ICT enabled blended micro-course for secondary school mathematics teachers: A large scale design experiment

Bindu Thirumalai & Ruchi S Kumar

Abstract: In this paper, we illustrate the findings from a design experiment conducted for an ICT enabled micro-course for large scale implementation to address high school mathematics teachers' teaching of geometry. In the paper, we have described the theoretical principles of the design of a micro course for teachers which includes implementing a student module developed for teaching geometrical reasoning at high school level. The 11-week course involves integration of ICT in teaching mathematics as well as using ICT to engage in professional development through the micro-course. The preliminary findings of running the course in three states have been reported indicating the challenges faced in implementing the ICT based course for teachers at scale along with the insights gained for refining the theoretical assumptions based on which the course was designed.

Introduction

All Indian education policy documents recognise the need to significantly improve the quality of teaching learning in the Indian government schools. The schools need to transform from spaces where learning is passive and rote based to an active and constructive learning environment. Several efforts, such as the National Curriculum Framework 2005 [NCF 2005] (NCERT 2005), National Council of Educational Research and Training (NCERT) textbooks have worked towards this goal, where the intended curriculum and the textbooks have made a paradigm shift towards this end. However, unless the teachers can transform their practice, the learning aims and goals as espoused by the NCF 2005 will not be a reality (Batra, 2005). Apart from a few innovative training programmes, majority of the in-service teacher education in India is implemented through cascade model in the form of short-term training workshops, lecture based pedagogy (MHRD, 2009). They assume disciplinary and curricular knowledge as 'given', delivering prescribed methodologies leading to a large gap between preservice and in-service teacher education (NCERT, 2006b). This also results in a failure to engage with the professional identity of the teachers and is insufficient to impact pedagogical transformation. Recognising that limited studies exist about in-service teacher education, Yadav (2012) found that pedagogy

adopted by most resource persons are not interactive. The training modules lack focus on local contexts that teachers engage with and there is lack of "practice oriented modules" with clear rationale for selection of content of modules.

Theoretical Frameworks

In-service teacher education needs to make a paradigm shift from a training mode to professional development. The NCFTE (NCTE 2009) lays out specific aims for continuous professional development, including, developing teacher learning communities that enables teachers to critically reflect on their practice, develops critical collegiality, form their professional identity and develop their practice based on researched frameworks and theories rather than quick-fix strategies. NCERT (2006) has laid out a vision of mathematics teaching that focuses on mathematical processes like reasoning, problem solving, justifying etc. that can serve towards developing understanding as well as making mathematics accessible to students from underserved communities. This requires a significant transformation in teacher's instructional strategies, content and pedagogical understanding, as mathematics classrooms need to shift from spaces where children do procedural activities alone to classrooms where teachers and students engage in mathematics talk and reason and solve problems in mathematics collaboratively (NCERT, 2006a). There is increasing evidence that effective continuous professional development needs to be situated in teacher's practice as classroom interactions are complex and unpredictable (Borko, 2004). Studies have indicated that engagement in professional discourse and communities of practice where teachers can compare each other's practice, derive best practices, articulate their beliefs and knowledge, analyse and reflect on practice, share their explorations and experiments in teaching contributes to effective professional development (Clarke, 1994; Kumar, Subramaniam and Naik, 2015). Countries like Japan and China have integrated such community meetings of teachers as an integral component of their in-service teacher education system which are marked in the school calendar in form of lesson study. Such communities of practice (Wenger, 1998) have served the in-service teachers as important avenues for their professional development in these countries, while Indian teachers have lacked such professional spaces for engagement with peers. What seem to be working in these contexts is that teacher education is situated in practice using 'artefacts' like student work or responses,

blackboard work, tasks, lesson plans, curriculum documents to unravel the complexity of teaching mathematics and to go deeper into understanding mathematics that is required for teaching (Borko, 2004, Ball and Cohen, 1999).

Professional Knowledge and Learning

A professional is a member of an occupational group or profession which consists of individuals who possess special knowledge and skills derived from research, specialised education and training and is recognised by society as having the ability to apply this specialised body of knowledge towards a certain function. Professionals are also governed by codes of ethics and are morally and ethically accountable to the profession, to whom they serve and to society (Winch, 2004). Professional knowledge, from an Aristotelian conception is an amalgamation of *episteme*, theoretical knowledge that is generalizable and context free, *techne*, craft knowledge, that is context-dependent and practical and *phronesis*, generally known as practical wisdom, the ability to make practical judgements informed by reflection and based on values (Kinsella & Pittman, 2012; Winch[1], 2004). Professional practice is characterised by uncertainty, conditions that do not have simple solutions and requires action based on reflection and practical judgement to resolve (Schön, 1987). Essentially the application of professional knowledge is contextual and value based and serving to promote public good, making it social and situated in nature.

Social Learning Theory

This section theorizes on a social learning theory that has evolved over a period and includes two interrelated key concepts: situated learning and communities of practice. Lave and Wenger (1991) developed the idea of situated learning (or situated social practice) where they describe learning as occurring through participation in social processes situated within specific sociocultural contexts that shape the learning through participation in its practices. In a situated learning theory, deep learning or the ability to 'transfer' one's understanding to a different

[1] Winch (2004) uses the German concept of *Beruf* (occupation), *Wissen* (theoretical knowledge) and *Können* (practical skills) and the social identity of the acquirer to explain the conception of professional knowledge.

context or situation is also understood differently from a cognitive learning approach. The learner is not taking a concept or idea and applying it in another situation. Rather, the learner recognises the notion of the concept within a situation, sees the similarities and differences of it in the new situation and make new connections to understand the notion of the same concept in the new situation and therefore further strengthen the understanding of the concept.

A community of practice is a framework that draws on the idea of a situated learning theory. It is an informal group of people who are passionate about their work or practice and interact regularly to improve their practice. There are three key characteristics of a community of practice, (1) the domain, an identity that is defined by a shared domain of interest, shared competence that distinguishes members from other people; (2) the community, where members interact and continually engage in joint activities, share and develop resources; (3) the practice, members are practitioners share and challenge ideas and actions and contribute toward the creation of knowledge of the practice (Wenger-Trayner, E & B, 2015). The CoP is thus a situated social learning system. As argued by Wenger (1998), the practice is itself the curriculum and learning or meaning making takes place through the dual actions of participation and reification. Participation is the process of engaging in community activities, discussions, conversations and reflections either individually or collectively. Reification is the process of creating artefacts such as teaching resources, methods, documents and knowledge. Artefacts without participation do not carry meaning within a community and when there are no artefacts produced through participation in a community the learning is not deep.

Given the nature of professional knowledge, it's situated and social nature, what is the pedagogy or learning process that would work for professional learning? Many teacher education models have been developed to integrate theory and practice through personal and technical reflection. The underlying principle and goals of these models is to enable teachers to apply the theoretical notions to practical classroom situations. However, teachers' practice are rarely clean theory-guided actions, which creates a theory-practice gap that teacher education has been perpetually struggling with (Korthagen & Kessels , 1999). Building on this, argument, Korthagen & Kessels (1999), suggest a realistic[2] approach to teacher education where the teacher learning process

[2] Based on Hans Freudenthal (Freudenthal,1999) realistic approach to mathematics learning

involves developing theory from practice, considering the relationship between teacher cognition and teacher behaviour. In their realistic approach the authors use a model[3] of levels of learning that is based on the psychological idea of *Gestalts*. In psychological understanding, individuals respond to a situation holistically through the formation of Gestalts, a holistic perceptual identity of a situation. For example, a teacher forms many such gestalts of different teaching situations from previous experiences that includes multiple factors including social, emotional and technical that creates a holistic perceptual identity (Gestalt) used almost unconsciously to respond and act in specific situations. There are three learning levels in this model, the Gestalt Level, the schema level and the theory level. In the bottom level, the gestalt level, teachers reflect on their own Gestalt, examining their behaviour, beliefs and theories of learning of specific teaching situations. This enables teachers to start developing a *schema*, moving slightly away from the specific situation to analyse and reflect on the situation in more general terms making use of theoretical knowledge (*episteme*). "The kind of knowledge embedded in a schema shows characteristics of phronesis, as it builds on Gestalts and is thus connected to specific situations and personal perception. (p10)". The final level, theory level, where teachers can reflect on the situation in more general terms, reflecting on their experiences and constructing logical relationships and meanings that may apply to many such situations, that is, the development of theory (*episteme*). This learning is a cyclic process where in due course the learning in the theory level becomes intuitive and subconscious in the teachers' action leading to the refinement of teacher's Gestalts, which is termed as *level reduction*.

Literature Review - In-service Professional Development and Communities of Practice

This literature review highlights the implementation and findings of three in-service teacher education initiatives, in India and Brazil. These two studies were selected because they illustrate a variety of aspects to consider in the design and implementation of large scale in-service TPD and CoP for secondary school teachers in the Indian context.

[3] Based on Korthagen and Lagerwerf (1996) model of levels in learning based on a theory of mathematics education (a theory developed by Van Hiele, 1986)

The *Subject Teacher Forum (STF)* (IT for Change, 2015) is a large scale innovative in-service teacher education programme that was conceptualized by a Bangalore based Non-Governmental Organization, IT for Change [ITfC] in collaboration with RMSA, Karnataka, India in 2011. STF is a blended in-service teacher education programme that combines face-to-face training and online email groups that function as learning communities. The face-to-face training adopts a cascade model (training the trainers) and the learning communities are organised by subject domains. ITfC also provides specialised and technical support to teachers and schools to enable adoption of technology in teachers practice and in the school. Currently there are over 20,000 teachers participating in the STF programme across the state of Karnataka across subject domains and approximately 1432 master resource persons have been trained by ITfC. Professional development involves development of open educational resources, skills to use open educational tools and pedagogical training to integrate these tools into their regular classroom subject teaching. STF uses a constructivist framework drawing significantly from the NCF 2005. The programme also focuses on developing digital literacy skills, advocates and uses only free and open source software. During the second phase of the programme STF began focusing on the creation of open educational resources (OER) in the local language (Kannada) to enable building a repository of good quality learning resources in Kannada. A web portal[4] has been created for teachers to access, create and share OER. There are many positive outcomes of the programme. One, the blended programme has been completely adopted by the department of education, with ITfC playing a more peripheral role. Two, technological diffusion among the teachers has seen success through this programme. More than 30% of the teachers have been motivated and inspired to purchase their own laptops, which is significant, given that the state government funds all professional development expenses of teachers. Three, the online learning email groups are active with almost 70,000 emails exchanged, although the report indicates that only about 20% of the teachers are active on the online community. The teachers also use mobile messaging tools to stay connected. An impact study of the programme to understand the nature of pedagogical transformation and quality of the OERs created by the online learning community is not yet available.

[4] Karnataka Open Educational Resources - Collaborative creation of, for and by Karnataka Teachers http://karnatakaeducation.org.in/KOER/en/index.php/Main_Page

ComPratica (El-Hani and Greca, 2013) is a virtual community of practice for high school biology teachers in Brazil. This started as an online network of 87 members that included 32 high school in-service biology teachers. The rest of the members were composed of pre-service biology teachers, science education graduate students and researchers and biology undergraduate and graduate teachers. The community met face-to-face just once a year largely to become familiar with their virtual platform which included Moodle (https://moodle.org) for discussions, access to write blogs and wikis and a shared space to store documents. The discussion forum was structured. Five forums were created by the researchers to cover the following areas of scope (i) To inform members of events, (ii) Teaching Evolution, (iii) Teaching Genetics and cell and molecular biology (iv) Teaching ecology and (v) General issues related to science teaching. A sixth forum about botany teaching was created by the teachers themselves. One of the goals of this online community was to lead to pedagogical innovation, hence the intervention modelled it such that at least three to four in-service teachers belonged to the same school to enable peers to support each other at the school level. The study analysed two and a half years of the community activity and the results showed that the community transitioned into a CoP and it was a valuable tool for professional development especially in decreasing the gap between research and practice in science education. It also saw the emergence of collaborative action research projects and of critical reflective learning among its members. The highest number of discussions in the forums were about teaching sequences. While the number of postings related to "knowledge that" and "knowledge how" were small, the discussions themselves were rich and enabled researchers and teachers to collaborate and learn both theory and its practical implications in the classrooms from each other. The community was still vibrant after four years with about 173 members participating.

The Study

This study is located within the larger context of Connected Learning Initiative[5] (CLIx) which is a large-scale initiative working with students and teachers and aims to transform learning experiences in government secondary schools in rural districts. It is being implemented in four

[5] CLIx is founded by Tata Institute of Social Sciences (TISS), Massachusetts Institute of Technology (MIT), and funded by the Tata Trusts. See https://clix.tiss.edu/

states in India aiming to reach approximately 150,000 government school students and 6000 government school Science, Mathematics and English teachers. CLIx adopts a multidimensional approach to in-service teacher education that includes (i) creating a social learning environment through communities of practice (Wenger, 1998) for teachers (ii) professional development through certified blended pedagogical courses in mathematics, science and English language, adopting a framework of learning in and from practice (Ball & Cohen, 1999), (iii) digital literacy and communicative English skill development, (iv) a resource rich environment with access to high quality technology enabled open educational resources and (v) building a local ecosystem, by connecting pre-service, higher education institutions and the local community, to support pedagogical transformation and innovation in the schools. It draws from the NCF 2005 that supports active learning in a multilingual environment. This approach has also drawn from Shulman's (1986) Pedagogical Content Knowledge (PCK) and TPCK (Mishra & Koehler, 2007) work in teacher knowledge and practice that supports active learning pedagogies for student learning. (CLIx TPD Approach Paper, *work-in-progress*).

In this paper, we illustrate the design of an ICT enabled micro-course for large scale implementation to address high school mathematics teachers' teaching of geometry. The micro course has been designed at two levels. At a macro level, the purpose is to develop online mathematics teachers' community of practice (Wenger, 1998) to create a sustainable online social learning environment for teachers and at a micro level to enable teachers to develop theory from their practice through the refinement and reformation of their own Gestalts reflecting on their personal beliefs, values and already available research based theory.

We will discuss how the theoretical design principles informed the design of the course and justify why we think it will serve towards enabling teachers' agency to support pedagogical transformation and innovation. Engagement with the CESI community will contribute towards our refinement of design of future courses and our own practice as teacher educators.

In the study, we have used design experiment (Cobb et al,2003) as a methodology to develop a blended micro-course. Design experiments are meant to test theory and frameworks to be able to better describe the theory as well as understand the local nuances that the theories and designs need to respond to. This course is based on following main theoretical design principles

1. Developing a community for sustained interaction with teachers through a blend of ICT enabled online and face to face interaction
2. Using practice based artefacts for engaging teachers in the interaction to help articulating their beliefs and knowledge, analysing and reflecting on their practice, sharing implementation issues and trials, problem solving and deriving best practices.

We aim to use ICT to develop online learning communities to address the systemic situations of quality, scale and diversity. Such online platforms factor in the problem of teacher time, ability to host communities in multiple languages, providing access to quality curricular resources and professional development in the Indian languages, break the teacher's intellectual isolation, enable teachers to network with teachers across geographies, interact directly with curriculum designers, academicians and experts and scale the programme. However, the use of ICTs among school teachers, especially from rural areas is very low. Therefore, a judicious blend of face to face and online interaction is offered to provide a continuous and sustainable mode of teacher education.

One of the main artefacts that is used to engage teachers in the micro course is a student module for teaching geometrical reasoning using a special case of quadrilaterals for ninth grades students. The function of the micro-course is to both support the use of student module and to support development of knowledge and practices for teaching geometry using teachers' experiences of implementing student modules in their own classroom. The student module will be implemented by teachers for 5 weeks in schools in their regular mathematics classes. The design of the module draws from Van Hiele's (Battista, 2007) theory on geometric learning and aims to reinterpret the curriculum by building foundational skills in geometric reasoning and transforming the pedagogy to support active learning. The module is also offered in the blended mode, where teachers facilitate an educational computer-based game, other digital activities, hands-on learning through construction and manipulation of shapes and whole class discussions where teachers engage students in mathematics communication, reasoning, conjecturing and other mathematics processes (CLIx Mathematics Approach Paper, *work-in-progress*). The module is thus a curricular offering, use of which is supported through this micro-course.

We hypothesise that teacher's engagement in the micro-course, based on the above mentioned CLIx TPD theoretical framework, will lead to

1. Pedagogical transformation (Gestalt formation) in terms of focusing on reasoning and mathematical communication while teaching geometry
2. Development of knowledge for teaching of geometry
3. Skills to actively participate in learning communities and networks for professional development

The evidence for above will be collated from teachers' online and face to face participation. The scope of this experiment will be to understand, the quantum and type (social, professional, engagement in assignments) of participation, the type of academic and expert support required to nurture learning communities and networks, the considerations around running multiple language courses and finally the technical and infrastructural support that would be required towards refining the course design and its underlying theoretical assumptions. The data will include interviews with CLIx teams involved in participating and implementing the course, internal process documents and the online discussion forum. This experiment will lead to learning and insight for developing large scale ICT enabled teacher education courses. This micro-course will be ready to be implemented around September 2016 and we would have empirical data from at least two states to support this experiment.

This will be implemented in four Indian states, Chhattisgarh, Mizoram, Rajasthan and Telangana covering approximately 600 mathematics teachers teaching in government high schools across these four states. The course will also be offered in three languages, English, Hindi and Telugu in each of these states.

This study will inform and strengthen policy (NCTE, 2009) in continuous professional development at scale for secondary mathematics school teachers.

The Micro Course

The course has primarily been developed to support teachers to meaningfully implement the intended design of the student geometry module and has been broadly divided into three phases,

namely, pre-implementation, implementation and post implementation. The course is running for 11-weeks during the academic year, which includes 5 weeks of implementing student module. It has been designed using a blended mode of delivery (See Figure 1), where teachers participate before, during and after the implementation of the student module in face-to-face workshops and meetups as well as an online learning community. The following features highlight the integration of the theoretical perspectives, the literature review and the prevalent practical conditions.

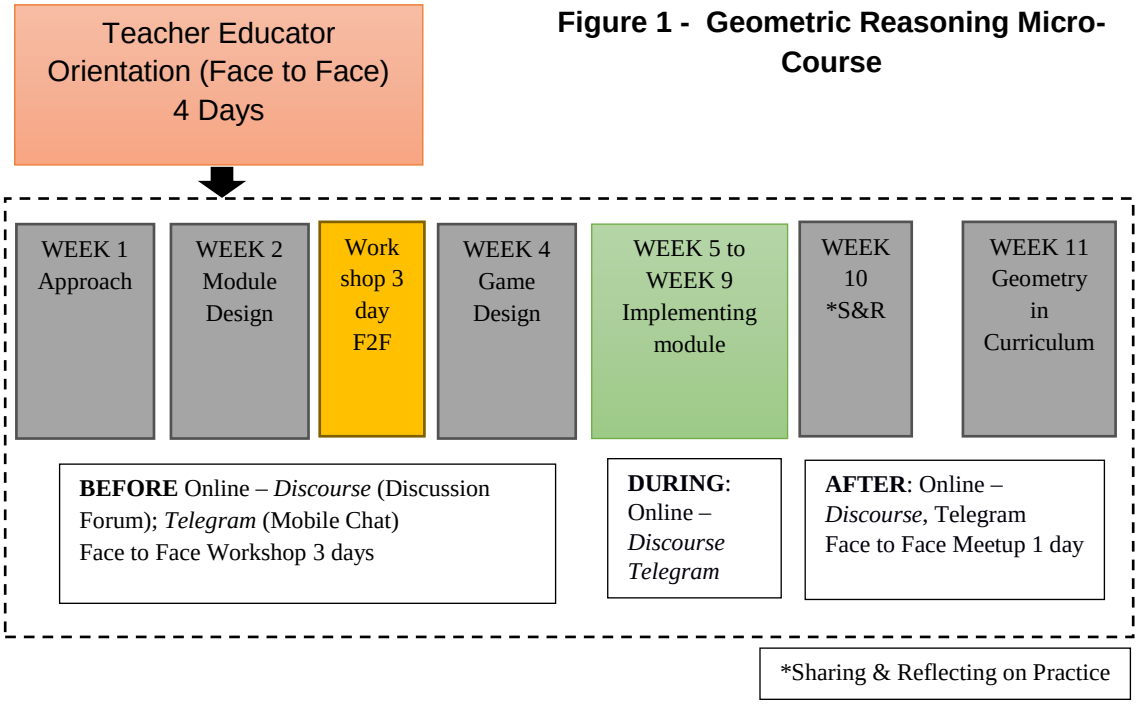

Figure 1 - Geometric Reasoning Micro-Course

The modes of communication used are online via a mobile chat, a discussion forum and through videos; face-to-face workshops; and a printed teacher handbook, to understand the intended curricular design of the student module. The intention of the mobile chat is to enable teachers to connect quickly to troubleshoot issues in school related to the implementation, share photos of their implementation and so on. The online discussion forum has been planned keeping in mind a more deeper domain based discussions and is conceptualised based on the literature reviewed (El-Hani and Greca, 2013; Wenger--- Trayner, E. & B , 2015). Additionally, a few more activities related to research have been added, see *Table 1* below.

Table 1 - Typical Activities of a CoP

Activity	Reference	Description
Problem Solving	(Wenger--- Trayner, E. & B , 2015) (El-Hani and Greca, 2013)	"The way I am teaching proofs in geometry does not seem to be working, can we brainstorm some ideas"
Seeking Information	(Wenger--- Trayner, E. & B , 2015); (El-Hani and Greca, 2013)	"I need to know how to login to the clix platform"
Seeking Experience	(Wenger--- Trayner, E. & B , 2015) (El-Hani and Greca, 2013)	"Has anyone worked with blind children, I need some help"
Reusing Assets	(Wenger--- Trayner, E. & B , 2015)	"Ï have an experiment to understand *force* that has worked well, would anyone like to try it and share your experiences"
Coordination and Synergy	(Wenger--- Trayner, E. & B , 2015)	"Can all the schools in the block discuss where we can buy good material for science lab and get some discounts"
Building an argument	(Wenger--- Trayner, E. & B , 2015)	"How do schools maintain ICT labs in other states. Can we get some best practices to recommend to the department"
Growing Confidence	(Wenger--- Trayner, E. & B , 2015)	"Before I implement this new classroom strategy I'll discuss with the other teachers in the community"
Discussing developments	(Wenger--- Trayner, E. & B , 2015)	"What do you think the new programme CLIx is all about, how will it really help improve learning "
Documenting projects	(Wenger--- Trayner, E. & B , 2015)	"We have faced this problem of uploading files for English module, let us document this problem"
Visits	(Wenger--- Trayner, E. & B , 2015)	"Can we visit your learning Lab in HBCSE we want to establish such labs in our schools "
Mapping knowledge & Identifying gaps	(Wenger--- Trayner, E. & B , 2015)	"Does anyone know what kind of laptop a teacher should buy, what information is missing, how do we get it "
Reflect upon one's	(El-Hani and Greca, 2013)	"I am always disciplining this student who keeps

own practice		disrupting my class and it's not working. How can I do something different"
Express feelings	(El-Hani and Greca, 2013)	"I really think drill and repeated problem solving is very important for maths learning "
Stimulate and manage participation in a community activity	(El-Hani and Greca, 2013)	"In the last meetup very few teachers were present. I am going to talk to some of my colleagues and explain why they should not miss this meetup"
Operation of the community	(El-Hani and Greca, 2013)	"I would need to meet with CLIx state implementation partners to work out the dates and location for the teacher meetups"
Collecting Data for research		"I have some ideas about what data the CLIx science research team would find useful, I will discuss this with the team"
Constructively reflect on peer's practice and analysing practice		"After observing my peer's geometry class, I feel that there are some gaps in how I have understood geometry learning and how the teacher taught the class. I will create a forum discussion thread to begin a dialogue"
Interacting with key stakeholders of the education System		"Assessment systems have changed. How should we discuss this aspect with parents"

Four videos have been created to introduce the student module, discuss the overall approach and the design of the module and the main technology based educational game that was developed for the module. Two face-to-face (FTF) workshops, one three-day workshop in week 2 and another one-day workshop in week ten of the course were planned. The 3-day workshop was planned to introduce the teachers to the module and all the various activities and lessons, so that teachers would experience the module like students with the intended pedagogies and also learn to facilitate the module. The one-day FTF workshop is meant to be a forum where teachers collaboratively reflect on their experiences of implementing the module. The handbook is sub-divided into sections for each lesson of the student module and each lesson is further divided into four broad sub-sections describing the objective of the lesson, plan of activities for the lesson, ideas for facilitating the classroom discussions and a "My Notes" section which asks guided questions that enable the teachers to observe students as well as reflect on their own teaching.

The pre-implementation phase has been designed to enable teachers to make their Gestalts related to geometry teaching explicit through guided questions asked via the discussion forum and the videos describing the module. The implementation and post implementation phase are designed to enable teachers to build their schema of the teaching situations related to geometry teaching. The post implementation phase, in the last week begins to engage with some general ideas of geometry learning, and this along with the ongoing discussions are meant to engage teachers in the theory level. In the long term, it is envisioned that when teachers go through this cycle of implementing and reimplementing the module with different batches of students *level reduction* will take place, eventually leading to pedagogical transformation.

Experiences from the field

The course is currently running in three of the four states; the first three weeks have been run that includes the three-day face-to-face workshop. This section describes the experiences of running these first three weeks of the micro course. These experiences from the field have enabled us to understand and refine the theoretical assumptions used in the conceptualisation of the design of the course while tailoring it to the Indian context.

The CLIx TPD programme is being designed to work at scale. The idea of using the model of Gestalt formation (Korthagen & Kessels, 1999) for teacher learning requires professional development over an extended period and skills for reflecting on one's own practice. Any programme that must run over an extended period and at scale must necessarily rely on online modes of communication for the professional development. The pre-implementation phase of the course did not take off in all the three states. The field and the teachers were not prepared in terms of infrastructure, they were unable to provide access to internet in the face-to-face workshops on digital literacy, thus not being able to introduce teachers to the discussion forum platform as intended. The technical capabilities to communicate online were a challenge as many teachers did not use emails, a requirement to join the discussion forum. We also saw that the idea of an online course was quite alien in the imagination teachers for professional development. Hence the first level of Gestalt formation did not happen as conceptualised in the course. This was however attempted in the workshop, but there was too little time for such an engagement as

the workshops were focussed on providing a hands-on experience of the student modules. Additionally, although teachers understood the idea of an online learning community and participated enthusiastically in the discussion forum, we realised that teachers do not have the skills to participate in discursive dialogue. When asked to discuss about how they currently teach geometry, teachers posted discussions in the form of questions like "What is a point What is a line?", essentially questions that would elicit factual answers and definitions. This also indicate paucity of opportunities that teachers have had for discussing the theoretical aspects of their practice, thus contributing to the theory-practice gap. We also realised that they are not familiar with theories of learning. For example, teachers across the states had heard about the Van Hiele Theory for the first time and found it difficult to map the Van Hiele theory for developing geometric reasoning with the evidences of student thinking and the tasks that could help in developing geometrical reasoning at a level. They could think in terms of whether student gave the correct answer or wrong but found it difficult to visualise the development of student thinking. Teachers could only think about content related issues for discussing teaching and hardly any comments were made about pedagogy or theoretical underpinnings.

Organising the face-to-face workshop in the State system was also a challenge. In Rajasthan, despite various efforts made by the CLIx Field Support Persons, such as calling the teachers personally and discussing the workshop, the attendance was very poor. On the first day of the workshop in Sirohi, Rajasthan only 7 of the 39 teachers attended the programme. In Jaipur, Rajasthan the attendance was just over 50%. This indicate that teachers do not value professional development opportunities, maybe because of earlier experience of workshops not being useful or relevant. However, several teachers who did attend the workshops in Rajasthan as well as the other two states participated eagerly in the workshop and were enthusiastic about implementing the student module in their classes. Teacher's time, systemic processes, costs and facilitator availability necessitate minimum time for face-to-face workshops when implementing at scale. However, in the Indian context the teachers and the system are not yet ready to participate in purely online programmes.

Teachers in Mizoram are starting to implement the student module in schools and many teachers are attempting to send pictures of students engaged in the computer based learning activities via the mobile chat. We also realised that many more teachers have smart mobile phones with access to Internet and the need to use learning platforms that are easily accessible on mobile phones to encourage more participation. Additionally, all schools in Mizoram are not implementing the module together, hence the scheduling of the course around the implementation is posing a problem. This also impacts the online discussions as many teachers will not be able to participate in implementation discussions, posing a challenge for developing the online learning community (Wenger, 1998; El-Hani and Greca, 2013).

We used two types of open source applications to run the course. First *Discourse* a discussion forum application and second *Moodle* a learning management system. Initially we used only Discourse as a discussion forum. However, we found that the discussion forum was not sufficient for teachers to visualise an online course. Teachers found the interface of the Moodle more attractive since they could see the organisation of the course more clearly along with the resources for each week. Thus, the organisation of Moodle enabled a better initial perception of an online course.

This initial large scale design experiment is already informing us about how the models, theories and ideas will need to be re-thought within the Indian context to work at scale. One, we would need to understand how to develop skills of reflection and discursive practices along with the course or before the course. Two, the planned curriculum for the face-to-face workshop of engaging teachers in hands-on activities to experience the student module worked as intended, with most of the teachers participating actively and engaging in good discussions on geometric reasoning. Three, designing the timings of the course around the implementation would need some re-thinking as all states have indicated a staggered implementation in schools, which has implications for conceptualising the development of the online community. Finally, from the point of view of the state owning the programme (IT for Change, 2015), it is important that technological diffusion among teachers is achieved. To achieve this, it may be necessary to use mobile based applications for teachers.

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