Designing a Blended Learning Course on Pedagogy of Science of Pre-service Teacher Education Programme

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Abstract

Blended learning, an innovative pedagogical approach, has been emerged as a catalyst in optimising learning by strengthening the prospects of online and face-to-face mode of learning. This has a lot of relevance in teacher preparation programmes with its potential for providing multiple learning opportunities. Student teachers are in the process of becoming 'reflective practitioners' and so blending the strengths of online learning along with face-to-face instruction could be of immense help. It provides room for open communication and deeper analysis on wider platforms by allowing flexibility, convenience and critical reflection that online mode offers along with the benefits of in-person communication and interaction inside the classroom. However, designing a highly participatory, reflective blended learning course on Pedagogy of Science is challenging. This paper is an attempt to reflect on the relevance and scope of blended learning course on the pedagogy of science in a teacher education programme. Theoretical perspectives of blended learning are analysed in detail. The paper also provides an exemplar model of blended course that may be adapted or explored further while redesigning the course on Pedagogy of Science as a blended course in teacher education programme.

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Introduction

Blended learning has gained momentum as one of the innovative pedagogical approaches in both school education and higher education. The pedagogical principle behind blended learning is to tap the potentials of both the learning environments meaningfully and thus ensure maximum student engagement. Blended learning represents a 'thoughtful fusion of face-to-face and online learning experiences' (Garrison and Vaughan, 2008). We can find variations in the way blended learning is defined in literature as it is considered as an 'ill defined' term.

Oliver and Trigwell (2005) asserted that identifying the impact of growth in blended learning has been challenging because of the definitional ambiguity. 'There are numerous definitions used for blended learning (BL) environments in research' (Graham, 2017). However, online learning is considered as one of the major components along with classroom instruction. In a blended class, 'various learning experiences are synthesised, complement each other, and are planned or orchestrated to run in parallel' (Cleveland-Innes and Wilton, 2018). There are researches indicating that student success and satisfaction had been improved in blended courses and the possibility of developing sense of community in a blended learning environment is enormous (Dziuban and Moskal, 2011; Means et al., 2013; Rovai and Jordan, 2004). Researches also suggest that blended courses can have a positive impact on efficiency, convenience, and learning outcomes. (Online Learning Consortium, 2014; Garrison and Kanuka, 2004).

Though the potential of blended learning is recognised widely, designing such a course by duly exploring the underpinnings of both methodologies and by combining the strengths of both pedagogies is a challenge for curriculum planners, designers and developers. A blended course must be designed in alignment with the learning needs of students, curricular expectations, and quality learning experiences and also based on the extent of access to various technological tools. While designing pre-service teacher education programme in a blended mode, it raises certain issues depending on readiness of students and teachers- mental, technological and pedagogical readiness to engage in the course, need for overcoming limitations of traditionally perceived course, infrastructural challenges along with its highly practicum based modality of teaching-learning practices, etc. Pedagogy course, as one of the most vital skill based courses in teacher preparation programme, blending online learning environment with offline experiences, raise lots of concerns. However, by realising enormous potential of both the modes of learning, it is interesting to explore the potentials of designing a blended learning course on pedagogy of science.

Significance of Blended Learning in Teacher Education Programme

As teacher preparation programme involves meta-learning activities, it is imperative to understand the process in a multi-faceted way. In this instance, blended learning offers continuous and systematic resource supply in online and face-to-face modalities with scope for flexibility in terms of time and space. At the same time, without compromising the vision of teacher education as preparing 'reflective teachers', blended learning can extend a variety of learning experiences to student teachers by providing opportunities for self-analysis, peer reflection and feedback from teacher educators. That would help them to critically examine their own activities, thus creating space for reflection. Researchers such as Hernández-Ramos (2004); and Stiller and Philleo (2003) found that 'teacher educators used the blended format mainly for developing reflection skills'. 'Student teachers were satisfied with the blended approach as it provided them with opportunities to improve their knowledge by themselves' (Khine and Lourdusamy, 2003).

There is no doubt that face-to-face activities help in stimulating thinking among student teachers on various issues at hand. But it is also worthwhile to understand the additional benefit of accruing deeper sense of teaching as a profession with minute nuances of field reality and contemplation on the issues relatively large online platforms. The discussion and analysis may take a varied turn through mentored activities inside classroom too. This continuous cycle of exploration offers prospective teachers to dive deep into curricular inputs in a more systematic way to understand the subjective reality of schooling with plausible pedagogical interventions and related issues. There are researchers like Collopy and Arnold (2009), El-Deghaidy and Nouby (2008), and Turvey (2010), who confirm effectiveness of blended learning approach in teacher preparation programmes in terms of competency, achievement and professional knowledge. In addition, it is found that 'pre-service teachers favoured the blended learning method in comparison to face-to-face or online learning alone, as blended learning was observed to be more effective' (Le and Pham, 2021). However, designing blended learning programmes is not easy it, requires lot of planning and effort in bringing synergy and orchestration between online and in-person learning environment in teacher preparation. Understanding theoretical perspectives of blended learning may be of help to realise the potentials of a blended course in teacher education programme.

Theoretical Perspectives of Blended Learning

Any innovation in the educational field is sustainable if it lies on a strong theoretical framework. There are many researchers who worked

on various pedagogical principles and theoretical frameworks of blended learning. As per Community of Inquiry (CoI) model proposed by Garrison and Akyol (2013), blended learning offers a combination of these three— Cognitive, Social and Teaching presence in the course. Cognitive presence denotes to what extent students are able to construct in a community of engusing through continuous reflection. (Garrison, Anderson and Archer 1999) It also includes the meaning making process where the learner is thinking, listening and is seen actively involved in the discourse. Social presence represents the critical dialogue among peers and mentor whereas, 'teaching presence' is related to design and facilitation. The scope of blended learning in meaningfully engaging learners with the content, peers and teachers could be tapped in the pedagogy course considering the very aim of teacher education programme of developing a critical community of learners. Understanding elements and strategies of each presence is very essential to create this community of deep learning. The teacher educator can design and transact the curriculum accordingly to facilitate the interactive process in both offline and online mode, and give immediate feedback to learners easily.

The TPACK framework is a model proposed by Mishra and Koehler, (2008), the which explains the integration of technology, specifying the need for a strong knowledge structure for teachers such as Technological Pedagogical Content Knowledge to facilitate the learning process. Developing this deeper knowledge structure is quite challenging through limited classroom interactions and fixed learning activities of regular classroom. By integrating both the learning environments for students, opportunities are provided to restructure and transform their knowledge in content, pedagogy and technology into a higher knowledge structure which is called Technological Pedagogical Content Knowledge structure that is of immense potential for making an effective teacher for develop 21st century skills among learners.

Another model called Technology Integration Matrix powered by Arizona K 12 centre suggests five mutually dependent attributes of meaningful learning environments, which are— active, constructive, goal-directed, authentic and collaborative. 'Online and blended learning bring opportunities and challenges, including more opportunities for authentic activities' (Gikandi, et al., 2011). A beautiful blend of offline and online learning environment is an attempt to bring forth meaningful learning with all these characteristics. The higher learning outcomes could be achieved by involving students through problem-based learning and engaging them in purposeful inquiry process through collaboration and built a sense of community amongst each other.

As per Complex Adaptive Blended Learning System (CABLS) by Wang et al. (2015), another approach of exploring theoretical perspective of blended learning, there are six elements, such as the learner, the teacher, the technology, the content, the learning support and the institution, which are highly significant in creating blended learning environment. However, it is important to understand that each element has sub systems and each has a vibrant relationship to one another but learner is at the centre of the whole learning process. The CABLS framework is intended to 'facilitate a deeper, more accurate understanding of the dynamic and adaptive nature of blended learning' (Wang et al., 2015).

The theoretical frameworks would definitely help the curriculum planners and teacher educators to design any specific course or restructure the complete teacher education programme in a blended way.

Relevance of Designing a Blended Learning Course on Pedagogy of Science

After National Curriculum Framework for Teacher Education (NCFTE), 2009 came into action, followed by National Council for Teacher Education (NCTE) Guidelines 2014, most of the teacher education curriculum of the country has been reorganised. There is consensus on the relevance of pedagogy course in any teacher education programme as it offers a detailed knowledge structure on the various pedagogical strategies with its theoretical relevance. Its scope for empowering student teachers with indispensable skills of becoming a competent facilitator is enormous. Most of the teacher educators would agree that in a face-to-face classroom environment in a teacher education institute, the scope of examining the nature of the discipline, which is the essential starting point of any pedagogy course, is delimited only to lecturing the history and philosophy of the subject. Also, most of the students remain in a mute mode with little scope of pondering over aims and objectives of teaching the subject in detail. 'Teachers and students are no longer comfortable with learning in a passive setting that is still largely text-based and heavily dependent on the lecture format—the foundation of the traditional classroom' (Duhaney, 2012). One of the threats of this approach is that students do not get an opportunity to clearly articulate the nature of the discipline with the contemporary issues of pedagogy. They end up in considering it as something highly theoretical with little relevance to other aspects of pedagogy. No one to blame, the teacher education curriculum has been designed and implemented in a tightly compartmentalised form that most of the time, it resists an interdisciplinary outlook into it. In addition, the sociological and psychological perspective which are covered under other courses of curriculum are rarely integrated into pedagogy course. Integrating school content with pedagogy class

in a synchronised manner is another challenge considering the scope of the course and constraints like availability of time to explore. Critical analysis of content is, most of the time, done as a routine activity in a pedagogy class and identifying appropriate pedagogical strategies become difficult for majority of student teachers as the experiences provided most of the time fail in developing pedagogical content knowledge among prospective teachers.

"Currently, in a traditional face-to-face science teaching methods, course time includes the teaching of science content and pedagogical content knowledge leaving less time for practicing with hands-on inquiry methods" (Yimaz and Malone, 2020). Also, assessment, unfortunately is delimited largely to fixed mode such as tests and assignments which are mostly theoretical. This paper isn't trying to pinpoint the limitations in transacting a pedagogy course in a traditional classroom, rather it is an attempt to analyse the scope of blending online learning along with potential benefits of interaction plausible in face-to-face instruction.

Possibilities of Designing a Pedagogy of Science Course in a Blended Learning Mode in Pre-service Teacher Education Programme

A critical understanding about the nature of the subject and implication of pedagogical principles and skills to facilitate learning are key factors in designing and implementing science curriculum to school students at secondary stage. As prospective Science teachers, if these and many more skills like these if could be imbibed through a pedagogy course, it would be of immense help. One of the concerns in teacher preparation programme is this organic synchronisation of content with school curriculum. As curricular expectations, increase, so the responsibility of a Science teacher, especially in the fast advancing world. Blended learning strategy provides scope for involving students in an open and trustworthy dialogue both offline and online. The meaning making process, by interacting with peer and mentor, do have a scope for engaging in critical discourse with the content at the same time in building up the ideas learnt. Many of our students in the teacher education institutes have access to technology especially internet facilities either in their laptops or mobile phones and these students in addition to can critically use online learning their regular classes. 'Learning environments, incorporated with information technology have been shown to have specific benefits for learning science in terms of (1) promoting cognitive development, (2) allowing for a wider range of student experiences, (3) supporting students' self-management ability, and (4) supporting students' development of conceptual understanding by facilitating data collection and collaboration.' (Webb, 2008)

A blended course has to be purely customised considering the leaning needs of students and curricular expectations. So it is highly important to identify learner centred learning outcomes with an intention to optimise student engagement and participation. Also, it is required to make a well informed decision to choose which activity has to be planned for in-person environment and the activities for offline learning environment. No 'one size fits for all' works here. The design has to be customised as per the requirement of the course, for every model to be used. We need to make sure that the design has scope for flexibility, convenience, better opportunity for interaction with content, peer and teacher. 'Facilitating the flexibility now needed in the learning environment can help to reshape teacher preparation programmes to better assist teachers to be more effective in the classroom' (Duhaney, 2012). Garrison and Vaughan (2008) has listed three key design assumptions for an effective blended course: '(a) the thoughtful integration of face-to-face and online learning; (b) fundamentally rethinking the course design to optimise student engagement; and (c) restructuring and replacing traditional class contact hours.' Therefore, teacher education curriculum has to be redesigned by specifying the desired learning outcomes. The type of blended learning activities need to be organised with the integration of technological tools and techniques following the appropriate assessment processes in accordance to the blended learning environment to ensure students' participation and learning. It is very important to specify which activities are meant to be conducted offline and the activities which are planned for the classroom.

If both online and in-person activities are not deep, engaging, challenging and complementing to each other, we cannot expect a blended course to be as effective as we had planned. Student teachers may get largely benefitted from this approach because of larger interaction possible in both online and in-person methods. It is evident from research findings of Yimaz and Malone (2020) that 'students' perceptions are positive towards the use of blended learning within their science education methods course'. To ensure students participation, there should be enough opportunities for individual activities as well as group activities to build a sense of communities among learners wherein collaborative reflection is possible, be it through online forum discussion, wikipedia, blogs, chat, etc. Restructuring the design for developing students' self-regulated learning skill by providing flexibility, and having the possibility of reflection, individually and in group, is very significant. However very few researchers such as Heba and Nouby (2008) and Jahjouh (2014) explored the potentials of blended learning programmes for pedagogy course in Science. Therefore, a lot of scope exists in blended learning with

specific attention to pedagogy course in Science. One possible method that could allow for more active science learning in science methods courses for elementary preservice teachers could be the use of blended learning (Yimaz and Malone, 2020). National Education Policy (2020) also reiterates the need for identifying and implementing different effective models of blended learning for different subjects.

There are different models of blended learning such as flipped learning, rotation model, self-blend model, etc. Selection of the appropriate model, is based on the course requirement and the context. An exemplar design of blended learning for pedagogy of Science course of teacher education programme is provided below. This is not the only way; however, this proposed design may help teacher educators to initiate the process of designing a blended course in teacher education programme.

Design of a Blended Course on Pedagogy of Science—an Exemplar

The following exemplar is an attempt to integrate online component into an existing pedagogy of science course with more possibility of deep discussion and reflection in the offline class in a blended environment. This could be tried out, in place of the conventional, fully face-to-face science pedagogy course with introduction of a Learning Management System (LMS) for online learning component. Just as an example, one of the design frameworks for blended course on pedagogy of science is provided below. It is open for the teacher educators to make changes in the strategy or tools as per contextual demand and variation in content. The given exemplar is prepared largely considering the overall aim and objectives of the pedagogy course of science in teacher education institutes. This could be extended further to bring changes in the curricular structure of field-based experience activities such as school exposure and internship of Pre-service Teacher Education Programme.

Learning Objectives

A few important learning objectives of the pedagogy of science are:

1. Explain the nature of science and specify the aims and objectives of science learning
2. Analyse science curricula and textbooks
3. Explore the methods of facilitating science learning in schools
4. Create unit plans, lesson plans and concept maps in science
5. Design assessment framework for science learning

Available and required resources

Computer facility with good internet speed, textbooks and other reference materials, lab, smart classrooms, software and apps

Assessment

- Assessment of student teachers' projects on the preparation of blog, report, concept maps, etc., on various themes

- Assessment of participation in online discussion board as well as classroom discussion
- Assignment assessment based on criteria such as perseverance, creativity and applicability
- Assessment of textbook analysis based on textbook analysis criteria
- Tests to assess the overall understanding of student teachers
- Preparation of e-portfolio

Design Plan

- LMS such as Moodle or Google Classroom or any other may be used to run the course online along with in-person classes and lab activities.

Learning objective	Content	Activity description	Technology requirements/ OER*	Teaching/ facilitation/ Assessment Requirements
Explain the nature of science and specify the aims and objectives of science learning	• Meaning and nature of science • Evolution of science • Aims and objectives of learning science • Writing learning objectives in science	1. Posting a video online about a pseudo-science topic like astrology, asking students to reflect on how it is not a 'science'. By analysing the attributes of pseudo-science areas, students are asked to reflect on the attributes of Science. With the help of the mentor, students identify the characteristics of science and the facilitator gives a brief description about the nature of science by a historical analysis of evolution of Science.	1. Video on Astrology 2. Wikipedia 3. Slide share (https://www.slideshare.net/) 4. Jamboard/ padlet (https://jamboard.google.com/) (https://padlet.com/) 5. ICT collaborative tools, such as Parlay ideas/ Flipgrid, for organising discussion (https://parlayideas.com/) https://info.flipgrid.com/)	1. Preparation/ selection of the video 2. Assessment of wiki project and adding inputs into it 3. Initiating the online discussion using any online discussion tool 4. Facilitating classroom discussion in small groups and consolidating the points 5. Preparation and sharing of the presentation on slideshare

* Open Educational Resources

		2. A collaborative group project using Wikipedia on the contribution of scientists in the process of evolving science, with an intention for learners to appreciate the historical perspective of science 3. Discussion on Social and ethical concerns of scientific achievements in an Online Discussion Board available in the LMS or using interactive discussion board tools such as Parlay ideas or Flipgrid 4. Brainstorming session on 'Why Students Should Learn Science' using jam board / padlet/ideaboardz in the classroom 5. Classroom discussion in small groups to identify the aims and objectives of Science. Teacher facilitates the activity and elaborates on the aims and objectives of science learning.		

		6. Teacher presentation and sharing information on slideshare about the revised taxonomy by Anderson and Krathwohl 7. Students identify learning objectives in science topics based on revised Blooms Taxonomy and a critical reflection by posting it online		
Analyse science curricula and textbooks	• Place and scope of science curriculum • National and International science surricula projects • Criteria of sood science curriculum	1. Online lecture video on various National and International Science Curricula and self-reflection of students on the evolution of science curricula at secondary school level 2. Online lecture on criteria for science curriculum/ textbook analysis 3. Small group work of textbook analysis in the classroom using the criteria posted online in the course page and asking students to upload textbook analysis document in the course page	1. E-textbooks (http://ncert.nic.in/textbook/textbook.htm?iesc 1=0-15) 2. Science Curricular Project of Reports 3. National Curriculum Frameworks	1. Preparing and using PowerPoint presentation during lecture 2. Identifying the criteria of curricula/ textbook analysis 3. e-Assessment of textbook analysis using Rubi Star

Explore several methods of facilitating science	• Pedagogical methods and strategies of learning science • Approaches of learning Science • Constructivist approach of learning science • Various pedagogical strategies • ICT based teaching-learning in Science	1. Students are asked to blog on their experience as students in their science classroom at school 2. Uploading a video on constructivist way of learning science and students are asked to reflect their perception online about the possibilities of constructivist classroom 3. Classroom discussion on how constructivist way of learning is different from the traditional way of giving lectures 4. Watching online science learning episodes based on various approaches and strategies (one of the resources could be National Repository of Open Educational Resources (NROER) 5. Demonstration of various pedagogical strategies such as experimentation, problem-based learning (Use of laboratory as required)	1. Videos 2. Blog 3. National Repository of Open Educational Resources (NROER) 4. Science specific free and open resources such as Stellarium (https://stellarium.org/), avogadro.cc (https://phet.colorado.edu/) 5. Laboratory resources	1. Giving feedback on students' blog and encouraging students to go through other students' blog 2. Uploading a video 3. Facilitating group discussion in the classroom 4. Giving feedback on simulated lessons by students 5. Encouraging and providing necessary help in downloading free softwares in science learning and online mentoring

		6. Simulated science teaching-learning process in the classroom using various approaches followed by discussion. Video of the simulated lessons could be uploaded on the course platform and reflection of students on the same could be invited 7. Exploring and listing various ICT based teaching-learning approaches in Science using Google search 8. Practice sessions in the computer laboratory or own laptops on science specific simulation software/ apps such as Stellarium, Kalzium, Avogadro, PhET, etc. 9. Online discussion on how the above listed softwares/ apps could be integrated into science lessons		
Create unit plans, lesson plans and concept maps in science	• Need for planning a lesson • Development of unit plans and lesson plans	1. Students watch videos posted online in the course webpage by the mentor on the relevance of content analysis in the process	1. Video 2. Concept map softwares/ apps (https://cmap.ihmu.us/)	1. Preparation of video and uploading on the course webpage 2. Facilitating content analysis

	• Meaning and process of concept mapping-tool for planning	of planning a unit, lesson and activities 2. Classroom activity of content analysis of a science topic 3. Representing the interrelationship of the identified concepts in the form of a concept map using Cmap, Freeplane or any other concept map tool and uploading on the course site 4. Peer reflection on the concept map developed by students on online discussion forum 5. Group activity in the classroom on preparation of unit plan and developing an exemplar lesson plan in science 6. Uploading of a lesson plan as an assignment and taking mentor feedback on the same	(https:// sourceforge. net/projects/ freeplane/ files/latest/ download)	activity by evolving the criteria of analysis through discussion 3. Managing peer reflection on concept maps prepared by students 4. Motivating and encouraging students' activity in the classroom and giving necessary guidance on the preparation of unit and lesson plans 5. Providing feedback on assignments
Design assessment framework for science learning	• Paradigm shift in assessment • Factors to be considered for assessment (Creating assessment framework) • Forms and tools of assessment	1. A small video lecture uploaded on the course page by the facilitator on significance of assessment and paradigm shifts in the process of assessment 2. Classroom discussion on various forms of assessment in science	Video e-rubrics e-portfolio softwares (https://kahoot. com/schools/ assessment/ https://quizizz. com/ https://www. edcite.com/)	1. Preparation of video lecture 2. Facilitating classroom discussion on forms of assessment 3. Monitoring and guiding the group activity on blueprint

	• Preparation of blueprint • ICT in assessment	3. Group activity of preparation of blueprint in the class with guidance from the teacher 4. Role of ICT in assessment—students posts opinion in the discussion forum 5. Mentor uploads the examples of e-assessment tools such as Kahoot, quizizz, Quizlet, Edcite, etc. 6. Assignment—preparation of e-portfolio		4. Initiating discussion forum on the role of ICT in assessment, specifying a few examples 5. Demonstration of ICT assessment tools 6. Preparation and uploading of worksheet on e-assessment 7. Developing guidelines on the preparation of e-portfolio

Note: The ICT tools and activities mentioned here are only suggestive, recommending designers to choose the best for their classes.

Conclusion

A blended learning design for science pedagogy course in pre-service teacher education programme is suggested in this paper. There are many challenges of implementing it in the current teacher education system of India such as technological requirements including access to internet and lack of knowledge and skills in using the technological tools, etc. Students' varying degrees of learning competence is also another concern. Also, teacher educators' skill of redesigning the curriculum becomes imperative in effective designing and implementation of a blended course. However, with proper guidance and support from the institute and a conscious effort of teacher educators in bringing improvement in teacher preparation process, these challenges could be addressed and towards achieving higher learning outcomes which is possible in a blended learning environment. Blended learning is an immediate requirement and with effort, teacher educators would be able to design a course having a beautiful blend of between classroom as well as online learning environment.

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