their project practice. Only A, had presented their project with evidence of student productions as well as videos of students conducting projects and presenting their work. Other teachers just described their work. This was followed by session planning for role-play.

Plan for role-play on PBL and BASE workshop

Each group discussed, drafted the scripts, and rehearsed the play. Though the groups started independently planning their work, they collaborated on the similar plans and adapted their plans to bring coherence while role-playing. In the last session of the day, the plan for the BASE workshop was discussed. The plan includes the kinds of resources that would be used in the workshop, and the responsibility of participants of the workshop series as resource persons for the sessions of the BASE workshop. In addition, teachers who had conducted projects in their schools were requested to present the project practices in the BASE Workshop.

On the last day of the third workshop, teachers mostly engaged in rehearsing the role-play and staging the play. Rest of the time was devoted to summarising the teachers

work, sharing the feedback on the teachers' work, distributing PBL Handbook etc.

Plan for role-play and staging the play

In the first session, participants continued working in groups. Each group planned their skits independently, and then came together to sequence and loosely connect them. School system F and I made a joint presentation and so did D and H. School system A and E presented separately. It was heartening that they could make a narrative and tell the story with smooth transition from one story to another.

The skits presented a variety of themes conveying the workshop participants' understanding about PBL as well as the sentiments about PBL and the TPD workshops that they wanted to convey to their fellow participants and resource persons. A brief outline of the content of the role-play is given below:

Teachers to teachers: In these skits that had participants in the role of teachers, the challenges of PBL were discussed and ways of addressing these were also suggested. In one skit, participants playing the role of different subject teachers discussed the *new* and *effective* teaching strategy called PBL. Another skit compared the advent of PBL in teaching-learning to the coming of the space age. Yet another compared the evolution of students' learning through PBL to the evolution of humans from apes. Teachers situated the discussions in imaginative scenes, talking to aliens, all complete with impromptu stage props.

Teachers and parents: There were a couple of skits on teachers discussing with the parents of their students. One skit had a parent complaining that their child had recently become less *serious* about studies and was seen having fun engaging in a variety of activities. The teacher assured the worried parent of the benefits of the new strategy as a fun way for their ward to learn better. PBL was also presented as being suitable to draw out the best in all learners. In one of the skits, a parent assured a concerned teacher that her new strategy that she felt diffident about was actually working and that her students were enjoying learning through PBL.

Parent to parent: In one of the skits one parent bragged to another about how her child had found joy in learning after the school had introduced PBL.

Teacher and students: A couple of skits enacted the gist of a project aligned with PBL and conducted by a group of teachers among their students. The groups enacting them systematically referred to the characteristics of PBL. One of these skits was a musical.

Findings and analysis are presented in Chapter7.

6.8 School visits

In these visits, researcher primarily focused on whether teachers conducted the projects with students and the extent to which these projects followed PBL criteria. The visits also included sharing information regarding follow-up workshops and preparing for the workshop. The findings of the visits are discussed in Chapter7.

6.9 Teacher workshops and seminar

After the series of three workshops, the teachers participated in three single shot workshops. One was conducted with school system F where two of the participants of the same school system attended the workshop. The resources used in the workshop series were revised and used in this workshop. I used productions and processes from two PBL units. One was the exemplar PBL unit shared in the workshop series and the other was another PBL unit conducted by me with 58 students of the same school system. The students' productions from this workshop as well as the students' portfolios were used for developing assessment rubrics. No research papers were used in this workshop as well as in others.

The next workshop was conducted for BASE, a science teachers' association based in Mumbai. A two day workshop was conducted with science teachers. Participant teachers led the group work and presented their learning from the implementation of projects in their school.

The third workshop was organised by an organisation devoted to science popularisation. The learning from PBL workshops helped prepare two presentations in the workshop. There was a panel discussion in the workshop and two teachers from the workshop series participated in the panel discussion.

In another two-day workshop, the idea of using analytical rubrics while assessing Children's Science Congress exhibits was presented to the meeting organised by a science activist organisation. The audience included senior scientists of DST and high level stakeholders of NCSTC network. Though the presentation was appreciated by the participants the possibility of using students' projects in assessment was declined. Participants also declined any possibility of sharing assessment rubric with the students.

6.10 Learning from the TPD engagement

The TPD engagement was initiated with a deliberative curriculum approach (Null, 2011). Deliberations were held among teachers with respect to the policy directives. It was observed that there is a diversity of terminologies and vocabularies used in curriculum in connection to teaching and learning. There are frequent circulars spelling

out expectations and guidelines to implement the policy directives. The principal of school AE1 stated that these circulars were sent in hurry to ensure implementation of policy directives without much deliberations or giving time to the system to prepare for the change.

The engagement with teachers and visits to school indicated a strong reliance on textbooks. Interestingly, the schools catering to low socio-economic groups followed state board textbooks as the only resource, while the schools catering to higher socio-economic groups followed private publisher books in classrooms as teaching resources. NCERT books are also used regularly and this hints towards problematising Krishna Kumar's observation of Indian classroom dictated by textbook.

It is felt that there is a need for careful review of teaching-learning materials prepared at different levels and used for in-service TPD engagement. In this study, I worked in a research group that served as a community of researchers to critique, evaluate, and develop resources. Expanding such a resource pool for a diverse country like India would be difficult to attain soon. Interestingly, the existing mechanisms of Government of India (e.g. DIKSHA / NISHTA) and several State Governments (e.g. state educational portal) to have a repository of quality resources and engaging with teachers with such resources are timely steps to establish an authoritative resource pool of the country.

There is also a need to educate stakeholders of all levels to engage with the literature of TPD. In the culture of Indian hierarchical structure, knowledge of curriculum and capability of transacting them would require support from higher officials. And this can happen when both teachers and other stakeholders come together to engage with curriculum resources. Interpretation of circulars, how these circulars would be implemented, and how these will manifest in teaching-learning depends on stakeholders' creativity and imagination. And this creativity and imagination is anchored in the knowledge base of curriculum, shared vision of curriculum, and building a sense of agency in the curriculum implementation.

This TPD engagement primarily focused on forming a teacher community. Researcher began this engagement with a hope to grow this community with time. Multiple platforms were opened for teachers to sustain communication. It required effort and hard work to maintain such communications and hold the group together. Even though the researcher was outside the school system, it was possible to engage with teachers at school and share teaching practices.

Exploring teachers' views about projects and their project practice through the questionnaire survey gave multiple insights. This kind of questionnaire has the potential to explore teachers' original ideas about certain aspects like projects. It allowed me to understand the context of teachers' practices better. I therefore planned and implemented the engagement that was more relevant to teachers, e.g. Most teachers praised the outcome of projects in the open-ended questions but while responding to Likert type questions they registered contradictions. This contradiction hinted at the problems in teachers' practice. For example, it was evident that some teachers did not take care of aligning assessment indicators and stated learning objectives. Some teachers did not provide multiple opportunities to express, and some were unable to

ensure learning of all the students while engaging in projects. Conducting FGD and semi-structured interviews was found to be effective to develop shared meaning with teachers. A similar kind of engagement could be followed in any TPD engagement.

It is difficult for readers to read research papers for the first time. As the participants were not familiar with reading research papers, it was difficult for them. It was realised that for pragmatic purposes it is important to share narrative write-ups that would elaborate the practice of PBL (suggested practice). The proceedings of exemplar PBL practice shared in the third workshop helped several teachers to understand PBL better. The theoretical aspects related to practice need to be written or compiled as per the context.

Similarly, constructing rubrics is a difficult task and it is effective if teachers are already provided with samples of different rubrics. It was found that it is productive to work around tangible materials in contrast to drawing out from memory, e.g. reading handouts in the second workshop helped to maintain the focus of the discussion and using students' productions in the third workshop helped teachers to prepare assessment rubrics. The actual students' productions used in the shorter duration workshops and seminars helped teachers to develop assessment rubrics faster.

Several rounds of discussion based sessions around planning of PBL in the first workshop of the workshop series revealed that planning teaching units based on PBL is intricately related to several other aspects like teachers subject expertise, understanding of pedagogy and assessment, understanding of knowledge and curriculum, and views towards students, etc. Participants were facing difficulties in framing driving questions and problem context, stating learning outcomes, planning productions and activities corresponding to expected learning outcomes, and deciding assessment schemes for the students' learning. Elaborate planning of PBL required detailing the tasks for students and situating teachers as cognitive coaches. It was realised that solely relying on discussion on planning without PBL practice is unproductive. In such situations participants develop frustration at not being able to complete the task. The vocabularies used in such context also become incommensurate for the teachers and researcher.

During the discussion with teachers and observing their practice in schools, it was realised that how teachers interpret the participation in and learning from a TPD engagement is a complex phenomena. Several teachers focus on a few aspects of pedagogy and TPD engagement. Many of them showed strong resistance to change. Planning of PBL pedagogy is situated in the rich context of teaching-learning and demands a shift of teacher from an authoritative position to a cognitive coach. Therefore, making a teaching unit based on PBL and similar constructivist pedagogy in Indian context would require addressing related elements as discussed in the previous paragraph.

Teachers role-play provided an authentic context to understand teachers' learning from the TPD engagement. From the questionnaire survey and role-play, it was evident that teachers attributed good qualities to projects. Even some of them narrated projects as the best pedagogy. However, there was no relation between stating that projects are an effective pedagogy and using it in the classroom. Teachers who did conduct projects presented project practice in the role-play while those who did not conduct

projects in their schools, glorified projects. The teachers who were completely averse to projects even presented a scenario where coaching centres are going to follow PBL. So, recognising the effectiveness of a pedagogy is not sufficient for its implementation in classrooms. It was interesting that participants could differentiate between PBL and non-PBL projects. However, this was not sufficient to draft teaching plans on PBL.

Participants cited a range of challenges in their schools, with students and parents. Teachers from schools having practice of conducting projects showed better susceptibility to continue to engage with the idea of PBL, while others ended with a one time effort. Many teachers continued their usual practice of assigning projects as homework. Most of the students of all school systems were ready to do projects and they attributed projects as a joyful and learning experience. Students disliked the existing assessment practice of projects, large group size, burden of project work as home assignment, and limited scope of project work that emphasised writing (essay or report) and at the most presentation. The teachers assigning projects as homework did not change their mind even at the end of TPD engagement.

The learning from this engagement forms a basis of presenting the model of TPD engagement of the current study.

6.11 Model of TPD engagement

A model of PBL was developed that could meet the expectation of policy demands as well as meet the challenges teachers face while teaching and learning and implementing policy suggestions.

The major TPD engagement with teachers was primarily structured around three workshops spanning over five months. This included a total of 9 days or around 45-50 hours of engagement. The content of the engagement was developing Project Based Learning (PBL) in a collaborative mode. The workshops were organised outside the school premises, with interspersed school visits.

While developing PBL units, teachers learned about learning objectives, planning content and activity in alignment to the learning objectives, developing assessment schemes including analytical rubrics.

The workshop included three distinct foci. In the first workshop, teachers were introduced to PBL and developed a plan for implementation. In the second workshop, teachers prepared more focused plans for PBL implementation in school. In the third workshop teachers presented their learning from PBL implementation, evaluated and critiqued a PBL unit tried out and developed by me and developed assessment rubrics on students' productions derived from the PBL trial. I shared the students' views on projects with teachers and visited schools of some of the teachers and maintained communication over asynchronous mode. The learning from this engagement helped bring modifications in the successive workshops. The aspects of the TPD engagement are presented in the following subsections.

6.11.1 Situated in deliberations

The idea of deliberations is not an abstract idea or a rhetoric. Rather it is grounded in the kind of relationships established between researcher, policy documents, teachers, and students in their engagement. My motive was to learn from the experts, teachers, students, as well as other stakeholders. I had read the policy documents to make meaning for self and situate these in the school reality. The vision of policy documents was read in the context of establishing a democratic ethos as enacted in the constitution of India. I was looking for a liberating curriculum and felt PBL had the potential to be liberating.

I developed my understanding about PBL, the elements of PBL, and implementation aspects of PBL in the Indian school context while engaging in the process. A detailed account of evolution of researcher's ideas about PBL while engaging in this process is given in Chapter 7. The researcher also shared the plan of engagement and outcome of the work with different experts and people working in education and educational research. The work was also presented on different platforms for critical feedback and careful scrutiny.

The idea of deliberation was evident while conducting interviews, workshops, and school visits. Participants were given ample opportunities to work in groups and share their work, ideas and concerns. I maintained communication over school visits, telephonic conversations, and over several asynchronous modes. Keeping deliberations as core of the engagement resolved the antagonistic relationships that existed between teachers, teacher educators and policy makers.

6.11.2 Situated in social constructivist position

My work is situated in a social constructivist paradigm and this is evident in its focus on dialogue and deliberations with teachers and students, providing opportunities to teachers to work in groups, share their work, critique each other's work, allowing the work to evolve rather than beginning with a pre-determined outcome. Using teachers' productions during the workshop as resources for sessions, considering teachers' experiences and learning from implementation of PBL in their respective schools helped develop a community of learners engaged in meaningful tasks. Similarly, the engagement with the students during the implementation of PBL units followed a constructivist approach.

The expressions, languages, and tools used by the participants and experiences they brought in were diverse in nature. All experiences were heard and efforts were made to acknowledge them. The sharing of diverse experiences helps in understanding the complexities of issues. The meanings of the words and vocabularies are embedded in the teachers' experiences and cultural context of their respective schools. Therefore, it requires uncovering the practice of teachers and elaboration of the cultural context of their school to make sense of their language to any reasonable degree.

Workshops provided multiple opportunities for expression of teachers' ideas by articulating and demonstrating their practices and interpreting each other's explanations. I interviewed participant teachers after each workshop, visited their schools, observed their school culture, interviewed their students and teacher colleagues. It helped me gain comprehensive experiences about the school systems of the teachers

It is possible to organise TPD engagements in a way that provides opportunities to teachers to work in groups, prepare presentable work, present their work done in workshop as well as in their school, and critic each other's work. It was evident that participants did learn in this process.

The relationship between teacher educators or trainers and participant teachers should be in terms of exploration and negotiation of meaning rather than imposing each other's views divorced from actual practice. The goal of such TPDs should be more towards creating a culture among teachers to appreciate each other's views and consider the meaning associated is tentative and therefore subject to change. The goal of the participants and teacher educators is then working to establish envisioned realities in the classroom through constant dialogue and clarifications with all stakeholders of education.

The researcher or TPD planner needs to be a co-learner in this engagement and should have a disposition to invent meanings of purpose, actions, and solutions situated in context. The researcher should accept and face the challenges and failures. The participants should be given the opportunity to evaluate and critique the units developed by the researcher or TPD planners.

6.11.3 Situated in critical pedagogy

I was committed to engage in a relationship with teachers in order to experience a liberating pedagogy for both teachers and hence for students. There was always deliberate effort to value individual experience and evaluating those experiences in the light of the proposed PBL. The proposal of PBL was not presented as something given, rather it was co-constructed by the participating teachers of the workshop as a community. The challenges and difficulties associated with understanding and implementing PBL were reflected on by the researcher as well as by the teachers. I presented my practice to participant teachers for critique and deliberations.

In the current TPD model, researcher was not the sole source of knowledge. Participant teachers' and students' experience and their productions form a valuable content for the engagement. This content was used to elicit discussion. The agency of change was not located outside rather it could be created through an empowering discussion among the community of participant teachers. Further, this empowered pedagogy could be translated to the classroom.

It is possible to bring hope and trust in teacher professional development through a dialogue among the stakeholders. It is possible for teacher educators to engage in prac-

tice through teaching in the classroom, engaging with students, and sharing the work to the teachers for scrutiny. Teacher educators can take part in small group sessions with teachers to discuss the concerns, unfold the real causes behind the concerns, and commit to the vision for the larger purpose of establishing a democratic society rather than being dictated by a narrow view of education.

6.11.4 Situated in concrete productions

Participants were provided resources throughout the workshop. The resources included research literature, relevant assessment rubrics, presentation handouts and short write ups prepared by researchers, researchers' presentation on observation and findings from school visits, students' productions generated from transacting a PBL unit to the students, and format of teaching plans. Participant teachers' productions in terms of teaching plans following PBL and posters of the plans, presentation, and role-play formed the content of discussion in the workshop.

Developing teaching plans anchored to specific content and learning objectives, formulating plans to transact the teaching plans, anticipating required support from school community or relevant stakeholders engages participants in an authentic problem context. While making a teaching plan, a rich discussion on content, concepts, learning objectives, modes of assessment, alignment of assessment with learning objectives, etc. are possible. This context most likely elicits the pragmatic concerns of teachers like classroom management, lack of time and resources, need of school based support, etc.

There is no single plan but many possible teaching plans. So, the engagement of making a teaching plan by the participants even on one topic could give rise to diverse and valid plans. Presenting the plans to the wider audience would be enriching for all.

Concrete students' productions and researcher's log helped teachers to visualise how researcher had addressed elements of PBL pedagogy, and integrated students' self and peer evaluation. These logs elaborated on the effort and struggle in planning, how the actual classroom looked while transacting the PBL unit, how researcher responded to students' needs and challenges arising during the transaction and what were the evidence of students learning, etc. It also helped teachers to come up with an assessment scheme. Teachers' were relatively more open while critiquing the implementation of the PBL unit. Their criticism helped in understanding some of the deeper issues associated with the school system and in this process, researcher gained valuable insights.

6.11.5 Situated in diverse activities

In all the workshops, brainstorming on given resources was a major part (average 14% of the time). In the first workshop (14% of the time) the resources for reading and brainstorming were mostly in the context of research papers. While in the second workshop (20% of the time) reading materials included handouts prepared by me in simple language and materials of direct relevance like sample rubrics, sample teaching

units, proposals of subject integration etc. In the third workshop (10% of the time) most of the resources were the students' productions and researcher's log.

Summary sessions are a crucial part of the workshop and were included in all the workshops. Interestingly, the proportion of time dedicated to these sessions in the workshops varied. For example, in the first workshop it was only 2% of the time, followed by 7% in the third, and 10% in the second workshop. One of the reasons for such variations is due to the fact that in longer duration workshops multiple sessions have windows to summarise the learning in the respective sessions. However, in a shorter duration workshop summarisation is left for the last session.

In terms of degree and locus of participation of teachers the engagements can be divided in five domains. They are not always mutually exclusive but categorised based on the degree of presence in each, e.g. Lead talk is included in the domain of "Researcher as expert and teachers as active participant." That does not mean participants did not create knowledge in the discussion and contribute value. In a similar fashion, making a teaching plan is categorised under the domain of "Teacher as creator". While making teaching plans participants did look after the researcher as an expert, however, researcher positioned himself as a sounding board and facilitator in terms of posing more questions and providing resources. These include the following:

1. Researcher centric: These include introduction sessions, norm settings/logistic discussion, and summary sessions. They share 11% of the time in the workshop series.
2. Teachers engagement in closed format: This includes filling up survey sheets prepared by researcher. This shares 2% of the time in the workshop series.
3. Researcher as expert and teachers as active participant: This includes lead talk by researcher and share 11% of the time in the workshop series.
4. Researcher and teachers as participants of discussion: This includes researcher led discussion, presentation of reading, teaching plan, and brainstorming on given resources. These together share 37% of the time in the workshop series.
5. Teacher as creator: This includes participants preparing teaching plans, presentation of their teaching practice, preparation and staging of role-play,and feedback. They together share 39% of the time in the workshop series.

Empowering teachers is important for any policy change. This requires time and effort. The design of engagement should deliberately include aspects for that purpose, e.g. in the workshop series first three domains together indicating researcher driven form is 25% of the engagement. While researcher and participants worked together for 37% of the time. In the rest of the (39%) of the time teachers worked towards creating productions that formed the content for the workshop and learning resource for both the teachers and researcher.

6.11.6 Situated in formative and authentic assessment

The assessment of teachers' engagement as that of students in classrooms should be formative and authentic. The teacher participants were engaged in preparing and presenting teaching plans based on PBL, a practice very close to the teacher's professional behaviour. In schools, teachers usually make lesson plans individually. In the workshop, participants were asked to work in collaboration within a group. Participants' teaching plans were presented for evaluation and modified based on the feedback received. The arguments put forth by the participants and statements they expressed during the discussion helped to carry out formative assessment of participants' learning and what modifications are required in the session plan.

Watching the workshop sessions every day helped reflect on the sessions and gave insights to the researcher on how to design sessions on the subsequent day and what resources to be presented to the teachers. As a result, the order of sessions and their content were changed in a workshop as well as in the successive workshops. Students' productions acted as a major resource for teachers to prepare assessment rubrics. The role-play by the participants in understanding how participants have accepted the PBL pedagogy in their teaching and what kinds of dilemmas do they have in their mind on PBL.

In TPD engagements, teachers' productions also need to be included for formative assessment. Teacher educators need to provide in time formative feedback during TPD sessions, design appropriate group work, and facilitate forming a community of learners.

6.11.7 Situated in productive and valued engagement

Participants of the workshop had involved themselves in productive engagement with respect to development of the teaching plans and their presentations, evaluation of the students' portfolios and the PBL unit developed by the researcher. They presented their work to a larger audience through a role-play. Participants tried to implement PBL in their respective schools and some of them shared their practice during the workshop. They also brought students' productions from projects implemented by the schools to the workshop. Thus, teacher participation was central to the entire proceedings of the workshop series and the product generation process. Such ownership gave teachers a sense of purpose about their work and sense of being valued. A similar approach can be adopted for the TPD engagements conducted by teacher educators.

6.12 Conclusion

In the current study efforts were made to develop a TPD model for understanding PBL and implement it with teachers in workshop mode. It is heartening to note that teachers

evolved their understanding of PBL while engaging in the TPD model of the study. During the workshop series, participants could develop plans with increased alignment with PBL characteristics. The study found that to make better PBL plans, teachers needed cognitive and other resources (like materials, timely support, scaffolding, real examples) and certain dispositions towards learning and education. The school needs to provide liberal environment and support to teachers to develop understanding of PBL through regular practice and reflections. It requires time to absorb the key ideas of PBL and implement the same in the school system. For such implementation, the entire school community must work together. It was difficult for most of the schools in the current study to create a school community for implementation of PBL due to various constraints. Thus, projects remain the territory of individual subject teachers rather than involving collaboration among different subject teachers.

For PBL pedagogy and its effectiveness, it is necessary to have wider consultation with teachers, principals, educational stakeholders, and parents. The democratic and authentic aspect of PBL requires such engagement and is needed in the current school systems. In fact, local context can be integrated well with PBL and authentic resources can be used for the implementation. Such steps will help schools to develop as a community.

Research based PBL modules need to be developed and shared with teachers. The study is situated outside the regular TPD programmes that are conducted by the institutional structure at district and block level. This model can be adapted for regular TPD programmes but it is important to make necessary changes. Teachers need to occupy central positions in the TPD programmes and they need to be given ample opportunities to reflect, critique the practice as well as the resources (like the PBL unit developed by this researcher in current study). Such steps will help in building the potential of teachers with respect to practices like PBL.

Timing of TPD engagement is another factor. In the beginning of the academic session, teachers have time and will be willing to experiment. Thus, the TPDs that emphasise progressive pedagogies like PBL need to be conducted at the beginning of the academic session.

The development of the TPD model in the study has presented the difficulties and challenges faced while executing the same. The current chapter has also described how the model evolved in the face of these challenges. The process of development of TPD is interative and dyanamic. The researcher and teachers co-constructed the PBL units, in the process, teachers understood the process of co-construction meaningfully. In my opinion, this is the most crucial aspect of any TPD programme.

Chapter 7

Evolution of teachers' ideas about PBL

This chapter presents teachers' views on different elements of teaching-learning as expressed during the conversations in workshops, evolution of teachers' understanding on PBL during the TPD engagement, and information about teachers' practice of PBL.

Section – 7.1 of this chapter presents an overview of teachers' views and understanding of different aspects of teaching-learning. Section – 7.2 presents teachers' experience of reading research papers. Section – 7.3 presents an evolution of teachers' ideas and understanding on different aspects of PBL. Section – 7.5 provides a brief outline of teachers' PBL practices conducted in response to PBL workshop series. Section – 7.6 summarises the chapter, presents an exploration of teachers' ideas, their project practices, and implementation of learning from the PBL workshop. It also points out limitations of some findings.

The word "project" is a familiar term in Indian schools. In contrast, PBL is a fairly new word in the Indian educational context. On the first day of the workshop series, participants were introduced to Indian initiatives in PBL citing the Kendriya Vidyalaya Sangathan schools as an example. Only one teacher (SH-C) referred to the INTEL workshop about PBL in her school. However, this teacher failed to recollect the learning from this workshop. PBL was not known to most of the participants, but they were interested to know about PBL and other related pedagogies. The interactions during the sessions on the first day and subsequent days captured teachers' initial thoughts towards pedagogy, learning, and assessment.

7.1 Teachers' views and understanding on different aspects of teaching-learning

Teachers' views and understanding of different aspects of teaching- learning articulated during the TPD engagement provided valuable insights into teachers' world. The terms used in the workshop were interpreted by the teachers' and expressed while planning the projects, engaging in discussion and group work. These interpretations were not always stable and static. Therefore, relevant context is given while presenting the teachers' interpretation and wherever possible, examples from their practices are also drawn.

The following subsections present teachers' views and understanding about: (a) different constructivist pedagogy, (b) types of questions for projects, (c) nature of questions, (d) connection to everyday world, (e) decisions on depth and breadth, (f) assessment, (g) disciplinary divide, (h) textbook as authority, and (i) sequencing textbook content in projects.

7.1.1 Views on different constructivist pedagogy

On the third day of the first workshop, a presentation was made on different constructivist pedagogies. Teachers' views in this context are important and interesting. Some teachers (e.g. RO-C) thought that inquiry based, activity based and discovery based learning took place in sequence "Inquiry leads to activity ... activity leads to discovery". Some teachers (e.g. SU-C), thought that all the teaching-learning methods were subsets of project based learning but mutually exclusive. Later, in discussions several teachers (including SU-C, MA-C, RO-C) mentioned that these teaching methods shared some common components and therefore were not mutually exclusive. Teachers interpreted inquiry as "students are curious about something" (RO-C), something preceded by observation (RA-C), critical thinking, and reasoning (UM-A). One teacher (SH-C) elaborated her complex idea about inquiry based learning:

> ... inquiry based can be ... give five six situations without any prior knowledge to children ... but still based on students' prior knowledge ... let them work on the situation ... and come out with some kind of research ... that will be inquiry based ...

It appeared in the discussion that teachers conceptualised inquiry based and similar pedagogies as something students would do on their own, with minimal or even no teacher support.

Most important aspect of inquiry based & other similar pedagogies is that students are given a problem that requires an intellectual engagement of students as inquirers and teachers as cognitive coaches. The success of an inquiry task rests on how the problem context is presented & problem question is framed.

7.1.2 Views on types of questions for projects

Teacher participants were asked to frame driving questions for projects. It was communicated to them that these questions could be considered to be of four broad types: conceptual, concrete, problem solving and design challenge. Some participants (UM-A) held the view that teaching should be structured to introduce students to ideas that are "concrete" before "abstract" or "simple" before "complex". A teacher (RA-C) stated, "It is very difficult (for students) to learn (when going) from abstract to concrete". Her explanation presented below, seemed to equate ambiguous with abstract questions.

> For abstract questions there will be ambiguous answers. If you frame a question (in the) abstract, you have to be prepared to get ambiguous answers... taking to that topic is very difficult... Several answers will come, and (students) will go in different directions. Therefore, one should go from concrete to abstract and not from abstract to concrete.

Three teachers (UM-A, SU-C, RA-C) also made similar comments about going from the known to the unknown. In fact, one of these teachers (SU-C) clarified that this meant moving from prerequisite knowledge or previous knowledge to the new knowledge. Thus, terminologies were problematic for some teachers. SU-C was partly right in her articulation but this was more in terms of known answers instead of considering students' cognitive level. Some other teachers held the view that one should teach simpler things before going to complex ones (UM-A, RA-C). In contrast, the teacher SH-C, presented the importance of giving the whole picture before teaching the parts or details.

> The idea is to... give the picture as a whole. And then go part by part, and then conceive the whole. So the idea is to first figure out the whole and then look into its detail.

The discussions highlighted teachers' beliefs about what students can learn. These views imply that teachers used the words 'conceptual' and 'abstract' as colloquial terms and used them synonymously with the word 'ambiguous'. Secondly, teachers' preference to go from simple to complex is also situated in terms of known answer to unknown answer. Such views would not encourage framing of open -ended questions, essential for inquiry based teaching.

Teacher RA-C pointed towards the greater need for teachers to be sufficiently prepared to know the final results. Typically, teachers tended to be preoccupied more with the answers than with the process. She stated that:

> ... We should know the answer first ... We should be well prepared when we ask out-of-the-box questions. We should be prepared for that. It is a challenge for us also...

A variety of driving questions were discussed with teachers. In general, several teachers vehemently criticised the open-ended questions, which are an important aspect for conceptualisation of projects. UM-A wondered, "If I ask, 'What is history?' and a student answers that history is about the past. That implies the student has to go to all past information... and it is so vast..." Clearly, The teacher was not prepared to handle open-ended questions. Similar kinds of views were also expressed by most teachers of school system I, F, and B. In such cases, teachers would frame closed ended questions or even if teachers provide open-ended questions they would dictate the answer. In fact, for inquiry, it is important that the teacher becomes a co-constructor of knowledge and engages with the child as an expert investigator in the process of inquiry.

One example of project was , "Plot the following places on an outline map of India: Plassey, Buxar, Srirangapattanam, Allahabad, Vasai" from the Chapter "The foundation and the expansion of British rule in India." Three teachers (RO-C, RA-C, UM-A) insisted that this was an important skill to be learned in geography and therefore an appropriate project in this chapter. One of these teachers (RO-C) pointed out that the skill of locating places on a map is an important skill that is required across several chapters. I tried to point out that such a skill should not be the central goal of a project for this chapter. Identifying places on the map is a skill that is already introduced in Geography Class VII and thus, such a task particularly given in isolation cannot add any new knowledge for the students.

In the context of identifying learning goals in a project, two teachers argued about whether locating places on a map was a skill or a concept in geography. In another context, a teacher wanted to know the difference between content and concept. An example of spiraling a concept was shared by RA-C: "... students would know the map pointing of main cities in earlier standard ... specially when you are going to a detailed study ... show the smaller cities and places too ..." It is interesting to note that teachers preferred to limit the task. The difficulties in identifying concepts, contents, and skills was a major issue that could led to simplified tasks as a project.

In fact, I tried to explain that such a skill (like identifying places on the map) could be integrated in a larger project which will address the central concepts of the chapter. This explanation was not convincing to teacher participants, who were unable to accept the need to have non-trivial and complex learning goals which should be non-repetitive.

7.1.3 Views on nature of question

Some teachers preferred certain kinds of driving questions, for example, SU-A equated abstract driving questions to essay type questions. He proposed topics like "What is science?", "Science is good or bad?" and said that students should write two page essays on these topics. He showed his dissatisfaction towards these questions:

> ... In this kind of driving questions ... I do not find any possibilities of some kind of action ... Go out and do something ... I do not see in this ...

He found that these did not require students to do empirical work. However, his idea of driving questions that will involve empirical work was based only on students' act of primary data collection. SU-A suggested that for the study to be empirical, students must collect data rather than use the existing data. For instance, he said that "Is Indian economy really developing?" did not need empirical work. He felt that one could read and come with the answer and therefore the question is abstract and conceptual.

SU-C suggested that students could study the standard of living of the people. VA-S differed with SU-A and argued that "...students are using statistics, it is concrete. It is not something in students imagination."

But SU-A objected that the data in this case was not collected by students. They just read the table and draw conclusions from that. The teacher was of the opinion that, even when students use the statistical data, in a project, they should collect data themselves, say from farmers, etc. Only when students collect primary data themselves, will the project be an empirical one. He stated his position in the following statements:

> Here some one else done it and not the students ... I am reading and looking at the table and drawing conclusions from that ... and I have not done it ... In spite of taking data from statistical report I can go to my village farmers and collect data that will be empirical. To be empirical students have to collect actual data rather than use the already known data ... I use the table made by others or I prepare my own table ...

For several teachers the idea of empirical was connected to collecting first hand data. SU-A insisted that,

> As I understand, PBL in secondary school education ... in this context students have to go out the classroom and collect data ... if one draws conclusion from already prepared report then it is analysis of an empirical evidence but our purpose ... In this question student are collecting data from already existing reports ... I think these questions does not fit in more concrete category ...

Another idea stated by SU-A, who was inclined towards empirical work, was that doing work outside school was a more worthwhile project than doing activities in the school. This was an example of how some teachers assigned limited meanings and possibilities to type of driving question.

In fact, the ideas of SU-A presented above were endorsed by all teachers of the school system I, F, and G. One of the possible reasons could be that these teachers showed less interest in understanding classification of questions and started evaluating the types of questions hastily. The second reason could be they considered their own understanding and practice while elaborating a type rather than engaging with meaning given in existing literature.

The other interesting aspect was straightforward denial of 'in school' projects. Teachers from school system I and F also supported the 'project with empirical engagement' position by citing it would allow students to gather knowledge of the outside world. They still preferred to keep these as students' autonomous projects without any help from teachers and keeping it limiting to select students.

Students' lives in school are primarily dictated by the authority of teachers. In such a situation, knowledge of inside school and outside world remain separated and this separation would hinder the process of framing authentic questions.

7.1.4 On connecting to everyday world

The meaning of the word "authentic" was not clear to the participants. When the term was simplified by using "real", teachers started sharing their project practices where they had included components of the real world.

ME-A cited an example of her "concrete way" of teaching where she drew an analogy between textbook representation of content and concepts to the students' personal context.

> ... for example if you want to tell about state government, central government or panchayati raj ... we usually start with family ... who is the head of the family ... who makes decision in your family ... who has more power ... who has less power ... what about your decision making power ... in this way we start our discussion and we can easily introduce them in a concrete way.

It was mentioned in the session that a connection should be made between school subjects and everyday life to make projects relevant to students. In support of this aspect, teachers VE-A, RA-C, and U-A cited their personal project practices and how they had addressed this issue.

VE-A recounted that while teaching the chapter on acid, base and salt, he asked his students to list all the ingredients present in all things they used and to prepare a list of the chemicals.

> ... in the chapter of acid, base and salts ... I have given a task to students to find out the ingredients present in all the stuffs we use ... right from the toothpaste and detergent ... and then make a table ... After that students made a table of all the chemicals we are using in everyday life.

RA-C assigned her ninth and tenth grade students the task of making diary entries as if they were a character from a literary fiction. She thought that such tasks allowed

students to express their feelings and have fun. She also thought that these activities were very "practical".

UM-A gave an example of a project on "Pollution in the Ganga river". She stated that in such projects, students would certainly find out the information on water pollution.

> ... pollution in the Ganga river. Project on water pollution ...then they can definitely find out the information ... they supposed to solve the problem in (for) future ...they will collect all the details about what happened.

It was evident that aspects of using real world elements in projects need to be widened. Though teachers VE-A and UM-A could introduce problems from the real world, there was no attempt made to ensure that these were relevant for students. Further, the tasks were not extended to a productive culmination that could motivate students to engage with. It was also evident that students' perspective is missing while deciding something relevant for students. Like, In RA-C's project students were asked to be in the shoes of the characters of literary fiction and it was assumed that they would have fun and they could express their feelings. So, there was a need to develop an understanding of what constitutes authentic context for students.

7.1.5 Deciding on depth and breadth

There was a discussion on addressing the conflict of managing depth and breadth of topics, for example, DY-M said "We have to sit with students and find out what topics are important to go in depth and others need to be covered in breadth. You do not teach the whole at that much depth and teach them that topic again at the higher level."

Teachers also expressed their discomfort to teach concepts at a deeper level at lower classes, e.g. PR-A said, "The content will be more at a higher level ... now ... here we are teaching the content of higher level at a lower level ... is it possible for the child to learn so much?"

The tension of covering the depth and breadth while conducting PBL is well documented. However, in this case, teachers' concern was also associated with teaching content. Such concerns stem from focusing the teaching plans on content rather than concepts. Any concept can be introduced at any level while customising content for the students of a particular cognitive stage.

7.1.6 On assessment

The discussion during the lead talk on assessment made on the third day of the first workshop gave some interesting insights regarding teachers' understanding of assess-

ment. It was observed that teachers were concerned about assessment and wanted to know about students' actual progress. However, their responses in the discussions revealed incomplete understanding about assessment.

It was discussed in the talk that formative assessment was also known as assessment for learning. Assessment and evaluation was a continuous process. Some teachers (e.g. UM-A) stated that they were already following assessment as a continuous process. It was interesting to see how a teacher with more than 25 years of experience adopted assessment as a continuous component in her teaching and focused on assessment as a way to improve her students' performance. However, her example indicated that her concern was focused only on students' motor skills.

> Every step, child is bringing something ... Whatever the child is doing you are assessing that. And then further improve the child. Suppose the child is writing, ...some of them use all the fingers in holding the pen... so it is important to observe the child. You are assessing the child — the holding part. Some of them write letter *O* in indirect way. ...it becomes like a burden. They do not know. So when they write indirect way we have to say to them to write direct way. From the first day of child entering the class to the last day (of) the child leaving the class, every action — we have to assess the child, so that you can improve the child.

A teacher (SH-C), expressed her disagreement, citing psychologists that students should be allowed to write according to their own way. She opined that if the child was able to write a word, it should not matter how the child was writing the word.

It was observed that teachers did have a lack of clarity on what is meant by formative and summative assessment, even though these words are an integral part of their professional vocabulary. Moreover, the vocabulary the resource person was using in the discussion was also interpreted by the teachers differently, e.g. While resource person mentioned that he preferred to use the phrase *forms of assessment* rather than *kinds of assessment*, a social studies teacher (UM-A) interpreted *form* as *formal*.

In continuation of this discussion, the resource person explained that there was an element of flexibility in the assessment as well as in the assessment tool. It was interesting that teachers' connected it to (e.g. SU-C) their existing assessment practice and claimed that their present assessment practice was more flexible in nature.

> Now we have started changing it ... earlier it was fixed ... you have to take little examination and this ... but now flexibility is given ... you can change ... so presentation of different pedagogic strategy come to forms ... there are multiple forms of assessment ... now any form you can assess ...

Resource person asked teachers to identify the aspects they wanted to assess for a set of windmill models, depicted in the presentation. It was encouraging to see that they

came up with a number of assessment criteria even though initially they were facing difficulties. The criteria included aspects like neatness, material used, cost effectiveness, structure of arms of windmill (by teachers PR-A, VA-S), durability, presentation, time taken to lift the weight (teachers from Desire), concept of windmill and creativity (UM-A, teachers from Gulmohar). One teacher educator (SU-A) wanted to know the students' conscious decision making in the preparation of the model. To know this aspect, he suggested interacting with students and asking questions like how they would like to modify their model. Another teacher (PR-A), suggested questioning the students to know the contribution of each student in making the model.

While the researcher asked whether there were any other ways to know students' thought process, teachers from Desire gave answers like behavior, aptitude and tests. One teacher educator (SU-A) suggested showing a video clip to the students and observing their facial expressions to see whether students have understood. One teacher (SH-C) argued that, for the 'naughty' students, it is difficult to infer such an understanding from students' facial expressions. Two of the teachers' (SH-C, RA-C) raised a different issue and stated that a student might be excellent in making models but might not be good in drawing diagrams. Thus, overall, there were issues in understanding assessment in a comprehensive manner and how to assess varied aspects.

7.1.7 Disciplinary divide

While presenting project plan on the second day of the first Workshop, DY-M pointed out an interesting point: "for us ... sometimes it is easy to divide things in different subjects ... but sometimes it is difficult to say whether something is in science or geography ... water can not be decided as science or geography topic."

A few school systems even declined any possibility of teachers planning projects and assessment together. One interesting observation was that the root of the disciplinary divide rested on pragmatic constraints or school culture rather than pedagogic limitation. For example, teachers debated about the criteria they would use for forming groups on the first day of the workshop series. Some teachers, (eg. VE-A) wished for subject-wise grouping. It was suggested that participants could form groups in which at least one member would be able to carry out the planned project in his/her school. Teachers were assured that help would be provided to meet their logistic and material needs and to get administrative clearances to conduct the project in their respective schools.

According to RA-C, an English teacher ,from a school system I, was the lone teacher in her group who taught neither science nor mathematics. She perceived it as a challenge. However, she was clarified that in the workshop, teachers needed to develop the projects in their current group, and collaborate with other teachers in their own school while planning and conducting these projects. Thus, perception associated with the disciplinary divide was one of the stumbling blocks for teachers and it was not easy to convince them to overcome the divide.

7.1.8 Textbook as authority

While discussing PBL criteria, I cited examples of projects from the textbooks published by NCERT and Maharashtra State Textbook Bureau that did not follow the particular criteria. The teachers wondered whether the researcher implied that none of the textbooks of either publisher have PBL projects. RO-C inquired whether there was no PBL in NCERT according to the researcher. It was evident from another teacher's (SH-C) response that she had disillusioned herself by confusing all the projects and activities listed in the textbook at the end of each chapter as PBL projects.

Several teachers seemed to appreciate the difference when one of them said, "... They (projects in textbooks) can be called as projects but not project based learning..." However, locating the authority of textbooks and demarcating projects to PBL projects are complex.

During school visits, it was evident that in several school systems (A, B, E, and G) State Board textbooks were the only source used in the classroom. However, school system E had the culture of conducting project day where all students took part in at least one project. Similarly, school system A conducted project day but with select students. In these project days, resources other than textbooks were used. School system I and F mostly used CCE manuals prepared by private publishers.

7.1.9 Sequencing textbook content in projects

One of the perceived challenges in conducting projects was the possible mismatch between concepts required in the project and their sequence in the textbook. A teacher (JU-S) gave a spontaneous example of this challenge where the sequence in the chapter - going from substances to their properties (separation of mixtures) did not match the sequence in the project.

> ... In textbooks, after the chapters of elements, compounds and mixture there is a chapter on separation of mixture. Suppose, I want to teach the topic, nature of matter, and I want to take the sample of unlabeled substance... finding out what is there in the substance... The project will be on 'How will you identify which substance is that?' So children will come up with their own test — testing, smelling, anything... They are coming from the properties to the substance... this does not match with the sequence given in the textbook...

Another teacher (DY-M) expressed that teachers are not allowed to link chapters arbitrarily, as Board guidelines of portions included in examinations tied the teacher to a sequence. However, one of the teachers (SH-C) strongly opposed the idea of following such examination guidelines, citing her own teaching practice.

> I think we should not disturb the teaching-learning process due to assessment problems. If any topic or chapter comes in the way, that will not be assessed. We cannot simply stop. For example, ...fifth chapter in tenth standard is periodic classification. And according to me, metals, acids and bases, and pH — anything — and rate of chemical reaction... Student can follow (this) once they know the periodic table... So, I teach the periodic table first...

Clearly, SH-C mixed the idea of assessment conceptualised in PBL and the need of maintaining sequence of textbook chapters as per the requirement of examination by respective boards. It also appeared that SH-C, SU-C, RA-C and other teachers interpreted assessment within the purview of examination. Different State Boards asked schools to follow a fixed order of textbook chapters. The summative assessments are based on these chapters and the results are shared with the Block Education Office. This norm poses some challenges while carrying out projects that require one to choose chapters not prescribed for the current session.

7.2 Teachers' experience of reading research papers

It was observed during the sessions on reading and presentation of research papers that there were challenges faced by teachers in this activity. These challenges were:

1. *Difficult to read:* All the participants faced difficulties reading research papers. However, only four groups stated this during the presentation. Participants found it difficult to follow citations given in the text. They also gave only a small list of difficult words. Two groups mentioned two words that they had found difficult in the papers. These included *scaffolding* and *serendipitous* by Umeed, *Plagiarizing* and *Gerbil* by Innovation. Teacher VA-S of Group Umeed, said that she knew the meaning of scaffolding in the context of building construction but not in the context of education.
2. *Difficult to comprehend:* Only one group (Innovation) responded to all the nine guiding questions that too partially. Groups also refrained from answering reflective questions on connecting the concerns raised by the authors to their own teaching concerns, and suggesting alternatives to the ways authors handled some challenges like time-related issues.

   In the guiding questions, participants were asked to address the time-related issues. Groups mentioned all the challenges presented by the authors. No one made any comment on whether they appreciated the way teachers handled the time-related issues. The groups also did not suggest any alternate method to deal with such issues.

   It was also found that the teacher interpreted the text differently than it was intended by the authors. For example, VE-A said that authors of the paper considered the students as "blank slate" as the students were from primary level.

3. *Reluctance to read:* Some members from Desire (NA-C, SH-C, and RA-C) interpreted the paper as a top-down approach. They wanted a write-up prepared by the researcher based on PBL conducted in an Indian context. Even after repeated mention of the task description, teachers of Desire were unclear about their role. According to them, researcher should not assign tasks like reading and answering questions to teachers. Instead, a summary of the papers should have been presented by the researcher.

7.3 Evolution of teachers' ideas on PBL

In the workshop, all the activities were carried out in groups. The ideas evolved in the community of participants, including teachers, teacher educators and researcher. The ideas found expression in the productions of one or more groups': written plans, presentations, interview responses, or class discussions. Hence evolution of an individual's ideas is not the focus here. The evolution of ideas is summarized below in terms of the themes that were used in analyzing teachers' responses.

7.3.1 Centrality

Centrality has been interpreted in the study in terms of addressing curricular and textbook topics from different subjects for a given class. Once they were introduced to the characteristics of PBL, teachers gladly included it in all their project plans. With time, more topics and subjects became a part of their project plans. Besides, they were more meaningfully integrated using coherent sets of planned activities.

In the first workshop, the groups made the project plan on a variety of themes e.g., convert and save energy, soil, hydrosphere and ocean floor, bicycle, and water. They covered a range of textbook content, but it was derived from a range of subjects. Some groups included a few subjects but others included multiple subjects. Group Angan included seven subjects in their plan, followed by group Umeed (five), group Desire (four), group Gulmohar (three), and group Innovation (two). Only group Desire had selected was a project around a chapter from the English textbook. In other groups, the core topic was either from science or was common to both science and geography. Interestingly, group Desire changed their plan of project on the successive day and included science, English and mathematics with science as core content of the project. They also could include multiple topics like soil, water, electricity in the project. In the first project plan, group Raigad limited the subjects to only science but in the next plan they included language and mathematics in their project.

In the second workshop, all the groups in their project planning had considered concepts/ skills prescribed in the syllabus. The number of subjects integrated in the project did increase for all the groups except for group Daffodils. Group Angan and Umeed integrated the largest number of subjects (eight), followed by group Indradhanush (seven), Raigad (six), Mrudhgandha, Gulmohar, Innovation (four), and group

Daffodils (three). The average number of subjects integrated in the project plan increased from 3.9 (with SD = 1.6) in first workshop to 5.5 (with SD = 2) in the second workshop. Science and geography were found to be the most chosen subjects for the projects even in the second workshop. Only group Raigad did not plan their projects with science as a subject.

However, when some of them implemented their project plans, the thought out ideas were curtailed. There were complexities when different subject teachers had to collaborate. Some of the barriers that they met were the issues of fitting such projects in existing school policies and schedules, time for different subject teachers interactions for developing the plan, and working out necessary details for subject integration, etc. In fact, teachers tended to implement the part of the project that addressed their subject. Another hurdle was that teachers' content knowledge was limited to a single subject. Hence the teacher could not guide or assess students' learning in topics from different subject areas.

One of the tasks for teachers was to decide the title and theme for the project. In the first plan, all the groups could mention a clear theme. Group Desire, Innovation, Angan and Umeed did not come up with a title for the project. All the titles and themes were relevant to the task and mostly aligned with the contents and skills listed.

Group Raigad listed the concepts and skills that were ambitious for students at grade VII, e.g. energy conversion was out of syllabus and measuring energy involves a difficult concept. The topic (armature of motors) was not aligned with content and skills. Content included "Nature and measurement of energy: magnetic, electric, kinetic, light; their interrelations (conversions?)", and skills included "Information gathering, self learning by reading and discussion, scheduling and costing, presentation and communication". Groups Angan, Gulmohar, and Umeed did not specify any topic and the content listed by them covered only one part of the theme "hydrosphere". While several topics and concepts listed by Desire were at the students' cognitive level but beyond the scope of the syllabus. Content, concepts, and skills listed by the rest of the groups were appropriate for students' cognitive levels and within the syllabus.

In the second workshop, the final project plans showed an interesting trend. All the groups listed several activities and on an average 6 activities were listed by the groups. It is heartening that most of the activity descriptions were aligned with activity titles that were largely aligned with LOs. So, it is evident that all the groups made progress in listing a diverse set of activities, provided a description of the activity, and listed a set of concepts, skills, and procedures.

7.3.2 Driving question and problem context

The driving questions set the scope for conceptualising the project. It should help students to organise their inquiry activities as part of the project. The statement of the problem to be investigated/solved needs to be reflected in the driving question. This section looks at the struggles and difficulties faced by teachers while devising the

Table 7.1: Driving questions framed by different groups in the first workshop.

Name of the group	**Driving questions framed in the Plan 1 in W1**	**Driving questions framed in the Plan 2 in W1**
Raigad	(a) If we are riding a cycle, heat is produced, can we use that heat to light a bulb? (b) How can I convert circular motion into electricity? (c) Is it possible to convert the motion of water to electricity?	Is it possible to convert the motion of water to electricity?
Innovation	Nil	Nil
Angan	What can we do about the increasing scarcity of potable water?	Do we have enough drinking water?
Desire	What is the mode of transportation in the clippings which does not cause pollution?	Is there a way in which earth can remain green for ever, yes or no?
Umeed	(a) What will happen if there were no water? (b) Can we drink water from the river Ganga? (c) How does the water flow?	How can you say that drinking water in your neighbouring area is safe or not?
Gulmohar	Nil	Where do we get food from?

driving questions and how they progressed over time.

One teacher (SH-C) from the group Desire continued questioning the necessity of having a driving question. Another teacher (RO-C) from the same group stated that driving questions helped motivate students. However, SH-C was not convinced about the same. The groups, Umeed, Gulmohar, and Innovation faced difficulties in framing driving questions in their first project plan even though they had created a relevant problem context. Most teachers appeared to lack confidence in framing driving questions

The driving questions generated by the participants initially were modified through discussions to form acceptable driving questions. Driving questions prepared by the groups in plan 1 and revised in 2 during the first workshop are presented in Table 7.1. However, it was difficult for most of the participants to frame driving questions that would directly lead to meaningful learning activities for students. Hence, from the second workshop onwards, framing driving questions was made an optional aspect of project planning.

The prominent problems observed were that teachers had difficulties to align the driving questions with activities to be done and the stated learning objectives. In some cases, the project titles, problem context were not aligned with the stated learning objectives and tasks,

7.3.3 Constructive engagement and assessment

During the session on the first day, only one teacher (RA-C) made a comment regarding projects and assessment. She mentioned that formative and summative assessment were important especially in Classes IX and X. Hence she felt that it would be more useful to discuss projects for those classes. Overall, teachers were unclear about how to diagnose students' difficulties and when and how to provide the right kind of support.

Aligning assessment with learning objectives and productions

Initially,the activities planned by the participants and the productions resulting from them were unconnected with the learning objectives that they set for the project. In fact, participants had difficulty in differentiating between the learning objective of an activity, the activity itself and students' productions in the activity. All the groups had listed several learning objectives in terms of content and/or skills in their project plan. The productions planned by groups Raigad and Innovation in their first project plan were aligned only with skills. Group Angan listed only content as a learning objective and their proposed productions failed to align with the stated learning objective.

All the groups listed several productions they expected from their students in their project plan. It was interesting to observe that in the first project plans, all the groups mixed up the productions with activity and some of the groups even included learning objectives as productions. However, in the successive plans, participants started delineating productions without such confusions. This can be due to the fact that articulating assessment for each of the productions required that the participants distinguish between these elements.

Only one group, Raigad, mentioned a relevant assessment criterion for each of the two student productions planned by them. But both the criteria did not include any descriptors. The criteria also did not include the rich assessment potential of the productions. Group Innovation, planned to just ask questions to assess students' understanding. Two of the groups, Angan and Umeed did not plan any assessment at all. Group Desire had difficulties in listing the criteria corresponding to the students' productions stated by them and aligning these criteria with the learning goals.

The evolution of project plans showed an encouraging trend. In successive plans, for all the groups except one, the alignment of assessment with learning goals listed and productions planned was enhanced. Besides, groups were able to generate better assessment criteria. In fact, in their final plan, they even generated analytical rubrics to assess several of the students' productions. A list of productions listed by different groups along with the planned assessment criteria against each production is given in Table 7.2.

When these productions are checked for stated learning objectives (LOs) it shows an interesting pattern. Only one group (Innovation) could align planned productions in alignment with the stated LOs while the other groups could not. Group Raigad focused only on proposals and therefore major LOs were not addressed. The major productions planned by Umeed also did not assess stated LOs on contents.

In the second workshop, there was an increase in alignment of planned productions with learning objectives for all the groups. A list of productions listed by different groups along with assessment criteria they planned against each production is given in Table 7.3.

Two groups (Daffodil and Umeed) provided several activities for students and the stated LOs were mostly aligned with these activities and how they would be conducted

Table 7.2: Students productions and assessment criteria prepared by the groups in the first workshop.

Name of the group	**Production (assessment criteria)**	**Analytical rubric prepared**
Raigad	Proposal (write up, scheduling, costing), Viva voce (understanding of concepts)	Proposal
Innovation	Project report (sample description, data recording, description of experiments, drawings of experiments), and Presentation (content, presentation skill, structure and organisation)	Presentation
Angan	Drawing (neatness, labelling, use of colour), Model (material used, size of the model), Viva voce, Invitation poster (layout, neatness, vocabulary, details mentioned), Poem (creativity, use of words, adjective used, imagination), Map (map skill, amount of space used)	Drawing, Model
Desire	Nil	Nil
Umeed	Oral presentation (communication skill, confidence level, systematic flow of presentation, voice modulation), Viva (content application, accuracy), Model (attractive, neat, proper labelling, functionality, appropriate use of material), Written report, Worksheets	Oral presentation
Gulmohar	Bar graph (Data table, scale and units, representation of bars, description of axis, index, colourful presentation), Drawing (labelling, neatness, completeness, scaled), Oral presentation (communication skill), scrapbook, conducting experiment, write up (sequence, content, conclusion), questionnaire and tests (reading skills, concepts, understanding)	Bar graph

in class. Innovation provided a list of activities aligned with the stated LOs, however, all these tasks revolved around teacher dominated discussion and often students needed to merely copy from the board. Even activities like making circuits were planned through discussion. Gulmohar relied mostly on home work to complete tasks and focused on collecting information. An activity planned by the group on measuring agricultural land was distantly connected to LOs. Like Gulmohar, Angan and Raigad planned several activities aligned with the theme. However, they partly could align LOs with activities. Most of the groups listed several criteria in order to assess the productions. Several of them also planned to use three or on nine-point scales for such assessment.

In the second workshop, all the groups listed several learning objectives in their planned project. They listed their planned sequence of activities, and the productions expected from students corresponding to each activity as required by the structure of the worksheet. Probably, because of the structure provided, or improved understanding or because of other factors, the confusion regarding mixing productions with learning objectives was reduced as was observed in the first workshop.

The participants also had difficulties listing the criteria for assessing students' productions. If they listed criteria, these were often not aligned with the learning goals they had set for the task. In fact, some groups confused criteria with the activity or task. For example, they used oral presentation as a criterion to assess communication skills. Oral presentation is an activity that could be assessed by a set of criteria like language use, content and its organization, clarity, etc. The number and suitability of criteria for activity and learning goals improved with increasing and varied engagements with

Table 7.3: Students productions and assessment criteria prepared by the groups in the second workshop.

Name of the group	**Production (assessment criteria)**
Innovation	Activity, map plotting, circuit diagram, simple circuit (Not clear)
Daffodils (A part of Desire)	Poster (content, organisation, creative ideas, impact), simple circuit (gathering of materials, correct usage of material, exploration by using other materials, time management), heating element (materials used, coil preparation, understanding), Electromagnet (understanding, involvement, application, overall impact), Graph (Neatness, clarity, use of instrument, interpretation)
Gulmohar	Write-ups in class and as home-work (classification/identification, organisation, coherence, fluency, content, vocabulary, grammar), presentation, measurement (identification, details of shape, calculation)
Indradhanush (A part of Desire)	Role play (Idea, presentation, effectiveness, acting ability, peer group assessment, participation, listening skills), Activity 1 (Choice of material, procedures, observation, drawing inferences), Activity 2: Find the focus (procedures, correctness, observation, accuracy, result), Activity 3: Image formation (procedure, observation, result, measurement, neatness, clarity, accuracy), Magazine, Presentation
Mrudha (A part of Raigad)	Soil sample (types, quantity of information, quantity of sample brought, how the property is arrived at), write up (importance, categorisation, relevance), Group work
Raigad	Group discussion (relevance, coherence, listening to others, taking into consideration the majority opinion and then take decision), Report (easy to understand, facts), collecting information from library (correct discussion with the librarian, behaviour in the library, whether you are able to search the book on your own), Library Report (importance of the chosen books, importance of the points chosen, are the points sequential), Making maps (Understanding what each symbol, unit and scale means, understanding political and geographical/physical map), Activity - discussion with subject expert (researching/ searching through different means, pre-planning before the discussion, listening and making points, combine the points and write in easy language, a (journal) article)
Angan	Write-up1 (number of living and non-living), write-up2 (appropriateness), Drawing1 (proper sequence, neatness), Role play (participation, teamwork, presentation skill, voice modulation, facilitation and support), Poem (rhyming, use of words, flow, relation), Drawing2 (use of colours), Charts of food chain and presentation (posture, eye contact, vocabulary, voice modulation), Discussion (thinking/communication: confident, hesitant, need support)
Umeed	Discussion and presentation, Arranging a display, Model, Write-up, Poster (No assessment mentioned)

assessment tasks through the workshops.

A glimpse of teachers' concerns and understanding evolved during the engagement can be summarised in the notes prepared by the expert group on assessment. The assessment group decided to ponder on two major points. The first point was whether the project assessment should be formative or summative with respect to learning and effort. The second concern was whether the criteria in a rubric should be 10-12 or limited to 3-5. The expert group of teachers felt that it was too difficult to frame an assessment rubric that would serve well for a class of 50 students. They wondered how assessment could reduce subjectivity from a student's point of view.

All the groups showed considerable progress in listing appropriate criteria for assessment with several descriptors. They tried to write descriptors for each criterion, however, the descriptors were not always clear or suitable e.g. the descriptor given by group Desire for criterion "novelty", was 'less suitable", "adequately", and "sufficiently". In the third workshop, when groups made analytical rubrics for students' productions for playground PBL, it was observed that they were able to make better quality analytical rubrics. Such a progress indicates that teachers had internalised the idea of the analytical rubric for assessment. Thus, the presence of actual productions catalysed teachers thinking about using performance descriptors for making the analytical rubric.

7.3.4 Aspects of realism

These were new ideas for most of the participants. It was presented in the discussion held on the first day of the workshop that the projects in PBL focus on authentic and real world questions and or problems that drive students to learn central concepts. Participants' came up with interesting questions while trying to connect the real world to the textbook content. SU-A wondered if he could ask students to invent a biodegradable plastic, and expect students to learn about carbon compounds. This question led to two tensions. One was matching the learning goal to the driving question, and the other was matching the question to the real world of students. For instance, though it was a "real" question for the polymer researchers, it may not be as "real" a problem for middle and high school students. Moreover, perhaps, the task may become too challenging for the students, compared to that prescribed at middle and high school level. It is interesting to note that in the final plan made in the second workshop, teachers focused on topics relevant and equally interesting to students which provided an opportunity for students to work in groups, carry out experiments, and present their work.

Classroom management

Teachers' explicitly mentioned about classroom management in the plan they had prepared in the second workshop. Innovation mentioned about 'group work' and duration of work in the management note. Gulmohar and Umeed added duration of work for each activity in class, name of productions to be used, topics to be discussed, and work

distribution along with the two aspects mentioned by Innovation. Indradhanush mentioned a long list of teachers' role in motivating students, that included, observing the process, appreciating work, understanding of work and relevance of theme, deciding group, venue, time, planning, procurement, individual time management, discipline, and involvement in the experiment. Mrudha and Angan mentioned only time duration to complete the students tasks. However, Mrudha counted the time duration including students' homework. In contrast Angan adjusted time in their regular time period, and even allotted three whole days for the project. Raigad also adjusted time in their regular time table, and they did it by putting time against specific work to be done.

7.4 Teachers' acceptance of PBL

When asked about implementing the project in their respective schools, participants from each school system felt they could implement the project either by modifying the project a little or getting some changes in their schools' schedules. One of the groups (Achievers) noted they needed to address implementation issues by getting help from extra teachers, providing instructions and materials to their students, and allowing them Internet use during their free time. Another group needed (Gulmohar) specific school periods to be allotted for such projects, to help plan subject integration consulting teachers of different subjects.

Umeed and Angan stated that the productions could be displayed in the school exhibitions or on a *projects day*. Although Raigad said their school had been conducting projects in their school since 1950, the group felt the need for brainstorming among their teachers to implement such projects in their school. Overall, the implementation issues raised were about modifying the project, or requiring changes in the school system or policies. It was hoped that the modified project would continue to have the major characteristics of PBL.

Through the skits, participants expressed their ideas about PBL and conveyed to the resource persons what they had understood. They conveyed that PBL was an effective teaching method, recognized its salient characteristics and assessment potential, and expressed their classroom management concerns. These ideas as expressed in the skits are summarized below.

PBL as an effective teaching method: This was one of the main ideas in the skits. Some teachers situated the effectiveness of PBL in the larger context of learning science and technology. Besides, some teachers recognized that PBL was different from traditional methods of teaching. In PBL, students work in groups to solve a real world problem, collaborate with each other and learn from different subjects in an integrated way. Teachers stated that in the process, students would develop confidence, communication skills, and vocabulary. Other teachers presented PBL as an alternative which can be used effectively to reduce the existing teaching burden.

Characteristics of PBL: All the skits included one or more of the characteristics of PBL either within the acts or through explicit announcements. They also contrasted

traditional projects with PBL. One skit criticized traditional projects for being *dictated by the teacher and not providing freedom to students to express themselves.* The most mentioned aspect was the possibility of integrating multiple subjects. Aspects such as significance of the driving question and assessment were woven into one of the skits. Other skits included aspects such as planning for implementation, total duration for the projects and assigning projects for every chapter of a given subject.

7.5 Status of project implementation

The projects were implemented differently by different teacher participants in their schools. Some teachers did not implement any projects in their school system. The current section captures the aspects that were implemented by these teachers when they carried out projects in their school. It gives insights about what factors influence structuring and carrying out a PBL project in the school system.

Maintained existing project practices

UM-A, selected projects from social sciences for the classes of 6 to 8 from CCE books prepared by a private publisher. She then asked her teacher colleagues teaching in these classes to assign these projects to students. This instance indicated she off-loaded her responsibility of conducting projects to other teachers, but at the same time she was able to convince them about the conduct of projects. These projects were to be carried out individually as homework. Students submitted the projects in the form of write-ups to the teachers.

RA-C, a teacher from another school, gave projects to be done as homework to her students of grade 9. These projects were assigned as group work. Students prepared write-ups and presented their work in class.

Both these teachers were convinced that they had conducted projects using PBL pedagogy. However, it is clear that they continued their own existing project practices.

Classroom management issues

VI-A, was implementing projects in the classroom for the first time. She assigned a project to students of grade 6 to be done in groups of 8. The driving question for the project was,"How many ways can you classify plants?" Students carried out the project at home and later they made a presentation in class. When researcher visited the school after a gap of 45 days, students brought the samples and productions and explained to the researcher. Teacher acknowledged that giving the project was helpful for her to finish chapter easily as students brought many things in class and students learned while listening to others' presentations. Even after such positive results, teacher VI-A

did not want to take on another project. She cited the presentations and discussions that enhanced the noise in the classroom and became a disciplinary issue in the school.

Teaching style and PBL

SH-C and his colleague asked students of Class 8 to bring soil samples for a project. Researcher managed to attend one presentation by students in the early phase of the project. For the presentation, two groups brought samples of soil. It was observed that SH-C was giving continuous instructions to his students throughout the presentation. While presenting their work students were not confident and appeared to be waiting for their teachers approval. The teacher asked questions that had only yes/no type of answers and in fact, answers were already part of the questions. The project was not continued after that presentation. In this example, students were not central to the process of conduct of the project and did not have autonomy. The teacher expected them to rely on him. Thus the teacher had not internalised the crucial aspect of PBL pedagogy that students should be co-constructors of knowledge for conduct of projects.

Dominant performativity in projects as hindrance

The two school systems, Angan and Raigad tried to integrate the project idea for the learning. Both the schools had a school based capacity development mechanism and conducted an annual project day. Teacher educators from both these school systems' attended the workshop. Two teachers of Angan were evaluating their school projects against the PBL criteria they learnt in the workshop. However, their school continued to conduct projects guided by the performance of select students.

Teachers of Raigad assigned projects to select students on making a dynamo. However, only one teacher was maintaining the record of the project implementation and the other teachers presented the task to the students. Both the school system could not translate the important idea of engaging all students from class with projects in that academic year along with other issues.

A willing system and timely reflection

There was one teacher V-S who conducted projects just after the first workshop. She shared a detailed write-up on how she had conducted it. She took "Water Bodies" , a project topic for class VI standard students. She used the day allotted for *integrated learning* in her school and collaborated with an art teacher. She started a paint activity and introduced the topic of the day related to water. She then generated discussion sessions followed by short videos.

She made groups of 3-4 students and distributed various topics to each of the groups. She mentioned an incidence of oil spill in the Arabian Sea near the city and therefore,

the topic *oil spill and pollution of our oceans* was an important topic. Different groups were allotted different information sources as per the topic to carry out literature study, and prepare a presentation. Students prepared the charts, poems, selected newspaper articles and enacted a dramatization etc. in front of the teacher and therefore she could carry out her formative evaluation and *saw the process leading towards its final destination*. She mentioned that she did formative evaluation while students were actually making charts, poems etc. for presentation purposes. At the end of group presentations, she had asked students to write the difference between pond and lake, lake and ocean etc.

She also noted multiple areas for improvements: (a) providing specific feedback to each group, (b) better topic selection, (c) sharing rubric with the students, (d) setting a norm for students to get checked their progress from teacher, and (e) correcting the content and information before presentation.

She had observed that some of the students were not "comfortable" with the explanation given by their peers. All the groups did not perform equally well in their presentations. Some of them hesitated, some were shy, and some gave a very elementary explanation on their topic and therefore other students asked for clarification. The teacher confessed that she could not give the answers to the questions to her satisfaction. She had also observed that the topic became too vast for PBL and it became too difficult for her to handle the 79 students. Overall, this teacher in true sense could implement various elements of PBL pedagogy.

7.6 Conclusion

The chapter presents a summary of the findings from the teachers' engagement with a series of the three PBL related workshops.

Even though teacher participants of the workshops series were familiar with inquiry based learning, they were not able to explain the same or present its examples. The pedagogies activity based and discovery based learning were similarly not familiar to teachers. During discussions, the teachers made efforts to interpret the characteristics of these pedagogies. However, they interpreted them literally. Teachers also attributed additional incorrect meaning to these terms using their personal experience.

These observations are consistent with those in the literature on teachers' views on inquiry based learning (IBL). Teachers' views on inquiry are diverse as well as complex (DiBiase & McDonald, 2015; Maass, Swan, & Aldorf, 2017; Correia & Harrison, 2020; Romero-Ariza, Quesada, Abril, Sorensen, & Oliver, 2020). These studies also reported that teachers assign idiosyncratic meaning and their personal experience while characterising IBL.

Teachers' diverse ideas on activity based learning are also documented in Indian context (Singal et al., 2018). The National Education Policy 2020 (MHRD, 2020), proposed adoption of inquiry based, activity based, project based, and discovery based learning.

It is important that teachers develop a deeper understanding of different pedagogic strategies and philosophical and psychological underpinning.

All teachers in the current study had a view of introducing a topic or teaching a topic from "concrete to abstract" and "simple to complex". Though there were different meanings associated with these phrases. For some, abstract implies ambiguous, while some considered simple means known. Some teachers preferred to introduce the topics in stages and present in a way that students could grasp the content or concept. Teachers' views on open-ended questions were also complex. Though teachers were in favour of supporting students' creativity, they were hesitant to pose open-ended questions to students. Teachers also conceptualised 'authentic' in a trivial manner.

Teachers' expressed some pragmatic concerns while conducting progressive pedagogic practices. They were concerned about resolving the tension of covering breadth or depth of a topic and sequential mapping of the chapters from the textbook to the projects. The disciplinary divide rooted in the school system appeared to be another factor which hampered collaboration among teachers with different subject backgrounds. Schools having greater interactions with teachers and school based TPD programs are more likely to address this challenge. However, it was also observed that even when opportunities of teachers collaboration are facilitated, teachers divide their work as per their own subjects.

It was evident that participants' ideas on assessment were complex and guided by the pragmatic drive of everyday teaching context. The policy guidelines in the form of circulars shape the meaning of assessment and pedagogic vocabularies directly or indirectly . Teachers were following the assessment practices as per the CBSE circulars. Interestingly, the CBSE circular that provided a list of pragmatic solutions to reduce the increased burden were not mentioned by the teachers or schools. There was also a considerable amount of resources developed by CBSE and NCERT on understanding assessment practices as per CCE and formative assessment. However, these resources failed to receive wider circulation among the teaching community and researchers. The TPD engagement in the current study opened up an avenue for teachers to develop an understanding in alignment to policy suggestions through informed discourse.

All the teachers stated several positive aspects of conducting projects. However, projects were mostly assigned as homework and teachers showed less enthusiasm to implement the projects in their schools. The same may be due to multiple reasons. Some of these reasons are: the idea of PBL was new to teachers and such projects need more preparation from teachers, or implementation of PBL requires a change in the existing school time table. It is also found that many of the ideas relevant to implementing PBL are also connected to teachers' content knowledge, their understanding of pedagogies and exposure to the same, understanding and practice of assessment, as well as philosophical disposition to learning, learners, education and society at large. Teachers who were not willing to ask open-ended questions would find it difficult to structure a PBL unit.

The TPD engagement in the current study showed an evolution of participants' ideas of PBL. The evolution was partly due to the way engagement was structured. Teachers

developed a problem context for students to motivate in a project work and they could integrate multiple subjects and content areas in a project. They listed multiple productions for the project and prepared a storyboard to organise projects. The teachers engaged in making analytical rubrics and made significant improvements for the same while preparing rubrics based on actual students' productions shared with them. All these observations open possibilities of engaging a wider community of teachers. The areas in which teachers struggled need to be addressed while engaging with them as a community of learners. It is equally important to reflect on their practices on a regular basis.

Chapter 8

Conclusion and implications of the study

The study presented in the current thesis has made efforts to design and implement a collaborative teacher professional development model for planning of PBL in the Indian context. The study followed a deliberative curriculum approach (Null, 2011) to address the challenges and opportunities created due to new policy change in the Indian educational context over the last two decades.

The declaration of National Curriculum Framework (NCF) 2005 (NCERT, 2005) aimed at bringing a "paradigm shift" in the state of teaching-learning in Indian classrooms led to wider deliberations in educational as well as in the public domain. By implementing Right to Free and Compulsory Education (RtE) Act 2009 (GoI, 2009), the country moved a step forward to meet its constitutional obligation made through 86th Amendment of the Constitution of India by the then Union Government of India (Tilak, 2004).

Like NCF 2005, National Curriculum Framework for Teacher Education (NCFTE) 2009 (NCTE, 2009) also advocated a paradigm shift in teacher education. NCFTE 2009 detailed the required knowledge base and expected dispositions for teachers to take part in transformative actions in the classroom as suggested in NCF 2005 (NCTE, 2009). Interestingly, while NCF 2005 and NCFTE 2009 created a space for deliberations, RtE 2009 pushed for a more accountability driven, reductionist, and homogenized model (Batra, 2014). The recent NEP 2020 (MHRD, 2020) consolidated the policy discourses of the nation over the last several decades and has opened up possibilities for initiating several pragmatic steps towards improving the state of education.

This study begins with a search for a unifying character and leveraging solutions that would help achieve the visions expressed in the policy documents and address the challenges of implementing the policy suggestions. This work has been based on a constructivist paradigm (Rogoff, 2003). In the context of the policy documents, CBSE circulars [Section 1.3], curricular materials [Section 1.4], the need of establishing a democratic ethos (Apple & Beane, 2006) and liberating problem posing education

(Freire, 2000), PBL was identified as an unifying pedagogy (Sriram, 2018) to address multiple concerns in a coherent way.

I adapted a model of PBL from Thomas (2000) [Section 2.2.1]. In addition, Waks (1997), guidelines for reformulation of projects for the present time helped derive four specific aspects to ensure while carrying out PBL [Section 2.2.2].

The study was guided by primarily two research questions [Section 3.1]. The first research question was: What are teachers' views about and practices of projects in teaching-learning, and the challenges they face in implementing projects? As a part of this main question, efforts were made to look at teachers' views towards addressing subject integration, assessment practices, group work for learning, and management of resources in designing projects in their own teaching context.

The second research question was: How do project plans and assessment strategies of teachers evolve through their engagement in a TPD program? What challenges do teachers face while generating teaching units on PBL projects and implementing these same. The stages of the study are already presented in Chapter 3. This chapter tries to present the salient findings from the study. It reports on the use of materials developed in the study, some action points in teacher professional development as well as highlights the role of other stakeholders in implementing policy guidelines. Finally some limitations of the study and suggestions for further study are presented as well as the evolution of researcher while engaging in this study.

8.1 Findings from the study

The major findings from the study are classified under the following heads (a) teachers' existing practices of projects in school, (b) teacher's views on proposed model of PBL, (c) evolution of teachers' ideas on PBL and acceptance of PBL, and (d) factors contributing to planning and carrying out of PBL projects.

Teachers' existing practices of projects

It was evident from the engagement with teachers that, after 2005, there is an increase in frequency of conducting projects in the schools and particularly in the schools under CBSE board. Projects also became a part of teachers' vocabulary, but the understanding of projects by teachers was not aligned with the meanings present in the policy documents (Furtak & Alonzo, 2010). During interviews, teachers expressed that the project assignments to be given led to burdening of teachers and students both. During school visits, students in some schools expressed their dislike of doing projects and parents are also not happy with such practices.

Even though policy documents suggest the conduct of projects during school periods, the school systems did not make space for projects in the school time table. Thus,

teachers continued to assign projects as homework and started providing small activities as projects. In this way, teachers responded to policy demands while addressing their pragmatic concerns. Thus they demonstrated apparent consistencies between their practices and stated views about projects as found in other studies (Bryan, 2003).

A large number of handbooks and assessment manuals have been published which can be used for implementation of projects. However, in absence of their use for the school system, teachers continued their project practices situated in Kilpatrick's model of anything and everything that students do is considered as project (Knoll, 1997). Some schools dedicated their time and effort with students in preparing projects to be showcased for the annual project day, and to do this they suspended their regular classes. Most of these projects are conducted in mathematics, science and geography as there was more scope for constructing working models. Working models often receive greater appreciation in project competitions too. Overall, it was found that often for projects, particularly in individual projects, students make charts, write essays or prepare booklets. Only in some schools, students were given opportunities to present their projects.

The nature of projects assigned to students and how these projects are assessed was primarily dependent on the school system as well as on teachers' personal preference. Teachers noted several positive outcomes of projects and even argued with anecdotal evidence of students' learning and changes in their behaviour. However, some of the participant teachers of the Focus group discussion (FGD), opined that students did not learn much from the projects.

However, teachers wanted to retain the projects. Teachers of FGD justified their preference for retaining projects by stating that projects often helped students to score well in examinations. In their opinion, projects provided practice for writing, especially subjective types of answers, which was beneficial for the final board examination.

It was interesting that the teacher praised the advantages of projects and provided a list of students' learning from projects, but kept the assessment practice unclear. Several criteria were used by them to grade students' submitted productions and generally, no feedback for improvement was shared with students. The assessment schemes were also not shared with the students and the assessment criteria did not align with the stated learning objectives. In fact, most of the projects did not delineate the learning goal and corresponding assessment criteria and standard. Thus, assessing students' conceptual understanding from these projects remained a difficult area and similar findings are found in literature (Marx et al., 1997).

Teacher's views on proposed model of PBL

Presenting a model of PBL to the teachers and holding deliberations around it with them, helped in initiating a mechanism for making meaning about PBL. In the discussions, teachers could reflect on their practices, and revisit their learning from earlier professional courses and life experiences. Teachers noted that there were possibilities to integrate two or more subjects for the projects. However, some teachers were not confi-

dent or interested in integrating multiple subjects. A possibility of collaboration among teachers with different subject backgrounds for conceptualisation and implementation of projects was also overruled in most of the school systems.

Teachers noted that the time table does not accommodate projects. However, in FGD, teachers suggested that the time allotted for social service and personality development could be diverted to conduct projects. A proposal of changing the class duration to one hour by a teacher was opposed by other teachers citing the psychological burden on the child.

Teachers in the study, similar to other teachers, stated that group work was not practical among students as students lack such skills (Achilles & Hoover, 1996) and that students often got engaged in non-academic conflicts (Scott, 1994). Teachers cited diversity of students as an obstacle for engaging students' in group work. Interestingly, group work was proposed to address the pedagogic challenges arising due to diversity (Waks, 1997).

Teachers' opined that students' self and peer assessment (NCERT, 2005) is both impractical and unreliable. These views are contradictory to the findings reported in the studies conducted in Indian context (Khunyakari et al., 2007; S. Mehrotra et al., 2009) as well as the development of PBL units presented in Chapter 5. They also disapproved of sharing the assessment scheme with students. Thus, an established knowledge among educational researchers regarding assessment was not yet a part of the teachers' understanding (Grant, 2011). Teachers also asserted that only high performer students do better in projects, a claim that is contradictory to existing research literature (Barron et al., 1998).

Evolution of teachers' ideas on PBL and acceptance to PBL

While engaging in the TPD workshops, teachers discovered the thematic nature of the curriculum, appreciated the aspects of subject integration and included this in their project plan. Teachers could integrate the element of centrality in their PBL units by including diverse topics and themes from the syllabus and planning activities in alignment to the topics and themes. The concepts and skills planned for the projects also became more relevant for students and aligned with the topic and theme of the project and the assessment scheme. Teachers also came up with diverse assessment criteria. They prepared several analytical assessment rubrics for diverse student productions even with detailed descriptors.

All the groups made improvements in drafting problem context and driving questions with the help of researcher, at the end of the first workshop. Teachers' included aspects of realism and focused on teachers' role in planning and conducting projects in school and classroom. Teachers tried out PBL projects in their school. Some of the teachers continued their existing project practices and did not find much challenges in implementation. However, two teachers who changed their existing practices did face challenges, especially in the context of classroom management. Both of them experienced that students' learned a lot through doing projects. Interestingly, one of

them refused to conduct such projects again while the other was looking for pedagogic solutions to address her challenges.

Overall, teachers' acceptance to implement the proposed PBL was mixed. Only in one school system, it was observed that the teacher implemented the projects almost on the line of PBL. However, teachers in other school systems were not very confident of implementing the PBL as it was expected to be implemented.

Teachers' dominant teaching style often does not allow students to perform well in the allocated projects and this might have led teachers to conclude that students do not learn from projects. It was observed for one of the teachers, she assigned projects to students but continued dictating the process. As a result, the project was abandoned midway. The culture of performativity also hinders progress in PBL. Too much focus on working and functional models takes away projects' focus on the productions. Moreover, in such environment, only a limited kinds of projects are valued. Thus, the significance of rich PBL context is lost and the projects are limited only to a handful of performing students.

Factors contributing to planning and carrying out PBL projects

To appreciate projects, it is important that one understands the content, concepts, and skills involved. For PBL, it is important to plan meticulously and facilitate students' learning by organising the learning environment. However, the teacher participants of the current study assumed that students were capable of carrying out projects independently and learning from it, similar to the students learning in the Typhoid project(Collings, 1929).

PBL and other similar pedagogies start with a problem statement and driving questions. Teachers had difficulties framing driving questions and also struggled to decide the nature of such questions. There are different types of open ended questions that can be investigated but teachers showed personal preference to certain kinds of projects. Such choices would certainly limit the exposure to students in the classroom. Teachers' dilemma of presenting content and concepts with a position "concrete" before "abstract" or "simple" before "complex" was another factor that created issues for problem context and posing driving questions to students. Some of the teachers expressed their discomfort when the answer of the question was not known to them as they perceived it as a challenge to their own position in the classroom. How teachers anticipate students' answers also depends on teachers' own content knowledge as well as their understanding of the subjects. Equally important is teachers' own perspective towards how learning takes place and this shapes teachers' preparations for the projects.

For making a meaningful PBL project, it is important to set the learning objective (LOs) clearly, design activities in alignment to the LOs, choose students' productions that would maximise learning, and prepare assessment criteria in alignment to both the productions and LOs. In the current study, teachers faced challenges in all these aspects while developing PBL units. Teachers also faced conflict between covering breadth and

dealing in depth for the project. Teachers' expressed a great deal of students' learning, however, assessment is the most loosely connected aspect in the projects. There was also incomplete understanding about formative assessment.

The study indicated that there is scope to include authentic aspects in teachers' current project practices. However, such opportunities were not explored well. One of the major elements of authenticity in PBL is that projects deal with real world problems and such problems are always interdisciplinary in nature. However, most of the schools maintain a disciplinary divide and have failed in making efforts to bring teachers together and allow collaborations. It was also observed in the current study that as textbooks were the main source of knowledge used in classrooms, the authority of textbooks (of certain kind) dominated in all the schools. Teaching learning materials of Digantar, Eklavya, and Pratham Science and Mathematics Curriclum of HBCSE, resources of NCERT, are not used in the classroom to engage students in real world projects and activities.

8.2 Journey of TPD: A critical reflection

The TPD model in the current study has been guided by aspects that are discussed in detail in chapter 6 (section 6.11). These aspects emphasise that TPD should be situated in deliberations with teachers, principals, teacher educators and policy makers. These deliberations would importantly give voice to teachers and other stakeholders. The TPD should be guided by social-constructivism and critical pedagogy that would allow co-construction of meaning by teachers and teacher educators. The resources that teachers bring in the TPD engagement are valued in this model. The content and process of the TPD need to be situated in diverse activities and concrete productions related to classroom teaching. The engagement should have both formative and authentic assessment so that teacher educators receive feedback on their interventions. All these aspects together constitute a model of TPD engagement to deal with educational initiatives.

Interestingly, reform in education has been introduced often in the form of new initiatives without a clear understanding of why the earlier initiatives did not work (Tyack & Cuban, 2003). The current study began with an engagement with policy context and deliberations among teachers and educational researchers. A model of PBL was conceptualised and a collaborative development of PBL units was initiated through a series of three workshops with teacher participants.

In order to make projects more central to the teaching-learning, as envisaged in NCF 2005 and NEP 2020, as well as to address some of the challenges that teachers face in conducting projects, a deliberative curriculum approach (Null, 2011), similar to that suggested by Marx and his colleagues (Marx et al., 1997), had been adopted in this study. Positioning researcher and teachers as co-constructors of knowledge was an important aspect of the TPD model in the current study which mutually benefited both the stakeholders. PBL naturally brings multiple subjects and disciplines together in a real world problem context. In PBL, students work in groups (Marx et al., 1997;

Krajcik et al., 1994; Tamim & Grant, 2013), and prepare multiple products that can be assessed by formative and summative assessment, including peer and self assessment (Barron et al., 1998; Barron, 2000).

Unfortunately, the official circulars shared to educational functionaries and to schools ask for prescriptive actions and do not allow deliberations among teachers and also different stakeholders. Often the implementation of TPDs is done through a cascade model and the teachers who will implement the innovations in the classrooms are not integral to the conceptualisation process. Additionally, the master trainers at various levels often do not get adequate time to connect new demands with old legacy. Thus, it often ends up in a dis-empowered situation. Since education is a social good and necessary for economic expansion (Kaul, 1998), there is a pressing need to "reorient the debate around education in the direction of democratic transformation so as to make it more people-focused" [p. 173, (Kaul, 1998)]

8.3 Implications of the study

Based on the TPD workshop series a *Guidebook on PBL* was edited and compiled. This was used in two other short one-time workshops on PBL for teachers. The handouts, worksheets, and presentations used in the TPD on PBL were also adapted and used in these workshops. Based on these experiences, an assessment tool has been generated and piloted for use in evaluating projects conducted by students across the nation, leading up to the annual Children's Science Congress.

The development of the TPD for planning PBL collaboratively among teachers and resource persons has implications for developing similar models of TPD focusing on other teacher and policy needs. The TPD model not only engages participants in activities relevant to practice, it also provides opportunities for dialogue, discussions and reflection about their current and proposed practices among participants. Thus it has the potential to have an impact on their classroom practices. The hand-on process of developing analytical rubrics is equally important to empower teachers with respect to assessment. The presence of actual products (as was the case in the current study) is important and essential for the same rather than conducting just theoretical deliberations. Such a process helps in understanding the nuances of the assessment process as in pedagogies like PBL.

Generally, the wide gap seen between policy and its implementation arises from mediating documents, like circulars to schools from education boards. They either use the terms defined in the new policy document incorrectly, or misinterpret them. In so doing, they tend to nullify the effects of the reform. On the other hand, teachers, struggling to cope with new policies, while working in incommensurate school environments, appropriate the new policies in terms of their old practices. The interactions with participants in the TPD workshop series showed that whenever there is a shift in the educational policy, it is essential to redefine and articulate the terms used in the new policy documents as part of the discourse within teacher education.

8.4 Limitations of the study

Teachers need support to successfully overcome the challenges of following PBL pedagogy in Indian schools. The TPD model can become more effective in changing teachers' practices only through a longer term sustained engagement with the participants, beyond the workshops. Besides, interventions are also necessary in the school education system. In fact, even the NCF 2005 had recognized a need for systemic change in order for practices to align with its recommendations.

The study could not focus on looking at actual classroom practices of projects in depth for logistic reasons. It might have revealed finer and authentic details of the aspects that were addressed through the TPD on PBL. Implementing a new pedagogy, such as PBL, is not simply a matter of the teacher learning new skills or procedures. The success of implementation of PBL needs a wider discourse on the goals of education and how they are to be achieved. This was too broad a canvas for the current study.

8.5 Reflections on self evolution

This study is a social co-construction of meaning for me as a researcher and as a person. I now understand project-based learning better than when I began. In the process of deliberations with teachers and students, I too evolved my understanding of education. The vibrant discussion with the supervisors, collaborators, colleagues, and even seemingly outsiders' views stimulated me to reflect on my work and my theoretical position and dispositions.

The vast literature that exists on research in PBL, TPD, pedagogy and assessment, and curriculum material helped refine my ideas on PBL. When I started the research project, I started with the naïve idea of conducting projects as part of science exhibitions or Science Congress projects and making it participatory for all students. During my work, I came across the struggles of implementing PBL as a curriculum in different countries at different points of time. The project method gained momentum in the USA and Europe after the Second World War; however, Russia discouraged the use of projects in curriculum to focus on prescriptive textbooks. Gandhi's commitment to Nai Talim was reduced to mere Socially Useful and Productive Work (SUPW) and never received a legitimate space in regular public schools. Curriculum intervention is a political affair and needs public scrutiny and deliberations.

I have worked with teachers in Uttarakhand and Chhattisgarh, and also with over a hundred teacher educators who work with teachers to improve the state of school education. I have observed a great deal of zeal and enthusiasm present in both teachers and teacher educators. However, a perspective on the curriculum and engaging with content specific pedagogic discourse is missing. Therefore, the pedagogic issues are dealt as managerial aspects and handled superficially due to lack of broader understanding of philosophical and psychological principles driving a particular pedagogy. There is in general a limited understanding of subject integration, assessment, group

work, school timetabling, and resource management issues in both these groups. In my opinion, delineating learning outcomes and aligning learning outcomes with assessment and tasks are other prevalent areas to focus on. In my research journey I found myself more empowered to deal with the teaching-learning realities in such complex situations.

Working as a school head for the last four years, I have found that it is possible to implement at least some parts of PBL in a regular school setting without disturbing the school's academic structure and curriculum. There is a need to establish a coherence in subject domains, mapping the contents, developing a consensus among teachers on learning outcomes, explicit articulation of assessment and learning tasks, and providing flexible time-table for teachers to transact the lessons in classrooms. Implementation of PBL requires constant whole school support. It is interesting to note that teachers' personal attributes and dispositions contribute a lot to how PBL is conceptualised and implemented in the classroom. Over time, I have realized that there is a potential and possibility of making change within and in the system. And this conviction has only strengthened as I got engaged in teaching and school operation as mentioned above.

I am optimistic that the desired virtues could be established in society as a rational need and requirement of a democractic egalitarian society for the wellbeing of all. Borrowing ideas from John Dewey (Dewey, 1966, 1915, 1997), Paulo Freire (Freire, 2000, 1972), M K Gandhi (Gandhi, 2009), Rabindranath Tagore (Bhattacharya, 2013) I am arguing that it is important to work towards preparing citizens for democratic polity that would be committed to egalitarian ethos while reconciling the idea of nation.

Appendix A: Teacher Questionnaire

Homi Bhabha Centre for Science Education
Tata Institute of Fundamental Research
V. N. Purav Marg, Mankhurd, Mumbai 400088

Teacher Questionnaire

Homi Bhabha Centre for Science Education (TIFR) carries out research and development in science, technology and mathematics education. A study has been initiated on Project Based Learning (PBL) at the middle school level. This will be carried out in collaboration with teachers through a series of workshops. As a part of this study, we are conducting a survey of teachers' ideas about projects. Moreover, we want to know about your ideas, expectations from this workshop. Your response to the questionnaire will help us develop methods to improve the teaching learning process.

This questionnaire has the following kinds of questions:

1. Personal details: Your name will be deleted from the sheet and your identity will be kept confidential.
2. Questions on your ideas about project.

The questions have no 'right' or 'wrong' answers. Please feel free to make your own choices. All responses are valuable.

Thank you.

Saurav Shome
Research Scholar

Full name in capital letters: _____

Name of school: _____

Form A – Personal Data

1. Sex (Circle one): Female / Male / 3

2. Your age in completed years {Tick () the appropriate box}:
   20 – 25 25 – 30 30 – 35 35 – 40

   40 – 45 45 – 50 50 – 55 55 – 60

3. Your academic qualifications: Tick () all the applicable ones and fill main subjects.

Qualification	**Tick**	**Subjects**
Higher Secondary		
Bachelor Degree		
Masters Degree		
Others (Specify)		
Educational degree (BEd, etc.)		

4. Subjects you are currently teaching in the school: **(Circle all applicable)**
   Env. Studies Marathi English Science Mathematics
   History/ Civics Hindi Geography Economics

5. In the school you are now teaching in standard (s): **(Circle all applicable)**
   V VI VII VIII IX X XI XII

6. How many students do you have in each Classroom? **(Circle approximate number)**
   20 30 35 40 45 50 60 65 Other _____

7. Medium of instruction (if more than one, please indicate): English/ Hindi/Marathi/
   Any other (specify)_____

8. Your teaching experience in school **(total years)**: _____

Form B – Projects and You

1. What ideas, words or phrases come to your mind when you think of a **Project**? Write them on the lines given below around the word Project.

2. Do you think projects should be a part of school curriculum? (Circle one) **Yes / No**

   Why do you think so?

   ---

3. Have you conducted projects ? (Circle one) **Yes / No**

4. Do you plan to conduct projects in the future? (Circle one) **Yes / No**
   Please write below, in brief, your reasons for conducting or not conducting projects.

Form C – Your choice...

Some statements about projects are given below. Please indicate whether you "Agree", are "Unsure" or "Disagree" with each statement by a tick () under the suitable column.

Sr. No.	Statement	Agree	Unsure	Disagree
1	Projects take up too much time.			
2	Students enjoy doing projects.			
3	School administration supports projects.			
4	Projects help students learn textbook content.			
5	Projects reduce time available to teach textbook content.			
6	Conducting projects requires funds for resources.			
7	Doing projects improves students' performance in all subjects.			
8	Parents feel that doing projects is a waste of students' time.			
9	Teachers lack guidance materials, like instruction manual, to conduct projects.			
10	Projects are only suitable for small class sizes of 25 students or less.			
11	Students scoring high in examinations do projects well.			
12	Projects need an equipped school laboratory.			
13	Project is an extra burden on students.			
14	Only some teachers can conduct projects.			
15	Projects enrich students' understanding of textbook content.			
16	A project should preferably include a working model.			
17	Projects can be used to teach all topics in the textbook.			
18	Projects are suitable for all students.			
19	It is not possible to assess students' understanding of concepts through projects.			
20	Projects help students to better prepare for examinations.			
21	Project is a burden on teachers.			
22	Students do not learn much from projects.			
23	Students conduct projects without adult help.			
24	Projects can only be done in science.			

Form D – About projects conducted

(This Form is applicable to those teachers who have conducted projects. If you have never conducted a project, please proceed to the next Form)

Please fill the project details of at least two recent projects:

Project - 1

Project title	
Subjects covered	
Topics covered	
Learning goal(s)	
Duration (days / weeks / months)	
Group (give size) or Individual student	
Teacher's role	
Student tasks	
Assessment Scheme	
List the positive outcomes of the projects	
State briefly whether the results matched your expectations	
Difficulties faced	

Form D (contd)

(Applicable to those teachers who have conducted projects.)

Project – 2

Project title	
Subjects covered	
Topics covered	
Learning goal(s)	
Duration (days / weeks / months)	
Group (give size) or Individual student	
Teacher's role	
Student tasks	
Assessment Scheme	
List the positive outcomes of the projects	
State briefly whether the results matched your expectations	
Difficulties faced	

Form E – About project planned

(This Form is for teachers who *plan to conduct a project*. It does not matter whether you have conducted projects before or not. If you do not plan to conduct a project, please proceed to the next Form)

Please fill the details of the project:

Reasons for planning project	
Project title	
Subjects to be covered	
Topics to be covered	
Learning goal(s)	
Duration (days / weeks / months)	
Group (give size) or Individual student	
Teacher's role	
Student tasks	
Assessment Scheme	

Form F – Complete the statement, "A Project ..."

In the space provided below, complete the statement, "A project..." in 5 different ways:

1. A project _____

   _____

   _____

2. A project _____

   _____

   _____

3. A project _____

   _____

   _____

4. A project _____

   _____

   _____

5. A project _____

   _____

   _____

6. Additional remarks (if any):

Form G – Your ideas about the Workshop Series

1. What do you expect to gain from the workshop series?

   ---

2. What do you think will be your role in the Workshop Series?

   ---

3. What do you expect from the organizers of the Workshop Series?

   ---

4. Please complete the following statement in at least two different ways.
   I am participating in the workshop because...

   (a) ---

   (b) ---

   (c) ---

Appendix B: Self information sheet

HOMI BHABHA CENTRE FOR SCIENCE EDUCATION
V. N. Purav Marg, Mankhurd, Mumbai 400 088

About Yourself

Your Name:

Class: VI Section: Date of Birth:

School:

Male / Female / Other (Circle one)

Nature of Father's work:

Nature of Mother's work:

Your favourite subject:

Write a few good things about yourself:

What do you like to do when you are not studying? What are your hobbies?

On which topic(s) would you like to do a project?

Do you like making things? If yes, what kinds of things do you like to make?

Have you heard the word "design"? Write what it means to you.

Appendix C: Sample Write Up

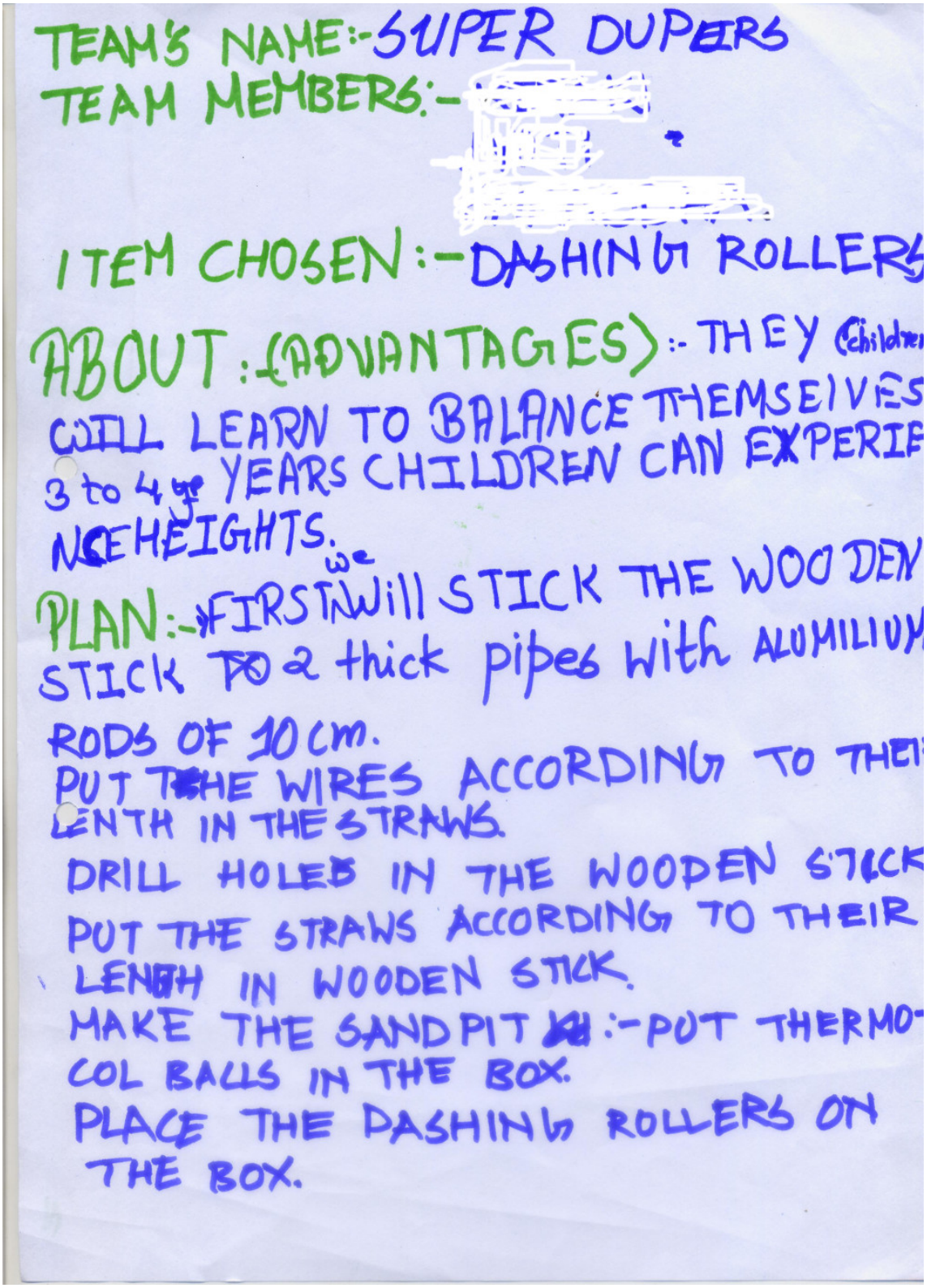
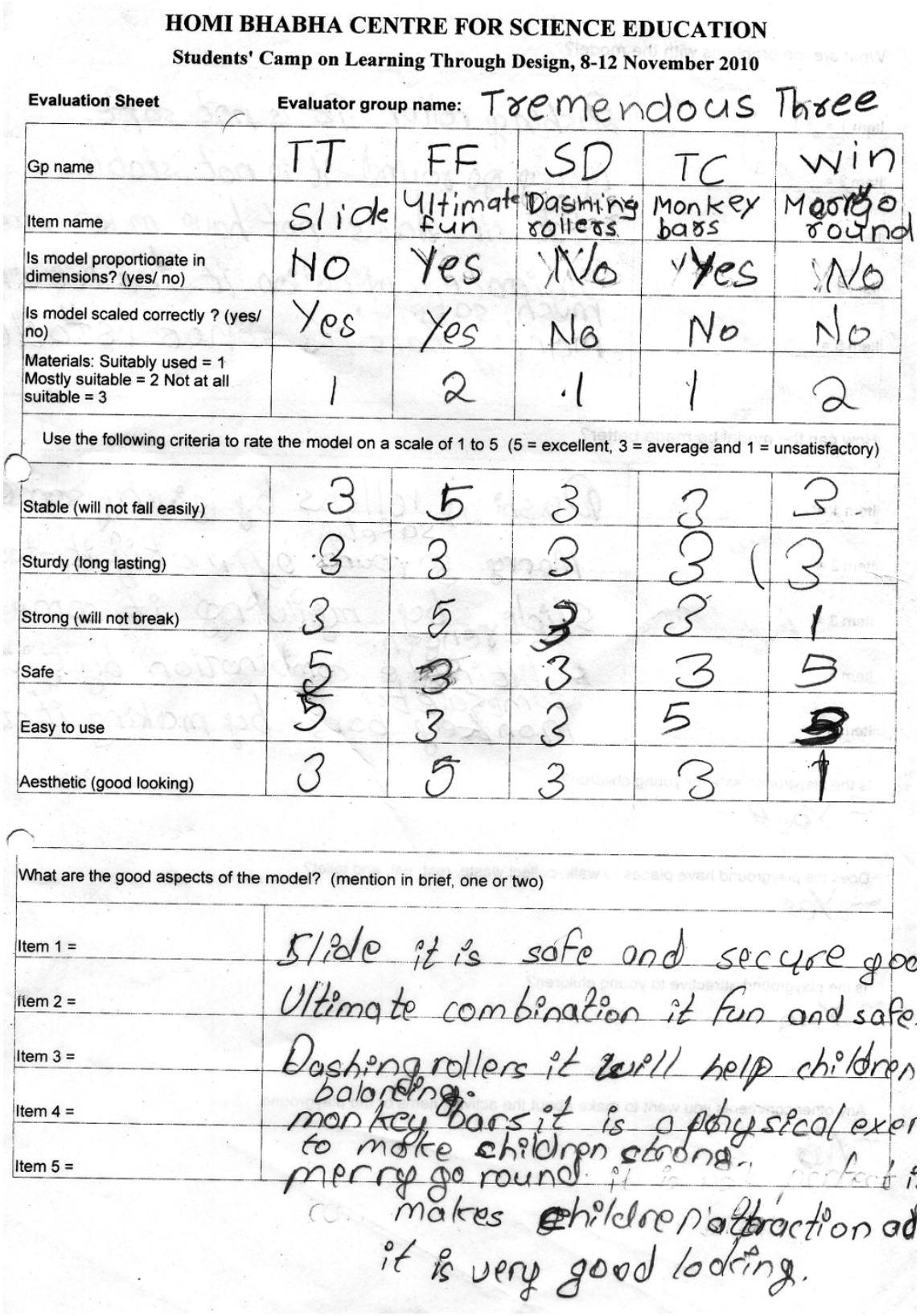


Figure C.1: Write up on play item model by Group Super Duper

Appendix D: Sample filled assessment sheet



HOMI BHABHA CENTRE FOR SCIENCE EDUCATION

Students' Camp on Learning Through Design, 8-12 November 2010

Evaluation Sheet **Evaluator group name:** Tremendous Three

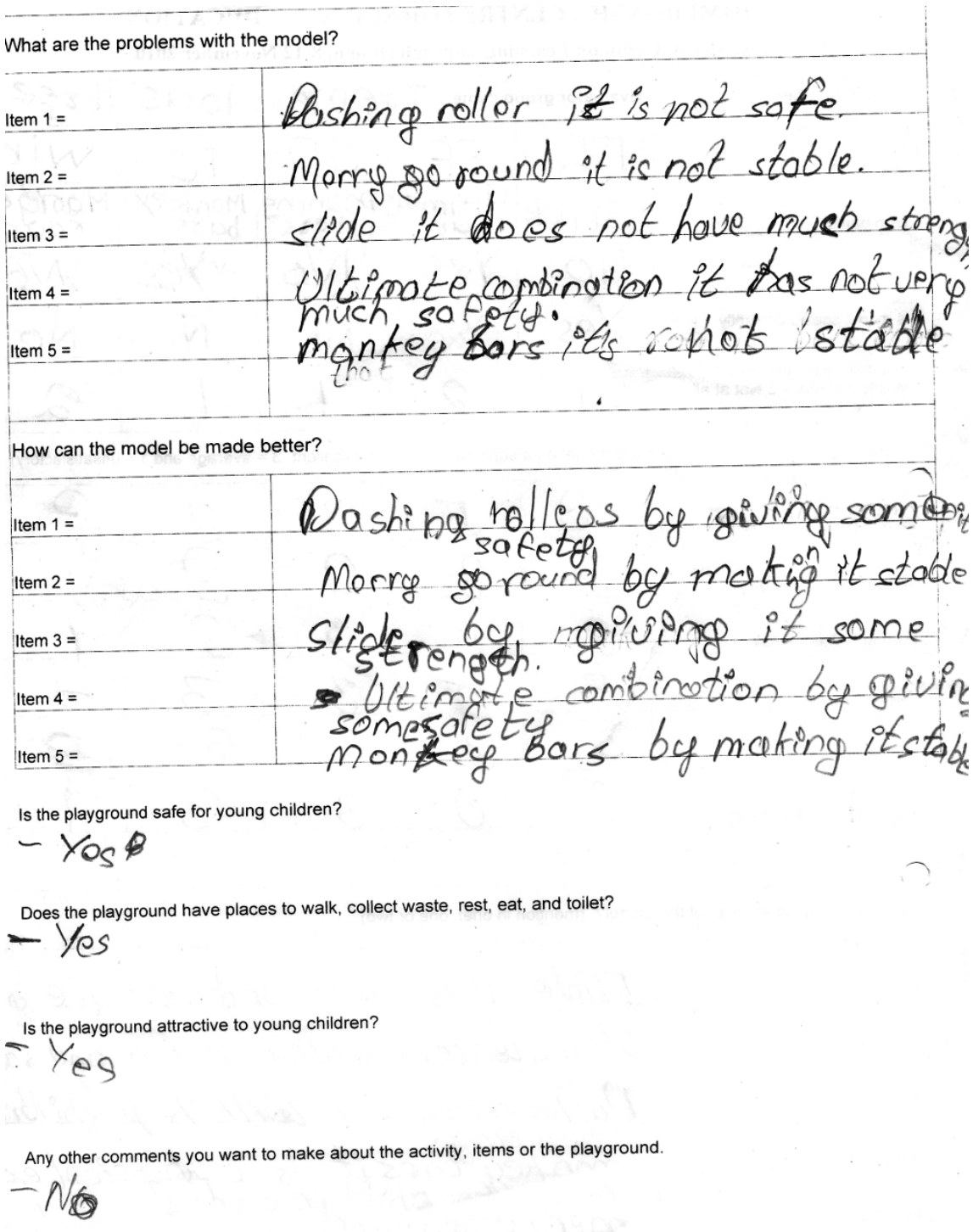
Gp name	TT	FF	SD	TC	win
Item name	Slide	Ultimate fun	Dashing rollers	Monkey bars	Merry go round
Is model proportionate in dimensions? (yes/ no)	No	Yes	No	Yes	No
Is model scaled correctly ? (yes/ no)	Yes	Yes	No	No	No
Materials: Suitably used = 1 Mostly suitable = 2 Not at all suitable = 3	1	2	1	1	2

Use the following criteria to rate the model on a scale of 1 to 5 (5 = excellent, 3 = average and 1 = unsatisfactory)

Stable (will not fall easily)	3	5	3	3	3
Sturdy (long lasting)	3	3	3	3	3
Strong (will not break)	3	5	3	3	1
Safe	5	3	3	3	5
Easy to use	5	3	3	5	3
Aesthetic (good looking)	3	5	3	3	1

What are the good aspects of the model? (mention in brief, one or two)	
Item 1 =	Slide it is safe and secure goo
Item 2 =	Ultimate combination it fun and safe.
Item 3 =	Dashing rollers it will help children balancing.
Item 4 =	monkey bars it is a physical exer to make children strong.
Item 5 =	merry go round makes children's attraction ad it is very good looking.

Figure D.1: Filled assessment sheet prepared by Tremdous Three - Page 1



What are the problems with the model?

Item 1 =	Washing roller it is not safe.
Item 2 =	Marry go round it is not stable.
Item 3 =	slide it does not have much streng
Item 4 =	Ultimate combination it has not very much safety.
Item 5 =	monkey bars its not stable

How can the model be made better?

Item 1 =	Washing rolleos by giving some safety
Item 2 =	Marry go round by making it stable
Item 3 =	Slide by giving it some strength.
Item 4 =	Ultimate combination by giving some safety
Item 5 =	Monkey bars by making it stable

Is the playground safe for young children?

– Yes

Does the playground have places to walk, collect waste, rest, eat, and toilet?

– Yes

Is the playground attractive to young children?

– Yes

Any other comments you want to make about the activity, items or the playground.

– No

Figure D.2: Filled assessment sheet prepared by Tremdous Three - Page 2

Appendix E: Announcement Brochure

Workshop Series

on

Project Based Learning

for Middle School Teachers of

Science, Mathematics, Social Studies and Language

between

July and December 2010

The highest education is that which does not merely give us information but makes our life in harmony with all existence. *Rabindranath Tagore*

Conducted by

Homi Bhabha Centre for Science Education

Mumbai

Who Can Participate?

Teachers of Science, Mathematics, Social Studies (History, Geography and / or Civics) and Language at the Class 6, 7 or 8 levels.

All those who enroll are expected to participate in all the workshops. On successful completion of all the workshops in the series, each participating teacher and school will receive a certificate of participation in PBL development and implementation.

How can you apply?

Fill the application form supplied with this brochure and send it to the address mentioned on the form.
Alternatively you may access the form from a link to the **PBL Workshop Series** on the website: www.hbcse.tifr.res.in/events/PBLworkshopseries
The filled forms may either be sent by normal mail to the mailing address given below, or sent as an attachment to the e-mail addresses below.

There are no fees for participating in the workshops. All materials needed, lunch at subsidised cost, and a token honorarium, will be provided to all participants for the days they attend. Light refreshments will be provided free by the organisers.

Venue and Contact

Saurav Shome
Homi Bhabha Centre for Science Education
V.N.Purav Road, Mankhurd, Mumbai 400 088

Ph: (O) 25072220 **Mobile:** 9969872306
Fax: 25566803
E-mail: saurav@hbcse.tifr.res.in; chitran@hbcse.tifr.res.in

Figure E.1: Announcement Brochure for the workshop series. Page 1

Today's students need to become critically aware citizens of a democratic nation and a globalized world. Hence, students need to be exposed to problem solving in school as well as in their local and larger communities. Besides, the widening access to information implies that teachers and students need to be equipped with the ability to select knowledge and skills for use in solving problems.

Educators around the world perceive that **Project Based Learning** (**PBL**) addresses issues that traditional classroom learning does not. Several benefits of PBL have been reported in research literature.

Project Based Learning

- Offers real world contexts and opportunities for learning
- Fosters self esteem and motivation among participants
- Helps develop critical thinking and communication skills
- Enhances problem identification and solving abilities
- Helps develop social skills: teamwork, leadership, civic responsibility
- Allows multiple modes of continuous assessment and feedback
- Leads to improvements in classroom and school climate

Major hurdles for implementing PBL in Indian schools include large class size, lack of teaching-learning resources, reluctance to embrace new approaches, and inflexible schedules. An important hurdle is lack of guidance to teachers in conducting PBL. According to research, empowered teachers and willing school systems are better able to implement PBL and reap its benefits.

Collaboration between teachers within and across schools and with school administration, parents and research institutions can help in implementing PBL. **We hope to achieve this through a series of workshops to be conducted by the Homi Bhabha Centre for Science Education, TIFR, Mumbai, between July and December 2010.**

The workshops aim to empower teachers with the knowledge, skills and tools to implement Project Based Learning effectively in their schools. We hope that a few motivated schools and teachers will volunteer to implement PBL at the level of Class 6, 7 or 8. It is hoped that the workshop will be beneficial to all participating schools and teachers.

Benefits from the Workshop Series

- Introduction to desirable PBL practices and strategies
- Information on research literature and resources related to PBL
- Collaborative environment to develop PBL projects, implementation strategies and assessment rubrics
- Peer group of motivated teachers and researchers
- Forum for discussion of PBL challenges and evolution of solutions
- Network with researcher practitioners to help generate research papers

One of the outcomes of the workshop series will be a PBL Guidebook for teachers including a bank of PBL modules including assessment tools. A copy of this will be made available free to all participating schools.

Structure of the Workshop Series

- 3 to 4 workshops will be held between July and December, 2010.
- The first 4-day workshop will introduce participants to PBL and initiate projects and implementation strategies.
- Subsequent workshops of shorter duration will discuss progression of PBL implementation and refine the strategies, assessment and evaluation tools.
- The last workshop will consolidate the evaluation and findings.
- **The first Workshop in the series will be held from Wednesday, July 7 to Saturday, July 10, 2010.**
- **Timings of the workshops will normally be from 9.30 am to 5.30 pm.**

Figure E.2: Announcement Brochure for the workshop series. Page 2

Appendix F: Schedule of the workshop

F.0.1 Schedule of workshop shared along with the first announcement

Project Based Learning Workshop Series
Schedule of Workshops - July to December 2010

Workshop 1
Development of PBL projects and implementation strategy

7 July 2010

09:30 to 10:00	Registration and introduction
10.00 to 11.00	Activity 1: Do Projects help Learning?
11.30 to 13.00	Lead Talk 1: What is PBL? Action plan for Workshop Series
14.30 to 16.00	Activity 2: Salient findings from (given) PBL Research Literature
16.30 to 17.30	Participant Presentation: Gains and Challenges of PBL

8 July 2010

10.00 to 11.00	Participants input: Projects and textbook content
11.30 to 13.00	Lead Talk 2: Problems & Projects – importance and suitability criteria
14.30 to 16.00	Activity 3: Developing problems and projects to address textbook content
16.30 to 17.30	Participant Presentation: Some PBL Projects and their Learning Objectives

9 July 2010

10.00 to 11.30	Lead Talk 3: Assessment issues in PBL
12.00 to 13.00	Activity 4: Developing student learning assessment tools
14.30 to 15.30	Activity 5: Integrating assessment in PBL
16.30 to 17.30	Participant Presentation: Choice of Project and Plan of Action (PoA)

10 July 2010

10.00 to 11.00	Participants input: PBL implementation issues
11.30 to 13.00	Lead Talk 4: Facilitating PBL implementation
14.30 to 16.00	Participant Presentation: PBL PoA and Milestones
16:30 to 17:30	Summary

Workshop 2
Progression of Students and Teachers in PBL (September)

Day 1

10.00 to 11.00	Participants input: Students' Ideas about Projects – effect of PBL
11.30 to 13.00	Lead Talk 5: Challenges of integrating subjects through PBL
14.30 to 16.00	Activity 6: Analysis of student productions
16.30 to 17.30	Activity 7: Completing the assessment rubric

Day 2

10.00 to 11.00	Participants input: Reworking and detailing PoA
11.30 to 13.00	Lead Talk 6: Facing the PBL implementation challenge
14.30 to 16.00	Activity 8: Developing criteria to evaluate PBL effectiveness
16.30 to 17.30	Participant Presentation: Evaluating PBL

Workshop 3
Results and Evaluation (December)

Day 1

10.00 to 11.00	Lead Talk 7: Students' Ideas about Projects and Learning
11.30 to 13.00	Lead Talk 8: Role of PBL in Indian schools
14.30 to 17.30	Activity 9: What our students learned through PBL – Analysis of PBL productions

Day 2

10.00 to 11.00	Participant Presentation: What our students learned through PBL?
11.30 to 13.00	Lead Talk 9: Exemplar PBL modules
14.30 to 16.00	Activity 10: Development of learning objectives, assessment for exemplars
16.30 to 17.30	Participant Presentation: Effectiveness of PBL

Day 3

10.00 to 11.30	The Way Forward
12.00 to 13.00	Feedback
14.30 to 17.30	Enrichment Session (e.g. Paper folding)

Teachers' seminar on PBL

A one day Teachers' seminar on PBL, where teachers who participated in the Workshop Series will present their experience to educationists and teachers from other Mumbai schools.

Note: The schedule of talks and activities may change to meet participants' needs.

F.0.2 Schedule of workshop shared along with the second announcement

Project Based Learning Workshop Series
Second Workshop: Developing Projects for PBL
Schedule: 22 & 23 October 2010

Friday 22 October 2010
09.00 – 09.30: Registration
09.30 – 10.00: Introduction
10.00 – 11.00: Group work – 1 Deciding Learning Goals and Developing Projects
11.00 – 11.30: Tea
11.30 – 13.00: Group work – 2 Selecting and exploring Projects
13.00 – 14.00: Lunch
14.00 – 15.30: Group work – 3 Parallel discussion sessions (3) on issues related to (a) Assessment, (b) Project management (class, time, resources) and (c) Subject integration
15.30 – 16.00: Tea
16.00 – 17.00: Group work – 4 Using expert learning to structure the projects

Saturday 23 October 2010
09.30 – 10.00: Discussions and feedback
10.00 – 12.30: Group work – 5 ...going beyond Group work – 2 Redesigning project structure
(11.00 – 11.30: Tea)
12.30 – 13.00: Summary/ Clarifications
13.00 – 14.00: Lunch 14.00 – 16.00: Project presentations and discussions (15.00 – 15.30: Tea)
16.00 – 17.00: Closing and Summary

F.0.3 Schedule of workshop shared along with the third announcement

Schedule:

Project Based Learning Workshop Series
Third Workshop: Consolidation of PBL and Assessment
Schedule: 9 to 11 December 2010

Thursday 9 December 2010
10.00 to 11.00 – Students' Ideas about Projects and Learning : Report + Discussion
11.30 to 12.00 – PBL: A short trial
12.00 to 13.00 – Teachers' activity – Assessment of learning - Rubric based on student portfolios
14.30 to 15.30 – Teachers' activity – Rubric... continued
16.00 to 17.30 – Teacher presentations: Assessing portfolios for students' learning

Friday 10 December 2010
10.00 to 11.00 – Discussion: Critique of Trial PBL
11.30 to 13.00 – Teacher presentations: Experiences of PBL development and implementation
14.30 to 16.30 – Teacher activity: Play on PBL implementation – preparation
16.30 to 17.30 – BASE Workshop on PBL: Planning, scheduling

Saturday 11 December 2010
10.00 to 11.30 – Teacher activity: Play on PBL implementation – Rehearsals
12.00 to 13.00 – Play followed by discussion with audience
14.30 to 16.30 – Certificates to participants, Feedback and future directions...

Appendix G: Research paper summary: Guiding questions

Use the following questions to focus your discussion on important issues relevant to the Workshop series.

For Krajcik et al, 1994

1. List the reasons stated by authors for the failure of earlier innovations in teaching, such as "hands-on" and "discovery learning" approaches.
2. What do authors suggest for empowering teachers to respond to difficulties or challenges in implementing project-based instruction?
3. List the goals of a collaborative research project.
4. List 3 ideas that you feel are central to this research paper. Briefly explain why you think so.
5. List all the words that you found difficult to understand in this research paper.
6. Carefully study the format of each reference in the last section on References . In the space below, write the reference of the paper you have read following the same format.

For all other papers

1. What factors, according to you, motivated the author(s) to engage with Project Based learning?
2. Do you, as teachers today, relate to any of these factors, or can you suggest some other factors?
3. Turning young minds towards any new activity as Project Based Science would always be a challenge. How did the author(s) deal with this?
4. What were the various topics covered in the 2 units: "What's in our water?" and "Acid Rain"?

5. How did the author handle the issue of time-management? Would you like to suggest any alternate ways to deal with such issues?
6. How was the success of Project Based Learning gauged by the author?
7. Based on the experience of the author, how can one compare Project Based Learning and Traditional Science Instructions?
8. List 3 ideas that you feel are central to this research paper. Briefly explain why you think so.
9. List all the words that you found difficult to understand in this research paper.
10. Carefully study the format of each reference in the last section on References . In the space below, write the reference of the paper you have read following the same format.

The complete references of the papers with page numbers is given below:

1. Krajcik, J. S., Blumenfeld, P. C., Marx, R. W., & Soloway, E. (1994). A collaborative model for helping middle grade science teachers learn project-based instruction. The Elementary School Journal, 94(5), 483 - 497. Total 13 pages without references.
2. Krajcik, J., Blumenfeld, P. C., Marx, R. W., Bass, K. M., Fredricks, J., & Soloway, E. (1998). Inquiry in project-based science classrooms: initial attempts by middle school students. The Journal of the Learning Sciences, 7(3,4), 313 - 350. Total 36 pages without references.
3. Marx, R. W., Blumenfeld, P. C., Krajcik, J. S., & Soloway, E. (1997). Enacting project-based science. The Elementary School Journal, 97(4), 341 - 358. Total 15 pages without references.
4. Meyer, D. K., Turner, J. C., & Spencer, C. A. (1997). Challenge in a mathematics classroom: Students' motivation and strategies in project-based learning. The Elementary School Journal, 501 - 521. Total 18 pages without references.
5. Scott, C. A. (1994). Project-based science: reflections of a middle school teacher. The Elementary School Journal, 95(1), 75 - 94. Total 19 pages without references.
6. Ladewski, B. G., Krajcik, J. S., & Harvey, C. L. (1994). A middle grade science teacher's emerging understanding of project-based instruction. The Elementary School Journal, 94(5), 499 - 515. Total 14 pages without references.

There were eight published papers on PBL and three papers on assessment in the docket. The papers could be categorised under the following heads:

1. Review: An article that discussed the characteristics of PBL and reviewed the theoretical underpinnings of PBL, practices of PBL, its advantages and its challenges.

2. Implementation: Articles that cited examples of teachers' practices, either written by a teacher or by researchers, so that teachers could identify with content and pedagogies associated with PBL.
3. Transformation: Article citing situations where a traditional project was converted into a PBL by making specific changes to give teachers an idea of how such transformations can be made by them.
4. Understanding assessment: Articles providing general idea of assessment, role of assessment in learning, and idea of formative assessment.

The papers on assessment are listed below:

1. Black, P., & Wiliam, D. (1998). Inside the black box: Raising standards through classroom assessment. Granada Learning.
2. Assessment Reform Group (2006). The role of teachers in the assessment of learning. Assessment Reform Group.
3. Earl, L. (2003). Assessment as Learning: Using Classroom Assessment to Maximise Student Learning. Thousand Oaks, CA, Corwin Press.

Appendix H: Activity: Is it PBL?

Homi Bhabha Centre for Science Education

First PBL Workshop for Teachers: Activity on "Is this a PBL Projects?"

7 to 10 July 2010

Group – Desire

1. Aswathy teaches science in class VII. Once she finished a chapter on Natural Resources, she asked her students to obtain information about the devices that work on solar energy. She told them to collect information from the school library and submit a report based on their findings. She also arranged a visit to a research centre working on alternative energy use.
2. Jeenath teaches geography in class VIII. Before she starts the lesson on "Land, soil, water, natural vegetation and wildlife resources" she draws students' attention to some newspaper articles which had reported the recent change in land-use pattern in the northern parts of India. She asked her students to analyze and predict the possible consequences of changing land-use pattern in their village, discuss on each Friday. She asked them to submit a written report and present the report to the Block Development Officer and Sarpanch of the village.

Group – Innovation

3. Ruchi teaches science in class VII. Once she finished a chapter on classification of substances she posed a question to her students "Do we need elements in our everyday life?". She asked her students to report their response in the form an oral presentation to the entire class.
4. Deepak teaches mathematics in class VIII. One day he demonstrates a geometrical proof to the students with paper folding activity. The proof is "the sum of the three angles in any triangle is always equal to one eighty degree". He questioned students whether it is possible to provide proof of all the geometrical theorem given in their textbook through the paper folding activity? He asked the students to form groups and report their progress as a whole class discussion. The proofs so developed by students will be published in school magazine and circulated in other schools too.

Group – Gulmohar

5. Aisha teaches geography in class VII. Before she starts a chapter called 'Hydrosphere' she draws the attention of her students to a news article report on oil spill in the Arabian sea. She asked her students to collect information on similar events of oil spills and write a report on it. She invited some experts from nearby research institutes so that students can discuss with them and get to know more about ocean pollution.

6. Anveshna teaches civics in class VIII. Before she starts a lesson on "International co-operation and development" she shows a map of the world depicting the poor and rich countries and their population. She asked why some countries are poor and some rich? They had to propose a solution for reducing the socio-economic gap between the rich and the poor countries. Students were asked to form groups and share their work. They were told to meet regularly and discuss the progress with teachers as well as the whole class. They also had to put across the proposal to the national and world leaders so as to initiate an appropriate action in this regard.

Group – Angan

7. Farhat teaches science in class VIII. Before she starts a chapter on "Coal and petroleum" she asked her students to perform a survey on five families to know whether their energy consumption has increased or decreased over the last five years. She asked her students to represent their data graphically. She also asked them to report their findings and explanations for the increase or decrease in the use of energy.

8. Amit teaches science in class VIII. Before he starts lesson on "Conservation of plants and animals" he took his students to a nearby park. Amit asked the students to list the kinds of animals and plants that the students had observed. Then Amit asked students whether all plants and animals of the park are interdependent? Student groups were formed and each group was asked to report their progress thrice a week.

Group – Umeed

9. Arindam teaches geography in class VIII. Before he starts a chapter on "Resources" he asked his students to observe carefully all around them and list ten human-made resources. He told his students that they need to search on their own and that no instructions will be provided to them beyond this. Finally they have to submit a written report to him on the description of resources they have listed.

10. Shikha teaches science in class VII. At the beginning of her lesson on "Blood circulation" she posed a question to the class, "how does blood flow in our body?" She asked students to form groups and read related material. The students were asked to report twice a week. She also asked them to submit a complete report on the mechanism of blood flow in our body and a working circulatory model.

Group – Raigad

11. Shamin teaches geography in class VII. Before she starts her lesson on "Population" she asked her students to collect data from 100 families in a village and categorise the number of individuals according to age groups. She formed groups of students. Each group was asked to present their findings to their class.

12. Shraddha teaches history in class VIII. She had planned her lesson on "The national uprising of 1857". Incidentally she happened to hear students talk about the newly released film "Mangal Pandey". She took advantage of this opportunity and asked her students the question, "Was the uprising of 1857 a mere sepoy mutiny or awakening of the whole nation?" She asked her students to discuss in groups and arrange weekly meetings with the group members. Students were supposed to present their report to a larger audience. They were further informed that two history professors will evaluate their presentation.

Project approval form

Group Name: _____ Project No. _____

Table H.1: Criteria to be used to approve given projects as PBL.

No.	**Criteria**	**To what extent?**		
1	Centrality	Learning goals include only textbook content and concepts	Learning goals include at least half of the textbook content and concepts	Learning goals include very little of textbook content and concepts
2	Existence of driving question	Exists	Question but not a driving question	Does not exist
3	Opportunities to engage in constructive activity	Very challenging, new knowledge and skills can be constructed	Challenging, new knowledge and skills can be constructed	Not challenging, less opportunity to construct new knowledge and skills
4	Autonomy	Limited instructions given, students work most of the time independently	All instructions are given, students work most of the time independently	All instructions are given, students work under teacher's supervision
5	Realism	Question addresses real world problem, authentic assessment, community connection, presentation to real audience, students contact and communicate with experts or concerned person/(s), visit place of study, etc.	Either question addressed is real world problem or assessment is authentic. Also some elements of community connection, presentation to real audience, students contact and communicate with experts or concerned person/(s), visit place of study, etc. are present	Questions addressed are not real world, assessment is not authentic, some of the other elements mentioned in the first column would be present
6				

We, _____ approve / disapprove the Project No. _____ as a PBL project. We suggest the following modifications for the project to be considered as a PBL project.

_____

_____

Appendix I: Project planning form

School:

Project title:

Teacher(s):

Background information of project idea (how project idea developed):

Subject area:

Class:

Begin with the end in mind

The theme for this project. Why do this project?

Identify the content and major concepts students will learn in this project (two to three per subject).

Identify important skills students will learn in this project. List only those skills you plan to assess (two to four per project).

Craft the driving question

State the essential question or problem statement for the project. The statement should encompass all project content and outcomes, and provide a central focus for student inquiry.

Plan the assessment - I

Step 1: Define the products for the project. What will you assess?

Product can be student worksheet, report, write-up, poster, drawing, design, model, or any other that you can assess.

Early in the project:

During the project:

End of the project:

Plan the assessment - II

Step 2: State the criteria for exemplary performance for each product:

Criteria should be in terms of performance expected from students.

Product: Criteria:

Product: Criteria:

Product: Criteria:

Map the Project I

What do students need to know and be able to do to complete the tasks successfully? How and when will they learn the necessary knowledge and skills? Look at one major product for the project and analyze the tasks necessary to produce a high-quality product.

Product:

Table I.1: Analysing to produce a high-quality product

Sr. no.	Knowledge and skill needed	Already have learned	Taught before the project	Taught during the project
1				
2				
3				

What project assessment tools will you use?

Plan the project II

List the key dates and important milestones for this project.

Use the Tuning Protocol with other teachers or a group of students to refine the project design or guide you further in your planning. What other thoughts do you now have on the project?

Manage the process

List preparations necessary to address needs for differentiated instruction for students, special-needs students, or students with diverse learning styles.

How will you and your students reflect on and evaluate the project?

You have to keep in mind the following things:

Does the project meet the criteria for PBL?

Have you posed an authentic problem or significant question that engages students and requires core subject knowledge to solve or answer?

Do the products and criteria align with the standards and outcomes for the project?

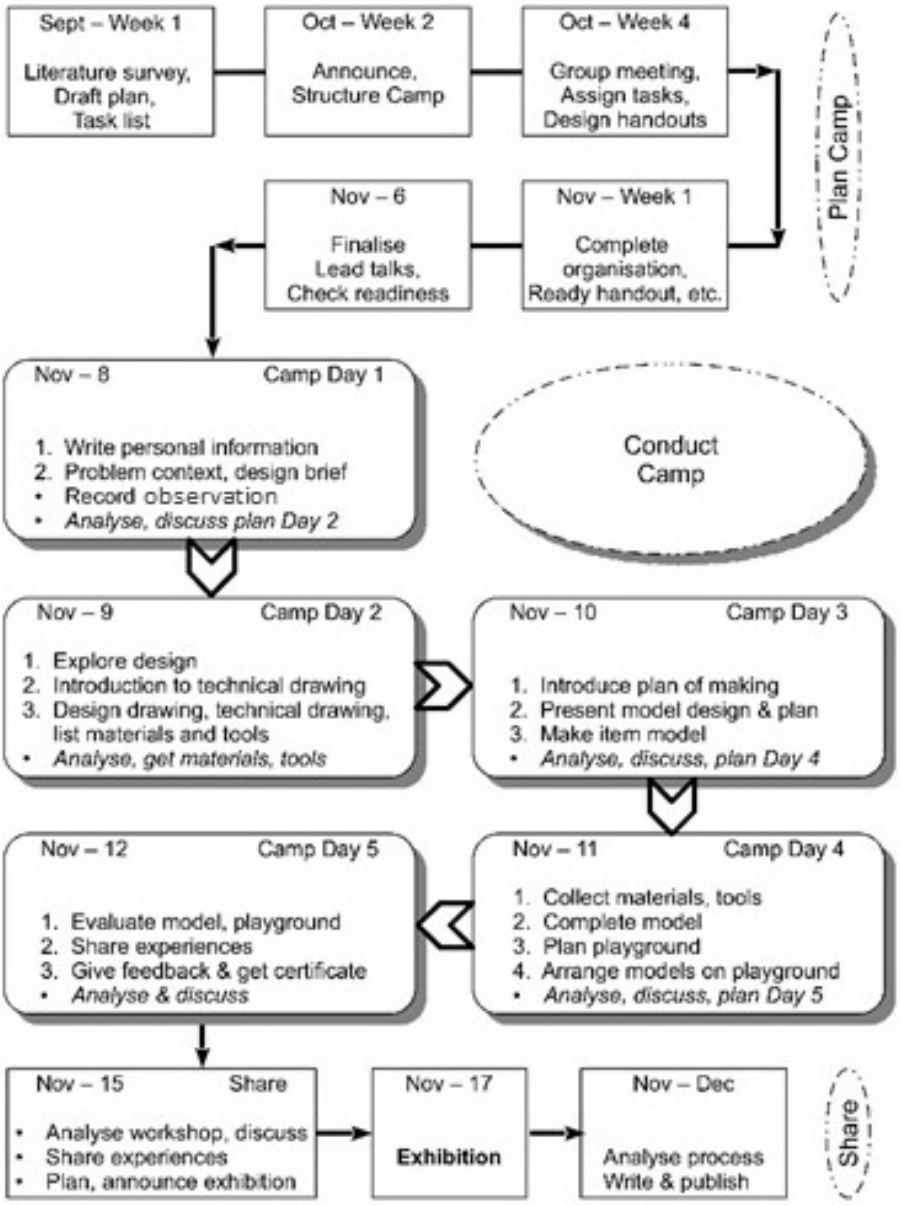
Do the products and tasks give all students the opportunity to demonstrate what they have learned?

What challenges or problems might arise in this project?

What do you expect to learn from this project?

Appendix J: Story board

Figure J.1: Story-board showing the planning, execution and reflection of the Design & Technology project on making a playground model.



Note: The events have 3 parts: Planning the student camp, conducting the camp, and refelcting on and sharing its findings.

Appendix K: Instructions to TPD participants for assessing student productions from the exemplary project

Make assessment rubrics for the following productions:

P1. List of ten playground items.

P2. List of 5 playground items with description of size, justification for including, and sketch.

P3. Exploration of playground item (model) design.

P4. Technical drawing showing the playground item, parts labeled, and sizes shown with dimensions, units and lebels, with materials list giving quantities, and tools.

P5. Plan of action with sketch, description of work involved and distribution of work (and materials list if not given above).

P6. Making of the item model - based on log of activities and observers' notes.

P7. Write up on completed product.

P8. Evaluation of own and others' products on given criteria (worksheets provided)

P9. Product (Item model)

Appendix L: Sample productions of the participants

Pr.	Centl		DQ		Engmt		Auto		Real		G	R	G	R
No.	G	R	G	R	G	R	G	R	G	R	App	App	Ave	Ave
2	3	2	3	1	3	3	3	2	3	2	A	A	2.6	2
3	1	1	2	1	1	2	2	3	1	2	D	D	1.6	1.8
4	3	3	3	3	3	3	3	3	0	2	A	A	2.7	2.8
5	1	1	1	1	2	2	2	3	2	2	D	D	1.7	1.8
6	3	3	3	2	3	3	3	3	3	2	A	A	2.9	2.6
9	1	2	1	1	1	2	3	3	1	1	D	D	1.7	1.8
10	3	3	3	3	3	3	3	3	3	2	A	A	3.0	2.8
11	1	1	1	1	1	2	1	3	1	2	D	D	1.3	1.8
12	3	3	3	3	3	3	3	3	3	2	A	A	3.0	2.8
Cor.coef.		0.88		0.72		0.95		-0.23		0.29				0.91

Table L.1: Ratings given to each project by teacher groups and researchers, and their correlations. Note: The ratings by the Groups (G) and researcher (R) are given for each of the five criteria: Centrality (Centl), existence of Driving Question (DQ), Constructive engagement (Engmnt), Student Autonomy (Auto), and Realism (Real). Based on the rating they also Approved (A) or Disapproved (D). This is given in the columns *G Appl* and *R Appl*.

L.1 Description of project plans prepared on W1-D2

Group: Raigad

AD-A presented the plan prepared by group Raigad to the whole group. The salient features of the project plan of group Raigad are given in Appendix L.9. The details of the features are analyzed below in terms of their presentation under the major heads.

Title and theme: The project of group *Raigad* was titled "Convert and save energy". Their theme was "To understand conversion of energy and save electrical energy" which also indicated the objectives of the project.

Table L.2: Reasons of approval of Project 2 by researcher and group Desire.

Criteria	**Reasons by Researcher and Group**
Centrality	*Researcher:* Comes before teaching lesson. Content may not be covered without teacher guidance. Task requires knowledge from other subjects. Task helps students understand natural resources and interactions. (2) *Group:*
Driving question	*Researcher:* No driving question. Poses a problem context. (1) *Group:*
Constructive engagement	*Researcher:* Task includes analysis and prediction; not limited to information collection; offers scope for constructive engagement. (3) *Group:* Students enact by doing field work and collecting data. Students acquire knowledge and learn new skills while completing the task. (3)
Student autonomy	*Researcher:* Student autonomy not clear; adequate guidance may have been provided during discussion. (2) *Group:* Teacher acts as guide by giving all the necessary instructions to students. Students given freedom to complete task, monitored from time to time. (3)
Realism	*Researcher:* Task has several real world elements - motivates students to work in their locality and present report to BDO and Sarpanch. Maybe students worked in groups. Whether learning assessed not clear. (2) *Group:* Students collaborate with peer group and community. They reflect by presenting the report to the Block Development Officer and Sarpanch of the village for approval. (3)

Problem context and driving questions: They included a detailed problem context, where students would be introduced to a dynamo used in a bicycle, which helped get electrical energy from the motion of the bicycle. In that connection they planned to ask their students to find opportunities to get electrical energy within the school. They suggested using kinetic energy of the flow of water from school laboratory wash basin outlet. Students had to device an instrument to convert different types of energy to electrical energy, which could serve a practical purpose like charging a cell phone.

They planned to ask three driving questions related to the problem context: a) Can we use the energy (heat) produced by the bicycle to light a bulb? b) How can circular motion be converted into electricity? and c) Is it possible to convert the motion of water into electricity? The first question was ambiguous in terms of scientific content. The second question was a specific form of the first question and directly leads to functioning of dynamo, a textbook topic. The third question allowed students to use the principle of dynamo in a novel context of a design challenge and gave opportunities to grapple with underlying physical phenomenon.

The group felt that the questions "How can circular motion be converted into electricity?" and "Is it possible to convert the motion of water into electricity?" were difficult for students of Class 8. However, they also felt that in the process of making the device, students would learn *something*. The group elaborated their idea and motivation behind choosing the topic. And how the group would present the problem context to the students. The excerpts given below the groups thought on on they would be presenting the problem context to the students.

Table L.3: Reasons for approval of Project 4 by researcher and group Innovation.

Criteria	**Reasons by Researcher and Group**
Centrality	*Researcher:* Not clear if teacher had already taught section on geometrical proof to students. (3) *Group:* Students come across basic mathematics operation such as addition, division, etc. according to the geometrical shape. (3)
Driving question	*Researcher:* The driving question requires refinements. (3) *Group:*
Constructive engagement	*Researcher:* Students need to struggle and understand the proofs of geometrical theorems to address driving question. (3) *Group:* Students should know different geometrical figures as well as their properties before doing. Students have to read first to prove the theorems. But they have to construct their idea. (3)
Student autonomy	*Researcher:* Evidence of student autonomy and adequate guidance. (3) *Group:*
Realism	*Researcher:* The question may not interest all students, but working in groups, discussing ideas, playing with papers, magazine publication are some of the real world components in the project. (2) *Group:* Since students' responses are going to be published in the school book, this could also be attractive for students.

... the basic work that we do and the energy which is required to do that work, how do we use that energy to do another kind of work. E.g. If we are riding a cycle, the electric power, sorry, the heat is produced, can we use that energy or heat to light a bulb? How to use this? ... Similarly, what other such things are found in school, where one kind of energy is produced from one kind of work and can be used for another work?

Somebody is riding bicycle the purpose is to go from one point to another point, but at the same time I have attached a 'dynamo' there which transforms energy and light the headlight. Then part of that work is used in conversion of energy ... so some energy is used in this ... so like that I can use my Iron also ... while Iron is still hot ... I can convert it (the heat) into other energy — so in school we can do this. So I expect from you some kind of ideas like that, suppose fan is also moving in circles, can I use that (motion)? It is also a circular motion just like wheel. Can I use that to convert that motion into electricity? ... Can I charge my mobile using that? They would not succeed in that but somehow we want to see if they can use the same principle of wheel into circular motion (here presenter cues him saying 'consumption of energy) ... Can I convert that into electricity, this is also circular motion. I see water flowing from there, third floor of the school and convert that motion into electricity.

May be this is ... bit difficult for eighth standard students ... How can I convert circular motion into electricity? It is difficult ... but it is challenging also ... In our school we have laboratory. Lot of water is used there ... water that flows through the pipe after washing test tubes etc. ... Is it possible to convert the motion of water to electricity? This is not so easy. But they will try something and at least they will built something ... like turbine or something like that ... Mainly this is difficult ... but making

Table L.4: Reasons for disapproval of Project 5 by researcher and group Gulmohar.

Criteria	**Reasons by Researcher and Group**
Centrality	*Researcher:* It comes before the lesson starts. However, it covers a very small portion of the chapter. (1) *Group:* Topic is related to water pollution. Textbook content is very little. Learning goals include very little of textbook content and concepts. Not follow chapter. (1)
Driving question	*Researcher:* There is a problem context. But no driving question. (1) *Group:* Unrelated driving question. (1)
Constructive engagement	*Researcher:* Task will help students know about consequences of oil spill. Will not necessarily help learn about other forms of pollution. However, for that experts were invited. (2) *Group:* Not very challenging. (2)
Student autonomy	*Researcher:* Seems there is student autonomy. Guidance is unclear. (3) *Group:* All instructions are given. No autonomy. (2)
Realism	*Researcher:* Real world connection in terms of drawing attention to immediate environmental problem. Real world contexts – inviting experts, writing reports. No evidence of authentic assessment. (2) *Group:* Writing is illegible.

the machine itself ...

Concepts and skills: The group had assumed that students would learn the nature of magnetic, electric, kinetic, and light energy and "their inter-relations". They probably meant conversion of one form of energy to another. They also assumed that students would learn to measure the amount of energy produced by the device. Finding the actual kinetic energy required to rotate the dynamo made by the students would allow them to derive quantitative aspects of kinetic energy and its conversion to electrical energy. It was interesting that the group had planned tasks that would help students know the properties of magnet and magnetic lines of force, the interactions observed due to relative motions of a magnet and a conducting wire, an electric circuit and its components, and the structure of a dynamo.

In principle, knowing about the dynamo demands knowledge about identification and selection of a suitable conductor, non-conductor, magnetic and non-magnetic substances, etc. In this way the project planned by the group could address parts of three unit lessons (chapters): (a) magnetism, (b) electric current, and (c) metals and non-metals. However, the group planned to address only a part of the second chapter. Besides, they did not connect the designing and making task in their planned task to possible chapters from the mathematics textbook. They had overlooked that it would be difficult for students to understand about all forms of energy at one go, especially light energy, and the tasks may not help students understand the "nature" of energy.

The skill development listed by the group included information gathering, self learning by reading and discussion, scheduling and costing, and presentation and communication. It was interesting that even though designing and making was a major component of the project, the group did not focus on the corresponding process skills.

Table L.5: Reasons for disapproval of Project 9 by researcher and group Umeed.

Criteria	**Reasons by Researcher and Group**
Centrality	*Researcher:* This comes before teaching the chapter. At least half of the chapter is covered by the assignment. (2) *Group:* Learning goals include very little of textbook content and concepts. (1)
Driving question	*Researcher:* No driving question and problem context. Task provided. (1) *Group:* Driving question does not exist. The students are just asked to list the "10 human resources". (1)
Constructive engagement	*Researcher:* Activity may allow students to know about part of the chapter. Not clear how that can be ensured. (2) *Group:* The activity is very trivial for std VIII students. There is less opportunity to engage themselves in constructive activity. (1)
Student autonomy	*Researcher:* Student autonomy is clear. No guidance from teacher. (3) *Group:* Although the students wok independently with limited instructions showing the features of autonomy provided in PBL, but the instructions given by the teacher are incomplete and no further guidance is provided. (3)
Realism	*Researcher:* Only real element is listing and collecting information about 10 human-made resources. No real world element in presentation, nature of production, group work, and authentic assessment. (1) *Group:* No real world problem is addressed whereas a 'direct activity' is assigned to the students. (1)

Products and assessment: The project plan included a set of products that students would produce during the early stages, in the middle and towards the end of the project. In the early stage students had to submit a written plan of action, circuit diagram of the device, and sketch of the final product. Students had to describe how they would carry out their plan, time schedule, their justifications for choices made, list the tools and resources they would be using in their work, and submit a cost estimate of the resources they needed to procure. Their expectation from students is articulated in the following excerpts.

> "... they (students) will fetch from school all the things that they will require. They will be required to plan for the same. Like, sketch of the final product. E.g. suppose if they use energy from Iron ... energy produced from Iron to be used for some other work and they will have to draw a sketch of that final product. This is all they will do in the early part of the project."

The group would assess students' presentation of their plan of action in terms of clarity of presentation. The term clarity would be gauge by how well or clearly students from another class, which was unfamiliar with the project understood the presentation of the plan. In their own words:

> "One of the assessment is that they are going to present a proposal. The proposal should be clear so that another group of students in another

Table L.6: Reasons for approval of Project 10 by researcher and group Umeed.

Criteria	**Reasons by Researcher and Group**
Centrality	*Researcher:* Comes before teaching textbook content, addresses it. (3) *Group:* Learning goals include content in textbook and more. (3)
Driving question	*Researcher:* Driving question relevant to address textbook content. (3) *Group:* Driving question was asked by teacher to create interest and encourage students to start learning about project. (3)
Constructive engagement	*Researcher:* Tasks designed have scope for constructive engagement. (3) *Group:*
Student autonomy	*Researcher:* Student autonomy, and indications of teacher guidance. (3) *Group:* Students were given enough time to analyse the data and observe it. Students were helped by teachers with a number of resources in the form of books and notes. All the instructions were given in advance and there were scope left for discussion with the teacher. (3)
Realism	*Researcher:* Several real world components, like preparing report, making working model. No evidences of assessment. (2) *Group:* Both formative and summative feedback is given. (3)

> 'classroom' will understand it very clearly. So clear presentation of proposal that is one of the criteria. Proposal is one of the product and criteria will, is it clear enough, easy enough to understand ..."

The group seemed to have completely separated planning from the remaining part of the project and considered it as a definitive process with a beginning and end. The tasks were planned to be assessed only on the basis of clarity and did not explicitly specify expectations from students. The group did not realise that such an unclear assessment plan may not help them provide specific feedback to students that could help the students through making the device. Further, the idea of presenting to the students of other sections would be a good element to bring authentic aspects but did not do justice for assessing clarity aspect. However, this can be realised if students were allowed to peer-assess them and therefore, not require to bring students from other sections.

While making the device, students were expected to learn about conversion of energy. Along with the model device, students were expected to submit a progress report, and keep a daily log. The group felt that this documentation would help other students outside the project understand about the project work. The group failed to appreciate that while making the device, students would experience a range of concepts from their textbooks besides conversion of energy.

> "Conceptual understanding... They should understand themselves how energy is converted from one form to other. This they will understand only when they do it and see for themselves how the energy produced from one kind of work is transformed to be used for different kind of work. And second one is, progress report – now, they should write a daily report of the project that they are working on. This will also be helpful for the students from other classrooms."

Table L.7: Reasons for disapproval of Project 11 by researcher and group Raigad.

Criteria	**Reasons by Researcher and Group**
Centrality	*Researcher:* Comes before teaching the lesson. A small part of the chapter can be addressed through the project. (1) *Group:* Learning goals include only a small part of the chapter. (1)
Driving question	*Researcher:* No problem context and driving question. However, the task was defined. (1) *Group:* Driving question does not exist. (1)
Constructive engagement	*Researcher:* Opportunity for constructive engagement. Limited content and concepts. (2) *Group:* Not challenging, not much possibility to construct any relevant useful knowledge. (1)
Students' autonomy	*Researcher:* Seems there is student autonomy. Guidance provided is unclear. (3) *Group:*
Realism	*Researcher:* Real world components like working in groups, collecting real data from community, presenting findings before class. No mention of assessment. (2) *Group:* No real world problem is addressed. Not much possibility of interaction with the experts. (1)

At the end of the project, the group planned to assess students on their overall engagement in the tasks. They planned to check students' *insight and depth of understanding.* According to them,

> ... We will check that insight and depth of understanding during — and in the aim they would consider one set of instrument ... they will construct some kind of instrument ... so they have to ... so we want them to apply that successfully or unsuccessfully, suppose they say that the electric source of the turbine is some tap water or something or some waterfall from drainage so we want them to prove that instrument there and see if it works or not ... they have to go all the way outside their (class) ... Suppose the bulb doesn't glow, or no energy is transformed, that would be fine too. It is more important for the students to experience the whole process, trying to find different things, to see if they can use the transformation of energy with those things.

The group accepted that they needed to work further on this aspect of assessment.

Teachers' support: In terms of teachers' support, they had limited their role to introducing the problem context to the students, making groups of students, communicating the expected final outcomes and stating the intermediate tasks to be performed. They did not explicitly mention the possibility of needing teacher guidance while students were engaged in the project. Other than stating the problem context they would be asking students to make the motor and calculate amount of energy. In their own words:

> "covered one lesson ... There is one topic ... tells them how to make

Table L.8: Reasons for approval of Project 12 as PBL by researcher and group Raigad.

Criteria	**Reasons by Researcher and Group**
Centrality	*Researcher:* It came before teaching the lesson. The entire lesson can be covered with this project.(3) *Group:* Learning goals can lead to cover most of the chapter. (3)
Driving question	*Researcher:* The driving question can lead to chapter content. (3) *Group:* If introduced properly, the question can be quite driving. (3)
Constructive engagement	*Researcher:* There were opportunities for constructive engagement. (3) *Group:* New knowledge about the culture, power-practise technology in the 19th century can be constructed. (3)
Students' autonomy	*Researcher:* There was student autonomy. Unclear about adequate guidance or moderation of sessions. (3) *Group:* Student will have to work independently most of the time. (3)
Realism	*Researcher:* Several real world element, like discussing in groups, attending meetings, presenting report to larger audience, and presence of two experts as evaluators. However, authentic and formative assessment missing. (2) *Group:* Question is very much relevant historically emotionally to many persons in the community. (3)

armature of motors ... let them calculate how much energy can be produced ..."

Group: Umeed

The group Umeed believed that it was important to raise students' awareness about environmental pollution through projects. They stated that they thought conservation was very necessary. And now a days there is pollution ... so to stop that these are the basic things and they should know by doing these projects ... The details of their project are analyzed below. The salient features are given in Appendix L.10.

Title and theme: They did not come up with a title or theme for their project plan.

Concepts and skills: The group planned to cover topics and content from science, geography, mathematics, arts, and English. They also planned to teach some skills through this project. the skills include map reading, preparing the model, observation, collecting relevant data, analysing, presentation, communication, cooperation, team spirits etc. They expected students to learn about matter and its types while answering the questions. The group anticipated that students will come to know about *matter ... different types of matter ... compound and all ...* while answering the driving questions. While doing the project students will learn *conservation, formation, and percentage etc.* They anticipated that in order to answer the question *Why can not we drink the water of Ganga?*, students had to *calculate the percentage of water polluted.*

Problem context and driving question: They planned to situate the problem for the students through a slide show and short movie that depicted greenery gradually diminishing and increasing wastage of water. At the end of the slide show they would tell

Table L.9: Group Raigad: Salient features of first project plan

Group, Class	Raigad, VIII
Title	Convert and save energy
Theme	To understand conversion of energy and save electrical energy
Centrality (a) Topics (b) Content (c) Skills	A topic in a science lesson - armature of motors. Outside textbook - Energy production (conversions?) Nature and measurement of energy: magnetic, electric, kinetic, light; their interrelations (conversions?) Information gathering, self learning by reading and discussion, scheduling and costing, presentation and communication
Problem context (realism) and Driving question	Transformation of motion to electricity in bicycle; Need for similar sources of electricity in school. (1) If we are riding a cycle, heat is produced, can we use that heat to light a bulb? (2) How can I convert circular motion into electricity? (3) Is it possible to convert the motion of water to electricity?
Products - Early During End	Plan of work, Time schedule, Cost estimate, Circuit diagram, Sketch of final product Progress report and conceptual understanding. Assessment of skills, and application of the work
Assessment plan	Assessment of presentation of (plan) proposal; Criteria = Clarity Assessment of device; Criteria = Depth of understanding (?)
Teacher support	Introduced the problem context, communicated the expected final outcome and intermediate tasks to be performed, no mention of teacher guidance during the students' work.

the students about the topic and pose the driving questions: (a) What will happen if there were no water? (b) Can we drink water from the river Ganga? (c) How does the water flow? The group planned to introduce the problem:

> "A ppt will be shown to the students. From ppt students will identify ... in ppt it will show total greenery to getting dry ... somewhere the tap is on ... water is just flowing ... this will be always there in ppt ... it will not be disclosed to the students ... it will be a silent movie ... and after that students will come to know exactly what is the topic ... what are we trying to say ... and then we are going to put on in front of them this particular question ... at the end we will put the driving question ..."

Products and assessment: Teachers stated that in projects students would do a lot of research, prepare models and write a report. They stated that students would gain an understanding of research, and why they were doing research. However, what they would research on was not clear.

To assess students' learning the group had planned to use worksheets. This they hoped would assess students' actual contribution in projects and their understanding. As an example, they said that while responding to "why cannot we drink the water of Ganga?" students needed to know the types of pollutants in the Ganga and calculate

Table L.10: Group Umeed: Salient features of first project plan

Group, Class	Umeed
Title & Theme	Water
Centrality (a) Topics (b) Content (c) Skills	 Science, Geography, Mathematics, Arts, English Nature of matter, states of matter, water bodies, map reading, water cycle, rain, pollution, percentage, volume, area, water cycle and water harvesting plant (in arts), prose and poems (in English) Map reading, preparing the model, observation, collecting relevant data, analysing, presentation, communication, cooperation, team spirits etc.
Problem context (realism) & Driving question	Slide show and short silent movie on depleting greenery, and wastage of water. The topic will be communicated in connection to the movie and slide show. What would happen if there was no water? Can we drink water from the river Ganga? How does the water flow?
Products	Conducting research, model, report
Assessment planning	Worksheet, models and report
Teacher support	

its quantity. The group had yet given no thought to whether students would be able to do these tasks and the nature of guidance the teachers would have to provide. They had stated their plan of assessment in the following words:

> In order to assess them we have planned for a worksheet ... model and the report ... in the worksheets we will come to know whether the child has actually understood the thing or not ... as we know now a days projects are made in home ... other peoples are making the projects ... parents and others also ... that is why we have decided to assess them properly at the end ... next will be a model ... and overall report ... what it is ... what are the uses ...

L.1.1 Description of Project plan presentation including assessment-W1-D3

The groups presented one by one on their plans of how they would conduct their projects. Each group's presentation is summarized below.

Group Raigad

The group Raigad revised their problem context and driving question. They had focused their problem context by introducing the generation of electricity by dynamo

from running bicycle which was less costlier that using electric cells to produce the same. They planned to ask their students to find opportunities in school where they can replace cell and battery to light lamps. And this will reduce the school expenditure on electricity. At this juncture they planned to ask their students that whether they can implement similar idea in school so that their school will save money.

> I use bicycle for certain purpose ... to travel ... but part of that work is used to lid the lamp ... the work is used for ... to convert motion into energy ... now wherever in school use that ... find it out and implement it ... I do not need a cell or battery to light that lamp ... so our school also can save money ... just think of the idea ... implement it ... how can we do that? This is the driving question.

They expected that their students would go around the school and come up with some nice ideas like producing some energy using fan or a bicycle. They also mentioned a rephrased driving question in the form of problem statement *find something like dynamo which can be used in the school and just go ahead and implement it.*

Teachers brought language, science and mathematics in the project. These included communication skill (language), amount of electricity generated and converted to other energy, strength of the magnet and speed of the rotation, measuring and maintaining flow of water (mathematical concepts), types of energy, measurement of energy, conversion of energy (science). Teachers believed that in this process students would learn the *inter-relation between magnetic energy and electrical energy, electrical energy and light, and information gathering.*

Teachers did relied on students' *proposal* as the only production. However, they would probably meant to had a portfolio as they said *proposal they should present and proposal should go through stages. First there will be two page proposal, which might evolve into 10 page proposal over three months.*

They planned to assess the proposal and actual instrument produced by the students. They had decided the assessment criteria for proposal as clarity, schedule in the proposal, cost estimation, and circuit diagram. Although teachers themselves mentioned that they had not finalised the rubric, their expectation from the proposal and its components can form the content of descriptors for respective criteria. Interestingly teachers elaborated on what did they expect from students against the criteria of *clarity* and partially mentioned about *Schedule in the proposal*, *Cost estimation*, and *Circuit diagram* and given in Appendix L.11.

The teachers pointed out that their main focus was using circuit diagram to understand the depth of conceptual understanding. To prove their conceptual understanding teachers thought about some questions that they could ask their students like "whether I can put 5 lamps?", "can I use a buzzer in place of lamp or a tube or a mobile charger?" and observe how they modify the circuit. They mentioned that they would pilot the presentation rubric sample given to them in the workshop in their project to assess students' presentation.

Table L.11: Assessment rubric for students' proposal by group Raigad.

Criteria	Descriptor
Clarity	The description is clear and lucid enough so that students of some other class can also understand just by reading it. Explanation given on plan of doing something and justification.
Schedule in the proposal	Sense of time management, time break up of the work
Cost estimation	Effectively estimating the costing
Circuit diagram	Neatness in drawing, electrically correct or not

Umeed

Umeed modified their earlier driving question and stated "How can you say that drinking water in your neighbouring area is safe or not?"

They planned to assess their students on oral presentation, design of the model, worksheets, written report, viva, and questioning. Teachers planned to ask questions related to the project and making of the model while students would present. After the completion of the project they would provide worksheet to the students to answer individually. The worksheets would have both subjective and objectives questions.

They had decided criteria for oral presentation as communication skills, confidence level, clarity in explanation of the topic, presentation is systematic or not, whether there was a flowing sequence in presentation. Their criteria was similar to holistic rubric where students would be awarded highest grade if all the criteria were met.

L.1.2 Description of Project plan presentations with revised assessment-W1-d4-a

Raigad

The group presented their assessment rubric to assess proposal. The rubric is given in Appendix L.12. They planned to ask students to submit the proposal within a week or two after the project start. The proposal would be assessed on five criteria under three proficiency levels A, B, and C. They had added that A would be taken as *best* and C as *worst*, although they would not mention such competitive words to the students. It was interesting to note that participants brought another component to reduce the subjectivity in assessing clarity of the students' proposal write up. They suggested that students would present their proposal to the students of another section to see whether these students understand their presentation.

Teachers mentioned that they will ask questions like "what if we attach a buzzer here?" or "what if I will attach a mobile charger here?" to probe their conceptual understanding. They had added that in order to reduce the subjectivity in deciding the

Table L.12: First assessment rubric for students' proposal by group Raigad.

Criteria	A	B	C
Write up	students paraphrased, correct, simple and easy to understand	correct, student wrote, rewrite on own, but not easy to understand	correct, directly copied from book, website
Scheduling	have a comprehensive check list for the task and keeps it flexible (e.g. some body falls seek)	made some plan, but not comprehensive, there are some gaps in the plan, not considered flexibility	there is only monthly plan, are not aware that weekly plan also need to be prepared
Costing	Comprehensive list as per local market list, suggest whole sale markets and mention reduced cost, suggestion of reuse and recycle and therefore, reduce cost further	list prepared by surveying local market	list draws from a single shop and total it
Understanding of concept (Questioning)	Answer the questions intelligently, some kind of reasoning, experimentation, suggest some creative uses of their instrument indicating a good level of understanding	In developing stage, suggest some reasons, some honest effort of creativity and application, but not have confidence	they have understood, but their approach is more like preparing for examination

ease of understanding they would ask students to present the proposal to the students of another section of the same standard. A teacher (RA-C), argued that students, who had copied correctly, at least know from where to copy, therefore they should not be given C. The presenter participant responded that they were focusing on language skill. However, it was somehow did not came in the discussion that articulating ideas in own language was also an indicator of understanding.

While assessing the cost estimation teachers planned to conduct a local market survey to see whether students have just went to a single shop and collected the price list.

Umeed

The group Umeed came up with detail assessment plan for assessing oral presentation of students. In oral presentation they had planned to assess students communication skills, energy level and enthusiasm of the child, facial expression, proper use of vocabulary, pronunciation, what are the aids students are using. A detailed assessment rubric for communication skill by this groups is given in Appendix L.13.

Table L.13: First assessment rubric by group Umeed.

Criteria	Exemplary (9-10)	Advanced (7-8)	Developing (4-6)	Limited (0-3)
Communication skill	Posture, eye contact, the clear-cut explanation, nice and audible so there is no confusion of what the child is saying	A little stiff, still maintaining eye contact but occasional, explanation with slight hesitation	very stiff, very unnatural, rarely maintains eye contact, presenting looking at the paper, slight confusion in the order of the presentation	child shows uninteresting attitude while he is presenting, no eye contact, very shaky and nervous, there is no clear explanation because he himself does not know what he is speaking and he is confused
Confidence level	100% confidence	80% confidence, confidence but something missing	60% confidence, some sign of nervousness shown in their face	absolutely lacking confidence
Systematic flow of presentation	He knows what he has to speak after what, and does not stop in middle, goes very naturally, there is absolute fluency when he is speaking	he has a flow, but some times he pauses at middle, pauses are very less	some points are bit jumbled up, and he takes few more pauses	totally jumbled up, lots of pauses

A set of assessment criteria decided for some students' productions are given in Appendix L.14. However, they mentioned that they were working on the assessment aspects to elaborate the descriptors.

L.1.3 Project plans focusing on learning objectives-W-2-D1

Group Umeed

Umeed discussed several possibilities of potential projects in three subject domains separately that included history, geography and mathematics. In history they came up with three potential project ideas, the highest among the three and least in mathematics with one project idea. However, it was important to notice that for mathematics, all the elements were aligned to each other. Interestingly, for geography the topic does not address much by the remaining elements. For example, the topic *The Continent of Antarctica* demands several content like the location, composition, topography, geographical importance, flora and fauna, natural resources, exploration of Antarctica

Table L.14: Assessment criteria for students' productions.

Students' productions	**Assessment goal**	**Criteria**
Viva and application based questions	Content application and accuracy	spontaneity and correctness while giving factual answer, confidence, the gesture, the movement, and the voice modulation, how well the student was answering
Model		Attractive, neat, proper and correct labelling, functionality, and appropriate use of material

and human expedition, effect of global environmental change in the environmental and geographical change of Antarctica. However, teachers limited themselves to *environmental issues* as major content. Interestingly, teachers expanded the scope by including climate and animal life as major concepts and at the same time restricted the environmental issue to global warming only. The tension of aligning the potential project ideas with the topics were evident for history and geography. The project on *Spread of religion over ages: Map it out* was much broader than the topic *Gautama Buddha*. The complete project plan is given in Appendix L.15.

L.1.4 Focusing on activity sequence

In the third session participants were supposed to select one project out of several projects they had planned in the Session 2. For the selected projects participants had to list the activities they were going to conduct in sequence. For each of the activities participants were supposed to write a brief description, whether the activities were to be conducted by individual or in group, expected productions from each of the activities, corresponding learning objectives in each of the activities and remarks if any. All their plan had to be noted down in a worksheet.

Group Umeed

It was interesting to find that Umeed came up with seven activities in sequence with detailed plan. They had incorporated subject topics and content from science, geography, and mathematics as well as some others subjects like visual arts. It was interesting to find that the participants developed a logical sequence of activities in terms of introducing students with environment, changes in environment, global warming, causes, effects and solution of global warming, and then understanding duties towards our environment. There were scopes to orchestrate all the products in a connected fashion in order to meet a common goal. However, it seemed that the activities were some extent independent to each other and considered as complete in itself.

Table L.15: Group Umeed thinks about project learning objectives.

Subjects	**History**	**Geography**	**Mathematics**
Topics in the subject	Gautama Buddha	The continent of Antarctica	Discount and commission
Major content area	Religious teaching	Environmental issues	Discount, Commission
Major concepts	Four noble truth, Eight fold path, Panchasheel	Impact of global warming, Climate, Animal life	Marked price, Selling price, Discount percent, Commission, Commission agent, Rate of commission
Major skills	Analyse the reason for the birth of new religion, Understanding Buddhist religious teaching, Compare religious beliefs, Understanding importance of the principle in our lives	Analysing, Mapping and creating solutions to overcome the problem of global warming	Trading, Communication, Enactment, Calculation of discount and commission
Potential projects	Utility of these principles in our current life style, Compare Jain and Buddhist religious principles & show similarities, Spread of religion over ages: map it out	Effects, causes and solutions for global warming, Students will differentiate between Antarctica and Europe	Final enactment by performing in front of the Head mistress with the help of number of activities performed with the teacher as a facilitator

L.1.5 Teachers' plan productions-W2-D2

This section summarizes the projects planned by each of the eight groups who attended all three workshops. The project structure made by the groups are given in the tables at the end of this chapter, while the story board, if any, a summary and comments on each group's work are given here.

Umeed

Umeed planned that they would begin with a video clipping followed by discussing on it was a good idea. The second related video clip in Activity 2 may have been useful. But presentation at that stage might result in insufficiently informed discussion. Such discussions tend to reinforce many misconceptions in the classroom. The argument goes like this: when several students present several ideas, while the teacher had less time to address all the incorrect data and interpretations, these unchallenged mistakes would be passed on to the whole class.

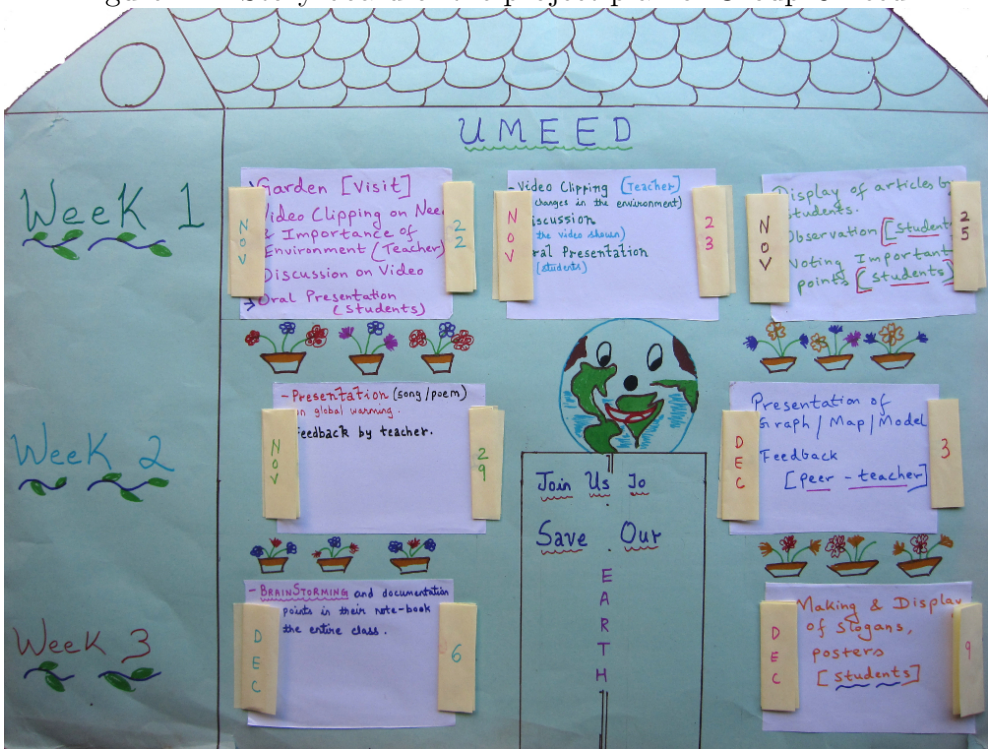
Activity 3 could have been made much more implicit by doing Activity 5 first, which could have led students to find information. Causes and consequences of Global Warm-

Table L.16: Group Umeed's sequence of projects activities.

S.No.	**Activity title (in sequence)**	**Activity description**	**I/G**	Products	Concepts	Skills
1.	Video clippings, discussion	Discussion on importance & need of environment	Go5	Sharing views on need and importance of environment (Scrapbook)	Need of healthy environment, Importance, value of environment	Analysing, Reasoning, Observation
2.	Video clippings, discussion on changes in environment	Reasons for changes in our environment	I, G, Think-pair-share	Causes of changes in our environment (Scrapbook)	Causes of changes in our environment	Reasoning, Observation
3.	Pre-planning (Collect newspaper cuttings on impact of changes in our environment), Observe display of newspaper cuttings	Move around, pick out commonalities observed in newspaper cuttings	I	Newspaper cutting display	Global warming	Analysing
4.	Presentation of causes of global warming	Presentation through dramatisation or poem/song	G	Enactment, Drama, poem, song	Causes of global warming	Communication skill
5.	Effects of global warming	Models, mapping, bar graph, % area affected by global warming	G	Model, presentation, graph, map	Effects of global warming	Mapping, graphing, communication skill
6.	Solutions to effects of global warming	Brainstorm various solutions	I	Solutions & views (web in their notebook)	Solutions to effects of global warming	Analysing, rational thinking
7.	Understanding our duties towards our environment**	Poster making, slogan, street play	G	Protection, awareness towards our environment		Drawing, communication, acting, creative thinking

Note: Collect information on religious principles that can help out to stop harm to the environment, find out the fundamental duties towards our environment

Figure L.1: Story board of the project plan of Group Umeed.



ing and solutions to the problem need not have been separate activities. These tasks that address an issue could have been set together: Students are asked to run a campaign in the school or make a presentation to their peers on global warming and every person's role in mitigating the problem. Similar ideas could have been used.

In general, the group Umeed had a good introduction of the problem context. The issue was complex and linked. Breaking up the tasks as activities 4 to 7 seemed to lose the thread, and could have hindered the connected understanding. A campaign or presentation may have brought better coherence. It may have allowed for time for the teacher to resolve students' misconceptions and helped them understand balancing decisions based on empirical data and emotional factors. The group Umeed was clear about their assessment criteria. But this needed to be communicated to students early on.

Table L.17: The final project plan of group Umeed.

No.	Activity title	Activity description, including product	I/G	LO – concepts, skills, procedures	Assessment criteria/ rubric	Management notes	Subj. Integrated
1	Video clip watch & discuss	Whole class watches video for 5-10 min. Discussion on video content – Environment (need and importance)	G - 5	General skills, team spirit, co-operation, leadership, communication, conflict resolution; Analysing, Reasoning, observation, value of environment	A1	Video – 5 min; garden – 5 min; Discussion in smaller groups (5) in each for 10 min 1 teacher 1 period; Presentation for 5 min each group	Env. edu., Geog, Science
2	Video clip watch & discuss	Whole class watches video 5 min. Discussion on video content – Environment (changes in the environment)	G	Need and importance of healthy environment; Changes in the environment; Reasoning, observation	A2	Video – 5 min interaction – 10 min presentation – 25 min Discussion in same group 1 teacher 1 period	Env.edu., Geog, Science
3	Watch, Display of (newspaper) cuttings, articles	Prepare/ arrange Articles and display, Move around, observe display, Note points	I	Impact of changes in environment leading to topic of Global Warming; Analyzing	A3	15 min for making charts, 15 min observing, 5 min discussion, making chart in same group and then moving around in groups to observe others charts, one period one teacher	Geography, Science, Env. Education
4	Presentation of cause of Global Warming	Presentation through poems/ Song	G	Causes of Global Warming; Communication skill; Presentation skills	A4	5 min presentation on Global Warming 10 min feedback one teacher one period	Geog, Science, English, Env. Edu
5	Effects of Global Warming	Models, mapping, bar graph, Area affected by global warming	G	Percentage of areas most affected leading to Global Warming – mapping, graphing, communication, presentation.	A5	(same group) 5 min presentation of model / draft / map 10 min feedback one teacher one period	Science, Geog, Maths, Envi-Edu
6	Solutions to effects of Global Warming	Brainstorm the various solutions, Participation, Noting points	I	Solutions and views to solve problem of Global Warming; Analysing, rational thinking	A6	whole class discussion on Global Warming; 10 min for writing points in notebook	Science, Geog, Maths, Envi-Edu
7	Understanding our duties towards our environment	Poster making from the information collected, Slogans	G	Protection, awareness towards our environment (communication, creativity, rational thinking, drawing, presentation)	A7	(same group) half an hour to make slogans and make posters 5 min to go and display	History, Art, English, Civics, Science, Geography

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