Teaching Mathematics in a MOODLE-Based Learning Environment

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Abstract - Development of technology in education includes eLearning approaches such as the use of a Learning Management System (LMS). The study focused on the processes undertaken to determine the usability of MOODLE in the teaching and learning of different mathematics courses in a university. Specifically, this aimed to determine the level of preparedness of teachers; the level of validity of the modules in mathematics as resource materials, the level of performance of the students in mathematics courses with the use of MOODLE, the level of usability of MOODLE, and the challenges encountered by the students and teachers in their use of MOODLE. This study made use of descriptive and developmental methods of research. The respondents of the study involved 6 mathematics teachers and 135 students who used MOODLE in the following mathematics courses, namely: Fundamentals of Statistics A, Fundamentals of Statistics B, Basic Statistics, Probability and Statistics, Linear Algebra, and Advanced Calculus. Findings of the study revealed that the teachers were not prepared to integrate technology for instruction which implied their lack of technology skills. The modules obtained high validity ratings which indicate their acceptability as inputs in the LMS. The students have satisfactory performance in their use of MOODLE as also manifested by the high usability of MOODLE as evaluated by both students and teachers. However, poor or lack of internet connection was the foremost challenge in using the LMS. Based on the findings of the study, a decision model was developed that may serve as a basis for teaching mathematics courses in a MOODLE-based learning environment.

Keywords -*learning management system, mathematics instruction, MOODLE, usability*

INTRODUCTION

The goal of all teachers around the world is to achieve excellence in the teaching-learning process. One way to address this goal is the conduct of several researches which aim to convince educators to pay more attention to finding more effective and more practical solutions for improving the progress of students in their education. Mathematics is important in providing students the ability to develop critical thinking and problem-solving skills. Mathematics allows students to model real-world problems or conditions around them. Mathematics provides opportunities for exploration of those problems in a variety of ways and search for possible solutions. Due to the advent of different forms of technology integration in the classroom, tasks in mathematics are easier to accomplish compared to the conditions in past decades. This includes more opportunities and new possible ways to carry out learning activities, new learning services, and the possibility to use new kinds of contents and activities. [1]

A quality mathematics education in the 21stcentury includes the opportunity for students to learn using appropriate technology. Although there are many forms of technology, it is important that technology use is available to all students and teachers in a country, rather than to only a privileged few, and that attention is given to matching the classroom with that of high stakes environments, where these are used. [2]

Teachers plan and organize their lessons with the help of readily available online references. They make use of slides or other audio-visual applications to present lessons. They utilize graphical tools such as GeoGebra in constructing mathematical figures in Geometry, Algebra and Calculus. They use Excel for recording and computing students' grades. Some teachers use Facebook and other social media for giving reminders and disseminating relevant information. Technology has already become an integral part of mathematics instruction. It improves delivery of instruction by enhancing traditional classroom practices and knowledge.

One important development taking advantage of computer technologies is the eLearning approach to instruction. It has become one of the alternatives in the delivery of any form of education and activation of

training programs, whether direct or indirect. The major concern of eLearning is overcoming the obstacles of space, time, and risk. It has become a modern teaching method which employs modern communication mechanisms to support the educational process and improve the quality of education.[3]

It is sad to note that there are some teachers who are not fully engaged in the use of technology in teaching. It is also observed that while some teachers use technology to compute grades and generate tests, only a few use technologies in the classroom to support learning and instruction. And some teachers could not commit to using technology unless required to do so. Perhaps, these teachers want to use technology as an instructional aid, but they lack the know-how or they are not confident to integrate such in their lessons. Based on initial interview with the mathematics faculty, most of them have no experience of using Learning Management System (LMS) as an alternative tool in mathematics instruction. Thus, it is a part of this study to train teachers with the use of LMS in their mathematics classes. This training program aims to equip the teachers with the technology skills, particularly on the use of LMS for teaching their mathematics courses. Results of the study will serve as a basis for adopting this initiative and highlight areas that require further attention to improve mathematics instruction.

There are significant attempts being undertaken to address these concerns in education, for example Trouche and Drijvers [4] pointed out several current projects at the European level and the study by Handal, El-Khoury, Campbell, and Cavanagh [5]categorized educational apps according to their specific role in the teaching and learning of mathematics, along with their media richness. There also have been a number of reviews and studies considering the overall value and place of technology in mathematics education and research.

The eLearning is commonly intended for providing a set of courses made on the websites. However, it is rather a set of teaching and learning management processes involving teachers and students. Thus, the eLearning is based on computerized systems to manage learning processes, known as LMS. Nearly 90 percent of the universities in the USA that support distributed learning programmers are using web-based course delivery methods. Directors of these platforms state that web-based delivery allows them to handle the wide range of connectivity among student populations [6].

Many higher education institutions have implemented LMS to manage online learning and teaching, with varying levels of support provided to staff and students, but often there is a little subsequent investigation into the quality of the online sites. Teaching students with enriched multimedia presentations, animations, simulations, images, videos, and pictures give better abilities to learn the knowledge because of complex effects on their senses [7].

One such system that has been gradually gaining worldwide popularity is MOODLE (Modular Object-Oriented Dynamic Learning Environment). MOODLE is an "open source", allowing developers to tailor the system to individual needs. It also communicates extremely well with many web -based resources such as Facebook, YouTube, Wikipedia, Clip, Hot Potatoes, etc., allowing developers' creativity and versatility. It is based on socio-constructivist pedagogy. This means its goal is to provide a set of tools that support an inquiry- and discovery-based approach to online learning. Furthermore, it purports to create an environment that allows for collaborative interaction among students as a standalone, or in addition to, conventional classroom instruction [8].

In the study of Senol, GeciliandDurdu [9], MOODLE was adopted by Kocaeli University to determine the usability of the LMS. The results of their study revealed that students were not satisfied with the system especially with the aesthetic features of it. On the other hand, the system provides error prevention and is found to be more efficient and memorable. On the basis of these results, the aesthetic features of the system need to be improved and informational cues should be added to its interface.

Many scholars have suggested that one of the promising reforms in education with the intervention of technology is the use of LMS, especially those courses that require eLearning approach. However, some studies address the constraints that inhibit the ability of teachers to use technology. Lack of affordability of the technology typically used for mathematics teaching has equity implications [10].The perceived advantages of this technology for supporting student learning and examination use may not be equally available for all students.

To address these issues, teachers need to deepen their content knowledge and learn new methods of teaching. They need more time to work with colleagues, to examine the new standards being proposed, and to revise curriculum. They need

opportunities to develop, master, and reflect on new approaches to working with students.

Hence, teachers must consider the opportunity of integrating technology into the classroom not only for improving the teaching and learning processes but also promote a paperless learning environment and be more productive of their time and effort. The respondents in this study are expected to learn skills and teaching strategies with the use of technology from the intensive lecture, training program, workshops, and actual implementation on the use of MOODLE.

OBJECTIVES OF THE STUDY

This study determined the usability of MOODLE for mathematics instruction during the 2nd semester of School Year 2017-2018.

Specifically, this aimed to determine the level of preparedness of teachers; level of validity of the modules in terms of content, face validity, presentation and organization, accuracy and up-to-datedness of information, and usability; the level of performance of the students in the use of MOODLE in the six courses; the level of usability of MOODLE as assessed by the students and teachers along learnability, efficiency, memorability, error reduction, and satisfaction; and the challenges encountered by the students and teachers in their use of MOODLE.Lastly, this study aimed to develop a decision model for using MOODLE in mathematics instruction.

METHODS
Research Design

This study made use of descriptive and developmental methods of research. This study involved describing the profile of teachers, the validity of the modules used, the challenges encountered by the respondents, the performance of students, and usability of the MOODLE through quantitative and qualitative data. The developmental method research design is used in developing modules of selected mathematics courses, a training design, and decision model for using LMS in mathematics instruction.

Respondents of the Study

The respondents of the study included6 mathematics teachers who underwent the training program and the implementation of MOODLE in one of their mathematics classes. A total of 135 students participated in the study who were enrolled in the 6 mathematics courses namely: Fundamentals of Statistics A, Fundamentals of Statistics B, Basic Statistics, Probability and Statistics, Linear Algebra, and Advanced Calculus.

Ethical Consideration

The undertaking of the study was also presented to the Research Ethics Committee of the University to be guided with ethical considerations. Before involving the respondents in the study, they were informed about the nature and purpose of the implementation of MOODLE in their classes, the plans for using the tests and the protocols observed to protect their anonymity. Consent forms were signed by the respondents which manifested their voluntary participation. Privacy and confidentiality were also observed in the study.

Lastly, an operational plan was prepared and submitted to the Office of the President in the University to request permission on the conduct of the training and activities for the study.

Instrumentation and Data Collection

The following instruments were used to gather the data needed in the study:

1. Teacher-Profile Questionnaire was used to assess the profile of the teachers to understand the type of respondents who were involved in the study and as basis in the design the training program on the use of MOODLE.

2. Quick Teacher Technology Survey, which can be downloaded from www.powerupwhatworks.org was accomplished by the faculty to determine their proficiency and perception of the importance of technology use, frequency of use of technology in their classroom instruction, opinions and attitudes towards technology integration and areas of improvement for technology integration

3.Questionnaire Checklist on the Evaluative Assessment of the Modules was used to determine validity of the modules. These modules were validated by selected mathematics faculty from the state universities and colleges in Region I.

4. Scale for Usability of Learning Management System (SULMS). This is a developed questionnaire as a result of study of Mehmet Bilge Kagan Onaca and AlperErturk (2016). It was used to evaluate the usability of MOODLE.

5. Written Survey Questionnaire and Interview Guide Questions were used to acquire qualitative data from the teachers and students, which focus on determining the benefits, experiences, problems, and other concerns about their use of MOODLE.

Data Gathering Procedure

This study followed 5 phases namely: requirements planning, design of the training, conduct of a training-workshop, implementation and monitoring, and evaluation. Phase 1 included the identification and organization of essential elements in the development and validation of modules, conduct of a training-workshop, and the use of MOODLE for implementation. For Phase 2, the researcher prepared and organized all the requirements of the training program. The results of the assessment among the math teachers were incorporated in the design of the training program. The training design included lectures, workshops, hands–on activities, and orientation of students; which were conducted for 5 days. Phase 3 was the conduct of the training program. For phase 4, the participating teachers implemented the use of MOODLE in their selected classes. The researcher served as the administrator of the MOODLE site used in this study to guide and monitor all the activities of the teachers and students. During the implementation, the researcher kept constant communication with the teachers. He also gathered feedbacks and addressed their concerns regarding problems they have encountered in using MOODLE. Lastly, phase 5 was the evaluation using questionnaires, written surveys, interviews, and focus group discussions. The usability of MOODLE was evaluated by the teachers using the Scale for Usability of Learning Management System (SULMS). Six teachers and 118 students out of 135 students from different classes responded to the written surveys by discussing the benefits of using MOODLE and their experiences, problems, and other concerns about their use of MOODLE. After this was the conduct of interviews with the respondents. Lastly, two separate sets of focus group discussions, one among a group of teachers and another group among nine volunteer students, were conducted to discuss the issues and express their viewpoint on topics developed from the written surveys.

Data Analysis

Frequency and percentage were used to describe the level of preparedness of the teachers in technology integration. Mean was used to determine the level of performance of students in their course. The level of performance of the students was based on their scores converted to percentages using the standard grading system in the university. Mean was also used to determine the level of usability of MOODLE. The challenges encountered by the students and teachers in the use of MOODLE were based on qualitative data from written surveys and were analyzed using Erickson's Analytic Induction. A set of statements were formulated through repeated reading and organizing of the data supported by data gathered from interviews and focus group discussions. Lastly, a flowchart was used in the development of a decision model for the use of LMS in mathematics instruction.

RESULTS AND DISCUSSION

Level of Preparedness of Teachers. The level of preparedness of the teachers in terms of proficiency on technology ranges from weak to adequate only. In terms of frequency of using technology in the classroom, most teachers never used specific technology resources such as apps for tablets, web design, management programs for student data, active board, tablets, and digital cameras. They used applications and the internet for developing lesson plans/ideas and test preparation weekly. Regarding their opinions about using the internet, they strongly agree that students can create products that show higher levels of learning, students are more motivated and there is more student collaboration. They agreed that internet can gauge problems that may interrupt students' learning such more discipline problems, going to inappropriate sites, plagiarism, and abundance of unreliable sources. Meanwhile, the teachers have extremely positive attitude towards technology integration that technology has changed the way they teach, is a good tool for collaboration with other teachers when building unit plans and is reliable. Lastly, the teachers have very urgent needs to improve many aspects of technology integration. Faster access to the internet is the leading urgent need of teachers for technology integration. It is followed by more support from administration when it comes to their technology needs.

These results suggest that teacher capability training on technology use as an instructional tool is urgently needed. Likewise, it implies that the teachers acknowledge their lacks and needs in terms of technology and thus they manifest their willingness to lean and perhaps embrace new methodologies and strategies in teaching. This is in consonance to the claim of Gorder [11]that integrating technology is considered important factors for success in teaching. However, they could not do it on their own; thus, a support from the administration and acquisition of technology skills and knowledge from training programs are essential.

Level of Validity of the Modules in Statistics, Linear Algebra, and Advanced Calculus.

Overall, the three modules are highly valid as shown in Table 1. The module in Statistics has the highest mean of 4.58 and the module in Advanced Calculus has the lowest mean of 4.23. Both modules in Statistics and Linear Algebra have high validity in all the five factors. The module in Advanced Calculus is highly valid in only two factors, namely presentation and organization and accuracy and up-to-datedness of information. The other three factors, content validity, face validity and usability validity need more attention for improving the module by integrating the suggestions and comments of the evaluators.

Table 1. Level of Validity of the Modules

Indicators	Module in Statistics		Module in Linear Algebra		Module in Advanced Calculus	
	M	DR	M	DR	M	DR
1. Content	4.46	HV	4.32	HV	4.14	V
2. Face Validity	4.63	HV	4.38	HV	4.05	V
3. Presentation &Organization	4.60	HV	4.35	HV	4.25	HV
4. Accuracy & Up-to-datedness of Information	4.50	HV	4.46	HV	4.38	HV
5. Usability	4.69	HV	4.44	HV	4.13	V
Overall	4.58	HV	4.38	HV	4.23	HV

In terms of content, the modules in Statistics and Linear Algebra are highly valid with overall mean of 4.46 and 4.32, respectively while the module in Advanced Calculus is only valid. This implies that contents and instructions in all the activities are clear and detailed. The modules can be understood and activities can be accomplished by the students without the teachers. On face validity, the modules in Statistics and Linear Algebra are highly valid with mean of 4.63 and 4.38; respectively. The module in Advanced Calculus is valid with a mean of 4.05. The three modules have high validity in terms of presentation and organization which indicates that the modules have logical and smooth flow of ideas. The vocabulary of sentence is adapted to target reader's experience and understanding. This result corroborated the contentions of Aureada [12] thatinstructional materials should be made by considering environment factors that would relate the lessons to the learners' milieu.

In terms of accuracy and up–to–datedness of information, the three modules also have high validity.

The inclusion of links of online sources for further understanding of lessons contributed to this result that the modules are free of obsolete information which implies that the modules are updated. On usability, the modules in Statistics and Linear Algebra are highly valid with mean of 4.69 and 4.44, respectively while the module in Advanced Calculus was valid with a mean of 4.13. These results indicate that the students know what to do and how to do the learning activities included in the module. This is in line with the findings of Devesh and Nesseri[13]that learning Mathematics is easier, useful, and more interesting with the use of modules.

As a whole, the three (3) modules obtained valid ratings. Hence, these may be used as materials in the teaching and learning processes. These modules served as primary materials of teachers for delivering contents of the different courses in the MOODLE platform. The purpose of using modules is appropriate as these are learning materials arranged systematically according to a curriculum, packed in the smallest learning units and enable students to study within a certain time independently. [14]

Level of Performance of the Students in the Use of MOODLE.

The level of performance of the students is described based on the scores of the students on different tests in the form of online quizzes and assignments. Table 2 shows the performance of the six groups of students in the courses they were enrolled in.

Table 2. Performance of Students in the Different Courses with the use of MOODLE

Courses	%	DR
Fundamentals of Statistics A	61.33	Fair
Fundamentals of Statistics B	69.36	Good
Basic Statistics	75.56	Very Good
Probability & Statistics	77.47	Very Good
Linear Algebra	78.81	Very Good
Advanced Calculus	65.56	Good

Legend:

Grade (%)	Descripting Rating (DR)
85.00 – 100.00	Excellent
75.00 – 84.99	Very Good
65.00 – 74.99	Good
55.00 – 64.99	Fair
50.00 – 54.99	Passing
below 50.00	Failed

The students who were enrolled in Fundamentals of Statistics A performed fair with an overall mean grade

of 61.33. The students who were enrolled in Fundamentals of Statistics B performed better because they got a higher overall mean grade of 69.36 described as good. The students who were enrolled in Basic Statistics obtained an overall very good performance with a mean grade of 75.56. The students who were enrolled in Probability and Statistics also obtained a very good performance with a mean grade of 77.47. The students who were enrolled in Linear Algebra also performed very good with a mean grade of 78.81. Lastly, the students who were enrolled in Advanced Calculus had an overall good performance with a mean grade of 65.56.

In summary, three groups of students obtained very good performance using MOODLE on their course namely: Basic Statistics, Probability and Statistics, and Linear Algebra. The students enrolled in Probability got the highest mean grade was obtained by the students enrolled in Probability and Statistics while the students enrolled in Fundamentals of Statistics A got the lowest mean grade.

The performance of the students using MOODLE is satisfactory. However, for one group of students specifically those enrolled in Fundamentals of Statistics A and some students in the other courses, they mentioned that they experienced technical issues and concerns while performing the assigned tasks such as poor internet connection which distracted their attention. They also complained about insufficient time limit given in finishing online quizzes which prompted them to answering questions in a hurry and without full understanding. Hence, it is contrary to the findings of [15] that students find easy in taking MOODLE Quiz. However, the good performance of the students is attributed to other findings of [15] that LMSs are effective tools for students to view multimedia materials, form learning communities, access lecture notes and submit homework, and communicate with their teachers.

Table 3. Level of Usability of MOODLE

Components	Students		Teachers	
	M	DR	M	DR
1.Learnability	3.65	High	4.39	Very High
2. Efficiency	3.64	High	4.43	Very High
3. Memorability	3.52	High	3.79	High
4. Error Reduction	3.28	Moderate	3.61	High
5. Satisfaction	3.70	High	4.00	High
Overall	3.56	High	4.07	High

Table 3 summarizes the usability of MOODLE as assessed by the students and teachers. Overall, both students and teachers assessed that MOODLE was highly usable as reflected by mean ratings of 3.56 and 4.07, respectively. It shows that the students and teachers have high level of agreement to the usability of MOODLE; hence, it is a useful tool for the teaching and learning process which is similar to the findings of Baytiyeh [16].In terms of learnability, the students rated their use of MOODLE as high with mean rating of 3.65 while teachers rated it as very high with a mean rating of 4.39. This can be attributed to the fact that teachers underwent training on the use of it while students were only oriented about primary functions of it for use in their class. The use of MOODLE is highly efficient for students while very highly efficient for teachers based on mean ratings of 3.64 and 4.43, respectively. MOODLE helps them do the necessary activities of the class faster and that they can easily find the necessary information. This result conforms to the findings of Senol and Durdu found that MOODLE was efficient for learning at Kocaeli University [9]. In terms of memorability, MOODLE provides a high memorability for both students and teachers supported by the computed overall mean rating of 3.52 and 3.79, respectively. It implies that the students and teachers can manage to use MOODLE without considering it an advanced LMS despite that it was their first time to use it. For error reduction, MOODLE has a moderate level of error reduction for students based on mean rating of 3.28 while high level for teachers based on mean rating of 3.61. The results show that teachers experienced fewer errors in using MOODLE. Lastly, in terms of satisfaction, both students and teachers are highly satisfied using MOODLE with a computed overall mean rating of 3.70 and 4.00, respectively. Their satisfaction on the use of MOODLE suggests that it is a useful tool in the teaching and learning process.

Table 4. Challenges Encountered by the Students on their Use of MOODLE

No.	Challenges
1	Internet connection affected the participation of students in the learning activities.
2	Students needed to strive harder in understanding the lessons on their own.
3	Submission of assignment in MOODLE was complicated.
4	There was lack of interaction.
5	Students were tempted to cheat.

Challenge 1. Some students encountered difficulty of logging in, error connection while taking online

quizzes, slow uploading of lessons when opening lessons, and lengthy downloading of files when submitting assignments. One student stated:

> *My problem using MOODLE is when I didn't have internet to access it, I missed the quiz. (Student 13)*

> *The struggles I experienced using MOODLE were sending and uploading the photo of my solutions. (Student 66)*

Challenge 2. The students became more responsible of their own learning by spending lots of efforts in reading and searching for answers to their questions. A student described it as:

> *I learn a lot by myself. It's a good experience to build my confidence to learn alone. It is also good for a student to learn because it's more challenging. [Student 1]*

Challenge 3. Below was a reaction of a student regarding his experience of using MOODLE when submitting assignments:

> *It is complicated in submitting files for assignments because there is a size limit especially for us who use cellphones. We still need to capture our answers and solutions, paste it on Microsoft Word, then convert to pdf file. It is annoying. (Student 18)*

Seemingly, the students' difficulty is not about the assignment given but on the process of submission. the system was usable in general, but students faced difficulty during assignment submissions. [17]

Challenge 4. MOODLE provides many interactive features such as online chat, forum, and the like. These interactive features may be used by the students, especially when they need to inquire about the tasks given to them. However, a student affirmed the lack of interaction as he stated:

> *I would like to have real time instruction that I can easily ask questions on lessons that need understanding even if forums were there. (Student 110)*

While there are features of MOODLE that can boost interaction for collaboration, students were not able to utilize them at the maximum level. To enhance the usability of LMS, human computer interaction holds a major role in the attainment of improving performance of users.[18]

Challenge 5. At the start, teachers perceived that with the use of technology, students' discipline problems may occur like copying one's work. It was evident that some students copied the work of their classmates as shown in the submitted outputs.

Table 5. Challenges Encountered by the Teachers on their Use of MOODLE

No.	Challenges
1	Internet connection hindered participation of students.
2	MOODLE demands a great deal of time and effort.
3	MOODLE can only be used as a supplement for teaching.
4	Lack of control on students' learning activities.

Challenge 1. The teachers affirmed that internet connection is a primary concern in using MOODLE. The following warrants this assertion:

> *Some students were not actively participating, the students are hard up uploading their activities, and some students do not have internet access at home. (Teacher B)*

This assertion of the teachers confirms the statements of the student. The teachers brought out this issue during the focus group discussion shared approaches which helped minimize the problem during the implementation. Three teachers organized a group chat using Messenger for their classes. They stressed that Messenger was the most accessible tool that they can use to keep communication with their students.

Challenge 2. Every user of MOODLE requires a wider scope of skills and knowledge. The following quote illustrates the experience of a teacher:

> *As an instructor, MOODLE is good and maybe best when I will be more expert of using it. My lack of knowledge on technology was at first a hindrance. But continuously learning will make things easy. In the same way, the net connection tested my patience most of the time. (Teacher A)*

The teacher agreed that MOODLE is beneficial in the teaching-learning process, but it has its drawbacks. Despite this, the teachers did their best to learn using the MOODLE. The assistance of the researcher during the implementation helped them address their concerns in managing their concerns.

Challenge 3. The teachers believed that the MOODLE can be used as supplemental to teaching the Mathematics lessons. One teacher shared that:

> *We can use MOODLE in implementing flipped classroom set up. We prepare the courses that we are going to deliver in*

MOODLE using video, modules, and others, then all we have to do in the classroom is to assess the performance of the students. With the use of MOODLE, it could be of great help to determine if students are engaged in the materials or not. (Teacher E)

Because of this statement, the group discussed the importance of blended learning. They recommended that MOODLE can be used as a tool for blended learning environment. Teacher E added that if he will not be using MOODLE as a pure tool for the whole semester but only to supplement his traditional teaching methods.

Challenge 4. The teachers believed that they lack control on students' learning activities. It is demonstrated in the following quote:

Using MOODLE, especially in quizzes or exams, has a higher possibility of cheating. They can give it to someone whom they think can solve the problems. Also, some students tend to copy from others without studying the lesson. Further evaluation may help by meeting them in the classroom. (Teacher A)

It must be understood that the students and teachers have similar feedbacks towards MOODLE as an instructional approach. These feedbacks regarding the challenges on the use of MOODLE provided insights on how to implement its use more effectively.

Decision Model in the Use of Moodle for Mathematics Instruction.

The decision model in Figure 1 is a flowchart that may help teachers implement the use of MOODLE for mathematics instruction. The first step involves determining the presence of primary requirements such as modules for a course and good internet connection to prevent problems that they may encounter when they use it. Modules that are evaluated and enhanced help teachers easily prepare learning materials that can be used for students' learning activities. Meanwhile, teachers and students must have stable internet access because enrolled users in MOODLE cannot actively participate without an internet connection. If these two requirements are present, teachers may follow the next step. Otherwise, they are discouraged to continue. The next step is to assess the profile of both teachers and students. One factor that needs to be assessed is their technology skills to determine if they are capable of performing computer-related activities. Also, consider

the assessment of some of their personal background. In fact, older faculty members in the university resisted to participate in the study and younger teachers were more active when they implemented the use of MOODLE in their classes. Their teaching strategies must also be considered because some teachers may not be ready to change their teaching strategies. In terms of the profile of students, three factors may be considered, such as the course they are taking, their place of residence, and computer/mobile access.

Differences of students within a learning context were considered in the areas of general skills, aptitude, information processing, and application of information to new situations. Learners differ in their ability to perform various education-based and real-word learning tasks. The use of LMS might not be suitable for the type of learners or the course they are taking. Based on the result of the study, the use of MOODLE in major courses such as Advanced Calculus and Linear Algebra was tougher to carry out than in general courses such as Fundamentals of Statistics and Basic Statistics. In the implementation of MOODLE, the place of residence of the students may also affect their participation in the online class using LMS, especially for those who reside in remote areas where internet connection is poor. Lastly, check whether the students have their own computer/laptop or smartphones, which they can use to participate in the eLearning class independently. After examining the profile of the teachers and students, let the teachers and students decide whether they are willing to use LMS in their class based on their profile, which indicates whether or not they are capable of using LMS. To complement their willingness to use LMS, they must undergo training that will enhance their capabilities to deliver a course with LMS. After the training, they would be able to increase their level of preparedness. A more intensive training program must be conducted with the help of more capable trainers to equip the teachers the necessary skills and expertise in usingMOODLE. Their attendance to the training program will increase their level of preparedness in using it in their class.

When teachers use MOODLE, they must not use it as a pure medium of instruction. Teachers must adopt instructional strategies for online learning environments, such as blended learning. The teachers involved in this study revealed that many students requested for meeting in the classroom to discuss lessons that were difficult to understand by just using the LMS.
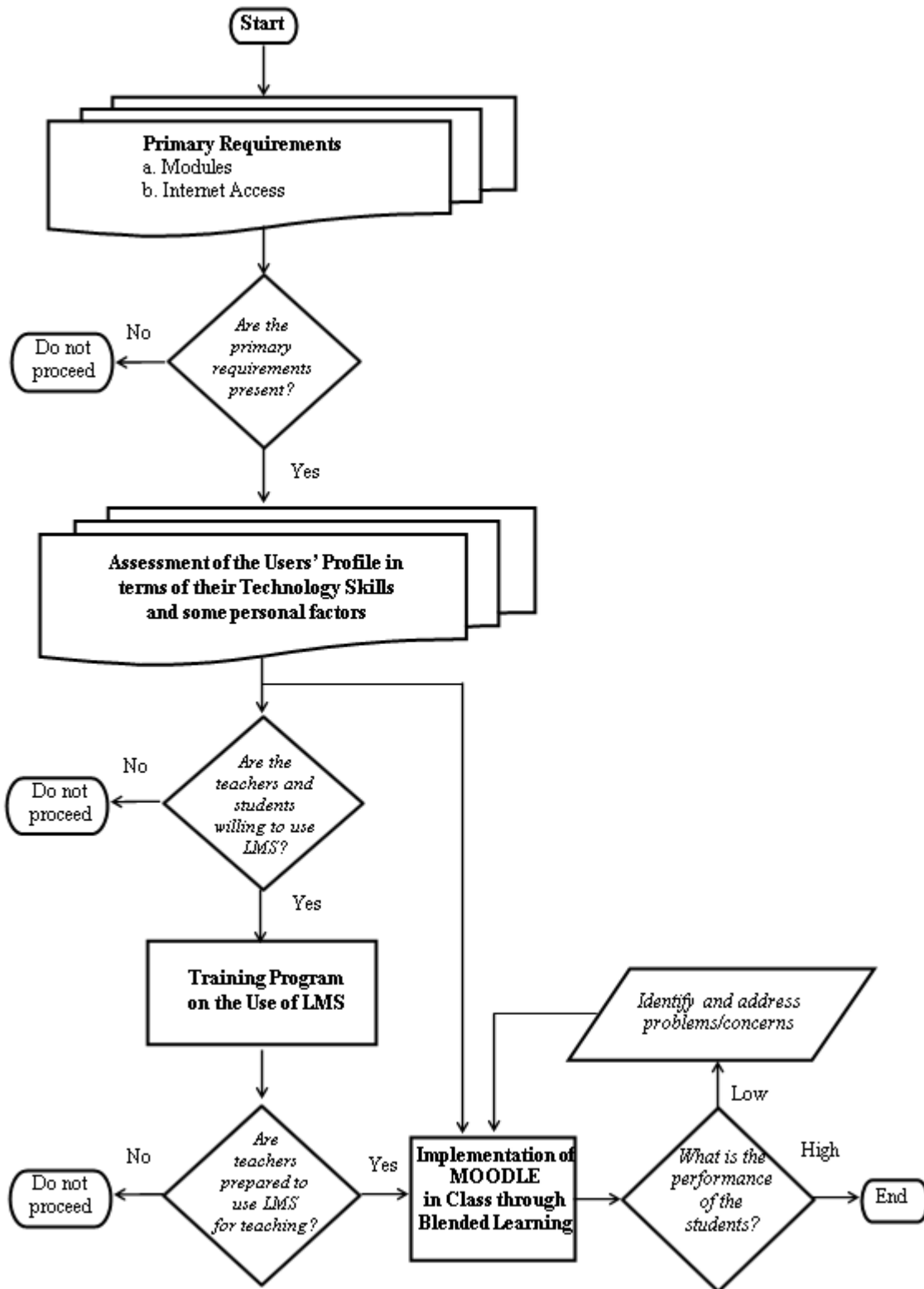
Figure 1. Decision Model in the Use of MOODLE for Mathematics Instruction

Lastly, evaluate the level of performance of students to determine whether or not the use of MOODLE in the mathematics courses is successful. If the students have a high level of performance, then the use of MOODLE can improve the learning of students. On the other hand, if the students have a low level of performance, the teachers must exert effort to identify the problems that occurred. By identifying these problems, they can reflect and think of ways to address these problems and enhance the learning of the students. When they implement the use of MOODLE for the next time, they already know how to prevent or minimize the possible problems that may occur. Hence, they would expect better outcomes on the performance of the students.

CONCLUSIONS AND RECOMMENDATIONS

The teachers who participated in the training program did not highly integrate technology in their classroom. High validity of the modules shows their usability as inputs in LMS. The students performed satisfactorily in their mathematics. Moreover, the use of LMS is more appropriate in Probability & Statistics and Linear Algebra than the other four courses. MOODLE can be useful in teaching and learning Mathematics. Internet connectivity is one of the major components in the implementation of the use of LMS in classes. Also, MOODLE can only be used as supplement tool for teaching Mathematics.

It is recommended thatteachers should take advantage of the availability of different forms of technology for instruction and so that they can practice, reflect, and think of ways to improve the teaching and learning process. The modules should be supplemented with other learning resources such as video clips, PowerPoint presentations, link to other online resources to raise more interest and participation of students when engaging in a learning management system. Teachers who are interested to use MOODLE for mathematics courses must have adequate learning resources or materials and careful preparation, be more committed to explore all functions of MOODLE and undergo a more intensive training to acquire the necessary skills in handling technical and pedagogical concerns.Promoting successful online learning requires integration of blended learning approach and support and initiative at the institutional level by providing stable internet access to students and teachers. Teachers should also focus on instructional strategies to enhance learning of students by examining their traditional perspective and adopt a philosophy of teaching and learning that is appropriate for online instruction. The decision model developed may be used as basis for the use of MOODLE especially now that online learning platforms has become one of the dependable tools for the teaching and learning process.

A similar study may also be conducted to determine the usability of MOODLE in other field of disciplines.

REFERENCES

[1] Conde, M. A., Garcia-Penalvo, F. J., Rodriguez-Conde, M. J., Alier, M., Casany, M. J., & Piguellem, J. (2014). An evolving learning management system for new educational environments using 2.0 tools. Interactive Learning Environments. 22 (2). 188-204.

[2] Kissane, B. (2015). Using calculators to improve the quality of mathematics education. Proceedings of the 7th ICMI-East Asia Regional Conference on Mathematics Education, (p. 31). Cebu City, Philippines.

[3] Hussein, H. B. (2011). Attitudes of Saudi universities faculty members towards using learning managament system JUSUR. TOJET: The Turkis Online Journal of Educational Technology. 10 (2).

[4] Trouche, L., & Drijvers, P. (2010). Handheld technology for Mathematics education: Flashback into the future. ZDM-The International Journal on Mathematics Education, 42 (7). 667-681.

[5] Handal, B., El-Khoury, J., Campbell, C., & Cavanagh, M. (2013). A framework for categorising mobile applications in mathematics education. Proceedings of the Australian Conference on Science and Mathematics Education.

[6] Jones, J. G., Morales, C., & Knezek, G. (2005). 3-dimensional online learning lnvironments: examining attitudes toward information technology between students in internet based 3-dimensional and face-to-face. Educational Media International. 42 (3).

[7] Guncaga, J., Janiga, R., & Kriss, S. (2014). Experience of using Moodle e-learning environment at the faculty of education. Proceedings of the Central European Conference on Information and Communication Technologies in Education, (pp. 69-75). Czech Republic.

[8] Kotzer, S., & Elran, Y. (2012). Learning and teaching with Moodle-based e-learning environments, combining learning skills and content in the fields of math and science & technology. Proceedings of the 1st Moodle Research Conference (MRC2012). Heraklion, Crete.

[9] Senol, L., Gecili, H., &Durdu, P. (2014). Usability evaluation of a Moodle based learning management system. Proceedings of the World Conference on Educational Multimedia, Hypermedia and Telecommunications.Vol. 9. Tampere, Finland.

_____

[10] Pierce, R., & Ball, L. (2009). Perceptions that may affect teachers' intention to use technology in secondary mathematics classes. Educational Studies in Mathematics. 71(3), 299-317.

[11] Gorder, L. M. (2008). Study of teacher perceptions of instructional technology integration in the classroom. The Delta Pi Epsilon Journal. Vol. 50.

[12] Aureada, J. J. (2016). The effectiveness of a work-text in logic for college students. Asia Pacific Higher Education Research Journal. Vol. 4. (1).

[13] Devesh, S. &Nesseri, D. A. (2014). Effectiveness of mathematics module in foundation programme in Majan College. International Journal of Emerging Research and Technology. 2(1).

[14] Telaumbanua, Y. N., Sinaga, B., Mukhtar, Surya, E. (2017). Development of Mathematics module based on metacognitive strategy in improving students' mathematical problem- solving ability at high school. Journal of Education and Practice. 8 (19).

[15] Kakasevski, G., Mihajlov, M., Aresnovski, S., & Chungurski, S. (2008). Evaluating usability in learning management system Moodle. Proceedings of the 30th International Conference on Information Technology Interfaces, (pp. 613-618). Cavtat, Croatia.

[16] Baytiyeh, H. (2011). Work in progress-open source usability evaluation: the case of Moodle. Proceedings of the 41stASEE/IEEE Frontiers in Education Conference, (pp. F4E1 – F4E2).

[17] Melton, J. (2006). The LMS Moodle: A usability evaluation. Languages Issues.11/12 (1), 1-24.

[18] Sung, E. & Mayer, R. (2012). Affective impact of navigational and signaling aids to e-learning. Computer in Human Behavior, 28, 473 - 483. doi: 10.1016/j.chj.2011.10.01.

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