ENHANCING LEARNING THROUGH STUDENT AND CONTENT INTERACTIONS BASED ON PREFERRED LEARNING STYLE AND CONTEXT AWARENESS

Ashwin Budoo, University of Technology, Mauritius (budooashwin@gmail.com)
Shireen Panchoo, University of Technology, Mauritius (s.panchoo@umail.utm.ac.mu)

ABSTRACT

In this paper, we have suggested a system, which displays learning materials as per the students' learning styles, and activated by context awareness, privileging personalized learning. As methodology, a mobile application is develop which uses information captured by sensors, to accompany students in their everyday experience. Result shows that the students termed the experience to be beyond their expectations as the application adapts to different contexts and notifies the students accordingly while assuring that the learning materials are adapted according to their pace and context in their respective location. Additionally, step-by-step assistance and constructive feedbacks are a necessary part of the learning process.

Keywords: Online Pedagogy, Learning Style, Mobile Learning, Context Awareness, Learning Analytics, Constructive Feedback

INTRODUCTION

The low academic performance of students is one of the most challenging problems that students as well as teachers face. There are numerous causes of this problem, including educational, social, cultural and psychological dimensions amongst others (Al-Zoubi and Younes, 2015). In 2015, 10,285 students from Mauritius took part in the Cambridge Higher School Certificate, of whom 58% were females. The overall passing rate was 75.3% which is lower than 2014 which had a figure of 75.4% (Government of Mauritius, 2016).

The mixed ability students have to make sure to merely master limited sets of knowledge according to the teacher's pace, e.g. by ensuring to understand when teacher explains and memorization of the content without addressing according to the actual process-skills required as a professional (Schön, 1983). A teacher-centered learning environment does not facilitate nor empower a student's autonomous study-skills, that is, the learning content is not according to the student's preferences (Trilling & Fadel, 2009). At any stage of the learning process, open inquiry can arise; teacher-centered learning does not include metacognitive skills as facilitated in problem-based learning which includes questioning the justification and validity of arguments, not just the reasons given by the teacher (Barrows H., 1992).

The fact that students learn in different ways and have different learning styles have been shown to yield positive results in the past when teaching according to the students' preferred learning style (Graf et al., 2009 & Popescu, 2010). These results were to increase learning satisfaction and achieve better performance. Content adaptation creates specific models of the students' needs by converting multimedia content provided into an appropriate format and use the model to provide adaptive learning experiences (Jannach et al., 2006). In this paper, we analyse and demonstrate the effectiveness of the adaptive mobile system with respect to students' satisfaction and improvement of knowledge.

Therefore, the aim of this research is not only to adapt the learning content according to a student's preferred learning style, but also to adjust the learning content according to the student's physical contextual environment.

RESEARCH METHODOLOGY

Seventeen secondary students filled a questionnaire, which helped to identify the secondary students' learning difficulties and the different daily activities they are engaged in. The software/tools such as FileZilla, Sublime Text 3, Gimp, XAMPP, Server Side Scripting tools: PHP, Database Tools: MYSQL & PhpMyAdmin, Android Studio and the CMS WordPress were used during the Agile Software Development phases.

To gauge the effectiveness of the application, thirty-one students of upper secondary were split in two groups. This study aims to teach Mathematics Modules: Group A used the traditional face to face learning techniques and Group B learned using the developed application. After this activity, the students were assessed on the newly learned topic using a questionnaire and the students shared their point of view, experience and difficulties faced after using the application.

To identify difficulties related to the usability and efficiency of the system, a group of upper secondary students used the application freely(including having access to the Expert Model).

PROPOSED WORK

A. Requirement determination based on the students' learning difficulties and the different daily activities

Out of the 16 students, interestingly, 56% and 31% students claimed that they spend much time in travelling and in using their phone respectively.
It was critical to identify the secondary students' time consuming activities as this shall contribute to design a system which provide and enhance learning experiences of the students by adapting the learning content during these time consuming activities.

A pedagogical questionnaire shows that 35.1% of the students find it difficult to understand the teacher (language/ content). Furthermore, 16.2% students are unable to adapt to the teacher's pace, 13.5% of the students cannot relate the topic being learned to her/his personal experience, 10.9% of the students notified that the learning content requires more explanation and 24.3% of the students found the class inactive.
Therefore, the main difficulties faced by students while learning are mainly due to their inability to follow the pace of their teacher and the teaching strategies were not adapted to the respective students' preferred styles (Trilling & Fadel, 2009). They also suggest that some more learning contents are required for them to grasp the lesson. On top of all, students qualified the traditional teaching style as boring due to the lack of visuals and entertainment while learning. If the traditional way of teaching has remained the same, it is obvious that digital native students' expectations are different.

B. Software

The application is design to provide learning content according to the students' learning style and as per the current physical context of the students. When registering, students need to fill-in a questionnaire to determine which type of learning contents (auditory, visual or kinesthetic) should be favored. The developed system is an enhanced version of the intelligent learning system. The system is categorized in a three-model architecture. The student's model, the interaction and the expert model. The student's model keeps information such as the preferred learning style, location and context. The expert model is accessed by the teacher, consisting of knowledge about the learning content, which include concepts, course components (text, examples, etc.), and consists of logic to teach the individual student with some specific preferences including the optional multiple-choice questions. Before proceeding to the next module, student evaluation is perform using one random multiple-choice question. Student, who is able to answer the question correctly, proceeds to the next module. In case of wrong answer is selected, the student is given constructive feedback and can have access to some additional learning material for that particular module. The interaction models customize lessons content according to student preferences (image, video, sound or text).The extension of the learning content is applicable only when student is away from home, i.e. the device's longitude and latitude are different from the student's address. The system uses sensors in-

built in mobile device to detect the student's learning environment to adapt the learning without changing the student's preferences.The table below shows adaptation of learning content according to context including the student's activity.

Learning Style	Student's environment	Extension to the content
Visual	Low illuminance	Add a button to access all the different types of learning content (different learning style).
Visual	High illuminance	Display all the visual learning content (like a slider).
Visual	High sound pressure level	Display the textual explanation of the visual content.
Visual	low sound pressure level	Add a button to view all the different contents using a grid view.
Visual	High shake level	Add 2 button: (a) pin the module, (b) make the slider full screen if applicable. (When a lesson is access again, learning starts from the pinned module instead from the beginning.)
Visual	Low shake level	Enable the swipe option to zoom in and out on visual content.
Visual	Earphone plugged	Play a beep sound when the content appears and add a button to explain the visual content.
Auditory	Low illuminance	Add a button to display the different module's content. (Same module but different learning styles).
Auditory	High illuminance	Add a list to display all the auditory contents. Click to open the content.
Auditory	High sound pressure level	Displays some text, which support the audio content and add a button to play/pause the auditory content.
Auditory	low sound pressure level	Add button to view all the auditory contents using a grid view.(same module and same learning style)
Auditory	High shake level	Add a button to pin the module and start reading the explanation. (When the lesson is access again, learning starts from the pinned module instead from the beginning.)
Auditory	Low shake level	Display seek bar to move forward/ backward within the auditory content.
Auditory	Earphone plugged	Play the auditory content automatically.
Kinesthetic	Low illuminance	Add a button to display the different content. (Same module but different learning styles).
Kinesthetic	High illuminance	Add a grid view, which displays the visual contents in terms of thumbnails.
Kinesthetic	High sound pressure level	Add 2 button: (a) pin the module, (b) start the kinesthetic content. (When the lesson is access again, learning starts from the pinned module instead from the beginning.)
Kinesthetic	low sound pressure level	Add button to display all the module's kinesthetic contents.(same module and same learning style)
Kinesthetic	High shake level	Remove all the available content and make the kinesthetic content take full screen
Kinesthetic	Low shake level	Display the seek bar of the kinesthetic content.
Kinesthetic	Earphone plugged	Adjust the sound according the environment's loudness.

Table 1: shows adaptation of learning content according to the student's activity

The system adapts the learning content according to the students' individual learning style and adapts the content further according to their environment. The system gives students the possibility to learn at their own pace as only after understanding a module, they can go to one level ahead.

Lessons are display using a pedagogical approach. It includes the lesson name, lesson objectives, the time required for this particular lesson, activities to be perform throughout the lessons and the display image of the lesson. A student views the next module only if she/he has well understood the current module using a

quiz. The quiz question is enable or disable by the Domain Expert (Teacher). The system uses constructive feedback to explain the students and furthermore, extend the display according to the student's environment. This process goes on until all the modules are covered and the lesson is finished.

1) *System Behaviour*

a) *Login/ Register.*

The system allows a student to registers using username, password, email address, first name, last name and address. A student is able to change her/his address. Initially when a student logins to the system, he obtains a basic explanation of what is learning style. Next, the system navigates through the learning style assessment. After the evaluation, the student is inform about her/his preferred learning style. The system uses the identified learning style to provide content to the student. The student has the possibility to reevaluate her/his learning style at any point in time.

b) *Lesson's Introduction*

The system displays all the lessons' details using apedagogical approach. Upon selecting an item in the list, a brief introduction about the lesson is display. The introduction includes the lesson name, objectives, topics to be covers and time required.

c) *Constructive feedback*

Before proceeding to the next module, the system assures that the student has well understood the content. The system evaluates the student after each module and provide step-by-step assistances and constructive feedbacks.

d) *Content Adaptation*

The system adapts the learning content by creating content models. The content model is adapted according to the student's learning style and extended according to the student's environment. Before presenting a learning content to the student, the system checks if the student is home or vice versa. Initially, the system displays the learning content according to the student's learning style. The system uses appropriate algorithm to check whether the student is away from home. When student is away from home, the system extends the learning content to assure that student feeds in the lessons without the environment's disruptions.

The environment's disruptions are identify by measuring the amount of illuminance, noise level, shake level and hardware connected to the device.

CONCLUSION

1. *Assessing the effectiveness of the System*

The table below list the marks obtained by each student. The class was split in two groups: Group A used traditional face-to-face technique and Group B used the developed system to learn a mathematical lesson called "Numbers" at upper secondary schools. The lessons include the modules namely, Whole Numbers, Integers, Prime Factors and Factor Tree.

Those who had the opportunity to use the mobile phone as an assistive technology enjoyed this new way of learning. The engagement and the motivation were obvious. They used the interactive contents based on their learning style preferences. They were curious in knowing the different learning content. They ended up viewing the same lessons several times, and this, without any doubt, helped them understand the new concepts described in the lessons.

Moreover, another factor that contributes to the improved results is that the constructive feedback enabled the students to learn concepts at their own pace before moving to the next. They could even go through the lessons more than once. Mostly all of the students claimed that it was first time that mobile learning was use according to their curriculum. Their perceptions and experiences are as described below.

Group 1: Face to face	Marks %	Group 2 Mobile	Mark %
Student 1	**70**	Student 16	**80**
Student 2	**0**	Student 17	**80**
Student 3	**30**	Student 18	**100**
Student 4	**30**	Student 19	**100**
Student 5	**50**	Student 20	**100**
Student 6	**20**	Student 21	**100**
Student 7	**30**	Student 22	**100**
Student 8	**0**	Student 23	**100**
Student 9	**0**	Student 24	**100**
Student 10	**100**	Student 25	**100**
Student 11	**100**	Student 26	**100**
Student 12	**100**	Student 27	**100**
Student 13	**100**	Student 28	**100**
Student 14	**100**	Student 29	**100**
Student 15	**100**	Student 30	**100**
		Student 31	**70**

Table 3: Marks obtained by the students using traditional face-to-face technique and the mobile application developed.

2) Assessing the efficiency of developed Application

After assessing the effectiveness of the application, there was a need to assess the efficiency of the application. Google form was use to capture the students' point of view, experiences and the difficulties encountered while using the application. Using open-ended questions, students are ask whether they have ever used application to learn. After studying the responses, it concludes that the number of students who are acquainted to M-learning is the same as those who have never used mobile technologies to learn. In line with Fayombo (2015), the result of an open-ended question showed that the majority of people who have got visual as learning style, followed by auditory and lastly kinesthetic; In face-to-face situation, teachers use mainly visual and auditory techniques to teach.

According to Kolb's (1999), students have preferences over how they learn. That does not necessary mean that this is the only way they can learn; according to the obtained result, 54.5% of the students were at ease with the learning content, 36.4% of the students had some doubt and 9.1% of the students are uncomfortable with the learning content used to learn. The mobile application had proved to save time while teaching as 21.2% of the students who used the mobile application to learn acknowledged having viewed the learning content more than once. In other words, there is simply no evidence that the model is either a desirable basis for learning or the best use of investment, teacher time, initial teacher education and professional development (Coffield et al., 2008). 84.8% of the students had found whatever the quality of data is, informative assessment focuses on how different role uses this data to understand and improve learning (Masters et al., 2006).

84.4% of the students were sure and 15.6% of the students had some doubt that context awareness enabled the application to use contextual information (Chen and Kotz 2004) to adapt the learning content. 54.4% of the students were sure that the developed application could assist them to learn anywhere.

The mobile application considers the students' pace and place in order to enhance learning. It also caters for the students' uniqueness, strength, weakness and progress; it provides a step-by-step assistance to the students. It concludes that digital native students are keen and motivated to use technology to learn.

There is a need to complete the development of the other resolutions layout, enhance the teacher's interfaces, and make use of proper pop up messages and some documentation to be use as guidance.

As future work, Youtube API can used to allow the viewing of 360 degree videos and virtual reality can be used to make the true feel of the videos. Moreover, personalized learning using Artificial Intelligence can add more value to this system.

REFERENCES

Alina Zapalska, Dallas Brozik, (2006) "Learning styles and online education", Campus-Wide Information Systems , Vol. 23 Issue: 5, pp.325-335

Al-Zoubi, S. and Younes, M. (2015). Low Academic Achievement: Causes and Results. *Theory and Practice in Language Studies*, [online] 5(11), p.2262. Available at: http://www.academypublication.com/ojs/index.php/tpls/article/viewFile/tpls051122622268/477 [Accessed 9 Sep. 2017].

Ashraf, R., Fendler, R. J. &Shrikhande, M. (2013). Impact of Personality Types and Learning Styles on Performance of Finance Majors, Journal of Financial Education, Vol. 39, Fall/Winter, No. 3/4: 47-68.

Chen, G. &Kotz, D. (2004). A Survey of Context-Aware Mobile Computing Research. Dartmouth Computer Science Technical Report TR2000-381.

Coffield, F., Moseley, D., Hall, E., &Ecclestone, K. (2004). Learning styles and pedagogy in post16 learning. A systematic and critical review. London: Learning and Skills Research Centre.

Coffield, Frank (2008). "Just suppose teaching and learning became the first priority." LSN Learning. London. [Accessed on 19th April 2017].

Dianabasi, E., E, U. and Diwa, O. (2017). Psychological Factors and Secondary School's Students Academic Performance in Mathematics. *IOSR Journal of Research & Method in Education* (IOSRJRME), 07(02), pp.06-13.

Dünser, A. and Jirasko, M. (2005). Interaction of hypertext forms and global versus sequential learning styles. J. Educ. Comput. Res., 32(1), 79–91.

Eklund, J. and Brusilovsky, P. (1999). Vol 12: InterBook: an Adaptive Tutoring System (Article). [online] Science.uniserve.edu.au. Available at: http://science.uniserve.edu.au/newsletter/vol12/eklund.html [Accessed 10 Oct. 2017].

Fayombo, G. (2015). Learning styles, teaching strategies and academic achievement among some psychology undergraduates in Barbados. Caribbean Educational Research Journal, 3(2), 46-61

Felder, R. M., & Silverman, L. K. (1988). Learning and teaching styles in engineering education [Electronic Version]. Engr. Education, 78(7), 674- 681. Retrieved on September 3rd, 2017 from: http://www4.ncsu.edu./unity/lockers/users/f/felder/public/Papers/LS- 1988.pdf

Goulding Jack, Syed-Khuzzan Sharifah, (2014) "A study on the validity of a four-variant diagnostic learning styles questionnaire", Education + Training, Vol. 56 Issue: 2/3, pp.141-164, https://doi.org/10.1108/ET-11-2012-0109.

Graf, S., Lan, C. H., Liu, T. C., &Kinshuk. (2009). Investigations about the effects and effectiveness of adaptivity for students with different learning styles. In: Proceedings of the IEEE international conference on advanced learning technologies (ICALT 2009) (pp. 415–419). Los Alamitos, CA: IEEE Computer Society Press.

ICT Statistics, (2015). *Highlights - Information and Communication Technologies (ICT) statistics, 2015*. [ONLINE] Available at: http://statsmauritius.govmu.org/English/Publications/Pages/ICT-Statistics-Year-2015.aspx. [Accessed 1 November 2017].

Ilsa-learning-styles.com. (2010). The Dunn and Dunn Learning Styles Model. [online] Available at: http://www.ilsa-learning-styles.com/Learning+Styles/The+Dunn+and+Dunn+Learning+Styles+Model.html [Accessed 30 Sep. 2017].

Khan, A. F., Graf, S., Weippl E. R., &Tjoa, M. A. (2011). Integrated Approach for the Detection of Learning Styles & Affective States, World Conference on Educational Multimedia, Hypermedia and Telecommunications (pp. 753- 761).

Kolb D. (1999). The Kolb Learning Style Inventory, Version 3. Boston: Hay Group.

Liegle, J.O., & Janicki, T.N. (2006). The effect of learning styles on the navigation needs of web-based learners. Computers in Human Behavior, 22 (5), 885-898.

Masters, G. N., Forster, M., Matters, G., & Tognolini, J. (2006). Australian Certificate of Education: Exploring a way forward. Canberra: Commonwealth of Australia: Department of Education Science and Training.

Pantho, O. & Tiantong, M. (2016). Using Decision Tree C4.5 Algorithm to Predict VARK Learning Styles, International Journal of the Computer, the Internet and Management Vol.24 No.2 (May-August, 2016) pp. 58-63.

Popescu, E. (2010). Adaptation provisioning with respect to learning styles in a web-based educational system: an experimental study, in: journal of computer assisted learning. Vol., 26, 243–257.

Schilit W N, Adams N and Want R. (1994) Context-aware computing applications, Proceedings of the Workshop on Mobile Computing Systems and Applications, Santa Cruz, Ca., IEEE Computer Society Press, Los Alamitos, Ca., 85-90.

Schwarz, E., Brusilovsky, P., and Weber, G. (1996) World-wide intelligent textbooks. In: Proceedings of ED-TELECOM'96 - World Conference on Educational Telecommunications, Boston, MA, June 17-22, 1996, AACE, pp. 302-307, also available at http://www.contrib.andrew.cmu.edu/~plb/ED-MEDIA-96.html.

Smith, D. M., and D. Kolb. 1986.Users' Guide for the Learning Style Inventory: A Manual for Teachers and Trainers. Boston, Massachusetts: McBer

Trilling, B., &Fadel, C. (2009). 21st Century Skills: Learning for Life in Our Times. San Francisco, CA: Jossey-Bass.

Vassileva, J. and Deters, R. (1998). Dynamic Courseware Generation on the WWW. British Journal of Educational Technology, 29(1), pp.5-14.

Weber, G. and Specht, M. (1997) User modeling and adaptive navigation support in WWWbased tutoring systems. In: A. Jameson, C. Paris and C. Tasso (eds.): User Modeling: Proceedings of the Sixth International Conference, UM97. Vienna, New York: Springer, pp. 289-300.

JL, D. (2019). *Learning style preferences and course performance in an undergraduate physiology class | Advances in Physiology Education*. [online] Physiology.org. Available at: https://www.physiology.org/doi/full/10.1152/advan.00048.2009 [Accessed 18 Apr. 2019].

Zualkernan, I. A., Allert, J., Qadah, G. Z. (2006) IEEE Transactions on Education 49 (4). 443-450 "Learning styles of computer programming students: A Middle Eastern and American comparison"

Government of Mauritius. 2016. Higher School Certificate 2015 Results Proclaimed. [ONLINE] Available at: http://www.govmu.org/English/News/Pages/Higher-School-Certificate-2015-Results-Proclaimed.aspx. [Accessed 26 January 2018].

Hendrik Thüs, Mohamed Amine Chatti, EsraYalcin, Christoph Pallasch, Bogdan Kyryliuk, TogrulMageramov, and Ulrik Schroeder, (2012). "Mobile Learning in Context", Informatik 9 (Learning Technologies), RWTH Aachen University, Germany, https://www.thues.com/upload/pdf/2012/MLC_IJTEL_final.pdf

Shu Ran Yang and Yan Peng Lim, (2011) "Towards Content Adaptation for Mobile Learning", 2011 2nd International Conference on Education and Management Technology, IPEDR vol.13 (2011) © (2011) IACSIT Press, Singapore , http://www.ipedr.com/vol13/15-T00026.pdf

D.Jannach, C.K.Leopold, Timmerer., and H.Hellwagner.A knowledge-based framework for multimedia adaptation, Applied Intelligence, Springer Verlag, 2006, vol. 24, no. 2, pp.109-125.

John L. Dobson. (2009). Learning style preferences and course performance in an undergraduate physiology class | Advances in Physiology Education. [online] Physiology.org. Available at: https://www.physiology.org/doi/full/10.1152/advan.00048.2009 [Accessed 18 Apr. 2018].