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E-pedagogy: Technology Matters in Mathematics Education

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Abstract

Growing culture of internet and technology use in Nepal has introduced new landscape of educational practices. These practices are growing in the form of e-pedagogy: technology integrated teaching and learning activities. In this context, this paper has explained engaged and interactive learning environment in higher mathematics education in Nepal. An action research intervention of VLE (Virtual Learning Environment for Mathematics) was carried out in a cohort of 170 master students in a course Differential Geometry at Central Department of Education, Tribhuvan University, Kirtipur, Kathmandu, Nepal. The instrument used in this study were baseline and end line survey questionnaire, interview-guideline and VLE generated log reports. The collected data were analyzed with descriptive statistics and themes using SPSS and Atas.ti. The results of the study showed that M-VLE as e-pedagogy helped students (a) to increase learning presence anytime anywhere, (b) to enhance personalized learning experience, and (c) to provide timely and recursive learning feedback and support. Therefore, the study concluded that e-pedagogy matters in higher mathematics education for engaged and interactive learning of higher mathematics.

***Keywords**:* VLE, Moodle, e-pedagogy, Mathematics Education, Nepal

Introduction

Common educational practice in higher education in the traditional classroom are classroom lecturer writing on chalkboard/whiteboard. Now a days, this practice has changed due to the growing culture of internet and technology use. Technology integrated pedagogy in the name of e-learning, o-learning, v-learning, m-learning, u-learning, blended learning, hybrid learning, MOOC, SOOC, etc., are emerging (Dhakal & Sharma, 2016). As result, use of laptop, projector, touch-board, e-pen, and different digital resources are becoming a part of pedagogical activities. Use of Moodle (modular object-oriented dynamic learning environment) as virtual learning environments (VLE) both in face-to-face and online mode of education is ever increasing (Johannesen, Erstad, & Habib, 2012). These are short scenarios on how educational technology has been upgraded with Information Communication Technology (ICT) use. This scenario has also seen in Nepal.

In Nepal, students have started to use a range of technological devices like hand-held touch mobiles and high- speed internet. Number of teachers in Nepal are quite familiar to use interactive touch-board. The use of internet and other technology is increasing day by day. In a classroom

survey at Central Department of Education, Kirtipur, 157 (92%) out of 170 students were found that they use internet daily. With this ever-growing use of internet and technology, we as instructor perceived that e-pedagogy is necessary to utilize in our educational practice in higher mathematics education. Therefore, this paper used Moodle as VLE in a face-to-face course Differential Geometry.

Problem Statement

Student learning is a main part of teaching, therefore it is said that "if student has not learned, then there is no teaching"(Ramsden, 1992). Teaching is mass phenomenon in a group of learners from a range of diverse backgrounds (e.g. prior knowledge, learning pace, cultures, and language). With limited face to face hours of classroom teaching, teachers are facing numbers of challenges to address "learn anytime anywhere". The face to face only teaching had caused number of limitations like time constraints, resource constraints, activity constraints, feedback/support constraints, and assessment constraints etc. in this paper, time constraints represent restricted and limited teaching and support hours, resource constraints represent few and limited text books only learning resources, activity constraints represent few or no teaching and learning activities except classroom lectures, feedback and support constraints represent less or no individual feedback for student learning, and assessment constraints represent lack of comprehensive continuous assessment (CCA) for summative ends. With this problem to address, the aim of this paper is to analyze "in what ways VLE can enhance students' learning opportunities in higher mathematics education?"

Literature Review

Internet and web technology has increasingly provided number of supportive pedagogical tools (Yunus, Nordin, Salehi, Amin Embi, & Salehi, 2014). Among various tools, learning management system (LMS) is one. It is for flexible access of learning opportunities (Miletic & Goran, 2016). In this paper, Moodle as an open source LMS (http://moodle.org). Moodle is cloud software. It has a simple and logical interface. User with simple digital literacy can use Moodle for F2F classes, blended classes, flipped classes, online classes and virtual classes. It constitutes constructivist learning framework where both teacher and student can work together and construct their own learning. Some interesting properties of Moodle are: it allows managing and tracking students work like forums, quizzes, questions, glossaries, lessons, questionnaires, wikis, books, chats, etc. Moodle helps to manage learning resources, activities, communication, collaboration, feedback, support and assessment (Johannesen, Ogrim, Pangeni, & Dhakal, 2016). Moodle has number of useful plugin for mathematics like WIRIS and LATEX (Mora, Mérida, & Eixarch, 2011) so that students and teacher both can work with mathematical symbols without any hassle. Therefore, Moodle is used as VLE. VLE allows learner to explorer dynamic and interactive educational contents. For example, student can use GeoGebra applets as learning objects to construct their learning.

In the literature, there are less evidence that has explored the potential of Math specific digital tools in VLE. Therefore, math specific technology GeoGebra and Mathematics are used in VLE to utilize e-pedagogy in higher mathematics education. Therefore, this paper understands e-pedagogy as combination of pedagogical tool Moodle; and mathematics specific tools; GeoGebra and Mathematica. Nepal government, its ministry of Education (MoE) has made number of national policy/plan (e. g. SSRP, SSDP, ICT master Plan). These policies/plans have mentioned that ICT must be use/integrate in all educational sectors and sub sectors. So, there is an urgency to articulate an ICT integrated pedagogy in teacher education programme. However, pedagogical model for ICT integration has not been exposed in Nepalese context, very few empirically tested

and justified model of ICT integrated pedagogy is found, particularly in higher mathematics education. Therefore, ICT integrated pedagogical model with empirical evidence is necessary in Nepalese context.

Theoretical Framework

Instructional design and pedagogy are somehow backed up by learning theories. In this technology enhanced pedagogy, combined implications of behaviorism, cognitivism, constructivism were utilized. Therefore, this paper has used connectivism (Downes, 2005; Siemens, 2005) as theoretical framework. The connectivism as a learning theory is still in discourse but its use has been justified by number of works. For example, technological pedagogical content knowledge (TPCK)(Mishra & Koehler, 2006), professional digital competence (PDC) (Lund, Furberg, Bakken, & Engelien, 2014) both argues that 21st century pedagogy need to go through technology use. This essence has also been exemplified in a work (Johannesen, Øgrim, & Gi\a ever, 2014) saying that PDC is new and additional (in addition to existing) teacher qualification for 21st century teaching where educational environment, pedagogical activities and content knowledge all go through technology use. Therefore, connectivism is considered as theoretical framework. in this paper to analyze VLE pedagogical model.

Connectivism is promoted by Downes and Siemensm (Downes, 2005; Siemens, 2005). According to them, learning occurs through connections within and among networks. According to Siemen, learning is no longer an individualistic activity. Knowledge is distributed across networks. Siemen's has mentioned eight learning principles in connectivism. Among them this study has utilized four principles. These principles are (1) Capacity to know more is more critical than what is currently known, (2) Nurturing and maintaining connections is needed to facilitate continual learning, (3) Ability to see connections between fields, ideas, and concepts is a core skill, (4) Decision-making is itself a learning process. Within these four learning principles, VLE effectiveness was analyzed.

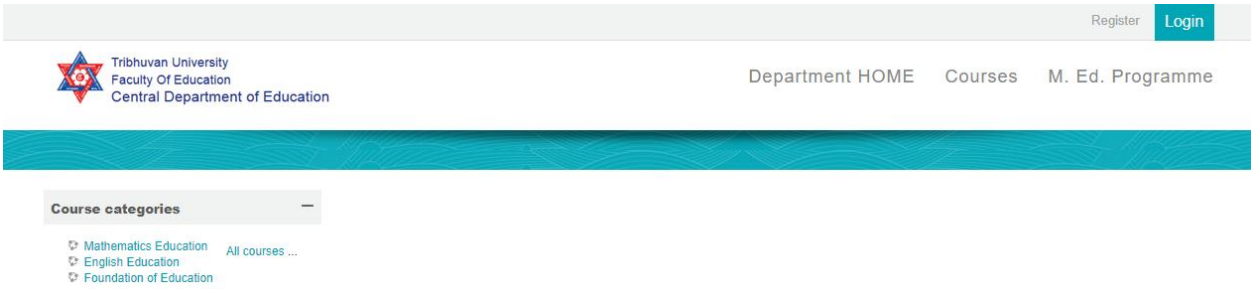
Methodology

This paper is based on an action research intervention study carried out among170 master students in a course DG of Mathematics Education at Central Department of Education (CDED), Tribhuvan University (TU) Nepal during the academic year 2017. These 170 students were in four groups each of 40-45 students. The action research (AR) is suitable to lead desired changes to improve educational practice (McNiff & Whitehead, 2006). The important part of AR is use of self-evaluation (self-reflection) which researcher can utilize. AR allows researcher to change/update outlined plan while implementing the action whenever circumstances require change. This is the main reason why AR is used. In this paper, VLE is action in one hand, on the other hand, data collection, analysis, and reporting are research. In this paper, three phase of AR intervention is described as below.

In the first phase, Moodle is installed as VLE on CDED domain (tucded.edu.np/moodle). The screenshot of the Moodle LMS homepage (www.tucded.edu.np/moodle) is captured above. After VLE setup, DG course was designed in VLE with a welcome section and 16 modular sections. The pedagogical elements in each weekly module were (1) Learning Resources, and (2) Learning Activities. Lecture notes, audios, and videos were developed on the contents of DG according to Gupta, Malik Text book (Gupta & Malik, 2006) and Lipschutz text book (Lipschutz, 2006). Learning resources were designed in VLE using word processing tools: MS, word, Excel, PowerPoint; assistive tools: Camtasia, e-Lacta; and mathematical software tools: Mathematica and Geogebra. Number of digital learning materials in the contents were text, graphics, audio, video,

animation, simulation, and worksheets. The learning activities in VLE were Quiz, assignment, lessons, discussion forum, Glossary and peer graded work.

First intervention: preparations



Second intervention: Orientation

After VLE preparation, a baseline survey was administered in a class. After baseline survey, students were oriented about VLE use. They were informed that the DG course will run in a blended mode, both F2F and online. Students were informed that "the course assignments, activities and course work in F2F delivery will be mandatory" as their course requirements as per the rule of FoE. Online learning activities in VLE will be supplementary and so go in parallel. They were informed that they can access VLE anytime anywhere and whenever they want it.

Facebook group was used to disseminate information on (1) how to login into VLE, (2) how to get username and password (3) how to change password (4) how to set profile picture (5) how to attempt Quiz, (6) how to upload assignments (7) how to use the discussion Forum, (8) how to use the mobile app. Similarly, other necessary updates were disseminated through Facebook group. After M-VLE orientation, students started to login into Moodle.

Third intervention: Implementing VLE

In third phase, DG course was implemented through VLE mode. Based on tutor's self-reflection, audio video resources, explanatory text, group work were emphasized in VLE. Dynamic and interactive applets through mathematics specific technology; GeoGebra and Mathematica were also used in VLE. Lesson format resources and peer-graded assignment activities were also used in VLE. Finally, based on authors' self-reflection pedagogical elements in VLE were designed with seven pedagogical principles; (1) Learning Contents, (2) learning Objectives (3) Learning Resources, (4) Learning Activities/Assignments, (5) Learning Interaction and Discussion, (6) Learning Feedback and Support, and (7) Learning Assessment and Evaluation.

Data collection and Analysis

The data in this study were collected from baseline and end line survey questionnaire, interview-guideline and VLE generated log reports. In the beginning of VLE intervention, baseline survey was administered. At the end of VLE intervention, same survey was administered as end-

line survey. After the survey, eight students were interviewed. These students were from four groups. For each group, two students (1 boy and 1 girl from each group) were taken. The collected data were analyzed using SPSS 18 for quantitative part for descriptive statistics, and Altlas.ti 8 for qualitative part for theme generation.

Results and Discussion

This study was carried out in a in a cohort of 170 students of master level in a course Differential Geometry at central department of education, Tribhuvan University Nepal. As basic demography, there were 70 students. Among them, 126 students have participated both in baseline and end-line survey. Therefore, 126 (111 Boys, 15 Girls) students were considered as study participants. In baseline survey, 46 students (39 Boys, 7 Girls) had their own personal PC. By the end-line survey, this number were increased to 77 students (66 Boys, 11 Girls). For mobile device, the baseline survey showed that, 102 students (90 Boys, 12 Girls) had smart phone. This number were increased to 118 students (104 Boys, 14 Girls) at the end-line survey.

In the following section, results and findings were discovered based on data analysis. The result shows that VLE implementation has embedded F2F teaching learning space into blended online space. VLE environment had connected home, school and online spaces for learning anytime anywhere learning opportunity; varied, individualized and digital learning resources; and timely/recursive feedback and support.

Anytime and anywhere learning opportunity

Using VLE, student experienced anytime anywhere learning opportunity. This study has shown that student used VLE for the following reasons.

Statements	Yes	No
I use Moodle to learn math at home	114	12
I use Moodle to learn math at campus	71	55
I frequently like to login Moodle	74	52

The table given above shows that, student used VLE to learn math at home and school. From Moodle log report (timestat), it is found that student spent two hours in an average (min 10 min, max 28 hours) in Moodle environment. These responses are the example that shown VLE enhanced learning opportunity. In addition, it is found that a student accessed VLE (tucded.edu.np/moodle) from seven different Internet Protocol address. This log database has ensured that VLE has created anytime anywhere learning opportunity. In the literature, it is mentioned that higher the engagement, higher the learning. For example, active participation, interaction, group work, projects work, and formative evaluation are important ways of engagement (Johannesen et al., 2016). Number of research (e.g., Johannesen et al., 2018) has shown that anytime and anywhere learning opportunities can enhance student's participation in various activities. This evidence is exemplified by this study.

Based on student interview, it is found that VLE has ensured flexible learning opportunity. It has offered choices on when, where and how students want to engage in learning on their own autonomy in terms of times and learning material. For example, a *student said,*

> *"using Moodle, I became able to learn accessing online resources like video, and animation using my mobile. I have collected these resources in my pen drive".*

From this data, it is exemplified that student used VLE as an information repository to access their learning anytime anywhere. The Connectivism learning principle highlights that learning is no longer an individualistic activity but occurs across networks. This principle of learning has been established in this study as students started to connect their knowledge across the resources in VLE. VLE helped students to enhance their learning hours beyond face to face

and campus boundaries. Therefore, it is found that VLE matters to create new learning opportunity anytime anywhere.

Varied, individualized and digital learning resources

Learning is an individual process. Learning occurs in different race and pace according to student's individual learning preferences and style. In a literature, it is mentioned that, earning preferences and style demands verities of learning resources. In this study, VLE ensured varieties of learning resources through text, image, audio/video, animation, and simulation, and examples. In the baseline survey, it showed that few students have used digital resources. The But the end-line survey showed that, all student (125 (99%) in internet use, 126 (100%) in math tools) used digital and interactive resources for their learning.

Statements	Baseline	End-line
I use internet and e-resources in my math learning	16	125
I use Math software (e.g., GeoGebra) in my math learning	26	126
I try to learn with audio/video image in my math learning	38	88

The table given above shows that, student started to use varied format digital resources through VLE in math learning. Based on student interview, it is found that VLE has ensured flexible learning opportunity. It has offered choices on when, where and how students want to engage in learning on their own autonomy in terms of times and learning material. For example, a *student said,*

> *"using Moodle, I started my learning on my own way selecting and organizing files like YouTube videos and audios". Another student said that "there are welcome note, syllabus, curriculum, semester plan, learning materials, and notice". Another student said that "I viewed 2D and 3D animated graphs using Moodle which I didn't know and used before, this visible thing made my learning easy".*

The data showed that student became more resourceful with varied resources in their learning using VLE. As connectivism principle mention, decision-making and resource browsing on learning personalization is itself a learning process. Visualization of information is also a learning. In this way, VLE became a panacea to ensure students learning opportunity through varied learning resources.

Timely/recursive feedback and support

Feedback and support are learning escalators. There is a quote, everybody can learn, but learning race and pace may differ (Dror, 2011). This quote showed that, homogeneity and learner similarities rarely exist in classrooms. Therefore, some student may learn fast and some other may learn slow. In this sense, VLE enhanced feedback and support mechanism/opportunity to excel both type of learners. In the baseline survey, it showed that few students received individual feedback and support in learning. But the end-line survey showed that almost all students get individual feedback and support.

Statements	Baseline	End-line
I ask question in Moodle if I don't understand my learning	52	74
I do discussion with teachers and students anytime if necessary in my learning	40	86
Teacher/student often reply answers to my questions in Moodle	24	102

The table given above showed that student started asking questions through VLE in math learning. VLE helped them to use electronic devices for communication, interaction, and

discussion. They started to interact with teachers/friends beside face to face classroom. As consequence, student (102 says yes in end-line survey) get feedback and support in individual level through VLE use. It is found that 2574 text posts and comments were created in M-VLE. This shows that, there were approx. 15 post/comments per student (min, max, SD). These kind of social networking and interaction were otherwise not possible without M-VLE learning platform.

Based on student interview, it is found that VLE has ensured Timely/recursive feedback and support. For example, one student said, *"In Moodle, teacher commented on my file and said thanks to me. I became happy and interested".*

In this way, VLE ensured feedback mechanism through sayback. Using VLE, comments on students' work were sent as feedback message. The connectivism learning principle highlighted that "nurturing and maintaining connections is needed to facilitate student learning. Using VLE students work (few sentences and theme, example, saying, quotation) were re-stated in their feedback text/comment. For example, one student said, *"teacher read our work and says us important things that we miss/do. This helped me in my learning and I feel happy that I am learning".*

Question asking is also found good feedback tools in VLE. In VLE, author asked, 'what do you mean by...?', 'have you considered .....?'. Such type of questioned helped students to bring their understanding to expand students' knowledge and skills. For example, one student said *" seen several videos of tangent plane in YouTube and GeoGebra tube, I became able to understand it, and I myself made GeoGebra animated file of tangent plane".*

The connectivism learning principle magnify that "*capacity to know more is more critical than what is currently known"*. From various quotes presented above, it is found that VLE has enhanced feedback and support mechanism. Appreciation, sayback, learning resources, interactive dynamic applets were found major feedback and support mechanism/tools in VLE.

Conclusion

VLE has provided number of learning opportunities. It helped students to remain engaged and interactive in their learning process anytime anywhere. VLE provided numerous of feedback and support tool/mechanism that otherwise not possible. However, VLE effectiveness is not a stable feature, rather it depends on both (a) teacher's presence and (b) instructional resources design. It is experienced that VLE intervention often need professional update in technology use. Enough utilization of mathematics specific educational software can be a challenge for teachers. The common challenges as experienced by tutor and leaner are instructor's ICT competency, online presence and dedication to course management. In the part, the students' challenges were: internet access and availability of e-device (e.g., mobile, and personal PC). Therefore, if teachers' competency, online presence and students' device and internet access are ensured, then VLE highly matters in higher mathematics education engaged interactive learning.

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