



Pedagogical Reforms Needed in Virtual Learning in Mathematics: Learners' Perspective

Prem Kumari Dhakal

Ph.D. scholar, Tribhuvan University, Nepal

Abstract

This paper aims to identify some pedagogical reforms needed in virtual learning in mathematics. This study is based on the lived experiences of the university level students. I have selected seven participants purposively to represent seven distinct provinces of Nepal from the batch 2017-019 of M.Phil.in Mathematics education from Nepal Open University. This study has followed qualitative case study design and interpretative research paradigm. In depth interview has been conducted using mobile phone to collect data. I have recorded the audio call taking permission of the participants for the analysis purpose. I listened the recorded audio, transcribed the voices and categorized them to developed themes. In the perspectives of the learners, immediate feedback and motivation to the learners, applied and practice-based curriculum, collaborative learning approach, exciting classes, the engagement of the learners, the use of different mathematical software, punctuality and flexibility are the main reforms needed in virtual learning in mathematics.

Key words: *Pedagogy, Reforms, Virtual learning, Mathematics, Learners' perspectives*

Submitted: 20 November 2021

Revised: 13 December 2021

Accepted: 19 February 2022

1. Introduction

Teaching learning in 21st century has been transformed due to rapid development of technology. After the crises of Covid-19, most of the developing countries like Nepal has started virtual mode of learning in university as well as School level, although developed countries have been using online mode of learning for many decades. According to Pappa (2015), Sir Isaac Pitman launched the first distance education course to his students via mailed postcards in 1840s. After the 1960's, computers had come into practice in different areas. With the rapid development of technology, e- learning has come into the practice for the past two decades (Pappas, 2015). After the worldwide terror of Coronavirus (Covid-19), most of the developing countries started online mode of learning from school to university level. Mostly, distance learning through radio and television, online learning via the internet and virtual classes through different software like Zoom, Google meet, Skype and Team has come into practice at the university level as well as school level in Nepal.

Using digital technology in mathematics or developing ICT integrated mathematics curriculum has been an issue of 21st century in developing countries like Nepal. (Freiman & Tassell, 2018) emphasized on technological infrastructure to develop new abilities and ideas in understanding and developing a new way of thinking by using digital tools. Integrating digital technology in Mathematics teaching to enhance the learners' understanding is widely recognized and the use of computers and graphic calculators is encouraged in developed countries, although effective integration of technology in classroom practices is still remains incomplete (Bennison & Goos, 2010). They emphasis that the causes of difficult in integrating digital technology in mathematics classroom practices are the teachers' knowledge and confidence, access to the resources, participation in professional development programs and their implementation. Although a little has been done in developing a pedagogy for online mathematics courses, there are some clear guidelines. Care should be taken to have a sound balance between teacher and learner- centered activities and that interaction should

be carefully planned; interaction between learner and content, between learner and instructor and between learner and learner (Engelbrecht & Harding, 2005).

Chatti et al. (2010) focused on shifting toward a more personalized, social, open, dynamic, and knowledge-pull model instead of the one-size-fits-all, centralized, static, top-down, and knowledge-push models of traditional learning. A virtual learning environment (VLE) or learning management system (LMS) is a Web-based platform for study courses, usually within educational institutions. The design of a virtual learning environment should include these five aspects knowledge (design of interactive digital content with pedagogical perspective), collaboration (student-student, student-teacher and teacher-teacher interaction), consulting (both synchronous and asynchronous), experimentation (simulation) and management (homework, evaluation and follow-up), all of this for technology to stimulate the required learning (Alarcia & Bravo, 2012). According to Hwang (2014), learning takes place in multiple settings and the learning environment may or may not be structured but the learning in different environments can complement each other. As the same way, Mayer (2001) states that the rapid progress of wireless communication, the internet and emerging technology have transformed the learning environment. Technology helped to provide appropriate information to the individual student in the right place at the right time. (Carpenter & Lehrer, 1999) proposed five forms of mental activities to develop mathematical understanding as; constructing relationship, extending and applying the mathematical knowledge, reflecting the experiences, articulating what one knows and making mathematical knowledge one's own. Similarly, Fraser (1998) focused on the influence of the learning environment in the mathematics understanding. He further emphasizes that mathematics learning environment refers to a given space for the learning process in the context of social, psychological and pedagogical which can influence students' mathematics achievement. Blended learning, which associates online and face-to-face classroom experiences, is becoming common in education at all levels (Owen & Dunham, 2015).

Nowadays, the main concern of educators and mathematicians is to apply ICT integrated mathematics curriculum from school to university level to make it more easy and interesting. In the same way, the government of Nepal has implemented Open and distance learning policy (ODL policy-2063 BS). The main aims of the policy are; to expand access to education to the learners of diverse needs, to improve quality of conventional education, to promote continuing education and professional development and to establish a system of knowledge and skill certification. E-learning is the most desired, effective and cheaply available tool for the learners because they can acquire more information from the internet. The learners of rural areas are still facing the problem of infrastructures and the internet. However, there is a rapid growth trend of e-learning in higher education in Nepal (Shakya, Sharma & Thapa, 2018).

1.1. Rationale of the study

This study will help the mathematics teachers and the administrators as well as the other stakeholders to make virtual learning effective; especially in mathematics teaching. In my perspective, it has also fulfilled the gap in literature on pedagogical reforms in virtual learning in mathematics. The findings of this study will be applicable for the policy makers and the curriculum designers to make better policy about online learning and to design practice-based mathematics curriculum.

Objective of the study

The main objective of this study is to identify some pedagogical reforms needed in virtual learning in Mathematics in University level.

Research Question

This study is limited to find out the answer of the following research question:

1. How can the virtual learning environment in mathematics be reformed?

2. Review of the Literature

Different studies have performed the perceptions and the challenges of virtual learning environment in global context as well as the context of Nepal. But no more studies are available in the field of Mathematics; especially in Nepalese context. In this section, I have mentioned some empirical literature on the challenges in virtual learning in mathematics and the ways of mitigating the challenges.

In an experimental study, Patricia and Jennifer (2011) examined pre-test and post-test of the student's mathematical knowledge. The result obtained from paired sample t-test indicated that there was no significant difference between the average achieving student groups in virtual manipulative and the physical manipulative. The qualitative data indicated that different achievement groups experienced virtual manipulation in different ways. Similarly, a quantitative survey by Amrites and Jeayaram (2019) concluded that 85% of students strongly agreed that VLE makes it easy for teachers to teach practical modules and 70% of students strongly agreed that VLE has helped to improve their mathematics and science scores. The researchers concluded that VLE helps the students to recollect the learning easily even after one month. It helps students to understand a concept in a much better way as compared to traditional labs. Likewise, a qualitative case study by Clarence (2017) explored that visual learning, learner control, ease of use, technical competence, instructors support, and technical support are the factors that must be addressed when using a virtual learning environment to improve the talent development.

Virtual learning in mathematics should be interactive to enable students in understanding. Different mathematical software have been developed to make mathematics class more active and interactive but the teachers should invest more time to be aware about new software and enable to use them in teaching. (Glover et al., 2007) found that Interactive White Board (IWB) enabled the teachers to extend and develop their existing approach. The study also showed that IWB alone cannot do all but the time investment of the teachers and the pupils is needed to make mathematics classes more interactive. Similarly, (Engelbrecht & Harding, 2005) mentioned that there is still an uncertainty whether all the mathematics courses can be successfully taught via the web, although they have mentioned a trend in teaching as; d-learning(distance learning) is being replaced by e-learning(electronic learning) which is making a way for m-learning(Mobile learning).

Each content area has certain objectives and needs that technology can address in different way. According to (Guerrero, 2010), technological pedagogical and content knowledge (TPACK) enables the teachers to distinguish between the technology required in specific contents and apply appropriately. Guerrero (2010) has also provided the central components of practical TPACK in mathematics classroom as; conception and the use of technology, technology-based mathematics instruction and management, and the depth and breadth of mathematics content. Following the TPACK components as mentioned above, each mathematics teacher should have the sufficient knowledge and the skill about the technology and mathematics contents. Also, the skill of using appropriate technology in teaching specific contents is the main requirement for mathematics teachers.

In an investigation on the effectiveness of VLE in primary education,(Berry, 2006) found that virtual learning environment have a positive impact on students' motivation and learning habit. School-wide implementation of VLE would be consideration and the blended approach of online access from home and face to face classroom interactions seemed to work well in primary education. Students participated in that investigation took VLE eagerly to use it for homework. Likewise, from a field experiment on 210 students in Tiwan, (Chou & Liu, 2005) found that the learners achieved better learning performance and higher level computer self-efficacy in VLE than their traditional learning environment. Also, the study found that the students in VLE reported higher level of satisfaction and learning climate than their traditional learning environment. Also, (Heemskerk et al., 2014) examined the effect of combined use of interactive whiteboard (IWB) and virtual learning environment in mathematics education. The study indicated that the students who were taught mathematics with the IWB and had the opportunity of using VLE after lessons consistently obtained higher average scores. The study also found that that learners appreciated the VLE in mathematics because the IWB

lessons were available on it. The researchers concluded that the combined use of IWB and VLE in mathematics is effective.

Different studies have examined the effectiveness of VLE and the blended approach of learning in different situations that I have mentioned above. But there is the scarce of literature on the pedagogical reforms needed in virtual learning in mathematics. So, I have taken this title to identify some pedagogical reforms needed in virtual learning in mathematics

3. Methodology

In this section, I have mentioned my philosophical perspective, research design, study site and the participants as well as the tools of data collection and the procedure of data collection and analysis.

3.1. Philosophical perspectives

This study has accepted the subject knowledge and the multiple realities. The reality of this study comes from different perspectives of the participants. I have given equal values to the views of the participants. So, the study follows multiple reality as its ontology and the subjectivity as its epistemology.

3.2. Research design and the Paradigm

I have used qualitative case study design and interpretive research paradigm throughout this study. The Interpretive research paradigm is the base for qualitative research as it believes social reality is understood exploring subjective interpretations of human experiences in different social and historical contexts (Dahal, 2017). Since, it follows non-numeric data collected through in depth interview, I have used this paradigm in my study.

3.3. Study site and the Participants

I have taken Nepal Open University (NOU); the first open university of Nepal as the study site because it has launched the different programs of university level through virtual mode. Among different programs of NOU, I selected the M.Phil. in Mathematics Education program since I was a student of first batch(2017-019) of this program. As a regular student, I had the email address and the contact number of all the students of the first batch. There were altogether thirty students from different geographical areas of Nepal. Among them, I selected seven participants purposively to represent each of the seven provinces of Nepal. All the selected participants have been teaching in university level as well as the school level. All of them have the experiences of teaching for more than ten years. I have used the symbols P1, P2, P3, P4, P5, P6 and P7 to represent each of the seven provinces as the pseudonyms of the participants.

3.4. Data collection tools and the procedure

In- depth interview was the tool of data collection. An interview guideline containing open-ended questions was constructed to conduct the interview. It was not possible to meet all the participants from different area physically. So, I interviewed using phone call after taking the oral consent of the participants before interview. The interview was conducted personally in the appropriate time according to their intention. I recorded the call in my mobile device by taking their permission. I also noted important points in my dairy.

3.5. Ethical Consideration

Ethical part is very important in each research; especially in qualitative research. I have taken the oral consent of the participants by calling them before interview. After selecting the participants, I had called them personally to inform about my research purpose and the cause of their selection. I did not interfere them in the procedure of interview. I interviewed at the time when they were free and

agree to share their experiences. I have used pseudonyms to protect their identity according to their intention.

3.6. Procedure of data analysis and the Interpretation

I have used thematic analysis method to analyze qualitative data in my study. I listened the audio recording carefully and matched the points that were made in my diary at the time of interview. After listening the voices of all the participants, I transcribed, coded and categorized the data. From the transcribed data, I developed different ten themes that have been described separately with quotations in the analysis part.

4. Data Analysis and Interpretation

When I asked the participants about the pedagogical reforms needed in virtual learning in mathematics in higher education, they gave different suggestions in their own experiences. After listening their voice many times in recorded audio, I developed the ten different themes; engagement of the learners, exciting classes, applied and practice-based curriculum, collaborative learning, motivation, flexibility, immediate feedback, using different mathematical tools, acceptance of handwriting and punctuality as the pedagogical reforms. I have described the different themes as follows:

4.1. Engagement of the Learners

The participants focused on the learners' engagement to make virtual learning in mathematics more effective. Participant P1 an experienced high school teacher shared his feeling as

One-way presentation of the instructor makes the class dull. In this situation, learners leave the class or join the class only for attendance. They feel tired and thought the period so long. Instructors should engage the learners to do some work, such as asking questions, discussing with each other, experiencing experience sharing, short project work, or any other. Instructors should ask questions personally while running class to test the learners' attention.

Other participants also emphasized on students' engagement in mathematics class. On the basis of their words, virtual classes should be more interactive and engaged than theoretical class. Participant P3 stated "Instructors should give some problems to the learners to solve and share in class one by one. This makes the learners engaged and classes also become fun." In my own experience, active chat rooms and discussion forums also make the learners engaged. Long periods without students' engagement become so boring. Instructors also feel tired. It is better to give short breaks after one hour and give some works to the learners and share. One -way presentation of the facilitator makes the class dull and learners may mute the class and do other works. Instructors think that students are listening because there may be a signal of presence without listening. So the active participation of the learners is needed in virtual classes on mathematics to make it effective.

4.2. Exciting Classes

Without interaction and communication, learners cannot get a clear concept of the subject matter. Learners in virtual mode cannot interact with peers as in face to face mode although there are different ways to create an interactive environment in virtual mode. Participant P6 shared his experience about the interesting classroom as "engagement of learners makes the classroom interactive and fun. Interaction among friends and interaction with instructors both options should be available in class. Group discussion and project work also make the class interesting". Most of the participants told that short break, short classwork and sharing opportunity in class, regular question-answer makes the classes more excited. Instructors should do more effort to make the classes interesting. Participant P4 stated "Chat room, Discussion forum, quiz and questioning make classroom interactive"

From the view of the participants and in my own experience attractive slides, question answers, active chat room, short break and interesting starting make the virtual class in mathematics more interactive and excited.

4.3. Applied and Practice-based Curriculum

Traditional curriculum is difficult to implement in virtual classes. On the experience of the learners as well as teachers, practice-based and applied curriculum should be made before starting virtual mode in learning. In the case of Mathematics, long theoretical problems of university level curriculum is too difficult to teach virtually. Participant P7 stated

I felt difficult to learn the prescribed mathematical course virtually. Different algorithms with more iterations and tables as well as theoretical proofs and long and complex numerical problems are difficult to teach and learn virtually.

Not only the participation P7, other participants also focused on practice-based mathematics curriculum in virtual mode of learning. So, it is needed to modify the curriculum that was prepared for face to face classes before starting virtual mode of learning mathematics.

4.4. Collaborative Learning Approach

In my own experience, sharing with friends helps to remove confusions. Learners can share more with classmate than instructors. So the instructors should create an environment of sharing each other in class. It makes the classroom more interactive and interacting as well as removing miss concepts on the subject matter. Participant P7 explained “competitive situation is not good in the research level. Personal assignment, presentation, quiz and other activities and personal grading process creates competitive situation than collaboration.” Participant P1 expressed the feeling of collaboration as “collaboration helps each other to remove confusion and submit works on time.” The views mentioned above are the symbols of seeking a collaborative approach in higher education. Learners are not satisfied on competitive situation and grading system. They need group work, discussion and group presentation to increase collaborative situation.

4.5. Students' Motivation

Motivation is necessary in any type of learning. Virtual learning is more challenges than face to face learning. So the teachers should play vital role in students' motivation. Participant P5 emphasized on students' motivation and said:

There is a lack of motivation on virtual classes than face to face classes. Since the learners are habitual on face to face class, they don't take virtual class easy. On the trial period, I felt a great trouble to manage time, home environment and other technical part. I had a great anxiety to manage all.

Other participants also focused on the motivation. In the same line, participant P4 shared “learners have more anxieties about assignments and other online activities. Instructors should be close to them and provide environment to share their troubles. Solution of learning difficulties and technical support are needed to the learners”.

The views of the participants indicate that motivation is needed to complete virtual classes. Due to the lack of face to face interaction with teachers, learners may have many confusions and obstacles. In the initial stage, instructors should guide them as their needs. Learners should also share their difficulties with instructors or friends without feeling any difficulty. Colleagues and teachers should support each other as need. So the teachers should play an essential role in motivating the students to make them confident in achieving the goal.

4.6. Flexibility

Most of the learners of higher level in the Nepalese context are job holders. They have to bear great responsibility of family and society. They have a great challenge of managing time to read. In the words of participant P6:

Some instructors give more assignments without thinking the learners' problems. Short period for more online assignments increases the anxiety in the learners. This may be a cause of drop out of learners. It does not mean that assignments should not be given but the deadline should be flexible.

Flexibility is the common expectation of job holders because they have to manage time for study, job, family and other responsibilities. Group work, project work, home works should be given but there should be flexibility on dead line. It increases the confidence on the learners.

4.7. Immediate Feedback

On the participants' perspectives, immediate feedback and opportunity to correct the mistake make the learners happy, motivated and engaged to do works. It also increases the confidence on students and good relationship with instructors. In my own experience, learners like the instructor most than others who respond to the works of learners fast, provide appropriate feedback on time, and remove confusions.

Fast response on the works of the learners makes the class also interesting. Participant P3 shared "Some teachers give assignments, we submit and they give low marks with more comments. But we could not get chance to correct our works and submit to get high grade" In my own experience, all the learners want to get high grade after reviewing the works. So the instructors should not give final grade at first time of assignments and presentations. Learners should get the opportunity to correct weakness and submit again.

4.8. Acceptance of Handwriting

Numerical mathematics classes are more challenging than theoretical classes through virtual mode. Although there are different mathematical tools in online classes but not easy to use. Long numerical solution with complex symbols and operators are not only difficult to type, it takes more time also. Numerical assignments on Mathematics also adds tension to the learners to type. All the students may not have capacity of mathematics typing. So the instructors should accept the image of handwriting of students on assignment. It will save time and decreases anxiety of learners. The experience of participant P5 was:

Pure numerical problem with more steps, complex symbols and operators take more time to type. It adds more tension to me. We have to do the assignments of other subjects also. So sending image of handwriting is better in numerical problem.

Other participants also supported his words and told that it is too much difficult to type long numerical problems with complex operators and symbols.

4.9. Using different Mathematical Tools

Teaching numerical mathematics contents is more complicated than theoretical content through virtual mode because it is difficult to type and takes more time also. In my own experience, if the teachers show slide of numerical steps and figures, learners cannot learn the steps of solving and drawing. They have a confusion on how the teachers did. Participant P4 an experienced lecturer, said

Readymade slides, charts and pictures arises confusion on mathematical content. If the instructors draw figures to show the learners, then it will be clear. Showing the technique of drawing is necessary in complex figures of mathematics. There are different required pictures in internet. If the teachers copy the picture and show to the students, it makes them surprised that how the teacher made that figure.

Other participants also emphasized on alternative tools/software in numerical problem because slide share does not make the concept clear as doing directly.

4.10. Punctuality

Punctuality is necessary to get success in any field. Virtual learning is a technology based practice. If the learners could not join the class on proper time, system might not support later. Similarly, there is time bound each activity. If we could not do on time, submission is not possible after dead line. I have my own experience about the punctuality of virtual class as

One day I could not join the class at predetermined time because I was not at home due to my personal emergency. I arrived at home after 10 minutes and tried to join but I could not join immediately. I waited around 15 minutes to join because our teacher was presenting and the symbol of 'Do not disturb'. Since the other friends were engaging in class work, they did not call and join me in class.

The participants also said that learners should be punctual, obedient, and serious in online classes. Attending regularly, listening carefully, doing works on time, engaging in chat, discussion forum, quiz and other activities given by the instructors are needed to complete. Without being punctual on such activities, learners cannot complete their virtual classes effectively.

5. Conclusion

Virtual learning is the need and an opportunity in higher education in Nepalese context, although it has been the alternative way to continue school education in the period of pandemic. In the perspectives of the participants of my study as well as me, teaching learning mathematics through virtual mode has been difficult due to the lack of knowledge and skill of using mathematical software. Because of difficult symbols and long numerical solutions, typing numerical solution takes more time. Although there are different mathematical software like as smart board, interactive whiteboard, geogebra, most of the teachers use slides and images of handwriting of numerical solution in teaching mathematics due to the lack of knowledge and skill.

This study has identified some pedagogical reforms needed in virtual learning in mathematics from the perspectives of the learners of university level although these are not sufficient. Most of the learners of university level start job to earn for themselves and their family in the context of Nepal but they want to continue their education through online mode. So, the curriculum designers, policy makers, administrators, teachers, guardians and all the stakeholders should be responsible to make virtual learning effective in higher education in Nepalese context.

References

- Amrithesh, P.S., & Jeayaram, S. (2019). A study on student's perception towards virtual learning environment, Palakkad. *International Journal of Recent Technology and Engineering*. <https://www.ijrte.org/wp-content/uploads/papers/v7i6/F2613037619.pdf>
- Bennison, A., & Goos, M. J. M. E. R. J. (2010). Learning to teach mathematics with technology: A survey of professional development needs, experiences and impacts. 22(1), 31-56.
- Berry, M. (2006). *An investigation of the effectiveness of virtual learning environment implementation in primary education*. University of Leicester.
- Bravo, I., & Alarcia, O. (2012). The impact of ICTs on lecturer and student interaction in university education process. *International Journal of Educational Technology in Higher Education*, 9, 213-228. <https://doi.org/10.7238/rusc.v9i2.1243>
- Carpenter, T. P., & Lehrer, R. J. M. c. t. p. u. (1999). Teaching and learning mathematics with understanding. 19-32.
- Chatti, A., Agustawan, M., Jarke, M., & Specht, M. (2010). Toward a personal learning environment framework. *International Journal of Virtual and Personal Learning Environments*, 1(4), 66-85. doi:10.4018/jvple.2010100105

- Chou, S. W., & Liu, C. H. J. J. o. c. a. l. (2005). Learning effectiveness in a Web-based virtual learning environment: a learner control perspective. *27*(1), 65-76.
- Engelbrecht, J., & Harding, A. J. E. s. i. m. (2005). Teaching undergraduate mathematics on the internet. *58*(2), 253-276.
- Fraser, B. J. (1998). Classroom environment instruments development, validity and the applications. *Journal of Learning Environment Research*, *1*(2), 7-34.
- Freiman, V., & Tassell, J. L. (2018). *Creativity and technology in mathematics education*. Springer.
- Glover, D., Miller, D., Averis, D., Door, V. J. L., Media, & Technology. (2007). The evolution of an effective pedagogy for teachers using the interactive whiteboard in mathematics and modern languages: An empirical analysis from the secondary sector. *32*(1), 5-20.
- Guerrero, S. J. J. o. C. i. T. E. (2010). Technological pedagogical content knowledge in the mathematics classroom. *26*(4), 132-139.
- Heemskerk, I., Kuiper, E., & Meijer, J. J. J. o. C. A. L. (2014). Interactive whiteboard and virtual learning environment combined: effects on mathematics education. *30*(5), 465-478.
- Hwang, G. (2014). *Definition, framework and research issues of smart learning environments: A context-aware ubiquitous learning perspective*. <https://doi.org/10.1186/s40561-014-0004-5>
- Mayer R. (2001). *Multimedia learning*. Cambridge University Press
- Owen, H., & Dunham, N. (2015). Reflections on the use of iterative, agile and collaborative approaches for blended flipped learning development. *Education Sciences*, *5*(2), 85–105. doi:10.3390/educsci5020085
- Pappas, C. (2015). *The history of blended learning*. <https://elearningindustry.com/history-of-blended-learning>
- Patricia, S., & Jennifer, M. (2011). *Learning mathematics with technology the influence of virtual manipulative on different achievement groups*. https://www.researchgate.net/publication/255567150_
- Shakya, S., Sharma, G., & Thapa, K. (2018). State education system with e-learning in Nepal impact and challenges. *Journal of the Institute of Engineering*, *13*(1). <https://www.researchgate.net/publication/325964271>

Prem Kumari Dhakal is an Assistant Professor at Central Campus of Education, Midwest University, Nepal. She has also chaired the Mathematics Education Subject committee in Midwest University. She is currently a PhD scholar in mathematics education in Tribhuvan University. She is interested in teaching and research in mathematics education. She has published different research articles in reputed journals and presented research paper on national and international conferences. Now she is the chairperson of Council for Mathematics Education, Surkhet branch, Nepal.