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# Virtual Learning Environment (VLE) in Mathematics Education

Bed Prasad Dhakal<sup>1</sup>, Lekhnath Sharma<sup>2</sup>

<sup>1</sup>Central Department of Education, Tribhuvan University, Kathmandu, Nepal

<sup>2</sup>Open and Distance Education Centre, Tribhuvan University, Kathmandu, Nepal

## Email address:

bed.dhakal@tucded.edu.np (B. P. Dhakal), lekhnath@odectu.edu.np (L. Sharma)

## To cite this article:

Bed Prasad Dhakal, Lekhnath Sharma. Virtual Learning Environment (VLE) in Mathematics Education. *Education Journal*.

Vol. 5, No. 6, 2016, pp. 126-135. doi: 10.11648/j.edu.20160506.11

**Received:** September 26, 2016; **Accepted:** October 31, 2016; **Published:** November 3, 2016

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**Abstract:** Mathematicians generally prefer less on the use of Virtual Learning Environment (VLE) in teaching mathematics at university thinking that this mode of learning can reduce the rigor of mental thinking needed to learn mathematics. This study tries to explore whether VLE promote engaged and interactive learning environment to master's students. It further draws critically the major opportunities and challenges that the teacher/students experienced while using VLE. This is an experimental case study, a part of a longitudinal study in CDED. Intervention is the learning platform Moodle with e-pedagogy blending with conventional mode, starting with more conventional less e-pedagogy and latter increasing the amount of e-pedagogy and lessening the conventional. VLE as case was introduced in teaching Projective Geometry among thirty-six students of Master's in Education (Mathematics). The instrument used in this study were baseline and end line survey questionnaire, observation checklist, interview-guideline and archive analysis. The results showed that students were found more interactive in learning through VLE being engaged emotionally, socially, and cognitively. Among different activities and resources in Moodle as VLE, quiz came out effective activity and videos as most preferred resource for the students of all types- fast as well as slow learners. Personal computing device, internet connectivity, and teachers' efficiency in using ICTs tools, maximizing teacher's presence in learning support were found as major challenges in using VLE. Despite the challenges, the major opportunities that VLE contributed in F2F classes were to improve study habits, make study more active, provides opportunity to learn and re-learn and to clarify the concepts. This gives the implication that the F2F courses need to be designed integrating VLE in an appropriate way.

**Keywords:** Moodle, Mathematics Education, ICT in Education, Engaged and Interactive Learning, Nepal

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## 1. Introduction

Educational practices, during last two decades are continually growing with the prevalence of use of information communication technology (ICT). Its use in education has introduced some new jargons for pedagogical practices. These newly introduced jargons are blended learning, hybrid learning, e-learning, o-learning, M-learning, U-learning, MOOC, SOOC, etc [1]. Researches showed that these practices are found supportive to enhance access, quality learning, engaged and interactive learning, meaningful and contextual learning, dynamic and fun learning [2], [3]. As a result, formal educational institutes these days are under increasing pressure to understand,

respond and adapt these rapidly growing technological innovation in their educational services/practices.

Tribhuvan University (TU) in Nepal is also trying to adapt ICT use in education both in academic and administrative works. It has started open and distance online education. Under different Faculties and Institutions, TU has started ICT as a separate subject, blended into different courses and incorporated as a means of educational delivery. Most of the faculties and students in TU these days are using ICT in their teaching learning activities. In this context, blended learning can be a means to enhance access and quality learning, help students to be more engaged and better interactive in their

learning pace.

ICT use in education is raising phenomena in Central Department of Education (CDED) in recent days, both institutionally and professionally. Second Higher Education Project (SHEP) and QUANTICT have made significant impact on this phenomenon. SHEP is World Bank funded higher education reform Project, which has funded CDED to set up dedicated internet access and necessary ICT infrastructure. QUANTICT is acronym for "Enhancing Quality and Sustainability of Teacher Training/Professional Development of Teachers Using ICT and Distance Delivery Mode", a NORHED, Norway funded collaborative project among three universities - Tribhuvan University (TU), Kathmandu University(KU) and Oslo and Akershus University College of Applied Sciences (HiOA) Norway. Both projects have provided necessary technical and pedagogical support to enhance capacity of academic faculties to conduct/support ICT integrated educational delivery. As an impact, technology use in CDED has been prioritized these days.

Mathematics education is a major and challenging discipline in CDED. CDED has prime role in preparing mathematics teachers of school level and mathematics educators. Mathematics education is one of the core subjects of school education and an umbrella concept in mathematics teaching in higher education in Nepal. But the practiced teaching approach is 'one size fits all' [4] which cannot work well among the students of mathematics with varied interests, strengths and prior knowledge. The question of the quality of mathematics education at university, particularly teacher education and training, directly impact on school mathematics education.

As a faculty member of mathematics education in CDED, the researchers have realized the importance of growing innovation in technological tools that consists of software as well as new pedagogical possibilities in mathematics instruction. From the researchers' own experiences and knowledge on using ICTs tools, motivated on ICT integration in mathematics course teaching in order to enhance and improve conventional practices of mathematics teaching integrating with e-pedagogy to reduce the limitations inherent in traditional approach. Campus premises is equipped with ICT infrastructure. Students have started to experience digital era, practicing social media, facebook, twitter, youtube, email and internet. This changing educational atmosphere signaled a possibility of use of ICTs in higher mathematics. Therefore, researchers were motivated to carry out this intervention study using Virtual Learning Environment (VLE) in mathematics education. This study, particularly focused in teacher education programme, is aimed to explore and analyze the students' access in VLE for more engage and better interaction in learning mathematics.

## 2. Statement of the Problem

Mathematicians generally prefer less on the use of VLE in

teaching mathematics at university thinking that this mode of learning can reduce the rigor of mental thinking needed in student to learn mathematics. On the other hand, as cited in [1], it is assumed that students' active forms of learning through projects, group work, collaboration and formative evaluation are the important ways of learning in university education. These are practically and particularly key principles of learning in higher education. Contrary to student-centred approach of teaching mathematics, Nepalese higher education seems to be more lecture dominated in large class and making students' a passive listener. Students are heavily devoted on memorizing the facts rather than meaningful understanding; and focusing doing tedious and boring calculation rather than creating context for meaningful learning. Also most of the teachers do pay less attention in higher order thinking skills, instead they simply works with pie-in-the-sky motivation. This kind of teacher centered practices of one-way traffic instruction is not working well for students to be engaged and interactive in their learning [5], therefore needs to figure out new approaches of teaching using possible ICTs innovations in conventional mode as supplementary tools for learning. In this circumstances, the research is carried out for the implementation of VLE to explore and analyze how it can contribute in interactive and engaged learning between and within students and teacher in higher mathematics education.

## 3. Research Questions

The recent issues in teaching and learning practices of mathematics education are less engaged and interactive in learning. In this concern, use of VLE is considered as supplementary tools to enhance students' engaged and interactive learning for higher mathematics. Thus, the following research questions led this study.

- In what ways do the implementation of VLE contribute for engagement and interaction between and within student and teacher in mathematics education?
- What are the problems/hindrances and opportunities that the teachers and students experience while using VLE?

## 4. Operational Definition of Key Terms

The student engagement and interaction are the key terms in this study and also the key factors of learning both in F2F and in internet supported courses. There are not a single independent measure to capture engagement and interaction, rather it needs to devise proxy measures to capture the level of interpersonal communication among the contents, teachers and peers in course of learning mathematics. So, the measures need to be constructed contextualizing to mathematics education. In this research, engagement is defined as an effort that students pay to log in Moodle for the purpose of learning taking attributes like study, practice, obtain feedback, analyze content, and solve problems (Kuh (2003) as cited in Petty and Farinde [6]). The level of

engagement is calculated by counting the attributes in Moodle generate login using quartile range. The term interaction is defined as creating, disseminating ideas, working in problem solution in group, participation in discussion forum as community of practice. The level of interaction is calculated by counting the postings of the materials in Moodle platform by the students.

## 5. Conceptual Framework

As an effort to modernize higher education, many institutes now have adopted purely online courses and blended online learning in conventional system. In fully online courses, students interact virtually, whereas in blended mode both face-to-face and virtual mode are supplementing each other [7]. Controversy rests on whether this educational option is viable to both teachers and students. Nevertheless, the students of 21<sup>st</sup> century students prefer more collaboration, freedom to create knowledge, and authentic audience in order to increase engagement, participation and activity [8]. The supporters of e-learning, therefore, claim the relevance of ICTs based learning on the theoretical ground of the constructivist and connectivism as the principles of learning. Connectivist theorists explain that cognitive tasks between students and technology happens in networks between individuals, groups, systems, fields, ideas or communities [9]. The use of Moodle not only transmits the learning contents to the students but also it establishes connection and build a learning community between teachers, students and the learning contents. As online learning is adopted, the roles of students and teachers change from the conventional mode of teaching in face-to-face class. Students' roles is shifted from fixed time activity performer to flexible and independent learners, where as teachers role shifts from transmitter to facilitator, developer of the contents - a complex and time consuming [10]. Students success of online learning depends upon the time they spent on learning activities offered through VLE. Learners in online environments spend more time on task than students attending traditional courses in classroom environment (Jaschik, 2009, cited in [7]). Online (e-learning) benefits to both students and teachers from the possibility of 'anytime, anywhere' appeal for the learning [11].

Chickering and Gamson (cited in [12]) has proposed seven principles for good practice in undergraduate education which are widely accepted in improving teaching and learning in higher education: i. encourage contact between students and staffs, ii. develop reciprocity and cooperation among students, iii. use active learning techniques, iv. give prompt feedback, v. emphasis on time on tasks, vi. communicate high expectations and vii. respect diverse talents and ways of learning. These principles need to address in designing and implementing VLE. Use of VLE can create environment to the students to be engaged and interactive in learning mathematics.

An operational framework for identifying students' engagement and interaction is necessary to captured various

evidences. This operational framework consists of evidences collected from students' motivation, social and economic background, institutional support, peer interaction, and teacher behavior. Perkins & Murphy's [13] designed, and Petty & Farinde's [6] used framework seems relevant to develop a new framework to identify engagement and interaction in mathematics learning. So some ideas from Perkins & Murphy's framework is adapted to prepare the present framework to analyze students' engagement and interaction in Moodle (as VLE). The present analytical framework has adapted three attributes: emotional, social, and cognitive from them. Within which the contents of good practices in higher education as suggested by Chickering and Gamson are incorporated. The emotional attribute intends to measure positive and negative feeling student's holds for subject, and attitude towards the use of email, short message service (sms), phone call and number of logs recorded in VLE. The social attribute intends to measure the amount and frequency of interaction with peer and teacher via posts, comments, discussions, chat and messaging. The cognitive attribute comprises of the frequency to attempt quiz, assignments, and view/download resources for the coursework. This framework contributes to identify and analyze students engagement and interaction in learning mathematics using VLE. Operationally, engagement and interaction in Moodle is the amount of quantitative degree to which students' log, post, comment, discussion, sms and submission as a sense of being physically present or 'real' in doing all these activities.

## 6. Methods

There are different research paradigms in educational research. Among them the broad concern are about empirical, interpretive and the critical theoretic research paradigms [14]. According to Denzin and Lincoln [15], qualitative research under interpretive research paradigm places emphasis on the processes and on the socially constructed nature of reality, and establishes intimate relations between the researcher and the research. The present research problem falls to the qualitative sort of investigation with a substantial support from quantitative information to analyze and explain the level of engagement and interaction among students, teachers and contents in course of learning higher mathematics. In this argument, an experimental case study research [15] design with mixed methods [Qual-quant] is used in this study. Case study is one of the qualitative research method involves in-depth examination of a definite instance. Here in this study the case instance is VLE intervention. Instead of being only rigid and structured in research method, a flexible mode of collecting information keeping live connection between researchers and researched is preferred both epistemologically and ontologically. So, a mixed method case study is chosen with an assumption that a case study provides a systematic and flexible way of looking at VLE for students' engaged and interactive behaviors in learning.

## 7. Study Unit

CDED is a main Department of Faculty of Education (FoE) under TU. The prime aim of CDED is to produce competent, qualified, and workplace demanded teachers and educators. The student enrollment in this Department are from across the nation, and these numbers are around 2000 every year. The intervention of VLE is made in this unit. Due to the growing ICTs facilities and preparation of faculties in using ICTs in education in a new setting of educational organization, CDED is selected for the intervention unit. It has started semester based Master's programme and planned to start distance mode programme using blended mode (face-to-face and online delivery). SHEP and QUANTICT have supported to set up necessary ICT infrastructure and internet connectivity for this department. QUANTICT, in addition, has also provided some professional training for the faculties to equip with necessary e-learning pedagogy and course development competencies to run ICT supported instructions in conventional and distance mode of learning. Having run series of workshops, trainings and sharing of other countries experiences' of using ICTs in education, faculties in the department have gained necessary competencies on using ICTs in education. Now they have developed courses in Moodle and able to run the course using e-learning pedagogy. Students are exposed to ICTs tools for learning other courses partially. It is found that faculties of CDED now can act teaching ICT supported pedagogical approach using VLE. Most of faculties advocate for student-centered and dialogic pedagogy when introduced VLE as web 2.0 technology. Therefore, CDED was chosen for the study unit with a focus on Master's course in mathematics education.

## 8. Course Management and VLE

Moodle as an open source learning management system is used as VLE. This is designed and hosted in the Department's website. The Department's domain is [www.tucded.edu.np](http://www.tucded.edu.np) and the Moodle is hosted in [www.tucded.edu.np/Moodle](http://www.tucded.edu.np/Moodle). The Moodle as VLE was experimented on a second semester master's course "Projective Geometry, Math Ed. 527" under FOE during the academic year 2072/073. All the course materials taught in F2F classes were digitized, some contents were developed in dynamic and interactive form using mathematical software Mathematica and Geogebra. Some teaching contents were developed into video file format.

In the very beginning of the course, students were oriented about the dual structure of the course delivery and the way they need to interact using VLE. They were informed that the course Math Ed. 527 would be run in dual mode, both F2F and online. One day was spent to create their user account, and they were also oriented to open/browse resources, submit quiz/assignments and post/ask questions/answers in discussion forums/chats in Moodle. The course materials, assignments, activities and course work in F2F delivery were mandatory as their course requirements. Online learning in

Moodle were considered as supplementary and optional. They were informed that they could access these materials any time anywhere when they login into the Moodle.

The VLE of the course was designed for 16 weeks explicitly with resources and activities in weekly module. The resources in Moodle were learning contents digitized in varied format such as teachers' handout, simple text, explained text, PPT file, dynamic and interactive format with necessary figures/models and recorded content teaching in video format. The activities for the above resources use in learning were set in different categories, like quiz, assignment, short questions, project work, presentations, and discussion forums. The support and feedback were ensured and maintained by email and Moodle chat box. Students could use this VLE using their personal devices – computer, android mobile/tablet and for those who did not have personal device could use computer lab in the department. Teacher was available in a scheduled basis to provide necessary learning support and learning management.

## 9. Data Collection Tools

Denzin and Lincoln [15] and Patton [16] has emphasized: (a) experiencing (b) enquiring and (c) examining are key aspects of doing qualitative research. On the basis of these three aspects of the way of doing qualitative research, observation to experience the natural phenomenon, interview and group discussion to enquire more about using VLE, and archive analysis were used to verify/examine the obtained information for the level and type of engagement and interaction. In addition, baseline and end line survey were done to explore changes in students' learning behaviors and achievement.

The observation in the study was most important data collection method. It was done both in F2F and online learning. Observation checklist was used to observe three level of engagement: Emotional, Social, and Cognitive. This observation checklist were developed using the theme of Perkins and Murphy's [13] framework. The reliability and validity of the checklist was ensured by contextualizing in CDED context.

Interview guideline were administered in three groups of students based on the level of access in VLE. The questions for interview were related to their access, opportunities and challenges while using VLE. These questions for interview were adapted from the theme of Dixson [6] and contextualized in CDED context. The reliability and validity of the questions for the interview guideline were established by simulated piloting among students who were not involved in the study.

The archive in this study was mainly the student's activity logs generated in the Moodle. These archived documents were collected and used to analyze the records of logs and post by students in course of learning mathematics. Two surveys were conducted to know about the access, use, opportunities and challenges faced by the students and teachers in using VLE. The same survey questionnaire was

used in both baseline and end-line survey.

## 10. Results and Analysis

The participants in the study were master's degree students in mathematics education in second semester taking course "Projective Geometry" at University Campus, Kirtipur. There were total of 85 students studying mathematics in the semester, were divided into two sections (groups). Among the two groups, one group of 42 students were selected as study participants, the sample group for this study. Among the participants, 36 (80% Male and 20% Female) students were participated in end line survey. So, 36 is considered as the study sample participants for this study. Though, there was few number of female as participant, this is very good in number compare to female students' enrollment in mathematics education as a whole.

Among the participants, the baseline survey reported that 64% students (18 male, 5 female) had general Android version mobile. During the course implementation period, the percentage raised to 72% students (19 male, 7 female) who had Android version mobile. The attitude of students to use VLE for the sake of their learning promotion seemed positive by the raise of the number of participants using mobile device for learning purpose from base line to end-line survey. Moreover, the participation level of students in VLE in different activities increased significantly from the beginning to the endline survey.

### *Motivation and Emotional Engagement*

Students' choice and tendency to use ICT tools imply that they are motivated and emotionally attached in VLE. The level of access is taken as proxy measure of motivation and emotional engagement of the students in VLE. From the archived document in Moodle, a log report was generated. From this log report, three levels of access in Moodle is categorized such as low access, moderate access and high access based on login frequency. The login frequency of 36 students were divided into quartiles. Among the four quartiles, lower quartile login were considered as low access students group. Middle two quartile login were considered as moderate access groups and upper quartile login were considered as high access students group.

In the low access group there were 9 students (8 Male, 1 Female). Their logs report shows that their average login was 32 per student. Since the course was hosted in dual mode (F2F and online both), 32 logs per students is satisfactory level of participation in LMS against the barriers with ICTs literacy, internet access, device limitation, and competency to manage ICT and online resources. From the personal records of the students prepared by the researchers, these students were those who did not have their own device to access the online portal. From the end line survey, it was found that four male, and one female students in this group had neither android version mobile nor their own laptop/computer. Among the remaining 4 male students, 2 had internet access at their home, and 2 managed to login Moodle using mobile data. The five students, who did not have android devices,

managed to login from the public cyber café. So, these groups login was low. Even then, they were found interested toward Moodle. In an interview, a question, 'why don't you use Moodle as many times as the other students did?' A student replied,

"I have simple mobile, and no laptop. So it is very difficult to use Moodle for me at home. I went cyber to access the Moodle, but not feel pleasant. I have done some of the assignment (quiz) from my friends mobile..."

In the high access group there were 9 students (6 Male, 3 Female). Their logs report shows that they had 340 average login per student. This is very interesting log reports that shows that students were very satisfied and interested in VLE platforms. Since the course was already delivered in F2F mode, this high number of login in the Moodle shows that students were motivated to the VLE. The resources and activities designed in Moodle made them motivated and engaged in VLE. From the personal records of the students, these students were those who had their own device to access the online portal. From the end line survey, it was found that all 9 students in this group had android version mobile and laptop/computer. They managed to login from their own devices. Similarly, 5 male and 2 female student in this group had internet access at their home. And 1 male and 1 female student managed to log in Moodle using mobile data for internet connectivity. So, these groups login was high. They were found very interested toward the Moodle. In an interview, a question, What made you motivated to use Moodle? A student replied,

"It is very enjoying to attempt quiz in Moodle. Immediately after giving the response to the quiz, this gives score. The videos in Moodle are very helpful to learn mathematics. We can see this video as many time as we like. And the animated figure in Moodle really helped us to understand mathematical concepts easily..."

In the moderate access group there are 18 students (15 Male, 3 Female). Their logs report shows that they had 123 average login per student. From the end line survey, it was found that 4 male and 1 female students in this group did not have neither android version mobile nor laptop/desktop computer. It was found that all 9 male students and 4 female student in this group had android version mobile and computer. Among these, 3 male and 2 female students had internet access at their home. And 6 male and 2 female student managed to login Moodle using mobile data. Remaining 4 male and 1 female student managed to login Moodle from cyber. In the case of moderate group, 123 log per student is good, that shows students were interested in VLE. Since the course was already delivered in F2F mode and VLE was a supplementary for their option, however, the students participated well implies that they were motivated to use VLE. The resources and activities in VLE made them engaged in learning and came out to be need based. In an interview, a question, How does Moodle help in your learning? a student replied,

"It is available all the time in internet. We can read in our time. When we are ready, then we can attempt the quiz in

model. We can see our progress report and notice from Moodle. We can also discuss and share our ideas from Moodle..."

Therefore, from the analysis of the narratives of the experiences of the students who participated in VLE and the analyzed archived log in Moodle, it can be inferred that students were engaged in the Moodle being highly motivated. The interesting result from the logs reveals that out of 7 female students, 3 were in the high access group. Also, the interesting fact is that, average login of male is 137 per student, whereas average login for the female students is 203 per student. Though, there are less number of female students participated in the research, but results showed that female students were more engaged in the VLE in comparison to male students. This implies that asynchronous mode of online learning is preferred by the female students.

#### *Social Engagement*

The social aspect of interaction and engagement of the students in the VLE was analyzed via the posts, submissions, comments in the Moodle being a member of a community of practice. The participation in discussion forum, messaging, chats and doing assignments interacting with the peer students were tracked for this purpose. In F2F classes where teacher-student and student-student interact lively is easier to assess how social engagement for learning performed. But social engagement for learning through online platform, particularly asynchronous mode, is difficult to ascertain due to distance and time flexibility in the participation and the media of interaction and participation used. From the log created from Moodle archive, the students were found engaged in Moodle platform for creating, sharing, commenting, discussing on the given tasks. There were 89 discussion posts/comments by female and 163 posts/comments by male students. Also there were 15 chat messages by female and 82 chat messages by male students. This is not very high in number for 36 students in a full semester course, but the online platform Moodle was an additional/optional environment as a supplementary arrangement for differentiated learning to the students. This degree of social engagement for learning seems natural for students who have never been exposed to this system before. In this sense, these posts are quite satisfactory. In percentage calculation of the use of social media, it was found that 6% of total communication or engagement/interaction is for discussion, 3% of total engagement/interaction were for chat and messaging, and 91% of total engagement/interaction were to view others posts, comments and status for learning. It seems that students were less proactive in creating contents for the interaction using learning platform. This is a challenge for the promotion of higher order thinking needed in higher mathematics.

At the same time, interesting observation were found that there was very high number of motivational logs in the Moodle environment to learn from others' communication. The students were found very curious regarding others' posts and status in Moodle. This was verified through the interviews with the students. Also the interesting notice is

that the level of participation of female students for the engagement and interaction is 23% of total logs. This is quite interesting with respect to F2F classroom participation level. In the F2F classroom, male students seems prominent in interaction and sharing comparison to female, but in online environment female students were found more proactive in participation in asynchronous mode. However, still female students were found back in creating the contents and sharing to others in discussion.

The students were interviewed regarding the role of LMS for their social presence. The students were asked "How does Moodle help them for social presence (connection and network) in the promotion of learning?" Most of the students responded that their social presence opportunity in Moodle was always at their hand. It is beyond the restriction of physical classroom premises, whenever they wanted they could login in Moodle and could connect to their friends and teachers through instant messaging or discussions forum. The instructional management came out to be the essential factor for increase in the social engagement in learning. In an interview, students reported about the benefit of VLE for learning as

"If I got confusion on subject matter, I got opportunity to discuss among friends through Discussion forum in the Moodle. When I posted my problem in the forum, the comment/answer help for learning"-student

They can share their problems through the Moodle whenever they feel difficulty in their study and could get answers and feedback from peer and tutor/teachers. Most of the students said that Moodle is very useful for sharing ideas, questioning and getting prompt suggestions/feedback.

#### *Cognitive Engagement*

Cognitive engagement refers the level of participation of the students in learning of higher mathematical concepts, principles, theorems and solving given assignment/problems sharing in group as a group project and/or individually. It further considers the involvement of student in higher level thinking tasks and the level of achievements gained after getting exposure to the learning management system. The cognitive aspect of interaction and engagement of the students in the VLE was analyzed in terms of two major categories and 12 subcategories. These major categories were resources and activities; and the sub categories under the major categories were PPT, interactive PPT, text, explained text, handout, videos, file, folder, quiz, assignment, discussion forum and chat. Since the moodle platform was designed for students' access of the learning content and assignments anytime, anywhere in the simplified, visualized and digitized format, the Moodle was hosted with varied and diverse learning resources and activities as mentioned above.

The result of the study showed that there was high level of cognitive engagement in the Moodle platform. Out of a total 5421 login in different activities, in the average the login activities/submission was 150 per student in a semester. There was very high tendency to view resources from Moodle platform and also to submit the given quiz, however a bit low in assignments and discussions. Since the learning

materials were available all the time in the Moodle, and also a provision was made that they could submit their quiz/assignments in their own pace in the given time frame, their engagement in Moodle were found interesting and encouraging. They showed high level of engagement to review/download the resources and do submission of their reflection, comments and alternative ideas at the later part of study. The log report showed that 33% of total engagement were devoted for activity and 67% of the total engagement for getting learning resources according to their level of learning. This seems quite reasonable that one third of the total engagement were for activities and two third time for browsing resources as learning materials.

The result obtained from the logs count in Moodle, showed that quiz is very effective activity tool for online students, and video is very good learning resources for the students to acquire mastery in the concepts. These are found very important to make students engaged and interactive in the VLE. Since there was resubmitting option in the quiz for getting better scores, students had tendency of attempting quiz more than one time to increase the score count for highest grade. The result showed that almost all students had re-attempted the quiz in order to excel their score. In an average each student had attempt each quiz more than two times (15 quiz were attempt 37 times in the average) for better score. The reason behind most engaged in quiz is that it is auto responsive for the score and self-evaluative as feedback for their learning promotion. Similarly, video file format was very popular as learning resources. The result found that, in the average each student had viewed the video file at least once (10 videos were viewed 13 times in the average) for better understanding. The reason behind most engaged in video file is that it is supplementary for physical classroom and on-campus activity and was designed according to the content complexity making simplified for understanding.

The achievement of the students was compared to the previous year's students to know how effective the intervention of the blending of the VLE (e-learning) to the conventional face-to-face mode of teaching and learning became. This course was the same, the teacher same and classroom environment same, only the intervention was the use of VLE as supplementary learning tools. The average scores increased and the difference was significant. The time on tasks increased and the attitude to mathematics became positive in the group who got VLE exposure for their learning support as and when needed. The reason behind most engaged in video file is that it is supplementary for physical classroom and on-campus activity.

For the assessment of the effectiveness of the cognitive part of engagement in VLE, the internal assessment and test scores of 42 students were compared with 43 students of previous academic year. The result showed that 42 students who used VLE along with F2F classes made average score 33.81 with standard deviation of 4.42; whereas the students who got only F2F delivery made average score of 29.32 with standard deviation of 6.37. The t-test at 5% level of

significance was used and found that the difference in achievement is significant.

Therefore, VLE with varied resources and activities and supplemented for F2F classes helped students to be more engaged and better interactive in their learning trajectories, consequently effective to improve the achievement.

#### Opportunities and Challenges

There are two school of thoughts in utilizing the ICTs in mathematics education – one claims that it provides multiple learning opportunity to the students and the other argues it hinders for individual student's rigorous mental thinking as mathematicians do in course of learning mathematics. From this study, it was attempted to established how VLE could be a supplementary learning tool it terms of getting more opportunities in learning and to ascertain the challenges in using VLE. Similarly, it is necessary to find how a shift in the roles of students and teachers in using VLE is needed. Analyzing the data obtained from observation, interview and Moodle archive, the result showed that the students engagement in Moodle platform were comparatively good enough in the context of higher education, particularly in CDED context. However, both opportunities and challenges were experienced by teachers and students while using VLE for higher mathematics. To identify the major opportunities created by Moodle platform as supplementary learning tools along with the F2F on campus teaching, a question "What are the benefits of using Moodle platform for the purpose of your learning?" was asked to the students during the interview and the end line survey too. The students replied that the provision of dual mode class had created opportunities to improve study habits, make study more active and even helped to those students who was absent in class by some reason for a particular day. In addition, the slow learners got opportunity to plan their learning pace to learn the given contents of the course using diversified learning materials. They have reported that Moodle platform provided opportunity for learning pausing and rewinding of the videos and other dynamic interactive visual materials as well as well-planned text in their own pace of learning. Student said, "...when there was problem in understanding the content, I repeatedly visited the Moodle, browsed resources (text/videos) and learnt..." - student

When they faced problem at home, it helped them to learn by exploring the things/resources in the Moodle. The students further reported that they got additional benefit being used to in online platform made them familiar to emerging educational technology in education to be update. A student added that Moodle provided option to get help of teachers and peers whenever needed, this was not easy in conventional mode. A response of student was,

"We found learning material from the course for reading and contact channel to help us to contact with subject teacher and friends"

The student of this course reported that Moodle platform helped them to make their learning more interactive. By using Moodle, they improved even their reading habit and ultimately improved learning too. They spent enough time in

learning by Moodle platform. They prepared exam and progressed their knowledge from Moodle. The students remarked that Moodle became a milestone for their success.

“For my learning, this time Moodle became a milestone. It brought teachers and students together through internet for learning-student.

The student got varied learning resources in the Moodle, some of which were very interesting and dynamic and interactive fit to their level of understanding. They got additional opportunity of learning through Moodle to improve their understanding and thinking through the use of materials in the Moodle repeatedly. It helped them for getting immediate support to learn when they needed, for example looking the video lessons and digitized explained text.

The online teaching/learning platform (VLE) has created some better opportunity for student’s engagement and interaction for learning. Not only the students, teachers also benefitted from online learning management, for instance, assessment that they did not devote much time to examine the papers and provide feedback. The system itself evaluated and reported the feedback immediately to the students. For example, a quiz became popular to the students and helpful to the teachers to get knowledge easily of how students were progressing in learning. Furthermore, it became better interactive and self-evaluative by the use of multiple-choice tests for formative sort of continuous assessment. Another major aspect that the online learning platform has provided was the access of learning resources. Students can browse their resource material anytime and anywhere, and also can ask for further readings through Moodle. The major aspect found from this course implementation was that, specially, Moodle platform helped to be more engaged and interactive for introvert type of students who were genius but did not want to be exposed in the classroom. The study found that female students participated comparatively more in the emotional, social and cognitive aspects of the engagement in Moodle.

In spite of the opportunities, the implementation of online course in the context of Nepal, has some challenges too. During the course implementation, the students were interviewed to get their response on “What are the challenges in using Moodle platform for the purpose of your learning?” All of them replied that the major challenge to use Moodle platform was lack of internet and appropriate personal device. The socio-economic condition of the students became one more hurdle to use the provided opportunity to the students. This is a challenge to the management and also to the student themselves. The students expressed,

“There is no access of internet everywhere so we got difficulty due to internet. Also due to technical awareness of ICT use in learning. One of my friend needed laptop for better learning and because downloading was not accessed from Mobile, so when interested and essential, we didn’t get chance to use learning resources.” (student)

The major challenges reported were connected to the costs of education such as mobile purchase, laptop purchase, internet cost, and cost of digital materials in addition of the

text book provided.

“I have simple mobile, so it is very difficult to use Moodle from this” (student)

From the perspective of teacher, some of the challenges were internet access and bandwidth, updated condition of electronic devices often created problem for the efficient use of VLE. Teachers’ competency on course development/delivery and time management were the challenges on the part of the teacher. Teacher’s motivation and devotion is important because it demands more time and effort from the side of the teacher/facilitator to make online learning effective. This is a challenge to the management to keep up teachers and the system update. The other challenge is monitoring, support and feedback to the students. From the course management perspective, the teacher needs to be very aware and highly engaged to develop and digitize learning materials. Teacher presence is very important while implementing VLE. Keeping teachers highly motivated and alert in student support is a challenge. The role and function of the teachers shift drastically from a transmitter to a facilitator and creator of the courses in VLE. Professional development of the teachers to this changing role and function is another challenge.

Another aspect for this course management was the lack of awareness of eLearning platform and their adaption among the stakeholders. Since the students were from fully F2F based experience, and no one had experienced online course before, some challenges encounter to the teacher make student fit and habituated in the online environment.

## 11. Findings

Based on the results, the following findings are drawn under three major themes – ways and methods used in VLE, opportunities and challenges faced by teachers and students and the generated impact from the use of VLE in teaching and learning higher mathematics.

Ways and Methods Used in Managing VLE:

- a. Using Moodle as VLE integrating varied resources, activities and discussion forums, addressing the diverse learning needs of students.
- b. Use of Blended learning supplementing each for creating opportunity of learning to the mathematics students and making them more engaged and interactive with increase on time-on-tasks perfectly related to learning contents of the courses.
- c. Use of three level of engagement - motivational, social and cognitive targeting higher level mathematics through the use of VLE.

Opportunity and Challenges

- a. VLE provided space to participate in widely accepted schooling and education practices by the students of university education.
- b. Opportunity of differentiated instruction and learning was promoted developing different nature of learning materials targeting learning levels of the students through the use of Moodle. Students used the materials

according to their nature and intelligence level for learning higher mathematical contents.

- c. While using VLE, the major opportunities were to improve study habits, make study more active in learning, provides opportunity to learn and re-learn to clarify the concept.
- d. Students participated more on online learning activities along with conventional face-to-face classroom having opportunities of diverse learning materials to the cognitive levels.
- e. Internet connectivity, and teachers' presence for learning support were found as major challenges for effective implementation of VLE.
- f. The other challenge is to bring students of different aptitude and social class/categories in higher order thinking activities compare to other learning activities through the use of VLE.

#### Impact from the Use of VLE

- a. The achievement scores were improved and were found significantly different between the group of students who were in only conventional mode and the group exposed to dual mode of learning.
- b. Female students were found more proactive in asynchronous communication and interaction in using Moodle base virtual learning.

The findings of the study corroborates to the statement that blended mode supplements to conventional mode of teaching [7]. The higher participation in VLE is associated to the statement of Rheingold's [8]. He says the 21<sup>st</sup> century students' preference on collaborative learning, freedom to create knowledge and share to peers, participating in more engaged and interactive learning, which is supported by the findings of this study. In course of development of VLE, the course creator has adopted the principle of diversified instructional approach with students' active participation in learning activities for the construction of mathematical ideas in collaboration with peers and teachers. The findings shows that students were found more engaged and motivated toward learning in groups using VLE. The claim of the use of constructivist and connectivists principle of learning guided instructional strategy came out to be supportive to use in designing VLE. The improved achievement scores of the students from the participation in VLE further justifies the positive role of ICTs based learning management in learning higher mathematics. This finding puts forward a counter argument to the argument that use of ICTs tools in learning mathematics decrease the rigor of independent thinking in learning mathematical content and problem solving. VLE came out to be supportive in mathematics learning form the finding of this study. The findings further justifies the claim of Hoskin [10] that the shift of roles of teachers and students in learning management and learners spend more time on task behavior compare to attending traditional courses in classroom [7].

## 12. Conclusion

Based upon findings and discussion, the VLE seems very

instrumental in improving students' engagement in learning tasks and achievement in higher mathematics. In order to replace and supplement 'one size fit all' pedagogy as practiced at present in Nepalese higher education, VLE can be a supportive model. As designing courses, the educators' needs to pay attention on integrating ICTs tools in higher mathematics courses following the principles of learning as guided by constructivist and connectivist theories. This blended approach of pedagogy can be more supportive to diverse needs of the learners. The important thing is to pay attention on the management of basic infrastructure needed to run VLE integrated programme and the preparation of the faculties to design and develop courses and ensure the motivation and commitment on the part of teachers as the roles of teaching is shifting to facilitation a complex role with more time consuming act. This study gives further implications that VLE can create a good opportunity to the students who are deprived from socio-economically and are slow learners. But care needs to be given to provide necessary support to address minimum costs implicated in the use of VLE. The support system can be foreseen in four levels: social, administrative, motivational and cognitive level. Thus, use of ICT tools in pedagogical exercise in the form of VLE can ensure greater access and participation among peers, resources and contents to improve learning outcomes.

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