

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

Synopsis

**Submitted in partial fulfillment of the
academic requirements for the degree of
Doctor of Philosophy
in
Science Education**

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April 2022

Abstract

This work is focused on designing and implementing a model of teacher professional development [TPD] through the development of a set of Project Based Learning [PBL] modules. The engagement evolved in collaboration with teachers and taking into considerations students' voices. The development of a model of TPD and PBL modules were in response to the suggestions and recommendations for pedagogic elements to be followed in the classroom given by National Curriculum Framework 2005 [NCF 2005] brought out by National Council of Educational Research and Training (NCERT) and National Education Policy 2020 (NEP 2020) formulated by Government of India.

The study follows a deliberative curriculum approach. Deliberative curriculum approach integrates contributions of systematic, existentialist, radical, and pragmatic traditions of curriculum making. This approach and process considers individual experiences, explores, and suggest radical action, or problem solving based on what works and places the practical art of deliberation at the center (Null, 2011). The approach engages teachers and researchers in a project of social co-construction of curricula.

The work began with studying NCF, 2005 (NCERT) to delineate the pedagogic elements suggested, educational philosophy and psychological orientation propounded; and textbooks and resource materials prepared by NCERT as well as of Central Board of Secondary Education (CBSE), Homi Bhabha Centre for Science Education (HBCSE), and Maharashtra State Bureau of Textbook Production and Curriculum Research (Balbharati). In the light of the literature survey conducted on different inquiry-based curricula and experiences of curricular intervention in India and other countries, PBL was identified as curriculum response to NCF 2005 and NEP 2020.

A model of PBL was adapted from the five criteria of PBL given by Thomas (2000). The idea was shared with teachers (four individual teacher interviews and Focused Group Discussion with 10 teachers) and their views on projects and practices of conducting projects in school were explored. This led to structuring a workshop engagement for a larger number of teachers (43 participants) from different school systems and constructing questionnaires to gather teachers and students views on projects and project practices.

Three workshops were organized with around 30 teachers, a few teacher educators, one teacher administrator, and two students of education within a span of 6 months to develop several PBL units for implementation in classrooms. Eighteen participant teachers and teacher educators were interviewed, and 13 schools were visited to observe the process, issues and concerns related to the implementation. Students' interviews were also conducted in five schools. In addition, conversations with two more teachers and one teacher educator over telephone and online chatting was carried out to know the status of progress made.

Two Units of PBL were developed and implemented with students in two workshops, one on designing and making play items for a park (15 students), and the other on making a tourism leaflet (55 students). The first unit was shared with teachers in the third workshop of the workshop series for feedback and evaluation.

The model of PBL adapted from the existing scholarship and considering Indian school reality shows an alignment with NCF suggestions and vision of education. Teachers' interviews confirm the plausibility of such PBL approach in Indian classroom. However, teachers suggested continuous teacher support and systemic changes as important for implementation of PBL in schools.

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 lesson plans for PBL. At the same the researcher also gained insights while engaging in the workshop, interviewing teachers during the span of engagement, and visiting the schools.

Some correspondence was found between different school systems that the teachers affiliated to them with their ideas about PBL and the progress in their ideas and their transaction of PBL in their classrooms. However, there were individual differences too among teachers' ideas and progress based on personal experiences, beliefs, and dispositions.

The transaction of PBL units conducted at the research centre with students showed that these units could ensure students disciplinary engagement as well as facilitate critical self and peer assessment. Overall, teachers and students expressed positive views of the use of projects.

The NCF 2005 and NEP 2020 had proposed the use of projects and had highlighted subject integration, group work, peer and self-assessment, authentic engagement, student autonomy and use of real-world contexts as pedagogical methods to make learning meaningful. NEP 2020 has also strongly recommended development of 21st Century skills among students and attaining Sustainable Development Goals (SDG) set by the UN. National Curriculum Framework for Teacher Education 2009 [NCFTE] prepared by National Council of Teacher Education (NCTE) and NEP 2020 (GoI, 2020) advocate continuous TPD in and outside school.

PBL has the potential to address the suggestions made by the NCF 2005, NCFTE 2009, and NEP 2020. This study demonstrates the possibilities of engaging with teachers around pedagogically relevant issue 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. This model 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.

Publications related to the thesis

In International Journal

1. Shome, S. and Natarajan, C. (2013). Ideas of and Attitudes towards Projects and Changing Practices: Voices of Four Teachers. *Australian Journal of Teacher Education*, 38(10), 64-81.

In International conferences

1. Shome, S. and Natarajan, C. (2013). Projects in school learning: Teacher experiences. In Nagarjuna G., Arvind Jamakhandi, and Ebie M. Sam (Eds.) *Proceedings of epiSTEME – 5*, pp. 321 – 327. Mumbai: HBCSE, TIFR.
2. Shome, S., Shastri, V. V., Khunyakari, R., and Natarajan, C. (2011). What do students learn from designing and making a playground model? In Kay Stables, Clare Benson and Marc de Vries (Eds.) *Proceedings of PATT 25 & CRIPT 8: Perspectives on learning in design and technology education*, pp. 357 – 366. London: Goldsmiths, University of London.

In National Journals

1. Shome, S. and Dwivedi, A. (2019). What it takes to run an Eco-Club? *Teacher Plus*. 34-36.
2. Shome, S., Dwivedi, A., Kumar, M., and Kandpal, P. (2019). Experiences of Working with Textbooks in the Early Grades. *Learning Curve*, 52-55.
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Book chapter:

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Acknowledgements

References

1. Chapter 1: Introduction

The thesis begins with an introduction of India's journey as a nation state and efforts to uphold the constitutional obligations. The chapter highlights the global political scenario and national agendas as striving for economic and social development (Jha, 2008). These agendas of development also include the preparation of citizens to develop 21st century skills (GoI, 2020; Geisinger, 2016).

For any functional democracy it is important that the citizens have the ability and opportunity to take active part in democratic processes and deliberations (Joseph, 2007). In this approach humans should not be viewed as 'human capital' but should be viewed instead through the lens of 'human capability' (Sen, 2000). Preparing students as citizens of the future requires nurturing the capabilities (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 (Freire, 2000; Dewey, 1915).

Project-Based Learning is advocated as a problem-posing pedagogy to achieve the goals mentioned above (Sriram, 2018). The history of using projects in school education dates back to the time of Italian renaissance and is practiced even to the present day. The form of projects, and the philosophical orientation and psychological underpinnings have evolved over time, shaped by contemporary ideological and socio-political forces (Knoll, 1997). Chapter 1 presents a short history of project practices and how they have evolved. The sections in this chapter also discuss projects as they have appeared in the policy documents for Indian schools and the writings of some Indian educationists.

Chapter 2 presents a review of literature on teachers' knowledge and beliefs about teaching-learning, and the role of TPD and PBL in schooling. The review also includes research on group work, assessment, subject integration, and matching of teaching and learning styles. In the first phase of the study, a model of PBL was developed in response to Indian policy documents. This is described in Chapter 3. The Chapter 4 discusses the methodology of the research study. This chapter includes the major research questions of the study, the three phases of the study, descriptions of samples, data collection and analysis.

In the second phase, teachers' and students' views and attitudes towards projects were surveyed using focused group and semi-structured interviews, and questionnaires. The description of the survey and its findings forms Chapter 5 of the thesis.

Chapter 6 presents how students responded to two PBL units carried out with two different groups of students and the evidence of learning gathered from these engagements. The findings from the first two phases informed the structuring of a Teacher Professional Development (TPD) program for planning PBL projects in the third phase. This is presented as a narrative of implementation of a TPD model for planning PBL projects in Chapter 7.

Chapter 8 presents how teachers' project plans and assessment strategies evolved through their collaborative development of PBL modules 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 9 presents salient findings from the research study and reports on the use of materials developed in the study to other contexts. The research suggests potential action points in teacher professional development, role of other stakeholders in implementing policy guidelines and provides suggestion 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.

1.1. Context

During the last three decades there is an increased emphasis on universalization of education at the global level. Global agendas are pushing for ensuring students' skills of foundational language and mathematics and also the development of 21st Century skills. The Sustainable Development Goals (SDG) prepared by UNO (UN, 2015) set a target and action points for the nations to follow.

India's efforts towards ensuring universal education have been consistent and in alignment with the charter of SDG. 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] (GoI, 2020) categorically mentions the Sustainable Development Goals. However, in a vast and pluralistic country like India it is challenging to meet the targets as per the expected norms.

One of the reasons of such challenges is lack of coherence in policy suggestions and its implementations. Policy suggestions and its dictum are often presented as fragmented short term target statements, are indifferent to diversity existing in the educational and social landscape (Batra, 2020; 2012), insensitive to burdened teachers, and rely on prescriptive and top-down approach (Hayes, 2000) in education.

1.2. Motivation

NEP 2020 and NCF 2005 have suggested a basket of pedagogic elements to be adopted in the classroom and in the curriculum. Both the documents advocated for using projects and diverse assessment tools along with regular teaching. 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 alternative to the national approach.

There is an apparent diversity in the presentation and also a lack of a common pedagogic strategy based on overarching principles to tie these diverse efforts in one coherent curriculum approach. Literature documenting efforts carried out in India as well as around the world suggests that Project-Based Learning can be an effective curriculum approach to address the challenges of education and educating future citizens (Sriram, 2018).

However, there is no defined model of Project-Based Learning suitable for Indian contexts. Any curriculum intervention must build an ownership among teachers and empower both the students and teachers to be effective. Therefore, the present study was designed to evolve through a deliberation with teachers and students. 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.

1.3. Project method and project-based learning in school education

Project work was first introduced in architecture and engineering education during the renaissance movement in Italy in the late 16th century. The use of projects as a pedagogic strategy has evolved over time, influenced by the dominant educational theories at the time, collective expectations, and government influences in different countries (Knoll, 1997).

Conducting projects in school education, known then as the project method, received attention in USA during the late 19th and early 20th century through the advocacy of Kilpatrick and Dewey (Knoll, 1997). During 1960's the project method came under severe scrutiny when it was criticized on the grounds that project method did not ensure students' learning (Barron, Schwartz, Vye, Petrosino, Zech, Bransford, et al. 1998). However, in the last two decades of the 20th century, projects reappeared in schools in the USA and Europe in the form of problem-based learning and project-based learning that would be central to the curriculum and ensure students' constructive engagement (Krajcik, Blumenfeld, Marx, & Soloway, 1994).

Projects and progressive education have been a part of early nineteenth century school education discourse in colonial India (Badheka, 1990). Learning through doing productive craft work was conceptualized as a vehicle to make the nation self-reliant (Gandhi, 1994). The vision was echoed in the Report of the Education Commission (1966) that suggested including projects as part of school pedagogy (NCERT, 1971).

1.4. Projects in Indian policy documents

At present, the Government of India, through its many departments, has been promoting projects among children of school going age through more than ten different schemes. These schemes, except a few like Eco-Clubs, are aimed at encouraging children to conduct Science and Technology projects and emphasize different aspects, such as scientific investigations, technical skills like model making, surveys, etc.

The NEP 2020 and NCF 2005 envisage projects as an important component of teaching-learning and recommends connecting school learning to students' lives. These documents also advocate an interdisciplinary approach in school education, integrating formative and summative assessments of student learning as well as self and peer assessments in classroom practices (GoI, 2020; NCERT, 2005). The circulars sent by the Central Board of Secondary Education (CBSE) to schools affiliated to it has called for strengthening internal assessment methods at the secondary school level, and widening the scope of assessment by inclusion of multiple assessment modes such as through projects, interviews, questionnaires, etc. (CBSE, 2007). The CBSE has also published assessment manuals for all school subjects (CBSE, 2009).

The recommendations mentioned above are reflected in the curricular materials, such as textbooks in fragmented ways. For instance, projects are explicitly included in the curricular materials. However, their potential for being relevant to students' lives, integrating concepts and skills from different school subjects, and inclusion of a variety of assessments is not explored. Besides, teachers continue to conduct projects in traditional ways that value the appearance and factual content of project reports above the assessment of learning. Mahajan noted that practices of projects in school and college science and mathematics curriculum are not yet part of students' learning experience (Mahajan, 2018).

Another source of challenge are the circulars sent by the education board to schools. The circulars focus on mechanistic aspects of conducting projects, and are not in alignment with NCF 2005 recommendations, and difficult to implement within existing school practices.

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 to do so, are the Design and Technology Education project among middle school students (Khunyakari, 2008; 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).

2. Chapter 2: Literature review

2.1. Project-based learning

When a teaching-learning strategy organizes learning around projects (Thomas, 2000), it may be referred to as Project-based learning (PBL). According to literature on PBL, the projects in PBL are complex tasks based on challenging questions or problems which involve students in design, problem-solving, decision making and investigative activities (Krajcik et al., 1994; Marx, Blumenfeld, Krajcik, & Soloway, 1997; Barron et al., 1998; Thomas, 2000; Abdulwahed, Nagy, & Blanchard, 2009; Wurdinger & Rudolph, 2009). The characteristics of projects in most PBL literature are summarized in Table 1. These characteristics combine in different ways to result in a variety of PBL practices (Thomas, 2000; Abdulwahed et al., 2009).

Project (tasks)	Teacher	Students
Non-trivial, complex tasks, involves explicit learning goals; Has authentic content, challenging questions, authentic assessment; Involves decision making, investigative activities, cooperative learning, adult skills; Culminates in realistic products or productions.	Plans learning objectives; Includes design, problem solving, scaffolds; Structures collaboration, reflection, etc.; Facilitates and enables students' autonomy.	Work relatively autonomously in group or individually; Investigate, solve problems, make decisions, evaluate options; Make presentations, tangible productions

Table 1: Characteristics of Projects, Teacher's roles, and Students' engagement in PBL

Thomas (2000) proposed five criteria that distinguish projects in PBL from other similar pedagogy. These are described below.

- Centrality:** Projects are the curriculum and central teaching strategy. Students encounter and learn the central concepts of the discipline while engaging in the project.
- Driving questions:** Projects are focused on questions or problems that drive students to encounter (and struggle with) the central concepts and principles of a discipline.
- Constructive investigation:** Projects engage students in investigations that lead to their constructing new knowledge, not only application of knowledge.
- Autonomy:** Projects are student-driven to a significant degree.
- Realism:** Topics of investigation and the tasks involved are connected to students' life and address real life challenges. Besides, they also involve presentation to a real audience and judgments in that context.

There is a lot of literature on how to carry out project-based learning at elementary and middle school in western context (Krajcik, & Czerniak, 2018; Caparo, Whitfield, Etchells, Caparo, 2016; Baines, 2014; Eisenkraft, 2008; Boss & Krauss, 2007; Fleming, 2000). While it is heartening to find that

similar kind of literature existed around a century ago mainly in USA (Krackowizer, 1919; McMurry, 1920; Stockton, 1920; Wells, 1921), it is interesting to note that there is a dearth of reported literature on how to translate PBL in Indian school settings.

Literature consistently claims effectiveness of PBL pedagogy in enhancing students learning in content and skills (Sriram, 2018). In Indian context, literature (particularly in teacher preparation courses like BEd) poses an unclear view about the project and project method. There is a dominant view on Kilpatrick's "purposeful" work. The projects are visualized as tasks that students should do independently. Interestingly, in PBL, projects are visualized more as a common enterprise of teachers and students (Dewey, 1915).

2.2. Teacher beliefs

Teachers have a direct influence on student learning and play a significant role in the success of any educational reform. Teachers construct their knowledge about teaching learning in dynamic and complex ways (Pajares, 1992). They derive their knowledge about teaching-learning from the knowledge in related domains like student behaviour and learning, subject-matter difficulty, multiple perspectives, and educational context into their pedagogy and thinking (Anderson, 1991; Ball, 2009; Chiodo & Brown, 2007; Hashweh, 2003; Joram & Gabriele, 1998; Nettle, 1998).

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

However, teachers' beliefs about teaching do not always play a functional role in planning their classroom teaching (Eley, 2006). Teachers' beliefs and practices interact dialectically. But change in practice can most likely lead to change in beliefs, though change in beliefs is not sufficient to enable change in practice. In fact, Guskey (2002) feels that the change in practice can only lead to changes in beliefs. In this context, TPD can form a platform for generating collaborative models of PBL practices through suitable discussions as well as for making explicit teachers' beliefs about PBL.

2.3. TPD in the context of National Curriculum Frameworks

The National Curriculum Framework (NCF) 2005 and National Curriculum Framework for Teacher Education (NCFTE) 2009 recognized the need for integrating teachers' voice in curriculum design and implementation (NCERT, 2005; NCTE, 2009). Both these documents emphasized empowering teachers to translate the policy suggestions in their classrooms. The Right to Education Act (RtE) of 2009 has created a new pressure on Government departments to ensure that all the teachers participate in professional development programs within a limited period. Multiple workshops and professional development programs are conducted across the country.

It is unclear whether all these efforts, that focus on policy change and are mostly decontextualized from teachers' classroom practices, have been effective in terms of changing participating teachers' practices and beliefs. 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 teaching practices were not aligned with these goals (Nargund-Joshi, Rogers, & Akerson, 2011).

Batra (2016) listed several factors responsible for such gaps in policy suggestions and teacher preparation to translate policy suggestions in classroom. The factors included elements from all dimensions of social, political, and historical context. The major gap identified in the teacher preparation is absence of coherence in teacher education courses. The problem is compounded when the theories are not anchored in the practice of teaching and vice-versa. A dominant practice is not including content or subject specific pedagogy in teacher preparation (Batra, 2014).

2.4. Model of TPD for PBL

Several studies have addressed the problems of aligning teachers' project practices with PBL. Marx and coworkers (1997) reported that their work with teachers in developing and enacting project-based science in response to science education reform in USA between 1993 and 1996, was based on the "dynamic interplay of four elements: collaboration with others, enactment of new practices in classrooms, extended effort to instantiate change, and reflection on change" (p. 350). The collaboration among teachers and researchers included "working together to inform, share, critique, and support each other" (Krajcik et al., 1994, p. 490).

Toolin (2004) in his study with six teachers' implementation of PBL through TPD concluded that teachers' implementation of PBL depends on the pre-service and in-service professional development experiences teachers receive, their formal education background, interest to attend teachers' workshop on PBL, and longer teaching experiences. School philosophy and guidelines, peer discussion about planning and implementing PBL, and teachers' own commitment also influenced implementation of PBL. Novice teachers with little to no formal education background seem to focus more on the concerns of the daily routine and classroom management issues and less on learning about inquiry approaches like PBL.

Desimone (2009) proposed a model of teacher professional development that included five core features: (1) focus on content to be learned by students, (2) active learning during the professional development experiences, (3) coherence of the learning to teachers' professional needs, (4) occurrence over a long duration, and (5) collective participation by educators in their professional learning.

Loucks-Horsley, Love, Stiles, Mundry, and Hewson (2003) proposed a professional development model for science and mathematics in which they contended that teachers' environmental context and beliefs directly influenced goals and plans ultimately leading to specific actions in the classroom. They noted that self-reflection by teachers provides a feedback loop for modifications of goals. For example, one cannot simply give quality science curriculum materials to a teacher and expect quality science instruction. Their model supports the contention of Haney and Lumpe (1995) that science teachers' beliefs must be identified and clarified prior to and during professional development activities. Similar conviction has been echoed in TPD conducted in Indian context. Kumar and Subramaniam (2013) suggested developing an understanding of teachers' beliefs as an integral part of the TPD initiatives to promote changes in teachers' classroom practices.

Teachers are primarily responsible for PBL implementation in classrooms. The limitations they face in implementing PBL affect their motivation. Empowering teachers in PBL approach has been suggested to solve the classroom implementation problem (Barron et al., 1998; Krajcik et al., 1994). A practical way to empower teachers in PBL practice would be to establish collaboration between researchers and teachers to implement PBL in classrooms (Scott, 1994).

3. Chapter 3: PBL: A response to curriculum reform

The NCF 2005 and National Education Policy 2020 envisages projects as an important component of teaching-learning. These also recommend connecting school learning to students' lives, including a variety of forms and modes of assessment, and so on. However, these appear in the curricular materials like textbooks in fragmented ways. For instance, projects are explicitly included in the curricular materials. But the nature of projects and their potential for being relevant to students' lives, integrating concepts and skills from different school subjects, and for including a variety of assessments is not explored. Besides, teachers, who have been doing projects even before the curricular reform, continue to do so in traditional ways that value the appearance and factual content of project reports above the process and assessment of learning. They neither understand the nature of change expected from them, nor can they find ways to meet the constraints of current school systems and parental expectations.

NCF 2005 and NEP 2020 identified persisting lacunae in the education system. These seek a shift to constructivist and child-centered teaching in Indian classrooms and re-state the importance of hands-on work, making connection with children's real world and adopting learning by doing as a pedagogic strategy. The NCF 2005 and the position papers on various topics that served as inputs to it emphasize several aspects as important components of pedagogy (NCERT, 2005): fostering the spirit of scientific inquiry, democratic decision making, caring for the environment, etc. These documents recommend that students participate in group activities, discuss with peers and teachers, conduct surveys and project work to generate an environmental database, take part in debates and role play, organize data and display the same exhibitions.

NCF 2005 advocates interdisciplinary approach in school education. It also suggests integrating formative and summative assessments of student learning as well as self and peer assessments in classroom practices. NEP 2020 reaffirmed these suggestions made by NCF 2005. The circulars sent by the Central Board of Secondary Education (CBSE) to the schools affiliated to it, asked to strengthen internal assessment at secondary level and widen the scope of assessment by inclusion of multiple assessment modes such as projects, interviews, questionnaires, etc. (CBSE, 2007). The CBSE has also published assessment manuals for all school subjects (CBSE, 2009).

Both the NCERT and state board textbooks incorporate projects in almost all school subjects, though these projects are not central to the 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, integrates topics from several subjects. Since these projects are not mandatory, and do not count for grades in examinations (NCERT, 2009), they are neither known to all schools, nor implemented. Unfortunately, all these result in an increased demand of time from teachers as well as from students and parents (Shome & Natarajan, 2013a).

The analysis of proceedings of National Teachers' Science Congress (NCSTC, 2010, 2012) shows that most projects reported are largely conducted with select students. Those conducted with the whole class are as motivation or co-curricular activities. They do not pertain either to projects as a primary pedagogic strategy with specific learning goals, nor as a context for formative assessment.

In order to make projects more central to the teaching-learning, as envisaged in NCF 2005, 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 our study. PBL naturally brings multiple subjects and disciplines together in a real-world problem context where students work in groups (Marx et al., 1997; Krajcik et al., 1994; Tamim

& Grant, 2013), and provides an opportunity of multiple products for formative and summative assessment including peer and self-assessment (Barron et al., 1998). While planning and conducting projects, teachers must take care of a great deal of management aspects like planning and managing resources, time, etc. (Scott, 1994).

Our study had adapted the idea of PBL (Thomas, 2000) to integrate pedagogic elements delineated in NCF 2005.

- a) **Centrality:** 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. Given this rigid requirement, it is not possible for almost all schools, which are under the Central or State Board, to make projects the curriculum.
- b) **Driving question:** Though this is a novel and hence difficult idea, it was retained as a useful motivation for teachers to engage students in investigation. They 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.
- c) **Constructive engagement:** Thomas' criteria of constructing new knowledge integrated with students' disciplinary engagement has been ensured through aligning activities, tasks, and assignments with explicitly stated learning objectives and assessment rubrics.
- d) **Student autonomy:** Thomas' criteria included unsupervised work time, choice of planning and execution, and responsibility. Ideas of peer and self-assessment by students were added to indicate explicitly their ownership of the project.
- e) **Realism:** Besides the real-world connection and judgment in the context of the real-world task that Thomas' criterion requires, the aspect of authentic assessment was explicitly added. In this student are asked to perform real-world tasks that demonstrate meaningful application of essential knowledge and skills. It can also be thought of as the assessment of students located within the contexts of tasks that they perform.

This part of the study also formulated four main aspects that PBL projects for Indian classrooms need to address: subject integration, assessment, group work and management of time and resources. These were derived from (a) the recommendations of NCF 2005 about learning, projects, and assessment, (b) the nature of projects suggested in textbooks, (c) the possibility of integrating these with the content in the textbooks of different subjects, and (d) the advantages for teachers in a school if they worked collaboratively. The four aspects are briefly explained below.

- a) **Subject integration:** There are several difficulties in aligning projects with the content in the textbooks (Krajcik, McNeill, & Reiser, 2008). However, projects can take advantage of the repetitions of the content in the textbooks of different subjects acknowledged in the syllabus (NCERT, 2006). This approach of subject integration may enable students to perceive connections between the topics, subjects, and their everyday lives, making learning meaningful and relevant (Beane, 1995; Kaskey-Roush, 2008).
- b) **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, as Hargreaves terms, an "instrument of surveillance" (Gipps, 1999, p. 362). It would be useful to conceptualise assessment from a socio-cultural perspective.

An interpretive approach, as discussed by 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 assessment provides a non-threatening environment for students. 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).

- c) **Group work and learning:** Learning is conceptualised as a social process along the lines suggested by 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 (Cohen, 1994; Echeverria & Hannam, 2013).
- d) **Management of classroom and resources:** 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.

This study led to the development of a model of PBL that could address the recommendations of the policy and the concerns of implementation. This was followed by surveys of teachers and students about projects and their current practices.

4. Chapter 4: Methodology of research

The study aims to design a collaborative model of teacher professional development (TPD). Through the TPD, teacher participants would plan projects that are in alignment with PBL criteria and hence with the recommendations of NCF 2005. Developed by the teacher participants, it would also address their current concerns of conducting projects as part of the educational reforms, which include aspects of time management and assessment.

4.1. Research questions

The study was guided by the following four research questions:

- a) How are projects presented and recommended in the NCF 2005? And how are projects introduced in the NCERT and Maharashtra State Board textbooks? How can the five criteria of PBL enunciated by Thomas (2000) be interpreted and elaborated in the Indian educational context to address the recommendations of NCF-2005?
- b) What views do teachers and students hold about projects and their practices?
- c) How can teachers' existing views and practices be used to develop a collaborative teacher professional development model that enables teachers to generate PBL and conduct it in their classes? What are the challenges of implementing PBL that teachers face and what TPD strategies may serve to mitigate them?
- d) How do teachers' project plans and assessment strategies as well as their ideas about PBL evolve through their collaborative development of PBL modules in a TPD program?

4.2. Theoretical Framework of the study

PBL is a way of encouraging students' engagement and addressing the contextualization of student inquiry (Blumenfeld et al., 1991). It is also consistent with the constructivist paradigm of learning (Krajcik et al., 1994), and follows in line with cognitive theories such as situated learning theory of Lave and Wenger (1991), the cognitive apprenticeship theory of Collins, Brown, & Newman (1989) and constructionism (Papert, 1980).

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 scaffoldings from the teachers as well as from the more able peers. In our study, we have conceptualized PBL from a social-constructivist paradigm (Rogoff, 2003) and Freire's critical pedagogy perspective (Freire, 2000). 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.

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 larger socioeconomic and politico-cultural landscape (Prawat, 1992; Price & McConney, 2013). Any attempt to improve teachers' practices must consider the school context as well as the larger social context (Lam & Lidstone, 2007). Thus, the social constructivist paradigm is also important to consider while implementing programs for teacher professional development. TPD also provides an important platform to address teachers' beliefs about the nature of the domain they teach and the processes of teaching-learning.

The main aspect of the study was development of a TPD model for PBL that emphasised assessment of students' learning, subject integration, group work and other related areas. The study situated the research in the frameworks of social constructivism (Rogoff, 2003) and critical pedagogy (Freire, 2000) as discussed above.

Following Krajcik and his co-workers (1994), we have collaborated with workshop participants to plan and implement PBL, provided a platform to articulate and share participants' practices, critiqued, and reflected on projects, those conducted by the participants as well as researchers. Like in the work of Desimone (2009), the PBL planning was based on textbook content, and the workshops were 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. We have designed the engagement with the participants over a duration spanning more than six months and attempted in a collaborative environment to address teachers' professional needs. The study was conducted in three broad phases as shown in Figure 1. We have also explored teacher beliefs and attitudes in every phase of the study and incorporated it as integral part of TPD (Loucks-Horsley et al., 2003; Haney & Lumpe, 1995; Kumar & Subramaniam, 2013). Each phase is briefly described below.

4.3. Phases of the study and context

Phase I: In Phase I, a variety of curricular and policy documents were studied to uncover the role of projects in the current Indian education. This study led to a suitable interpretation and elaboration of the five criteria of PBL given by 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 (a) National Curriculum Framework 2005 (NCERT, 2005), National Curriculum Framework for Teacher Education 2009 (NCTE, 2009), and National Education Policy 2020 (GoI, 2020); (b) the middle and high school syllabi, textbooks, project and assessment modules published by the National Council of Educational Research and Training (NCERT) as well as the Maharashtra State Bureau of Textbook Production; (c) the circulars relevant to projects and assessment that were sent to schools periodically by the Central Board of Secondary Education (CBSE) (CBSE, n.d.); and (d) proceedings of the biennially held National Science Teachers' Congress (2009 and 2011) (NCSTC, 2010, 2012).

At the end of Phase I, a model of projects along with some broad criteria for the Indian context was developed based on the PBL conceptualization of Thomas (2000). This was then used in Phase II for designing survey tools - for semi-structured interviews and questionnaire surveys of teachers and students.

Phase II: As part of the study in Phase II a focus group interview with 10 teachers of one school system, and semi-structured interviews ranging from 30 to 55 minutes were conducted with four teachers to know their views about and practices of projects. Their responses were also sought on the implementability of the PBL model developed in Phase I. Details of the four teachers interviewed are given in Table 2.

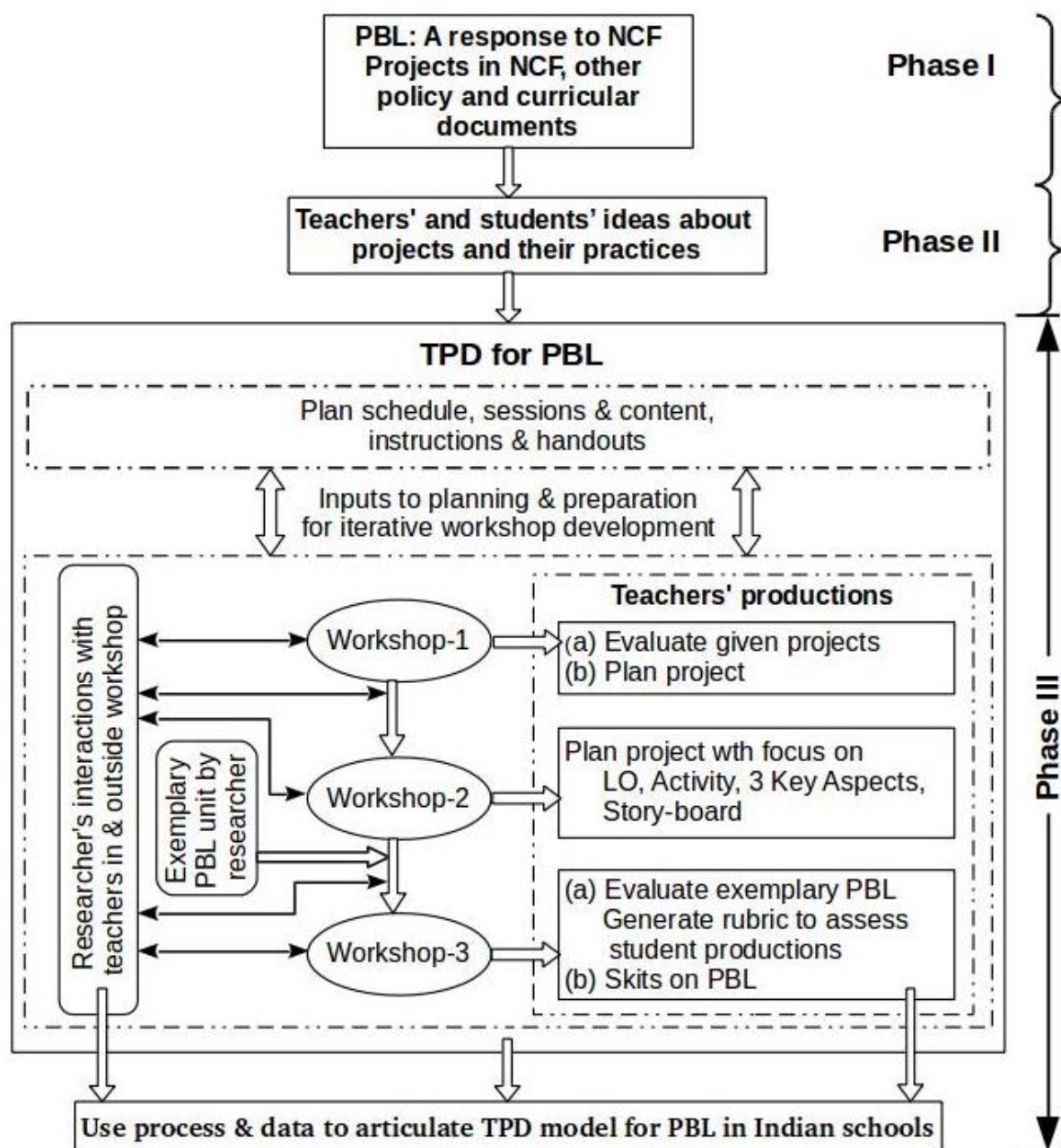
Another part of the study in this phase was exploration of the views and practices of 34 teachers and educators through a questionnaire survey. The respondents, who were participants of the first workshop of the workshop series conducted in Phase III, comprised of 30 females (25 teachers, four teacher educators, one teacher administrator) and four males (three teachers and one teacher educator). They represented 22 schools from nine organizations (or school systems) with different organizational structures and socio-economic profiles of students and teachers.

There were five broad categories of organizations: a) schools partially funded by government and run by a private body (A), b) funded and run by government (B, F, I), c) voluntary educational organization (C), d) government funded schools run by voluntary organizations (E, G, H), and e) privately funded and run school that follow curricula different from the Central or State board (D). Most of the practicing teachers had either a Diploma (Dip.Ed.) or at least one degree (B Ed.) in education. There were teachers of different subjects among the respondents. Half the participating teachers were 35 years or older and had 10 or more years of teaching experience.

A part of Phase II was a questionnaire survey and interviews of students to explore their views towards projects. The sample surveyed is given in Table 3. The synopsis reports only a preliminary analysis of responses from students. Details will be reported in the thesis. This survey was conducted in the middle of Phase III.

Using the findings from the documentary analysis in Phase I, and based on teachers' views about projects, their statements about their project practices and their response to the suggested model for conducting projects, an outline of a series of workshops was drawn up in the next phase.

Phase III: In Phase III an iterative model of TPD was developed, where teacher participants collaboratively generated project plans in alignment with PBL through engagement in a series of three workshops organized over a period of six months. Total 43 participants (31 teachers, 9 teacher educators, 1 teacher administrator [earlier was a teacher], and 2 students of education) attended one or more of the three workshops. There were 34 participants in the first workshop. Twenty-two participants attended all the three workshops. A few participants dropped out after the first workshop, while a few more joined in the second workshop.



Note: Workshop 1 held during 7-10 July 2010; Workshop 2 held during 22-23 October 2010; and Workshop 3 held during 9-11 December 2010

Figure 1: Phases of the study

There were also school visits and interviews of participant teachers between the workshops. Eighteen teachers and teacher educators were interviewed, and 13 schools were visited to

observe the process, issues and concerns related to the implementation. Students' interviews were also conducted in five schools. Follow up with two more teachers and one teacher educator was carried out over phone and online chat.

During the workshops, participants generated project plans guided by worksheets and presented these. The analysis of participants' productions, their feedback and inputs from each workshop and school visits helped to plan and restructure the following workshops.

In fact, in response to the participants' needs in the first and second workshops, two PBL modules were developed by research group. One of these modules was conducted among middle school students and the other was conducted among high school students. The story board, students' productions, and log of events of the first module were then used as an exemplary PBL unit for participants to engage with in the third workshop. The inputs from participants' productions and school visits formed the data, based on which the evolution of participants' project plans and assessment strategies, as well as their increasing alignment with PBL criteria were studied.

The model developed through the workshop series and the materials generated were applied and refined in Phase III by conducting two teacher workshops.

The learning from these phases and development of resources from the engagement were also piloted and used in the other Teacher Professional Development Workshops.

4.4. Data and analysis

The research had three phases and used multiple methods in its design. One was the interpretive analysis of relevant policy and curricular documents for specific aspects like projects, activities and assessment.

Survey responses through semi-structured interviews were audio recorded after obtaining permissions from participants. The records were transcribed verbatim. The utterances from interview responses and the responses to the questionnaire were independently coded by more than one person and inter-rater reliability was checked each time.

The interview responses were analysed using case study approach, while questionnaire data that contained both free responses as well as responses to Likert type scales was analysed using mixed methods.

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)
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Table 2: Profile of interviewed teachers.

Sr. No.	School system	School	School Board / Management	Class	No. of students	Mode of data collection
1	I	IK	CBSE	IX	86	Interview
2	E	E	State Board	VII	43	Questionnaire
3	G	GR	State Board	IX	12	Questionnaire
4	F	F1	CBSE	VIII	23	Interview
5	F	F4	CBSE	VI	34	Questionnaire

Table 3: Profile of participant students.

Participants' productions during and between workshops were in the written form as completed worksheets and online communication. Data was also collected as audio and video recordings of discussions, presentations, and interviews of teachers between workshops, and researcher observation notes. The audio in the recordings were transcribed verbatim. The text from the recordings and written responses were analysed for the five criteria of PBL adapted from 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 understanding of PBL and related ideas like assessment, subject integration, group work, etc. through the process. The results from the different phases of the research study and their significance are discussed in the following sections.

5. Chapter 5: Teachers' and students' views on and practice of projects

This chapter reports on the views and attitudes of teachers and students conducted through focused group discussion, semi-structured interviews, and questionnaire surveys. The model of PBL developed through literature review and observation of school processes was shared with teachers of one school system in a focused group discussion. The reconceptualised model was used for designing semi-structured interviews and questionnaire surveys of teachers. The semi-structured interviews helped further refine the survey questionnaire for teachers and students. Here the findings from individual semi-structured interviews and questionnaire survey are reported. Findings of focused group discussion is given in the thesis.

5.1. Teachers views on the proposed model of PBL: Individual interviews

In this study, semi-structured interviews ranging from 30 to 55 minutes were conducted with four teachers from three schools from two different school boards. The main findings are summarized here. The detailed study has been reported elsewhere (Shome & Natarajan, 2013a, 2013b).

One of the significant findings was that the term project was a part of the everyday vocabulary of all teachers. Yet, their ideas of what constituted a project differed from the policy as well as each other. Teachers appropriated the recommendations of circulars in their teaching schedule by reducing projects to home assignments or simple short duration activities. The practice of projects was varied

across the school and teachers from the same school in terms of frequency of such projects, nature of project assignments and assessment of students' productions. How teachers will structure and assess project seems to be based on the kind of learning they value, the role they perceive in students learning, and the role entrusted upon them by their school authority. The variety of such practices may also have resulted due to ambiguity in circulars and lack of teacher support to familiarise new policy demands and curriculum goals.

Teachers' project practice and their views in the context of the four proposed aspects are described under separate headings.

Subject integration: Based on PBL literature, Krajcik and co-workers summarised that there was a tension in aligning the standards (Krajcik et al., 2008) – in the Indian context, one can consider this as a tension between 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. Resolving this tension, the teachers in our study gave primary importance to textbook content and 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 subjects. They also agreed to the proposed aspect of subject integration.

Assessment: 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 students and when used, these 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 and NEP 2020. 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: The teachers felt that group work was not practical among their students. And they stated teachers' lack of time, students belonging to diverse socioeconomic strata in their classrooms, and students' lack of interest as challenges to students' work in groups. Teachers were also unsure about the learning from projects by all students.

Issues of management: Teachers cited time as a critical resource constraint to conducting projects proposed by the researcher. Other constraints included large class size, lack of guidebook for students, and lack of library facility.

Although teachers did not agree to the many of the aspects of the proposed PBL model, three of them asked for a systemic change to make the proposal functioning. Two of them added that such projects can be conducted at the most once or twice in a year. The study identified that teacher did not feel empowered to bring about the changes in classrooms needed to implement the NCF 2005 and NEP 2020 suggestions.

The tensions between addressing policy requirement within the systemic and social constraints, may be resolved by enabling the sharing of the educational goals and expectations among all stakeholders, especially, school management, teachers, researchers, and policy makers. Towards this end, a discourse was initiated between a few teachers and researchers about existing project practices, and on evaluating the constraints and identifying the leverage that can bring about tangible change. The

insights gained from the study have guided all the later developments in the longer-term collaborations with teachers on PBL.

5.2. Teachers views on and practices of PBL: Questionnaire survey

A questionnaire was used for survey of teachers' ideas and included: seven open-ended questions, and 24 statements with Likert type choices. Two examples of open-ended questions are given below: the first sought teachers' views and the second explored their practice. The questionnaire was administered to 34 teachers who participated on the first day of the series of PBL workshops as part of the TPD.

Form B: 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".

Form D: Please fill the project details of at least two recent projects: Title, subjects, topics, learning goals, duration, group or individual, student tasks, teacher's role, assessment scheme, difficulties faced, and expected outcomes.

Teachers' responses to the open-ended questions were whole sentences, phrases or just one word. A word, phrase or a simple sentence in a compound sentence was each counted as a unit of response. In some cases, two simple sentences were coded as one unit, as they made sense relevant to projects only when taken together. When a phrase or sentence had multiple ideas joined with conjunctions, each idea was counted as a separate unit. The total units derived from the responses to the four open ended questions on views about projects were 688 (N=688).

The category code assigned to each unit emerged from the units of responses and were guided by considerations like those used in preparing the questionnaire tool as well as by aspects of PBL and its implementation. Final coding scheme evolved iteratively, between two researchers. Inter-rater reliability of the final coding was 87%. Disagreements were resolved by discussion. The responses of teachers on views about projects from the four open ended questions could be grouped largely under ten categories (Given in Table 4). 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.

Sr. No.	Category	Percentage of total response	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	teamwork, 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

Table 4: Pattern of teachers' views about projects. N = 688

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 based on 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 teamwork, it came from most of the teachers. In the practice related questions, over a third of the teachers (38%) mentioned assigned group projects. Only 4% of the responses referred to students selecting and conducting project tasks or learning on their own. Despite assessment being an issue of frequent discussions and circulars on continuous and comprehensive evaluation had brought it to the foreground, very few responses (2%) referred to it. Together with the 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". In the practice related questions, assessment was limited to evaluating final productions. Despite the question asking for it, most teachers did not mention the learning goal and corresponding assessment criteria. Those who did mention assessment criteria, did not match them with the stated learning goal.

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. In this context, it is important to note that in the practice related questions, teachers from three school settings reported constraints of resources. These school settings included poor as well the well-funded schools.

5.3. Summary of students' views

The objective of the study was to explore students' views about projects, and their actual practice of carrying out the project. A questionnaire survey and semi-structured interview were conducted with students of five schools.

The student questionnaire was based on similar considerations as the teacher questionnaire. The questionnaire contained 5 open ended questions, one close ended question and a set of 20 Likert Type statements. A preliminary analysis of responses of students from two schools (F4, M) to two of the open-ended questions and a set of 20 Likert type statements is summarised here.

The analysis was along similar lines as for the teachers' responses. Most of the students associated projects with learning, fun, and group work. They mentioned that project helps them to understand better. These match with the teachers' views about projects. Interestingly, students of one of the schools (F4) stated that projects should be done 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 same school system. In semi-structured interviews conducted among students from two school systems (F1, IK), students stated that their teachers assign project topics to groups of students. The group size in one school (F1) was three to four, while in the other (IK) it was between six and nine. Students did their work at home helped by their family members. Students from one of the schools (F1) liked to do projects and claimed that they learned a lot through doing projects, as did their teachers. However, though a teacher of the other school claimed that her students learned from projects working in groups, her students did not support this view. They also mentioned that there was little clarity in assessing projects.

A detailed analysis of students' responses is presented in the thesis chapter.

6. Chapter 6: Development of PBL units with students

The researcher along with the research team developed and piloted two PBL units with students. The first one was "designing and making play item models". Students visited a given area of proposed park and asked to make scaled down models of play items. The second task was to draft an India Tourism Leaflet. These two units are discussed separately in the following two sections.

6.1. Designing and making play item model

The objectives that guided the project included gathering evidence of students' learning through student productions in D&T tasks and developing suitable assessment rubrics to help evaluate students' learning through D&T tasks. The idea was adapted from Malcolm's (1994) story of a similar unit, which illustrated how learning objectives of concepts and procedures in science and mathematics are met while students engage in planning and designing a playground.

A workshop was planned to keep in mind the PBL pedagogy (Thomas, 2000) to include several issues relevant to learning concepts, procedures, and designing. The workshop was conducted among Class 6 students (age 10 to 12 years) from a neighbouring school. It engaged 15 students working in 3-member single-sex groups (2 boys groups, 3 girls groups) in designing and making play item models. 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 (Mehrotra, 2008). Each group of students would make a different item model and all the models would be placed on a scale model of the park.

A detailed log of all the events including the planning was maintained by the researcher. A story board was developed, as shown in Figure 2. The workshop was scheduled over five consecutive days of four hours each during the short mid-term school vacation. The tasks planned for each day are given in Table 5.

Day	Tasks
Day 1	Fill personal information sheet, form groups Discuss playground context Measure and map playground space List 10 playground items, 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, 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, Evaluate products through self and peer assessment

Table 5: Schedule of tasks for each day of the “making a playground model”

Every student group maintained a portfolio of all its paper/pencil productions: 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 their making experience. The productions were analyzed to gain insights on students’ learning in and through the activities. An

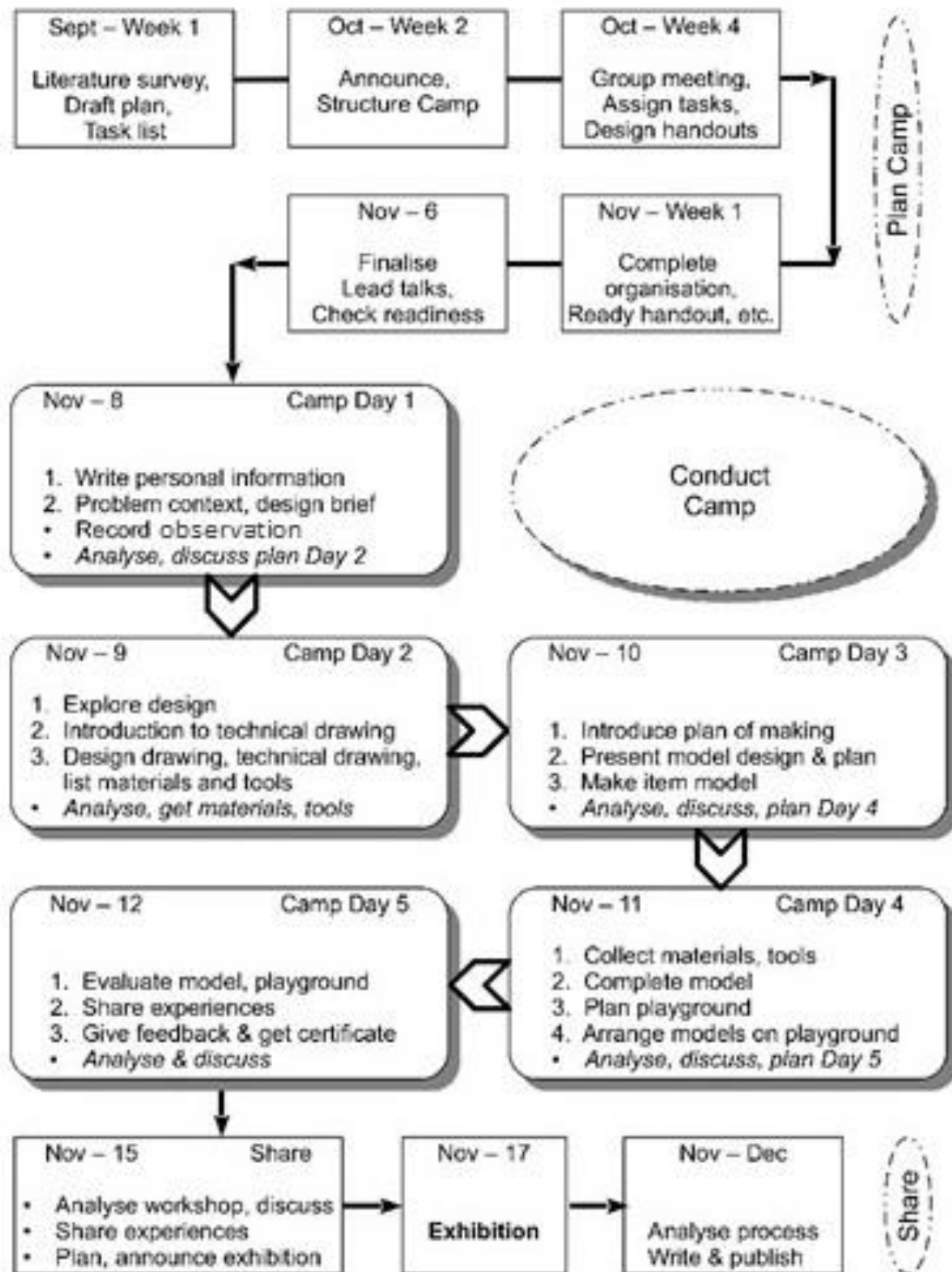


Figure 2: Story board showing the planning, execution, and reflection of the Design & Technology project on making play-item models.

assessment rubric was also developed to record and facilitate student learning. Students used the rubric for self and peer assessment. The evaluation of students' work and the PBL was based on group portfolios, observers' notes as well as notes on students' presentations of their design and anticipated

making, as well as their self and peer evaluations. Students' tangible productions in response to the demand of tasks made this activity a PBL unit, which was placed in an exhibition for their parents, teachers, and staff of an institution.

A summary of this project activity, the story board, researcher's logs, portfolios of groups of students, and the actual playground with all the items made by the groups of students was made available to the teacher participants during the third and last workshop in the TPD series, which is discussed below.

6.2. Drafting India tourism leaflet

Learning from this engagement followed piloting the second PBL unit on Drafting India Tourism leaflet. Fifty-eight students of Class 9 (age 14 to 16) from the same school type attended the session. There were 2 sessions of total five hours duration. Students were given an instruction sheet and briefed about drafting a tourism leaflet in groups. Students were engaged in self and peer assessment of productions, presented their work to the whole class, and engaged in discussion through question-answer session.

Students' productions in the form of draft tourism leaflet, rough work, video recording of the sessions and presentations, and self and peer-assessment sheets served as data sources for analysis. The analysis of this work is presented in the thesis.

Both these piloting of PBL units indicates that it is possible to ensure students productive disciplinary engagement in a real-world problem context. Students were able to provide constructive feedback to their peers and reflected on their own work. Thus, students engaged in several of the 21st century skills like group work, demonstrating creativity, negotiation of ideas, respect of others views, sensitivity to diversity, listening, and presentation of ideas etc.

7. Chapter 7: Development of TPD model for PBL

A design research model of TPD was developed, where teacher participants collaboratively generated project plans in alignment with PBL through engagement in a series of three workshops organized over a period of six months. The sessions of the workshops are given in Table 5.

Day	Workshop 1 7-10 July 2010	Workshop 2 22-23 October 2010	Workshop 3 9-11 December 2010
1	<i>Questionnaire:</i> Views on projects <i>Lead talk:</i> Introduction to PBL <i>Group work:</i> Readings <i>Present:</i> On Readings	Recap of Workshop-1; Plan of Workshop-2 <i>Group work:</i> Plan project <i>Discuss:</i> Expert sessions on 3 key aspects – Assessment, Subject integration, Classroom management <i>Present:</i> Plan with 3 key aspects	Recap of Workshop-2; Plan of Workshop-3 <i>Group work:</i> Assessment of student portfolios <i>Present:</i> On Portfolio assessment <i>Discuss:</i> Plan BASE workshop
2	<i>Discuss:</i> Project activities <i>Lead talk:</i> Problems & projects <i>Group work:</i> Plan & structure project <i>Present:</i> Project plan	<i>Discuss:</i> 3 key aspects <i>Group work:</i> Structure projects <i>Group work:</i> Poster making <i>Present:</i> Poster presentation	<i>Group work:</i> Review of example PBL practice <i>Present:</i> Critique of example PBL practice <i>Discuss:</i> Plan BASE workshop; Group Skit on PBL

3	<i>Discuss:</i> Types of teaching-learning <i>Lead talk:</i> Assessment <i>Group work:</i> Plan projects with assessment <i>Discuss:</i> Driving question and project plan <i>Present:</i> Revised project plan		<i>Group work:</i> Skit practice, enactment & discussions <i>Present:</i> Revised project with assessment plan Summary & feedback
4	<i>Discuss:</i> Develop analytical rubric, include in PBL <i>Present:</i> Revised assessment plan Workshop-1 summary; Plan of further action		

Table 6: Sessions in the three workshops.

The following subsections will discuss the engagements among participants of the sequence of workshops designed for PBL. It will also analyze their written and oral productions as part of the workshop activities in terms of evolving ideas about projects and major aspects relevant to their planning and implementation of projects in alignment with PBL criteria. School visits and feedback from participants during and outside the workshops will be discussed in relation to their influence on iterative development of the TPD model.

7.1. Introduction to planning PBL

The first workshop primarily introduced the participants to PBL and to planning a project aligned with PBL for implementation in their respective schools. It was structured to include interactive enrichment sessions in the form of lead talks, participants' activities and group work, and discussions and presentations by participants. The sessions aimed to encourage participants to (a) articulate their ideas about PBL, (b) discuss their concerns about conducting PBL, (c) share ideas and strategies to address some of their concerns through planning PBL projects, (d) engage in planning projects on the lines of PBL suitable for their schools and students, and (e) develop insights about the challenges and possibilities in the exercise. Participants' engagement and productions are discussed here under the broad themes of introducing participants to PBL pedagogy while contextualizing it in relation to Indian curricula and classrooms, and the results of their attempts to plan projects.

7.2. Introducing and contextualising PBL

The workshop began with formal registration and introductions of participants and resource persons, including the researcher, after which, the participants filled a survey questionnaire. The details of the findings of the survey have been discussed earlier in Section 5.2. The participants were then introduced to PBL pedagogy. A discussion was initiated on different types of projects and comparing them with PBL in terms of the five characteristics of PBL adapted from Thomas' (2000) PBL criteria as given in Section 4.

Participants were requested to form groups, and each group of participants was assigned a research paper to read and prepare a presentation based on a set of guiding questions. In the limited time of the session, the groups responded to most of the relevant guiding questions partially. Overall participants found the papers difficult to read. All groups responded to questions that required them to link the authors' concerns and their own teaching concerns. However, they found it difficult to reflect on how their responses to the challenges would be different or like those expressed by the authors.

The discussions and presentations on the first day indicated that participants had difficulty in making the connections between the PBL issues and their own project practices. Therefore, it was planned to include discussions of projects set in local contexts on the second day. Each group was given two short descriptions of projects. Each project satisfied one or more of the PBL criteria to different extents. Participants had to evaluate whether each was a PBL project or not based on a given analytical rubric including the five PBL criteria with descriptors and a project approval format. The researcher also independently rated each project on all the criteria.

There was complete agreement between the researcher and participant groups in approving the projects as PBL (corr coeff 0.91). However, there were qualitative differences between the two in justifying the projects as PBL or providing feedback. There were some agreements on constructive engagement (corr coeff 0.95), and centrality (0.88), a little less on whether there was a driving question (0.72). However, the rating agreement was lower for student autonomy () and realism of the project ().

A lead talk on problems and projects included five themes: (a) Discussion of PBL criteria, (b) Developing PBL project ideas, (c) Driving questions and their types, (d) Teachers' role in PBL implementation, and (e) Perceived tensions in planning and conducting PBL projects. A session introduced participants to different types of activity based and constructivist teaching learning methods, their similarities and differences. Another on assessment introduced forms and types of assessment, tools of assessment, formative and summative assessment, role of rubrics in assessment and ways to assess students' productions.

On the second day, each group of participants was then given a project planning format and an activity to plan a project that they would conduct with their students after the workshop. Their plans subsequently evolved because of their engagements like group work, presentations, etc. and in response to discussions, inputs, and structured worksheets. In fact, the TPD was structured, and activities and worksheets were designed to engage participants with PBL so that the evolution of their ideas about PBL could be studied.

7.3. The beginning of PBL planning

The project planning task required participants to select the learning goals of the project that they were going to assess, select productions to assess the listed learning goals, and prepare an analytical rubric to assess students' productions. Discussions generated inputs for including PBL elements and modifying the project plans: a) role of driving question, b) steps to construct driving question, c) aligning driving question to the learning goal. The discussion included steps to decide learning goal, tasks, and productions, aligning productions to the learning goal, delineating criteria to assess productions and communicating the assessment criteria as well as assessment scheme to the students.

Throughout the first workshop participants worked in approximately 5 member groups to create (or develop) project plans that they would implement in their respective schools.

7.4. School visits and teachers' project implementations

After each workshop the researcher visited the schools (No. of schools=13) of several participants and met the teachers, their colleagues, the school principals, and students and conducted semi structured interviews and discussions with one or more of them. The school visits provided insights into the nature of teachers' difficulties in implementing projects aligned with PBL in their school contexts. These insights were used as inputs for planning future interactions.

7.5. Inputs for TPD planning

It was heartening that throughout 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. However, discussions with the participants and the findings from the activity on “Is this PBL?” suggested that they did not yet appreciate the nature of differences between traditional projects and project-based learning, though they intuitively decided whether a project was in alignment with PBL or not. Besides, this intuitive understanding was not sufficient to enable them to structure and implement projects aligned with PBL pedagogy in their school context. During the school visits it was observed that teachers mostly continued to follow their earlier practices.

Experience from the workshop, analysis of participants’ productions, successive school visits, and communication with the participants indicated a need for restructuring of the second workshop both in terms of its schedule of sessions and content. 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. They still lacked a coherent understanding of formative and summative assessment and how these could be naturally integrated within PBL practices.

Further, it was felt that (a) emphasis on generating driving questions, (b) introducing unfamiliar terms (like authentic), (c) lack of exposure to an exemplary practice, and (d) not situating assessment in the PBL context, were all making PBL planning difficult for participants. To address these concerns the second workshop was restructured to focus on three of the four key aspects relevant to successful implementation of PBL in Indian contexts and discussed in Section 4. These were identified as 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 collated or generated.

Worksheets with project planning formats were modified and 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.

7.6. Workshop on three key aspects

In the second 2-day workshop, the participants worked in smaller groups of three members each on planning a project that they would be able to implement in their school. But this time, the planning was more focused on three key aspects: subject integration, assessment, and classroom management. The 3 member groups were called home groups. There was a total of ten home groups in the second workshop. Each home group presented the plan of their project in the form of a poster at the end of the workshop on the second day. Besides there were expert groups on three key aspects: subject integration, assessment, and classroom management. Each of the expert groups were formed by drawing one of the members from each home group.

First, guided by a worksheet, each home group had to think of a project and list a number of topics from one or more subjects that they would address by conducting the project. They had to list the major concepts and skills that their students would learn through their planned project.

Second, 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 concepts and skills they had listed would be assessed through the planned productions. After the second activity the ten groups split and regrouped into three expert groups, each engaging in discussions on one of the key aspects. The concerns and issues raised in each of the expert sessions are summarised below.

Subject integration:

Subject integration involved including concepts from across disciplines. It may not be possible to integrate across different subjects for every topic. In this approach several aspects like social and community issues, and current affairs or everyday experiences may be addressed. The group opined that learners with different interests would find it enjoyable if projects brought together topics from multiple subjects. Students could be formed in groups and assignments could be allotted to groups based on students' interests in a subject.

The group had doubts about time management and completion of the curriculum. They wondered if they could get the needed cooperation from teachers of other subjects and anticipated that it would be difficult to generate suitable assessment when different subjects were involved. But they were also hopeful that the issues of assessment pertaining to subject integration could be solved through the workshop.

Assessment:

The assessment group pondered on two major points. The first was whether the project assessment should be formative or summative with respect to students' learning and effort. They discussed whether the criteria in a rubric should be large in number, say 10-12 or limited to 3-5 and were of the opinion that the choice of assessment depended on what learning goals were expected to be achieved. They decided that each outcome must be assessed irrespective of the difficulty level of the task and mentioned that a well-designed rubric depicted the level of students' performance and brought about transparency in assessment and may have criteria for different aspects of performance, like impact of the performance, work quality, craftsmanship, behaviour, validity of the content.

However, they felt that it was too difficult to frame an assessment rubric that would serve well for a class of 50 students. They were also unsure of how assessment could reduce subjectivity from a student's point of view.

Classroom management:

The classroom management group was given a research paper and handouts on classroom management. The research paper listed activity goals and corresponding learning goals, and the classroom management required in each activity. During the session some of the teachers asked for clarifications regarding the readings given to them. Finally, the teachers summarised their concerns and suggestions.

The group agreed that it was important to plan the projects and make a storyboard, and that the deadlines of task completion should be announced in advance. The students could be motivated to do activities through discussions/guest lectures/field trips/newspaper cuttings, or some other ways. They insisted that when making groups, each student's abilities and interests must be taken into consideration, but the group members must be flexible and take up tasks to meet the demands of the project. However, activities should be in tune with learning objectives and needed to be monitored, regulated, and assessed. To keep track of activities, relevant resources need to be gathered, time had to be managed, and slow performers motivated.

They suggested that to optimise use of time teachers could conduct activities both in sequence and in parallel. Group management could be done by a combination of teacher directed, self-learning and enrichment activities. Several components like intra-group collaborative, cooperative and peer learning strategies could be introduced in the classroom.



Figure 3: Story board of the project plan of Group DH

7.7. Analysing project plans

The concerns raised in the expert group sessions as well as from the activity sessions were shared and discussed among all participants. Using this shared understanding within and across groups, the participants continued planning their projects. They were also asked to prepare a story board of the project plan that they would share with their students while carrying out the projects in their schools. A story board is a timeline of activities of the planned project. An example of story board by group "DH" is shown in Figure 3. Guided by the worksheets, each group prepared posters of their project plan. Each group had several interesting elements that could all be potential PBL projects.

The enthusiasm of all the groups during the preparation of posters was noteworthy. It was evident from their work that they had fully engaged with developing story boards, project plans and making the posters. The formal and informal interactions throughout the poster preparation and presentations helped them reflect on their ideas and plans. To clarify persistent doubts relating to PBL, and help them develop better PBL structures and plans, each group was given feedback on their poster about the salient PBL features not addressed or addressed incorrectly. Most of the posters were aesthetically appealing, neat, and coherently ordered, especially with regard to presenting the story board and plan of the project. Some aspects of PBL that were evident are contrasted with participants project plans prepared in the first workshop.

7.8. Insights from second workshop

Under several of the categories discussed above, improvement could be seen in teachers' project plans in the second workshop. However, the difficult issue of deciding what their students could accomplish on their own with moderate effort and meaningful engagement, 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, to proceed when they were stuck with a problem, as giving the solution to their problem. Most groups did not explicitly mention that they would communicate their expectations of tasks completion, the expected productions and assessment criteria to the students. All 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 students' 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. Videos of such practices would have been ideal. These were not available then.

Therefore, it was considered important by us to conduct and maintain written records, if not video, of a project with students that was conducted in alignment with PBL pedagogy. Such a project was attempted, and its 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 has been reported as a research study and published (Shome, Shastri, Khunyakari, & Natarajan, 2011). The exemplary practice is summarized in the next section, while its use with the teachers is discussed in the following section.

7.9. Consolidating ideas of PBL

The interactions among participants and their productions in response to structured questions about the exemplary project formed a major part of this last workshop in the TPD series. A few of the participants, who had conducted projects in their school, which they felt were aligned somewhat with PBL, presented their work. All participants had to present their shared understanding of PBL by planning and enacting a collection of skits on PBL. Besides, they gave inputs for, and some volunteered to participate as resource persons in, a two-day workshop for teachers of Mumbai region to be conducted a couple of months later.

The introductory sessions of the workshop included a discussion of students' views on school projects. It was motivated by two considerations. First was the practical use of teachers knowing what their students thought about school projects. The second consideration came from an ethical demand of the research design. The data collected from students must serve a useful purpose for the students, even though not directly. That is, the students data must enrich their teachers' ideas and enable change.

Then the exemplar PBL project was described. The participants, working in groups, studied students' portfolios, the log and story board. Using these, the participants worked in groups to generate rubrics to assess the given productions of students. 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 1. They then presented their assessment rubric. Participants also had to critique the exemplar PBL practice in terms of how it was conducted. They were given three guiding questions: What did they like most about the project? What further improvements would they suggest? Whether and how their school would implement such projects?

Generate 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 labels, 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 (worksheet provided).
- P9. Product (Item model)

Box 1: Instructions to TPD participants for assessing student productions from the exemplary project.

7.10. Plan and enactment of skits on PBL

The participants, still working in groups first planned, and then enacted several skits based on PBL. Each group planned their skits independently and came together to sequence and loosely connect them. The skits presented in a variety of themes conveyed 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. These are briefly 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 them 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 coming 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. They situated the discussions in imaginative scenes, 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 confident 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 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 few 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. Through the skits, participants expressed their ideas about PBL and conveyed to the resource persons what they had understood. These ideas as expressed in the skits are summarized here.

- a) **PBL is an effective teaching method:** This was one of the main ideas in the skits. Some situated the effectiveness of PBL in the larger context of learning science and technology. Some others went so far as to extrapolate that once PBL was implemented, students need not go to coaching classes (tuition classes attended by large number of students) to get higher marks in examinations. Besides, some recognized that PBL was different from traditional methods of teaching. In PBL students working in groups to solve a real-world problem, collaborated with each other and learned from different subjects. In the process they also developed confidence in learning, communication skills, and vocabulary. Others presented PBL as a remedy for their recent increase in teaching burden resulting from policy demands for doing projects.
- b) **Characteristics of PBL:** One way or another, all the skits included one or more of the characteristics of PBL either within the acts or by explicit announcements. They also contrasted traditional projects with PBL. One skit criticized traditional projects for being dictated by the teacher, which did not allow students to express themselves. Possibility to integrate multiple subjects was most mentioned, while the driving question and assessment were woven into one of the skits. Some stressed the aspects of planning for implementation, while others focused on the length of time over which projects were done in PBL. They even mentioned that they could assign projects on every chapter from a subject.
- c) **Assessment in PBL:** The skits with teachers talking to parents presented the concerns related to changes in assessment and grading and explained that in PBL students, based on a variety of activities, were given grades. They even explained how assessment rubrics were useful, and descriptor indicators in assessment rubric helped reduce the subjective biases.
- d) **Management aspects:** Two of the groups that stressed planning also raised issues of management: to plan a project on multiple subjects' teachers of those subjects needed to plan

the project together and take care of respective subjects as planned. Others raised concerns of following school administrators' strict guidelines.

8. Chapter 8: Evolution of teachers' ideas about PBL

Through the course of the nine days in the three workshops that the teacher participants collaborated, they made five written versions of complete project plans, supplemented by five presentations besides a critique of the exemplary PBL project and the skits. These together with insights gained from school visits and interviews with some of the participants between workshops, gave indications of the evolution of teachers' ideas about several aspects of 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 education researchers. The ideas found expression in the productions of one or more groups: written plans, presentations, interview responses, group, or class discussions. Hence evolution of 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 in Section 5.

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 exposed to this characteristic of PBL, participants, who were practicing teachers or teacher educators, 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 variety of themes e.g., convert and save energy, soil, hydrosphere and ocean floor, bicycle, and water covering a range of textbook contents. The textbook content tended to be derived from a few subjects to multiple subjects. Group E included seven subjects in their plan, followed by group DH (five), group I (four), group F (three), and group BC (two). Only group I had selected a project around a chapter from the English textbook. In other groups, the core topic was either from science or was common in both science and geography subjects. Interestingly, group I 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 AG limited the subjects to only science but in the next plan they had 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. There was an increase in the number of subjects integrated in the project for all the groups except one, group I1, that was earlier part of group I. In the second workshop group E and DH integrated the largest number of subjects (eight), followed by group I2 (seven), group A1 (six), group A2, group F, group B (four), and group I1 (three). The average number of subjects integrated in the project plan increased from 3.9 (SD 1.6) in first workshop to 5.5 (SD 2) in second workshop. Like in the project plan prepared in the first workshop, science and geography were found to be the most chosen subjects for the projects in the second workshop too. Only group A1 did not plan their projects with science as subjects.

These ideas, however, did not find a place when some of them implemented their project plans. This was largely due to the complexities of different subject teachers collaborating across several barriers: the issues of fitting such projects in existing school policies and schedules, issues of time management associated with planning subject integration – time for different subject teachers to get together and plan, etc. In fact, teachers tended to implement the part of the project that addressed their subject. Another hurdle was that teachers' content knowledge was at best limited to a single subject. Hence the teacher could not guide or assess students' learning in topics from different subjects.

Driving question and problem context: These were new ideas for most of the participants. The driving questions generated by the participants in the first workshop were modified through discussions to form acceptable driving questions. However, participants still found it difficult 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.

In the first workshop except the group BC, all other groups planned a problem context and driving question in their first plan. The groups AG, E, and DH listed driving questions that naturally followed from the problem context. However, group DH could not decide on the major driving question in their first plan. In the next plan they had framed a driving question, “How can you say that drinking water in your neighbouring area is safe or not?”. In the first plan, the group I framed a close ended question, and the answer was evident in the problem context. In the second plan they framed an open-ended question but for them the question had a single answer. In the third plan of the project, they had framed a driving question. It was interesting to observe that all the participants considered that they were not able to frame driving questions.

In the second workshop, most of the groups presented the problem context in their plan. Recognizing the difficulty teachers had in framing driving questions, this was made optional in the second workshop. However, group B and A2 framed driving questions for their project plan. Problem contexts given by some groups had the potential to generate relevant driving questions. The project title “Miracles of life” of group I2 that framed the problem context, did not relate in any way to the stated learning objectives that included reflection and image formation in convex and concave mirror.

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. Group DH had difficulty in distinguishing content and productions.

In the first workshop although there was several learning objectives and planned productions these were not always in alignment with each other. The productions planned by groups AG and BC in their first plan of the project were aligned only with skills. Group E 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 (AG, I) even included learning objectives as productions. However, in the successive plans, participants started delineating productions without such confusions. The reason of such shift could be due to the nature of task participants had to perform. Because articulating assessment for each of the productions required participants had to distinguish between these elements.

Only one group, AG, 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 BC, planned to just ask questions to assess students’ understanding. Two of the groups, E and DH did not plan any assessment at all. Group I had difficulties in listing the criteria corresponding to the student productions stated by them and aligning

these criteria with the learning goals. In fact, they had confused assessment criteria with the activity or task, and what they listed as criteria failed to align with their learning objectives.

Following this, each of these aspects was discussed and compared with examples. Besides, from the second workshop onwards, worksheets were introduced, which required groups of participants to first connect learning objectives with possible project and its constituent activities, then connect activities with student productions, productions with assessment of learning objectives. They were also given handouts with examples of learning objectives, activities, and assessment. This helped them differentiate activities from learning objectives on the one hand and students' productions on the other. The worksheets provided repeated exercises for aligning assessment with learning objectives and productions resulting from activities. This helped participants better align assessment with the productions and with the learning goals, as was evident from the successive project plans prepared by the participants.

In the second workshop there was an increased alignment of planned productions with learning objectives in all the groups. Except DH all the other groups also listed several criteria in order to assess the productions. Several of them also planned to assess the criteria either based on three or on nine-point scales. Although, they had generated analytical rubrics for assessment in the first longer workshop, they were unable to generate these in the second workshop because of the constraint of time.

In the second workshop all the groups listed several learning objectives for their students in their planned project. Most of learning objectives were focused on content, while a few included both content and skills. Here too the confusion of learning objectives with students' activities had decreased compared to their plans in the first workshop.

The nature of student engagement was not always easy to infer from the plan presentations. Some activities had potential for constructive engagement of students in learning about a theme or topic. For instance, group DH planned that student would write poems and songs on global warming, and hoped that through this activity, possibly carried out over 4 days, students would learn in depth about global warming. Their story board is given in Figure 2. Another group required students to read a story from the Panchatantra, of a lion looking at its image in water, and learn the laws of reflection. The activity in this case seemed farther from the learning goal, and it was also unclear how the learning goal could be assessed.

In the third workshop most plans included student group work, and associated student autonomy with students completing the task on their own once it was prescribed by the teachers. However, the nature of prescription varied among groups. Some groups merely stated the tasks to be done, while others prescribed even the sequence of steps in each task. Some groups planned the support required for students in carrying out the projects. However, none of the groups had considered self or peer assessment among their students.

Thus, the plans, which were made in a shorter time, after focused discussions on three key aspects, but with a far greater engagement of participants showed improvement in depth of understanding about PBL among them. These also gave important insights for planning the last workshop in the series.

Assessment: 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 of 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 assessment tasks through the workshops.

For instance, in their first plan, groups could only list a few criteria to assess students' productions. Whereas, while assessing students' productions in the exemplary PBL project, all the groups not only came up with a list of criteria for each production, but they also generated analytical rubrics for several students' productions. However, not all the descriptors given in the analytical rubrics were either relevant, appropriate, or complete.

All participants stated that PBL is useful and better method of teaching. Some of the participants implemented their planned project partly or wholly in their respective schools. Once these were implemented, some participants had a better idea about handling unanticipated situations and outcomes in the classroom. A teacher recognized her difficulty in assessing students using rubrics while students were engaged in an activity like a short presentation. Another found it difficult to control the noise while students were engaged in project tasks in school time. Some of the participants reflected on their practices and were dissatisfied with their earlier project practices in their schools. They realized that they needed to make detailed project plans before implementing projects. Overall, participants appeared to have developed a clearer understanding about the characteristics of PBL and how these characteristics differed from the projects they had been conducting. However, all these ideas did not always translate into an immediate shift in their practices. For one, implementing PBL with all its characteristics demanded several skills from teachers, which in turn would need a school climate and support for such practices.

8.1. Evidence of evolution from the analysis of exemplar project assessment

In Section 7.9 it was mentioned that participants had to critique the exemplar PBL practice in terms of how it was conducted. They were given three guiding questions: What did they like most about the project? What further improvements would they suggest? Whether and how their school would implement such projects? They were also asked to generate rubric for the nine productions as per the guideline given in Box 1. The results provide some encouraging insights.

Of the six groups of participants, groups I, F, and DH1 generated rubrics for all the nine productions, group DH2 generated for five while group A and E generated rubrics for only four productions. Five groups other than group A generated rubrics for three common productions: (a) List of five items with description of size, justification, and sketch (P2), (b) Plan of action with sketch and description of work involved and distribution of work (P5), and (c) the playground model (P9).

A few essential criteria were included in the instructions that guided their assessment, as seen in productions P1, P2 and P4 in Box 1. However, all the groups did not use these given criteria. For instance, group E did not generate rubrics for P4. Table 7 provides details of the criteria for different productions among the groups.

The average number of criteria per production (C/P) varied from 2.4 to 5 between groups. Though group A and E generated the least number of rubrics (4), their average C/P considering all items were respectively 5 and 4.5. Considering the rubrics only for the common productions (P2, P5 and P9), the average criteria per rubric was the highest for group DH1.

However, the criteria chosen by the groups did not always align with the production, possibly because they did not understand the specific instructions for that production. They were asked to use only the given log of events and observers' notes to assess students' making of a product (P6). Yet, group I chose presentation as a criterion for P6, the assessment of which was not meant to be inferred from given data. In other cases, criteria chosen could not be clearly and distinctly described for different levels, like imagination as a criterion for assessing P1 and P3, or scientific approach for assessing technical drawings (P4).

Item	E	DH1	I	DH2	F	A	Average / item
1	0	2	3	0	3	6	2.7
2	5	6	5	3	3	6	4.4
3	4	4	4	0	1	0	3.3
4	0	4	3	3	5	4	3.8
5	5	5	5	2	2	0	3.8
6	0	5	3	0	3	0	2.8
7	0	3	3	2	2	0	2.5
8	0	3	3	0	1	0	2.3
9	4	5	4	3	2	4	3.6
Criteria per rubric for all	4.5	4.1	3.7	2.6	2.4	5	
Criteria per rubric for item 2, 5, & 9	4.7	5.3	4.7	2.7	2.3	5	

Note: Crit. per rubric = Average number of criteria per rubric

Table 7: Criteria for different productions among the groups.

All the groups showed considerable progress from both the first and second workshops in listing appropriate criteria with several descriptors. They wrote descriptors for each criterion, though the descriptors were not always clear or suitable. The descriptor given by group I were not appropriate to differentiate the levels of performance and they were mere extensions of the criterion. For example, criterion “novelty”, was described as “less suitable”, “adequately”, and “sufficiently”. However, for at least half the number of criteria, most groups had provided descriptors that could clearly differentiate different levels of student performance.

Participants' responses to the first two questions in this activity were analyzed using a combination of categories used in Sections 5. This provided some insights about how participants' ideas about PBL had evolved so far. The responses are discussed here.

Centrality and learning objectives: The exemplar project was structured to address more than one chapter from the science and mathematics textbooks followed by the CBSE. Yet, one group (I1) felt that the project failed to address concepts from the textbook, while none mentioned anything else about

learning objectives. This is possibly because these aspects were not explicitly mentioned in both students' productions and researchers' log given to the participants.

Driving question and problem context: Participants noticed that the relevant driving question and problem context in the exemplary project had played in motivating and helping students focus on relevant activities. They acknowledged that gained insights about framing driving questions. This is important as framing a driving question was a major hurdle in the first and second workshops.

Students' productions: All the groups, except a few in I2, appreciated the students' productions. However, only one group (I1) explicitly stated that they liked the students' final model and they felt that the students did their best based on the material provided to them.

Aligning assessment with learning objectives and productions: Alignment between assessment, learning objective and productions were major concerns in the workshops and were discussed in detail. Only one group (I2) criticized that evaluation strategies were not emphasized.

Student engagement in constructive activity: All the groups felt that students learned through the tasks they engaged in as part of the project, and a group (I1) explicitly mentioned several aspects about students' activities that they liked, like tasks being interesting enough to motivate them to complete the tasks. However, they also inferred from the log that some of the students were not writing much, only recording data. One group (I2) even stated that they were not sure students would learn something worthy from the tasks.

Student autonomy and group work: Most groups noticed the aspect of student autonomy and group work in the exemplar project, that activities blended learning and enjoyment, and the plan was flexible enough in time scheduling to allow students choices based on their interest. One group noticed (I1) that in-time guidance was provided to resolve issues. Three groups (D, E, A) commended the peer evaluation idea: one group (E) because student groups could give constructive feedback to each other, while another (D) felt that this made students more responsible and helped them think objectively. A few groups (E and D) inferred from the logs that expectations from students was made clear, their innovations were acknowledged suitably, and the teacher only acted as a facilitator without "dominating over the thinking process of the students".

On the other hand, a group found fault with the fact that students were not taught to carry out each task in the correct manner, nor given instructions about what they felt were essential details to be included in the playground. One group felt that the teacher guidance and supervision was not enough, and yet another (D) suggested that students be given a sample production to get the expected outcome. Clearly, here, they missed the point about student autonomy. It was about getting each student group to make a play item and then all groups could together arrange them on the playground as they liked. On groupings too, there were different views.

Classroom management: Two groups (D and H) found the story board well-structured and was evidence of proper planning, while another felt that the storyboard needed to include clearer instructions about the role of each group in the making the playground, and on the assessment of their productions. One group even (D) suggested motivating performance and completion on tasks by including a competitive element between groups. In exemplary PBL project was focused on collaborative work, but teachers are trained to use competition as a useful pedagogic strategy.

Participants noticed that it planning the project needed time and effort, even more than that needed for the actual conduct. There were some criticisms regarding the details of sequencing and timing between

structured activities (I2). A valid point (D) was about guiding students to use eco-friendly materials in making the model, and to suggest that student groups could nominate members to record events, and keep time, to help schedule group activities better.

On the last question about implementing the project in their respective schools, participants from each school system had something to say, and most felt they could implement the project either by modifying the project a little or getting some changes in their schools' schedules. Two groups (H and I1) stated that they could plan a similar project in their school, with some modifications to the school schedule. One of these groups (H) 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 (I1) specific school periods to be allotted for such projects, to help plan subject integration consulting teachers of different subjects. 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 continues to have the major characteristics of PBL.

8.2. Teachers' project implementations

From teachers' communications between the first and second workshops it was found that seven teachers implemented projects in their school, four individually, one dyad of teachers, one teacher in collaboration with two others who were not workshop participants, triad. Thus, the projects were conducted in six schools from four school systems. Only one teacher shared her write up on her conduct of project and responded to the 24 researcher's query. Participants from one school discussed with the researcher between and implemented the project later. In only one case was researcher able observe the teachers' actual project implementation partially. Other teachers did not inform in time about conducting their project.

One teacher (V2-F) reported that carrying out the projects with her students reduced her burden in teaching the students. However, project created a lot of noise for others, and she was warned about not maintaining discipline in her classroom. This issue was included in a session on classroom management planned in the second workshop. Another teacher (V-D) reflected on her project practice and felt that she could better prepare her students before presentation by providing feedback. She mentioned that she found it difficult to assess her students following the rubric while students were presenting. She also stated that she could use her experience 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. These were used as inputs for planning future interactions.

9. Chapter 9: Conclusions and implications

The study followed a deliberative curriculum approach to address the challenges and opportunities created due to new policy change in Indian context namely NCF 2005 and the recent NEP 2020.

The study was guided by four research questions. The first concerned studying the curriculum and policy documents and adapting PBL in the Indian educational context to address the recommendations in NCF 2005. The second concerned teachers' views about projects and their practices were surveyed through focused group interview of 10 teachers, semi-structured interviews of four teachers, and a questionnaire survey of 34 teachers and teacher educators. Students' views were also gathered through

semi-structured interview and questionnaire survey conducted in five schools. The third research question concerning the development of a model of TPD based on PBL was addressed through the planning and conduct of a series of workshops with teachers. The fourth research question was addressed while studying teachers' productions indicating their ideas about PBL as they evolved through the workshops. Teachers' implementation of projects was studied through school visits.

The research used multiple methods like 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 changes.

In the first phase, recent educational policy documents, circulars regarding assessment and projects, textbooks, and assessment manuals were analyzed. The study revealed that the documents, from policy to textbooks, recommended projects as an important component of teaching-learning, including a variety of forms and modes of assessment. Textbooks and other teaching-learning materials are developed and brought out to align with the new policy suggestions. The study of reports of national teacher conferences that included innovative teaching-learning practices showed that, despite policy imperatives for making projects critical to learning in schools, these continue to be peripheral to student learning. The challenges in the implementation of projects as recommended in policy documents arise from several factors. A source of the problem are the circulars sent by the education board to schools which focus on mechanistic aspects of conducting projects and are not in alignment with NCF 2005 recommendations and are also difficult to implement within existing school practices.

This study re-conceptualized the criteria of PBL enunciated by Thomas (2000) as a constructivist pedagogic approach that has the potential to integrate several policy suggestions: address real world problems in the classroom, engage students in collaborative activities, integrate topics from multiple subjects, and use both formative and summative assessments. This has also potential to address 21st century skills. This conceptualization that adapted the five criteria of Thomas (2000), helped formulate a model of PBL for Indian middle and high schools. The model focuses on four major aspects of PBL: subject integration, assessment, group work, and management of time and resources while planning PBL for Indian classrooms.

In the next phase, proposed model was introduced to teachers, whose views and practices of projects and on the four aspects of the proposed model of PBL were studied through focused group interview and individual semi-structured interviews. Teachers' practices of projects had some common elements. None of the teachers used projects as a primary teaching strategy; projects came after teaching was completed, more as an exercise or enrichment task. In fact, projects had no defined learning goals, nor were they assessed for any learning. Students did not receive descriptive feedback, and teachers felt that peer and self-assessment among students was not possible.

Interviewed teachers cited time as the major hurdle in implementing the proposed PBL model in Indian school settings. They mentioned that teachers would need support to implement such projects. The responses of the four teachers also gave insights about the meanings they associated with the terms used in the new policy documents, such as formative and summative assessment, child-centered teaching, activity-based learning, etc. These responses also gave inputs about teachers' attitudes towards implementing the proposed practice of PBL, the challenges they would face and the possible solutions.

These insights from the semi-structured interviews helped develop the questionnaire tool for survey of views of projects and their practice among students and teachers. It was found that both teachers and students associated projects with better teaching-learning, though teachers' stated practice of projects

did not integrate assessment of learning. Moreover, most teachers did not plan their projects as a rich learning experience for their students in terms of learning content or major concepts or skills. It is not surprising that students, in the focus group interviews and whole class discussions (N=109), reported that most of the time they carried out projects mechanically, and learned nothing from the project activity.

The findings from the survey highlighted that project implementation in Indian schools need to be changed. One place to leverage such a change is teacher professional development (TPD). Hence, in the final phase the insights gained were used in developing the structure and content of a TPD model of PBL.

The TPD was designed so that participants and researchers collaboratively developed a PBL plan. Through the three workshops, the participants made five written versions of complete project plans, supplemented by five presentations besides writing a critique of an exemplary PBL project, and enacting skits on conducting PBL. Participants worked in groups guided by worksheets that required them to make project plans that were progressively more detailed. In the final plan, they had to address multiple subjects with clearly defined learning objectives, corresponding activities, and productions as well as assessment plan for each production based on a set of assessment criteria. They also had to prepare a story board that they would share with students.

Participants' project plans in the workshops were analyzed using categories derived from the major aspects of the PBL model proposed in the study. The evolution of participants' ideas in their successive project plans were also analyzed in terms of the same categories. This evolution could then be seen in the light of the views and attitudes of teachers inferred from their survey responses.

9.1. Evidence of evolution of teachers views and ideas on PBL

Before the workshop, as seen from the responses to the questionnaire survey, teachers did not use projects for teaching textbook topics. Instead, they used projects as a context for students to merely repeat what they had learned, or to gain extra-curricular information. Besides, they did not set specific learning goals for the projects they gave their students. On the other hand, in the PBL model used in the workshops, centrality was interpreted in terms of PBL being a context for students of a given Class to learn their curricular and textbook topics from different subjects. Once the workshop participants were introduced to this characteristic of PBL, they included this aspect in all their project plans. Over time, participants could include more topics and subjects in their project plans. They developed a better understanding and grasp over integrating multiple subjects in their plan of projects in a meaningful way using coherent sets of planned activities.

The ideas of asking a driving question and situating the project in a problem context were new for most of the workshop participants. Participants found it difficult to frame driving questions though they included problem contexts in successive plans. The surveys indicated that teachers gave little importance to assessment of projects. Assessment was made an important component of the workshop series. In the first plan of projects in the workshop, participants were not able to align learning objectives to the productions and had difficulties in differentiating between the learning objective of an activity, the activity itself and students' productions in the activity. The structured sessions of the workshops, and focused discussion on learning objectives, students' activities and productions resulting from them, helped participant teachers improve their understanding on these aspects. For instance, in the successive plans of projects participants could better differentiate activities, learning objectives, and students' productions. Moreover, the participants were increasingly able to align assessment with learning objectives and productions.

Generating an analytical rubric was a difficult and new exercise for the participants. However, participants made considerable progress in understanding analytical rubrics and even developed the skill to generate such rubrics. In the beginning, participants faced difficulties in listing the criteria or aligning the criteria with the stated learning goals. They also confused criteria with the activity. Towards the end of the workshop, all participant groups not only developed analytical rubrics with several assessment criteria for several student productions, but most groups also wrote meaningful and relevant descriptors for most of the criteria used in the analytical rubric.

Some of the participants even implemented their planned project partly or wholly in their respective schools. The implementation helped them refine their ideas from the workshop and recognize the need to make detailed project plans before implementing. More importantly, they could recognize when their practices did not follow the PBL strategy. Some of the participants even became resource persons for conducting sessions that addressed advantages and challenges in conducting PBL pedagogy in Indian schools.

9.2. Implications of the study

Based on the TPD workshop series a Guidebook consisting of handouts, worksheets, and presentations used in the TPD on PBL was compiled. This was used in two other short one-time workshops on PBL for teachers. Based on these experiences, an assessment tool has been generated and piloted for use in evaluating projects in 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, but it also provides opportunities for dialogue, discussions, and reflection about their current and proposed practices. Thus, the model has the potential to impact teacher's classroom practices.

Part of the wide gap normally seen between policy and its implementation arises from mediating documents, like circulars to schools from education boards. These documents are not detailed enough to define the terms defined in the new policy documents, so the concern of misinterpretation of these terms among teacher and teacher educators is large, which further leads 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.

9.3. 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, say over several years, engagement with the participants, beyond the workshops. Besides, interventions are also necessary in the school education system. In fact, even the NCF 2005 has recognized a need for systemic change for practices to align with its recommendations.

The study could not focus on the actual classroom practices of projects for logistic reasons. If that could be done, it might reveal 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 research.

Project based learning as a pedagogic strategy has the potential to be liberating for both students and teachers. However, teachers, barely coping with mounds of uncertainties and weighed down by so much authority, are afraid of embracing even such a liberating practice.

9.4. Reflections on Self evolution through the process

This research is a social co-construction of meaning for me as a researcher and as a person. I have understood project-based learning better than I had started with. In the process of deliberations with teachers and students, I too evolved over time. 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 exhibition or science congress projects and making it participatory for all students. During my research, 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 USA and Europe after the Second World War; however, Russia discouraged the use of projects in curriculum to focus on prescriptive textbooks and S&T. 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 about 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 a general limited understanding of subject integration, assessment, group work, school time tabling, and resource management issues in both these groups. According to me, 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 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 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.

Acknowledgements

This work began with the late. Prof. Chitra Natarajan. This work is dedicated to her. I am indebted to Prof. Sugra Chunawala for providing sustained academic as well as emotional support during work. I am fortunate to receive feedback and support from all the members of thesis advisory committee formed at various points of time. Prof. Jayashree Ramadas, Prof. Savita Ladage, and Prof. Deepa Chari continuously put their effort to keep me on track.

In this journey I got support from many individuals. Special thanks to all the members of HBCSE family.

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