Learning Analytics as a Method to Examine Students' Learning Patterns in an Online Module

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ABSTRACT

This research relates to the investigation of the written discussions in an asynchronous online activity, namely a blog activity that forms part of a fully online module for first year undergraduate students. The aims of this study were to (i) analyse the quality and depth of different levels of interactions by categorising students' responses into one of the three following categories: paraphrasing, value addition and critical thinking; (ii) explore of the relationship between this specific blog learning activity and development of higher order thinking skills of students; and (iii) investigate on possible patterns of learner behaviour in an online learning environment in the context of newly developed Web-based educational technologies at the VCILT, University of Mauritius. The study corpus used is a transcript of 764 postings generated by a group of 800 first year students engaged in a 6-credit general education module (GEM) delivered totally online in a time span of one year.

KEYWORDS

e-Learning, Web 2.0, Blogs, Critical Thinking

INTRODUCTION

In online teaching and learning, it is difficult for instructors to dynamically and scientifically observe students' learning behaviours. It becomes therefore rather complex to determine learner behaviour and patterns of learning in electronic media. Currently, the learning management systems
(LMS) or course management systems (CMS) are used extensively by online educators to gain basic data about learners' activities, such as login frequency, number of messages on the discussion forums and other quantitative measures, which nonetheless limit instructors' understanding of students' online learning process.

Learner activities are crucial for effective online learning [20]. Quality learning environments provide opportunities for students to engage in interactive and collaborative activities with their peers. Such environments have been shown to contribute to better learning outcomes, including the development of critical and higher order thinking skills [15]. In fact, different types of activities require the development of different skills that gradually promote students to extend their analytical skills and increase the depth and width of their information analyses and interaction.

The necessity and value of developing well-designed learning activities to facilitate and enhance learning is unquestionable. However, educators, using on-line learning environments and tools, have very little resources and support to evaluate learners' activities and categorise different online behaviours of learners. This inhibits educators from rapidly evaluating students' learning process and extracting useful learner behaviour pattern in order to better design learning activities to provide a more effective and efficient learning environment. It is therefore fundamental to investigate on and to observe and examine online learning behaviours and learning activity patterns.
Therefore, the purpose of this study is to make relevant and pertinent generalisations on different levels of interaction, learner behaviours and patterns of learning in a blog activity, which is an online asynchronous activity as far as full-time undergraduate students at University of Mauritius are concerned. The paper also aims at indicating

how analysis of student data can be exploited to help improve online teaching and learning with suggestions for educators, instructional designers and courseware developers.

The Notion of Interaction and Learning

Learning has been defined as the development of new knowledge, skills and attitudes, and interaction has long been seen and defined as a critical component of both the educational process and content [2]. Therefore, learning is a product of interaction that has often been tagged as a significant component of successful online learning. Different kinds of interaction promote different types of learning at different levels. Interaction is a multifaceted concept and that is perhaps why, there are no single but diverse definitions and interpretations of this concept. Interaction, according to [11], can consist of a learner accessing and reading some content; or it can be a more complex interpretation requiring the learner and the learning system to respond dynamically to each other. [6] argues that interaction can also simulate the seven characteristics of interpersonal communications namely: immediacy of response, non-sequential access of information, adaptability, feedback, options, bi-directional and interruptability. [12] sees interaction as a function of the type and meaningfulness of learner response as well as the quality of feedback provided. On the other hand, [3] makes reference to [6] who stipulate that interaction refers in a restrictive manner to only those activities where the learner is in two-way contact with another person (or persons).

Interaction and Online Learning

Since interaction has been considered as central tenet to the concept of online learning [5], interaction should, however, not be without a purpose. Interaction should be designed to maintain the learner's interest and mental stimulation. Interaction is, however, often used interchangeably with interactivity. In fact, interactivity research studies of online learning reveal that students value their opportunities to communicate with their peers and instructors. [15] states that "*what the virtual student wants and needs is very clear: communication and feedback, interactivity and a sense of community, and adequate direction and empowerment to carry out the tasks required for the course*". Thus, a major challenge for today's online courses involves creating a consistent level of interaction that fosters appropriate, efficient and effective academic learning. In online interaction research, it is a widely accepted belief that the use of interactive technology with the possibility of both synchronous and asynchronous communication and multiple representations may provide online learners with more interactions, leading to enhanced learning outcomes. [19] makes reference to empirical research to support this belief. He quotes the comprehensive meta-analysis of [22] who found that interaction is a key component in assessing the effectiveness of distance/online learning compared to face-to-face learning. More specifically, they found that distance/online learning programmes that provide opportunities for both synchronous and asynchronous interactions report more positive outcomes than programmes with a single mode of interaction.

Educational Data Mining

The recent years have witnessed an increasing interest in the use of data mining to investigate scientific questions within educational research; an area of inquiry termed educational data mining [4]. This is closely linked to the unprecedented growth and the emergence of the field of learning analytics, in which sophisticated analytic tools are used to improve learning and education.

Learning Analytics is defined in the 2011 Horizon Report [12], as "*the interpretation of a wide range of data produced by and gathered on behalf of students in order to assess academic progress, predict future performance, and spot potential issues*". It draws from, and is closely tied to, a series of other fields of study including web analytics, action analytics and educational data mining.

Educational data mining (EDM) is mainly about developing and using new methods to identify and unearth knowledge from educational database. In order to analyse student trends and behavioural

patterns, there are varieties of popular data mining tasks within the educational data mining, including classification, clustering, association rule and prediction among others.

EDM provides the possibility to collect and analyse data on student affect including their emotional states and their level of motivation which can be inferred from physiological sensors like for instance, facial expression, seat posture and perspiration [4].

Therefore, EDM can be used to predict students' academic performance, knowledge discovery on academic achievement, classification of students' performance according to learning styles, while investing the similarity and differences amongst students [1]. EDM are also used to analyse LMS data, server logs or logged data of users' activity with the aim of automatically discovering comprehensible and logical feedback and constructing knowledge on typical patterns of online learning behaviours. Web mining has been applied to education research and some studies have used it to investigate about the unique advantages of data mining techniques to explore and examine the behaviour of learners and individual learner differences with the aim of supporting dynamic online instruction, and to build a predictive model for online learning [15].
Students' both regular and irregular patterns can be determined so that the most frequently made mistakes can be identified and the most effective activities can be further accentuated. Thus, instructors are better positioned to provide feedback and appropriate intervention as and when needed. This makes adaptive learning or customised learning available in the online environment. Exploiting EDM techniques to extract useful patterns largely help online instructors and educators to evaluate and interpret online course activities in order to assess the learning process, track student actions and measure Web course structure effectiveness. EDM therefore, can also be very useful for instructional support by largely helping to determine learning resources and activities that are appropriate with respect to a learner's needs, interests, preferences, skill level [18] and previous activities. The benefits of analysing mining results are thus multi-fold: it enables online instructors and educators to better organise the learning process in order to improve the learning experience of students as well as increase their profits [13]

THE RESEARCH AND THE UNDERLYING METHODOLOGY

In this study, a case study approach that involved the qualitative analysis of data in the form of student written postings/messages in a blog activity was used. The study corpus used was a sample transcript of 764 postings generated by a group of 800 students engaged in a 6-credits module delivered totally online in a time span of one year. All students were first year undergraduate students and given the Mauritian educational context, it can be easily assumed that, for most if not all students, this module is their first experience of online learning.

Context of Study

The study was carried out at the VCILT (Virtual Centre for Innovative Learning Technologies), which was set up in 2001 to cater for online education including to the development of an IT-enhanced learning environment both for staff and learners. With a policy to innovate in the field of technology and communication, through the VCILT, the teaching and learning environment of the University of Mauritius (UoM) has gradually but surely transformed, with a healthy blend of traditional and modern teaching and learning tools and techniques. An offshoot of this strategy is that passive learning, usually linked to traditional teaching methods, gradually leads to active learning, associated with the student-centred environment of online courses. Indeed, learners now have the opportunity to take on more responsibility for their own learning and tutors act more as facilitators to that learning.

Learning Resource and Learning Environment

The module 'Educational Technology' was a GEM (General Education Module) that carried 6 credits and spanned over one academic year, that is, 2 semesters of 15 weeks each. Basically, the module targeted especially those who had an interest in

education. It helped students to integrate ICT in education and ways to improve teaching and learning through educational technologies.

The modality of the module was that it is fully online and all learning resources are available online. It was assignment based only with no examinations. However, students were expected to submit a piece of work or assignment every fortnightly or every three weeks' time. The tutor interacted with the students mainly through the discussion forum though he/she could also use chat sessions; set guidelines to help students with the weekly resources and activities; set deadlines for submission of activities and assignments; and provided feedback to learners.

Upon completion of this module, students got the opportunity of using E-learning authoring software without getting into codes and they acquired knowledge about how to use certain IT tools. In short, this GEM was targeted towards those with an interest in education, more precisely those willing to get a grasp on the potential of ICT in education and the use of educational technologies to improve teaching and learning.

It was first offered in academic year 2010-2011 and for that particular run (year 2011 - 2012), we had around 800 students enrolled for GEM 'Educational Technology'. The target population for analysis was students enrolled in academic year 2011-12; and we would focus on the first semester (15 weeks) only, that is, August-November 2011.

Profile of Students

The GEM was open to first year full-time undergraduate students (male and female) most of whom were fresh secondary schools leavers, that is, aged 19 – 21 years old. The student population enrolled for the GEM 'Educational Technology' cut across all the 5 faculties, namely Faculties of Agriculture; Engineering; Social Studies & Humanities; Law & Management; and Science. This was so because once enrolled in a programme of studies in any Faculty, it was mandatory for students to choose one GEM amongst four GEMS that were offered. Usually, students were not allowed to take a GEM that is related to their field of study.

Learning Activity

The learning activities of the first semester in 'Educational Technology' were as follows:

Activity 1: Views and Opinions
Activity 2: MCQs Activity
Activity 3: Self-Assessment Questions
Activity 4: MCQs Activity
Activity 5: Blog Learning Activity
Activity 6: Concept Mapping

For each topic, students were given 2-3 weeks to go through all the resources on the LMS, to attempt the questions and to submit the activity. For this research, we have chosen Activity 5: 'Blog Learning Activity' mainly because it required students to interact at different levels: with the technology; the content; and among themselves. Moreover, since the activity was scheduled as one before the last, students were already versatile with online learning including doing online activities. This activity also carried marks that added up for the final marking. In the Blog learning activity, instructions and requirements were given to students to guide them through the activities and to provide several gradual milestones to achieve the overall objectives that were mainly:

a) Choose 2 articles.
b) Post a constructive comment on the articles.
c) Critically comment on others' observation.

We have used Bloom's Taxonomy to analyse and decode each instructions of the activity as to the type of cognitive skill(s) represented and required from students. This has helped us to classify the different cognitive functions of the activity and determine the percentage of students who have been able to exhibit the highest cognitive level as expected in the activity. For the purpose of this research, we looked only at the cognitive domain because the aim was to assess the types of learning that occurs; the predominant level of interaction

with the learning activity; and finally, what typical patterns of online behaviours of learners can be drawn.

VCILT Blog on Educational Technology

The VCILT blog, created in 2010, served as a teaching tool for the undergraduate students opting for the GEM 'Educational Technology' and it was an active blog that had more than 790 users. Articles were organised according to the year and month they were posted on the blog. Students, in this study, had to choose between 29 articles: 16 articles in 2010 and 13 articles till October 2011 since the time span for going through the activity was 13-28 October 2011.

The 29 articles (at the time of the research work) can be broadly classified as:

1. General Educational Technology Research Articles (4 articles in 2010 &3articles in 2011= 7)
2. Report of a Research (3 articles in 2010 &3 articles in 2011=6)
3. Recital of a Research Project (3 articles in 2010 &4 articles in 2011=7)
4. Reflection from author/s (6 articles in 2010 &3 articles in 2011=9)

The articles were fairly distributed among the mentioned categories.

Data Collection

The case study approach involved the collection and analysis of student's responses to both activity instructions 3 and 4 which respectively referred to the two types of messages identified by [10] namely: independent and interactive. Independent messages dealt with the topic of discussion, but make no implicit or explicit reference to any other messages, as expected of students responding to instruction 3. Interactive messages on the other hand, dealt with the topic, but also referred to other messages by critically reflecting on them which included responding to them, elaborating on them, criticising them or building on them in some fashion. Henri's [10] interactive message correspondingly referred to instruction 4 of the Blog Activity.

However, while collecting data, we did not distinguish between independent and interactive messages, that is, between students' first constructive comments on their two chosen articles, and their critical reflection on one of their peers' comment because the aim was not to collect quantitative data with regards to the number of messages posted but rather an assessment of the degree to which students appear to be thinking critically when interacting. Therefore, content analysis of students' posts was necessary to discern what level of quality and higher thinking the discussions sustained which would indicate the level of interaction and typical patterns of online behaviour of students.

To achieve this aim, we analysed students' responses and sorted them out into three categories namely Paraphrasing; Value Addition and Critical Thinking. Categorising the contributions in this way was a rather subjective process. For the purpose of this study, out of the 29 articles available to students, five (5) most popular articles (representing 17.2% of the overall articles) were chosen, in terms of the highest number of messages posted by students in October 2011 for each article and they were:

1. Web 2.0, Social Networks, and Learning…. – 769 posts

2. VCILT showcases student's work – 457 posts

3. We have never done it before…. – 338 posts

4. Investigation of student understanding and learning in multimedia presentations using human and synthesized voices based on 'voice principle' – 190 posts

5. Plenary Speech at the 18th International Conference on Learning: Training of In-Service Educators through Online Activity-based Learning – 158 posts

Since the number of posts to be analysed was extensively numerous, we analysed a sample of 40% of the number of posts for each article to ensure that the sample reflects the characteristics of the student population from which it was drawn. The analysis of the messages posted by students for the five above-mentioned blog articles was based on the template below. The template was a very detailed and in-depth one, especially the 'Value Addition' and 'Critical Thinking' parts. This was so to ensure that no confusion and overlapping were made between these two categories while analysing and classifying students' messages.

Limitations of the Study

One unidentified variable that might significantly impact on the ease of use of online tools was the IT 'literacy' level of all students. Though it was assumed that all students had no prior experience in online learning as they were all first year and first semester undergraduate students, some of them might have formal extensive exposure to IT (through secondary studies or formal training) and developed IT -related skills and knowledge which might definitely make them feel more comfortable and confident in evolving in an online learning environment. However, it was to be noted that the GEM 'Educational Technologies' was designed and delivered with the assumption that, for all the students embarking on this module, it was their first and initial exposure to online learning.

Findings and Results

The overall results from data showed that most students' responses tended to add value to the articles. In fact, more than 50% of students' messages in all articles fell into the category of 'Value Addition'. We found that the majority of students had the competency to go beyond the level of paraphrasing and to contribute ideas, personal opinions and informative comments in a logical and reasonable way. Moreover, more than 15% of the posts for all articles bore testimony of students' ability to use higher order thinking skills by critically analysing and reflecting on the issue and providing credible and valid value judgments and making references to researches, studies and articles read. In fact, for Article 5, 29.7% of students demonstrated their critical thinking abilities. Therefore, the results of the study primarily revealed a rather laudable approach especially as this Blog Activity of the 'Educational Technology' module was done in the first year and first semester of programmes of studies and was delivered fully online. Such proactive approach of the first year students at the University of Mauritius can become even more commendable when we analysed the educational background against which most, if not all, these students join in the University of Mauritius. The primary and secondary educational systems in Mauritius are still, to a large extent, behaviourist. The main focus of these two levels of education remains on the content or on the curriculum and not on the students. Similarly, though school mission statements often wax poetic about the development of the "total child", what drive the everyday functioning of schools are the official curriculum and the tests and examinations that hold teachers and students accountable to that curriculum. There is standardised curriculum and the instructional

objectives are still fixed, implying that the class is conducted according to these objectives.

In such a context, the teaching remains largely teacher and content-oriented. Against this educational background, an analysis of data nevertheless showed a high level of clarification statements that demonstrated that students had reached a relatively high level of information sharing (Value Addition amounting to a range of 51% - 59% in the articles). But, at the same time, the same data suggested little knowledge construction, reflected through the lower percentage of students' postings in the category 'Critical Thinking'. Therefore, based on the overall figures, a large proportion of the learners' cognitive level of response did not match the cognitive level of questions (questions 3 and 4) asked.

Results of the study also indicated that there was certain stability and consistency as far as Value Addition is concerned. From table 1, it can be seen that, in all the five articles, 50%-60% of students' messages fall into the 'Value Addition' category. On the other hand, there was considerable variability in students' posting with regards to 'Paraphrasing' and 'Critical Thinking'. Active participation, in terms of demonstrating critical thinking skills, were relatively low among students in Articles 1 and 4. Only 18.5% is found in 'Critical Thinking' category compared to 29.9% for 'Paraphrasing' in Article 1; and 15.8% for 'Critical Thinking' compared to 27.6% in 'Paraphrasing' in Article 4.

In contrast, in Articles 2, 3 and 5, the percentage of students' postings in category 'Critical Thinking' was much higher than in 'Paraphrasing'. A close analysis of the data resulted to a correlation between the type of article and the level and depth of interaction. Here, the focus was more on the dichotomy between Paraphrasing and Critical Thinking that were at opposing ends.

Assessing Critical Thinking and Paraphrasing in Articles 1 and 4

Results showed lowest evidence of critical thinking in Articles 1 and 4 with 18.5% and 15.8% respectively. Article 1 (*Web 2.0, Social Networks and Learning*) was of an academic nature and pertains to general research article based on Educational Technology. Article 4 (*Investigation of student understanding and learning in multimedia presentations using human and synthesized voices based on 'voice principle'*) was a recital of a research project based again on the field of Educational Technology. In both cases, the articles were pitched at high academic level and they dealt with specific topics in Educational Technology and more cognitive engagement and higher order thinking were required for students to respond to them as expected. However, a large part of the postings indicated a fairly low level of thinking as seen with 29.9% and 27.6% representing the highest proportion of responses in the category 'Paraphrasing' for Articles 1 and 4 correspondingly. Concurrently, Articles 1 and 4 had the highest fraction namely, 26% and 24% respectively, of the overall percentage of students' postings for 'Paraphrasing'.

In these two cases, although students were given the platform to read other students' responses and interpretations and the opportunity to compare these with their own thoughts and perspectives, the above-mentioned percentage of students had merely regurgitated ideas from the articles. They had been unable to trigger the processes of reflection and re-construction of domains of knowledge and therefore, surface learning was the most evident resulting learning.

Assessing Critical Thinking and Paraphrasing in Articles 2, 3 and 5

In contrast, data collected clearly indicated a comparatively higher level of critical thinking for

Articles 2, 3 and 5. In these three individual articles, the percentage of postings for 'Critical Thinking' was also interestingly higher than that of 'Paraphrasing'. For example, in the category 'Critical Thinking', results showed the following percentage: 23.3%; 27.2% and 29.7% against 20.2%; 18.4% and 18.7% for 'Paraphrasing' respectively for Articles 2, 3 and 5.

In parallel, when we analysed the overall percentage of student's messages in the two categories, there was evidence that both critical thinking and paraphrasing varied considerably from article to article 4. But, such a comparison also testified that critical thinking tended to be higher than paraphrasing in Articles 2, 3 and 5 with 'Critical Thinking' overall scoring 20%, 24% and 26% against 18%, 16% and 16% for 'Paraphrasing' in the three articles respectively.

Articles 2 *(VCILT Showcases Student's Work)* and 3 *(We have never done it before….)* were reflections of the author on more general educational technology topics that dealt directly with the students (displaying students' work in a digital library) and that might pertain to different aspects of everyday life, in terms of people's attitudes and mindset. Unlike Article 1 and 4, these two articles were not highly academic ones, but as stated above, students had responded more in terms of critical thinking than paraphrasing resulting in a kind of learning which was not merely a regurgitation of readings. Results revealed that a larger portion of the student population were able to be more deeply and significantly engaged with course content in discussions, hence thinking critically about the discussion topics. Therefore, analysis of data in this study showed that the ability to use critical thinking depended on the nature of the article. Students felt more confident in indulging in a negotiated interpretation of ideas and suggestions presented in those articles that were not purely academic and more general in nature within the educational technology domain. Such articles tend to 'afford' behaviours that generated deeper learning.

DISCUSSION

Critical Thinking

Analysis of the patterns of interaction in the Blog Activity showed that interaction was variable, and that while all students were engaged, intensity and depth of participation were unequal among individual learners as far as the cognitive input was concerned. The findings showed that, if Value Addition was consistent throughout the 5 articles, then, the percentage of students paraphrasing and demonstrating cognitive thinking varied mainly depending on the nature of articles and the use of multimedia. The literature on asynchronous computer conferencing suggests that several factors can significantly impact on the students' ability to use critical thinking skills in their contributions to asynchronous discussions and these include disciplinary differences, cognitive maturity, the instructor's style of teaching, gender and students' understanding of critical thinking, among others. [7] for example, used a case study approach to determine whether students were actively participating in the conferencing course, interacting with each other to build on each other's postings in an online discussion forum, and thinking critically about the discussion topics. He analysed the content of messages and the quality of student participation and interaction. The result was that students barely referred to other messages and the level of critical thinking was low to medium.

However, in this study, the fixed variable of the students was the fact that they were all first year undergraduate students enrolled in a full-time on-campus programme of studies at the University of Mauritius. Therefore, these students were a representative sample of the University of Mauritius students so that we could generalise the

results obtained. They were generally all at par as far as educational level and age were concerned. However, since the aim of this study was to reveal and provide a first and initial general idea of the cognitive patterns of online UoM learners with respect to asynchronous online activities, this study had not deemed it important, at that stage, to look into other important factors that could have further streamlined the results according to specific parameters.

Blog as an Educational Tool

This study also provided clear insights on how blogs, as an educational asynchronous platform, could be used to engage instructors and students with one another in ways that potentially promote critical thinking and meaningful knowledge construction. The aim of this study was to analyse the written contribution of students' cognitive processes while engaged in thinking activities, and this had been possible through a blog that has been used as a cognitive tool. Though this has not, at any point, been the focus of this study, we cannot overlook the dynamic capacity of blogging as a communicative channel, an educational resource and learning sphere as witnessed in this study. There is, in fact, a growing academic literature on blogging that reflects the potential of blog as a tool for the promotion of deeper learning. According to [8], blogs as a social networking adaptive technology, require students to employ a collection of cognitive skills known as 'digital literacies' to be able to effectively perform and participate. Since blogs can be commented on, they offer a feedback feature that provides the learner with prospective scaffolding of fresh thoughts. Similarly, [20] refer extensively to several researches that assert that blogs address the discursive nature of knowledge construction by helping students develop a natural tendency for reflection and analysis. They also very successfully promote conversational interactivity and the researches affirm that blogs represent a mode of interaction that is conducive for promoting active learning, higher order thinking, and improving greater flexibility in teaching and learning generally.

Learning Analytics

Through this study, we also witnessed that large amount of data is available on students; their thinking and learning processes as well as their different interactions that could provide meaningful insights to facilitate, enhance and optimize both the teaching and learning process. A combination of the availability of tremendous amount of information and the acceptance and use of online learning on a large scale had raised concerns about the need to scientifically and technically assess, analyse and visualise students learning and interactions. Even today, there is still great interest in assessing student learning in open-ended environments. But students' work and interactions can evolve and progress in ways that are too complex and rapid to be detected, traced and followed by the human eye. Learning analytics offers one direction, with considerable potential to enhance teaching, learning, and assessment if used with sophistication and in tandem with productive theories of contemporary learning practices [12].

[17] defines learning analytics as "*the use of intelligent data, learner-produced data, and analysis models to discover information and social connections, and to predict and advise on learning*". During the last decade, learning analytics has emerged as a significant area of research into technology enhanced learning. Although this is a new area of research, it draws on extensive work in related areas, and has already developed a range of tools and methods that offer exciting potential [9]. There is a growing interest, both within the academic community and beyond, in learning analytics and the several possibilities they offer not only for predicting successful

learners, but more importantly, for customizing and tailoring educational opportunities to the need and ability of each individual student more effectively. This has implications not simply for individual student performance, but in how educators perceive teaching, learning and assessment. In fact, by offering information in real time, learning analytics can support immediate alterations, suggesting a model of curriculum that is more fluid and open to change [12]. Eventually, institutions may be able to provide unique learning paths, harmonizing instructional activities to students' learning needs and abilities. Therefore, one of the challenges for educational institutions is to find, adopt, customise and keep pace with the tools needed for processing and interpreting such data.

CONCLUSION

This study clearly showed that student's responses were consistent throughout the five articles as far as 'Value Addition' is concerned. As for 'Paraphrasing' and 'Critical Thinking', they vacillate depending on the nature of articles and the use of multimedia. We have also seen that there was much data available on online learners. These data should be further analysed to provide better and more in-depth understanding on how UoM learners use and interact in a Web-based learning environment and the different factors that affect them. This is crucial for providing insights to educators, instructional designers and course developers about learner behaviour for the development of a sound pedagogical framework for more effective and efficient design and use of online learning environment.

REFERENCES

1. AHER, S. B & LOBO, L.M.R.J., 2011. Data Mining in Educational System using WEKA. *International Conference on Emerging Technology Trends (ICETT)* [Online] Available at: http://www.ijcaonline.org/icett/number3/icett021.pdf [Accessed 20 March 2012]

2. ALI, M., 2002. Foundations of Educational Theory for Online Learning. *In:* ANDERSON, T. & F. ELLOUMI, F. (EDS.), *Theory and practice of online learning.* Athabasca University. [Online] Available at: http://cde.athabascau.ca/online_book/ch1.html [Accessed 30 September 2011]

3. ANDERSON, T., 2002. An Updated and Theoretical Rationale for Interaction. [Online] Available at: http://it.coe.uga.edu/itforum/paper63/paper63.htm [Accessed 3 September 2011]

4. BAKER, R.S.J.D., 2010. Data Mining for Education. *In*: MCGAW, B., PETERSON, P. & BAKER, E. (EDS.) *International Encyclopaedia of Education* (3rd edition) 7, pp. 112-118. Oxford, UK: Elsevier.

5. BALAJI, M.S & CHAKRABARTI, D., 2010. Student Interactions in Online Discussion Forum: Empirical Research from 'Media Richness Theory' Perspective. *Journal of Interactive Online Learning* 9 (1). [Online] Available at: http://www.ncolr.org/jiol/issues/pdf/9.1.1.pdf [Accessed 30 August 2011]

6. BORSOOK, T., 1991. Harnessing the power of Interactivity for Instruction. *In:* HIRUMI, A., 2002. The Design and Sequencing of eLearning Interactions: A Grounded Approach. *International Journal on E-Learning,* 1 (1), 19-27. [Online] Available at: http://www.eaglesemantics.com/system/files/hirumi_2002_design_and_sequencing_of_elearning_interactions.pdf [Accessed 03 October 2011]

7. BULLEN, M., 1998.Participation and Critical Thinking in Online University Distance Education. *The Journal of Distance Education,* 13 (2). [Online] Available at: http://www.jofde.ca/index.php/jde/article/view/140/394 [Accessed 20 December 2011]

8. DUFFY, P. & BRUNS, A., 2006. The Use of Blogs, Wikis and RSS in Education: A Conversation of Possibilities. *Proceedings Online Learning and Teaching Conference,* p. 31-38, Brisbane.[Online] Available at: http://eprints.qut.edu.au/5398/1/5398.pdf [Accessed 17 January 2012]

9. FERGUSON, R., 2012. The State Of Learning Analytics in 2012: A Review and Future Challenges. *Technical Report KMI-12-01*, Knowledge Media Institute. The Open University, UK.[Online] Available at: http://kmi.open.ac.uk/publications/techreport/kmi-12-01 [Accessed 31 March 2012]

10. HENRI, F., 1992. Formation a distance et téléconférence assistée par ordinateur: Interactivité, quasi-interactivité, ou monologue? *Journal of Distance Education,* 7 (1). [Online] Available at: http://www.jofde.ca/index.php/jde/article/view/412/302 [Accessed 21 February 2012]

11. HIRUMI, A., 2002. The Design and Sequencing of eLearning Interactions: A Grounded Approach. *International Journal on E-Learning*, 1 (1), 19-27. [Online] Available at: http://www.eaglesemantics.com/system/files/hirumi_2002_design_and_sequencing_of_elearning_interactions.pdf [Accessed 9 January 2012.

12. JOHNSON, L., SMITH, R., WILLIS, H., LEVINE, A., & HAYWOOD, K., 2011. *The 2011 Horizon Report*. Austin, Texas: The New Media Consortium [Online] Available at: http://wp.nmc.org/horizon2011/ [Accessed 25 March 2012]

13. LILE, A. (2011). Analyzing E-Learning Systems Using Educational Data Mining Techniques. *Mediterranean Journal of Social Sciences*, 2 (3)[Online] Available at: http://www.mcser.org/images/stories/2_journal/mjssso203september2011/46.%20anduela%20lile.pdf [Accessed 22 March 2012]

14. NOVAK, G. M., PATTERSON, E. T., GAVRIN, A. D., & CHRISTIAN, W., 1999. Just-in-Time Teaching: Blending Active Learning with Web Technology. *In:*NOVAK, G.M. & MIDDENDORF, J.K. Just-in-Time Teaching: Using Web Technology to Increase Student Learning. [Online] Available at: http://a-s.clayton.edu/henry/Jitt.PDF [Accessed 1 March 2012]

15. PALLOFF, R. M, & PRATT, K., 2003. Virtual student: A profile and guide to working with online learners. San Francisco, CA: Jossey-Bass.

16. SIEMENS, G., 2010. What are learning analytics?

[Online] Available at:
http://www.elearnspace.org/blog/2010/08/25/what---are---learning---analytics/
[Accessed 2 April 2012]

17. SCHEUER, O. & MCLAREN, B.M., 2011. Educational Data Mining. *Encyclopedia of the Sciences of Learning, Springer*.
[Online] Available at:
http://www.cs.cmu.edu/~bmclaren/pubs/ScheuerMcLaren-EducationalDataMining-EncyOfLearningScience2011.pdf
[Accessed 10 January 2012]

18. SO, H.J., 2010. Towards Rigor of Online Interaction Research: Implication for Future Distance Learning Research. *TOJET*: *The Turkish Online Journal of Educational Technology*, 9 (2).[Online] Available at:
http://www.tojet.net/articles/9226.pdf
[Accessed 11 November 2011]

19. WILLIAMS, J.B & JACOBS, J., 2004. Exploring the use of blogs as learning spaces in the higher education sector. Australasian Journal of Educational Technology 2004, 20(2), 232-247
[Online] Available at:
http://ascilite.org.au/ajet/ajet20/williams.html
[Accessed 28 February 2012]

20. ZHANG, K., & HUNG, J., 2008. Revealing Online Learning Behaviors and Activity Patterns and Making Predictions with Data Mining Techniques in Online Teaching. *MERLOT Journal of Online Learning and Teaching,* 4 (4).
[Online] Available at:
http://jolt.merlot.org/vol4no4/hung_1208.pdf
[Accessed 22 January 2012]

21. ZHAO, Y., LEI, J., YAN, B., LAI, C., & TAN, H. S., 2005. *What makes the difference? A practical analysis of research on the effectiveness of distance education*. Teachers College Record, 107 (8) *In:* SO, H.J., 2010. Towards Rigor of Online Interaction Research: Implication for Future Distance Learning Research. *TOJET: The Turkish Online Journal of Educational Technology*, 9 (2).
[Online] Available at:
http://www.tojet.net/articles/9226.pdf
[Accessed 15 October 2011]