

Identifying the Learning Path of Online Learners in an Adaptive E-Learning Environment

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Abstract— With the advancement of technology, there is a rapid growth in e-learning. The use of the Internet in the teaching learning process has made significant impact on both teachers and students. Learners in an e-learning environment have different behavioural patterns, attitudes, aptitudes, learning styles, etc. and the learning resources preferred by these learners also vary. Hence, it is a big challenge for 21st century teachers to deliver the courses in an effective way. One solution to solve this problem is to provide an adaptive form of education. Advantage of this adaptive learning system is that it helps to provide apt material according to the interest and knowledge level of the learners or by understanding the learning facts. An adaptive learning system helps to track students' knowledge, measure progress and provide solution accordingly. With the support of a suitable Learning Management System (LMS) it is possible to administer, track, report and document the delivery of e-learning courses. In this study, Moodle (Modular Object-Oriented Dynamic Learning Environment) LMS is used for managing every aspect of the course such as course creation, conducting online test, etc. In an e-learning environment, learning content accessed by individual learners will be different and they learn subjects at their own speed and interest. It causes the generation of different learning paths. Hence, the objective of the study is to develop a frame work for an adaptive learning system and identify the learning path of the learners based on their activities recorded in Moodle.

Keywords—Adaptive learning system, E-learning, Learning Management System, Moodle, Learning path

I. INTRODUCTION

Teaching is a purposeful and pre planned activity. In a traditional class room teaching, teachers find it difficult to deal with students from diverse back grounds. Especially in the case of slow learners teachers find it difficult to deal with them as well as to make them learn their academic subjects. In this information era, there is a strong tendency towards e-learning and this method has got various benefits compared to the traditional method of teaching.

E-learning is considered as a successful way of training and it makes education as a way of life for many people. The interactive capability within a course is another important feature in e-learning. Adoption of blended learning (BL), the combination of traditional face-to-face and technology-mediated instruction, is increasing in higher education around the world[1]. They also noted that BL has been started in many places as a grass-roots effort, adopted by individual faculty interested in using both online and traditional strategies to improve student learning outcomes rather than being promoted as a strategic institutional initiative. Blended learning is a new kind of teaching-learning process that combines modern media, communication modes, and times/places [2]. In this method the role of a teacher also increases. They act as a

facilitators and leaders of the whole learning process. They are more important than the class room and course structure[2]. In this information technology era, application of technology in the current educational environment shows an increasing presence in online and blended learning. In [2] authors explain that there is an increasing presence in the application of technology in online and blended learning. It is the right time to think of incorporating digital tools as technology in traditional class rooms. Educational institutions are the major drivers of this change. Use of LMS helps to incorporate technologies in traditional class rooms. Learners in a traditional classroom can communicate with their teachers or with other students using a learning management system. But in an online-environment, a course is delivered as a live program, and learners can interact in real time. Also there is the possibility of interactivity among teachers and students like grading of assignments, tests.

In order to make the teaching –learning process more effective we need to have an education model that uses recent technologies. One reason is that the ‘one size fits all’ approach used for providing education to the millennium generation students is not at all significant and suitable. Again the speed of acquiring knowledge by individual students may vary and they try to get the initial knowledge from different points. Hence, in the design of a new model it should have the

capability of monitoring, measuring and assessing the effectiveness of the learning process. An adaptive form of education is very significant in this context. Hence, the researcher has developed a frame work of an adaptive learning system and identified the learning path of the learners.

The structure of the paper is organized as follows. Section I contains an introduction about various teaching learning methods and its relevance in the current education system. Section II surveys some related works of this area. Section III explains the theoretical frame work and the methodology used in the study. This section discusses about an e-content developed in Moodle environment for the topic scaling in computer graphics. Section IV explains the method used for developing an adaptive e-learning system for online learners. Section V discusses about the result obtained through the system. Section VI concludes the research work with some future scope.

II. RELATED WORK

This section reviews some of the previous studies conducted in this area. Significance of learning management system in an e-learning environment, techniques used for analyzing the learning behavior of a students, etc. are explained in the section.

In order to create a good learning scenario among the learners it is required to include educational technology tools and constructivist pedagogical principles while preparing the e-content. Content developers as well as faculty have to always bear in mind the fact that students belong to diverse background while delivering courses. Therefore they have to identify a suitable learning management system for this purpose.

Learning Management systems (LMS) plays significant role in online learning and blended learning. It provides a cost effective way to provide flexible online learning environment for higher educational institutions [3]. There are many advantages to LMS. It allows students to access educational learning resources and provides opportunity to collect data about student activities during the completion of their course. Modular Object-Oriented Developmental Learning Environment (MOODLE) is a commonly used LMS for the support of both e-learning and blended learning [3] [5]. A Moodle-MOOC platform is a free and open source useful for delivering courses.

Several studies conducted on the learning behavior of a student in an e-learning environment and they have used different data mining techniques for analyzing students' behaviour.

A study [12] explained about the use of web log data and integration of data mining techniques to extract useful patterns. They found that online course activities can be evaluated and interpreted using these web access logs. It will be useful for assessing the learning process, tracking students' actions and measuring the effectiveness of the course. Analysis of students' behaviour has been explored through a

study by[4]. They suggested a data-driven investigation proposal for determining whether the Moodle log data obtained can be used for extracting and visualizing students' learning behaviour. They found that it is a useful tool for visualizing and monitoring students' progress.

There are different ways in which performance of learners in Moodle LMS can be improved. In the study[16] authors have tried to improve the Moodle functionalities for supporting computer science education. They have extended the Book activity in Moodle, and developed a module named VizCoSH (Visualization-based Computer Science Hypertext book) for algorithm animation. It helped to incorporate a group of hypertext based textual materials with image, video, and Algorithm Visualization content.

In this study, the researcher has used the lesson activity in Moodle, to provide suitable learning materials and to engage learners, through an adaptive learning system. Methods like including videos, images, virtual presentations, etc. help the learners to engage in their learning process. Providing different learning paths like choosing an online video presentation, a simple text material of the online lesson, etc. also helps to engage learners.

The following studies explain about adaptive e-learning. A study by[11] suggested that adoption of various strategies like adaptive learning can cater to the need of the user and produce data best suited to the interest of the user. It provides a personalised learning path to its learners. By using adaptive learning technology it is possible to evaluate learners' knowledge, skills, and attitudes at the beginning of online training itself. It helps to deliver learning materials at the level most suitable for each learner [7].

All these studies lead to the importance of developing an adaptive learning system which provides support to learners in their learning process. This can be achieved by designing a learning path, based on attributes that describe learning contents and student characteristics[10]. Creating a course with various learning contents of different complexity level will provide an adaptive system [8].

The two main challenges in the construction of learning path are formulation of pedagogy and student assessment [10]. An adaptive learning system helps the students to opt for any method of presentation of learning material that is most suitable to their learners' interests and needs[13]. In the study[4] authors explained that student activity logs are a key resource for gaining insight into student behaviour in online environments. The learning style of the students can be detected based on these behaviour patterns.

III. THOERETICAL FRAME WORK

Since this study incorporates some sort of educational pedagogy it is very significant to mention about the theoretical frame work in detail. Implementation of learning strategies using pedagogical approaches supported by digital technologies like e-learning ,blended learning etc. are

becoming widespread in recent years. This approach can be implemented by uploading various learning resources like lectures notes, presentations, videos, quizzes etc. on any LMS so that students can do their learning process online [14].

A. MOODLE – Learning Management Systems

Moodle is an e-learning platform developed by Martin Dougiamas and it has been used all over the world. It acts as a communication medium among universities, educational institutions, and teachers. Using Moodle, it is possible to include the technological and pedagogical features in the development of a course. In Moodle there are three levels of users and each user has different functions. It is explained through the following table [1].

Table 1. Different Levels of Users in Moodle

User Role	Function
Administrator	Manages the learning environment
Teacher	Make courses or subjects, events according to the requirement of the user
Student	Accesses and interacts with a course, events and participates in the activities recommended

In a Moodle environment, we can create various activities like chat, forum, glossaries, database, assignments, lesson, quiz, etc. These course activities enable the students to interact with the instructor or they can learn through system or they can interact with each other. Resources are course materials like presentations, graphics and PDFs that allow students to read but they cannot interact with. Different kinds of resources available in Moodle are Book, File, Folder, Label, Page, URL, etc. All learning materials are provided through the learning resources like Pages, Files (text, images, videos etc), Folders, URLs, etc.

Another feature is the ability to access learning resources uploaded in Moodle by the learners. It provides a big opportunity to collect data about student activities during the completion of their course. According to [4] log data related to student activities form the key resource for acquiring knowledge about students' learning behavior in online environments. Using the built-in features of Moodle there is a possibility of producing several types of reports that can be used to track student activity. One of these reports called action logs allow instructors to keep track of the information regarding, which resources and activities in a course are accessed, when, and by which student [4]. The action logs recorded in Moodle is categorised into six dimensions [3]. They are explained through the following table.

Table 2. Moodle Action Log Data Attributes

Action log data attributes	Description
Course Name	Identification strings of the course in which the action is related
Time of the Event	Date and time of stamp when action was executed
IP address	Unique numerical label assigned to the device used by the user
User name	User who initiated the action
Action	Type of action initiated
Information	General information on learning activities

B. Adaptive Learning

Adaptive learning means adapting, modifying and varying content, pedagogy and course delivery to improve student learning and the mastery of learning outcomes through the use of analytical tools. Adaptive e-learning technology personalizes learning. In order to provide the best form of learning, students should always be kept engaged while providing education to them. The paper [11] explains that adaptive e-learning has a significant role in the performance of student. In the following Fig.1 concept of adaptive learning is explained through a block diagram.

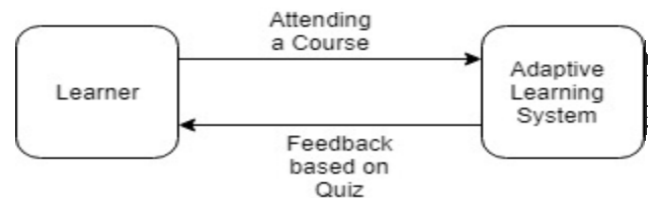


Figure 1. Block diagram of adaptive learning

C. TPACK model

Creation of digital educational content for effective delivery of courses of higher education by integrating blended and online methods is very significant in nowadays. Every faculty should acquire the skills of integrating digital materials, digital tools and contemporary teaching and learning methods into their educational practices. TPACK model is one method we can use for developing such a system. In this method we incorporate technology, pedagogy and content knowledge in the process of creating and delivering the course content. This model is comprises three kinds of knowledge- Technology, Pedagogy and Content knowledge. It is the knowledge for teaching a subject, knowledge for teaching a subject effectively and the knowledge for using the various technologies like Open Educational Resources (OER), etc. Content knowledge means proper understanding of subject knowledge. It improves the confidence of the facilitator. Pedagogy means the teaching knowledge. Teachers should understand the art and science of teaching. It refers to the method and strategies adopted to make the students more active and engaged. Here they have to arrange/structure the learning contents before delivering the

courses. Also they should be aware of the type of learning material and teaching method to be used. Examples are power point presentations, videos, group discussions, jigsaw methods, etc. The third is technological knowledge. It refers to teachers' capacity to appropriately select and use technology that best supports and promotes effective instruction.

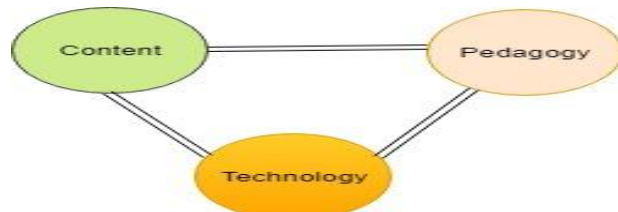


Figure 2. TPACK model

IV. METHODOLOGY

Education is said to be inclusive if it values diversity. In order to inspire and engage modern learners in e-learning, proper instructions have to be given. The process of creating web-based instructions and making use of learning objects require a lot of care and it is becoming a demanding area. Since Computer Graphics can be taught using web-based instructions the researcher selected this subject for designing a course. The learning management system Moodle has been selected for implementing the course. The lesson activity feature in Moodle has been utilized for making the course more adaptive and interactive. In this study, the researcher has developed an e-content for a Small Learning Object (SLO) 'Scaling', one of the basic geometric transformations in Computer Graphics Course.

A. Small Learning Object (SLO)-Scaling

Scaling is a geometric transformation used for changing the size of an object. Like translation, it is a simple transformation which just scales the coordinates of an object. This is not a rigid body transformation. This operation is applied for polygons. We use scaling factors S_x and S_y . Here S_x scales objects in the x direction. S_y scales objects in the y direction.

B. Lesson Activity in Moodle

The major difference between a Lesson and other activity modules in Moodle is its adaptive ability. Using lesson it is possible to create student's choices to provide self-directed lesson. The lesson module presents a series of HTML pages. There are two types of lesson pages-content pages and question pages. A Lesson consists of a series of web pages and it can be made up of text, images, videos, etc. In lesson activity it is possible to break down a topic into small pieces and can include web pages containing different kinds of learning materials. Students can do the learning process through these pages in a linear path ways or they can select any branching paths. It helps the students to engage in their

learning process. Since a lesson activity has the capability of including questions, students can perform a self- assessment about their learning. In this learning process, students are automatically directed to further questions, feedback pages or other content pages depending on the responses. Each content pages and feedback pages can be enriched with a pedagogical as well as technological concepts used in a TPACK model. The following diagram (Figure.3.) shows the learning path designed for explaining the concept of 'scaling' in computer Graphics using lesson activity.

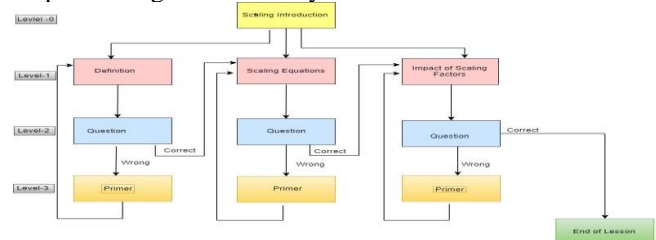


Figure 3. Learning path showing the lesson activity for scaling

At Level-0 an introduction about the concept of scaling is explained. At Level-1 details about scaling such as definition, scaling equations and scaling factors are explained. Level-2 contains questions corresponding to the previous topic. At this level evaluation of the learner is evaluated. If a student answers all questions correctly, he/she can move to the next topic which is explained in Level-1. Otherwise they have to move to Level-3, the primer page. This primer page is meant for some remedial learning content. In this page we can include more learning materials based on the result of questions answered. Each content page can be made up of with various resources like ppt, images, videos, etc. In order to make the learning process more engaged, some methods like videos, images, virtual presentations, etc were included in the course contents. Providing different learning paths like choosing an online video presentation, a simple text material of the online lesson, etc. also helps to engage learners.

V. RESULTS AND DISCUSSION

In an e-learning system a learning path is considered as a sequence of learning activities carried out by learners while they are going through learning units. A learning unit is an abstract representation of a course, a lesson, a workshop, or any other formal or in-formal learning or teaching event. In this study the topic 'scaling' is considered as the learning unit and it has been developed using various pages like content pages, multiple choice pages. In this study, the learning unit is made up of the web page-Ids 64, 68, 65, 74, 69, 70, 72, 77 and 73, where 68, 69, 72 and 73 are multiple choice pages and others are content pages.

From this study it is found that that web log data obtained from Moodle is of great use for identifying the learning path of students. A further analysis of the learning path obtained can be used for understanding more about learners. In this study, based on the usage of content pages and Question pages researcher has suggested a method to identify the slow learners in an e-learning environment. This system will also assist slow learners to improve their accademic performance. After the intial stage it is found that there is a decrease in the count of accessing the content pages and Question pages. Figure7 shows information about initial web pages accessed and time spent on all the pages included in the course by individual students.

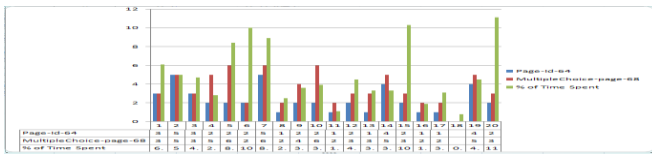


Figure 7. Initial webpage counts and time spent for the course

VI. CONCLUSION and Future Scope

The study designs an adaptive e-learning frame work in Moodle LMS to engage learners and identified the learning path generated based on the learning contents used. The researcher has tried to incorporate the TPACK model for the effective delivery of courses. The study has used only one small learning object 'scaling' for identifying the learning path of students. As a further step it is possible to design a course for other topics and identify their learning path. In future the behaviour pattern identified from learning path can be used for detecting the learning style of students in an e-learning environment based on Fielder Silver Learning Style Model (FSLSM). With the use of some machine learning techniques, the log data obtained can be used for predicting the academic performance of the students. It will help students, teachers as well as content developers to suggest proper learning materials or instructional strategies for the betterment of the academic performance.

REFERENCES

1. C.R. Graham, W. Woodfield, J.B. Harrson, "A Framework For Institutional Adoption and Implementation of Blended Learning in Higher Education", Internet and Higher Education, Vol. 18, pp.4-14, 2013.
2. A.Norberg, C.D. Dziuban, P.D. Moskal, "A Time-Based Blended Learning Model", On the Horizon, Vol.19, Issue.3, pp.207-216, 2011.
3. R.C. Raga Jr, J.D. Raga, "Monitoring Class Activity and Predicting Student Performance Using Moodle Action Log Data", International Journal of Computing Sciences Research, Vol. 1, Issue.3, pp.1-16, 2017.

4. R.R. Estacio, R. C. Raga Jr, "Analysing Students Online Learning Behaviour In Blended Courses Using Moodle", Asian Association of Open Universities Journal, Vol. 12, Issue.1, pp.52-68, 2017
5. T.Elias "Universal Instructional Design Principles for Moodle" The International Review of Research in Open and Distributed Learning, Vol. 11, Issue.2, pp.110-124, 2010
6. A.Deshpande, P. Pimpare, S. Bhujbal, A. Kommwar, J. Wagh, "Student Performance Analysis, Visualization and Prediction Using Data Mining Techniques", Imperial Journal of Interdisciplinary Research, Vol.2, Issue.5, pp.115-1118, 2016
7. S.Pawar, S.M. , "A Proposed System for Adaptive E-Learning Using Ant Colony Optimization" IJSART , Vol. 24, Issue.6, pp.72-76, 2015.
8. K.R. Premlatha, B. Dharani, T.V. Geetha, " Dynamic Learner Profiling and Automatic Learner Classification for Adaptive E-Learning Environment", Interactive Learning Environments, Vol. 24, Issue.6, pp.1054-1075, 2016.
9. P. Sarkar, C. Kar, "Adaptive E-learning Using Deterministic Finite Automata", International Journal of Computer Applications, Vol. 97, Issue.21, pp.14-17, 2014.
10. F.Yang, Z.Dong, " Learning Path Construction in E-learning: What to Learn, how to Learn, and how to Improve", . Springer Singapore, pp.15-29, 2017
11. A.Roy, K.Basu, "A Comparative Study of Statistical Learning and Adaptive Learning", arXiv preprint arXiv:1511.07538.
12. O.R. Zaiane, J. Luo, "Towards Evaluating Learners' Behaviour in a Web-Based Distance Learning Environment", In the proceedings of the 2001 IEEE International Conference on Advanced Learning Technologies, IEEE, pp.357-360, 2001.
13. L.K. Poon, S.C. Kong, M.Y. Wong, T.S. Yau, " Mining Sequential Patterns of Students' Access on Learning Management System", In the proceedings of the 2001 International Conference on Data Mining and Big Data, Springer, Cham, pp.191-198, 2017.
14. A.P. Lopes, "Learning Management Systems in Higher Education" In the proceedings of the EDULEARN14 Conference , Barcelona, Spain, pp. 5360-5365, 2014.
15. M. Kljun, K.C. Pucihar, F. Solina, "Persuasive Technologies In M-Learning For Training Professionals: How to Keep Learners Engaged with Adaptive Triggering", IEEE Transactions on Learning Technologies, 2018

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