Ogata, H. et al. (Eds.) (2015). Proceedings of the 23rd International Conference on Computers in Education. China: Asia-Pacific Society for Computers in Education

Personal Learning Activity Approach for Developing Adaptive Web-based Learning Systems

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Abstract: In recent years, researchers have attempted to develop adaptive web-based learning system to help and facilitate students' improvement of learning performance. Moreover, learning environment that involves physical hands-on experimentation and/or virtual computer-simulated experimentation related to pedagogical aspects is extremely important. Consequently, it becomes an interesting issue to develop an adaptive web-based learning system which provides suitable learning environment for individual students. In this study, we propose a set of personal learning activity rules to elicit and integrate the learning styles and learning experience provided by individual students. Based on the proposed approach, an adaptive web-based learning system was implemented on a physics lesson to investigate the effectiveness of this innovative approach. The empirical findings suggest that students who learned in adaptive web-based learning system based on the proposed approach had better learning performance than those who learned in conventional web-based learning environment.

Keywords: Learning style, experiential learning, inquiry learning, discovery learning, collaborative learning

1. Introduction

In recent years, researchers revealed that the knowledge level of the students, cognitive style, and the difficulty level of learning content are good factors for adapting presentation layouts and contents for individual students; while several researchers have suggested that individual preference and appropriate learning process are other important factors when developing the adaptive web-based learning environment for individual students (Srisawasdi, Srikasee and Panjaburee, 2012; Yang, Hwang, & Yang, 2013; Cheng, 2014; Chookaew, Panjaburee, Wanichsan and Laosinchai, 2014; Srisawasdi and Panjaburee, 2014). In the meanwhile, a drawback has been revealed in developing web-based learning system basing only on learning style or learning experience; that is, it little delivers effective learning systems to individual students (Klasnja-Milićević, Vesin, Ivanović and Budimac, 2011; Kollöffel, 2012; Yang et al., 2013; Chookaew et al., 2014). Owing to the delivery of effective learning systems, usually the taking multiple factors is needed. As these factors might have different advantages, it become as important and challenging issue to integrate learning style with learning experience for individuals to obtain more quality learning activity such that more accurate adaptive web-based learning system can be given to individual students.

In this paper, an innovative approach called personal learning activity approach is proposed to elicit and integrate learning experience with learning style from each student's characteristic. Moreover, an adaptive web-based learning system was implemented based on the innovative approach.

2. Background and Motivations

Learning style is a concept that indicates the way individual students perceived and process information, meaning that it is an indicator of how to design learning material layouts in which individuals like to learn (Keefe, 1991; Papanikolaou, Grigoriadou, Magoulas and Kornilakis, 2002). Therefore, learning style concept has been recognized as a factor for adapting the presentation of learning materials in web-based learning systems (Graf, Lin and Kinshuk, 2007; Papanikolaou, Mabbott, Bull and Grigoriadou, 2006; Tseng, Chu, Hwang and Tsai, 2008). Felder and Silverman's Index of Learning Styles (Felder and Silverman, 1988) has been recognized as being the most measurement for adapting presentation of learning material with respect to learning in web-based learning system (Kuljis and Lui, 2005; Huang, Lin and Huang, 2012; Akbulut and Cardk, 2012; Yang et al., 2013). Consequently, this study applied the Felder and Silverman's Index of Learning Styles as one of the factors.

To the delivery of effective learning systems, usually the pedagogical aspect is needed to be concerned. Based on Kolb's learning experience (1984), there are four different dimensions of learning experience: Concrete Experience (CE) includes performing task by direct practice; Reflective Observation (RO) means reflection and discussion of direct practical experience; Abstract Conceptualization (AC) includes a generalization of what was performed by direct practice; and Active Experimentation (AE) means ready to perform another concrete experience. The four types of students which rely on the combinations of these learning experience are following: the *divergent* type has the strengths of CE and RO; the *assimilation* type emphasizes learning abilities of AC and RO; the *convergent* type relies on the dominant learning abilities of AC and AE; and the *accommodative* type has the strengths of CE and AE. Such that, to match a personal's learning style with pedagogical aspect, we decided to apply Kolb, Osland and Rubin's (1995) learning experience as one of the factors.

Therefore, matching learning style with learning experience of each student might be concerned to provide the accuracy of personal learning activity in the adaptive web-based learning systems.

3. Learning Style and Learning Experience Integration Scheme

Although several studies revealed that two important factors (learning style and learning experience) have been usually applied in developing adaptive web-based learning systems, previous experiences of practical applications have also revealed some importance of matching them together (Srisawasdi, et al., 2012). To cope with this problem, in this study, an expert system approach is employed to matching learning style and learning experience of each student to specify learning activity for individuals. The matching learning style-experience procedure consists of the following three phases:

Phase 1: Learning Style Knowledge Acquisition phase: This phase is invoked to elicit learning style information from individual students. In this phase, each student is asked to provide the answer of the Felder and Silverman's (1988) Index of Learning Styles test. This test contains 44 forced-choice items covered by 4 dimensions (i.e., Active/Reflective, Visual/Verbal, Sensing/Intuitive, and Sequential/Global. Each dimension contains 11 forced-choice items, with each choice (a or b) corresponding to one or another category of the dimension. After the students submit the answer, the system will analyze learning style of each student. For example, the student S_1 is Active leaner; S_2 is Intuitive leaner, S_n is Visual leaner.

Phase 2: Learning Experience Knowledge Acquisition phase: This phase is invoked to elicit learning experience from individual students. In this phase, Kolb et al.'s (1995) learning experience test is used. This test is covered by 4 dimensions (i.e., Concrete Experience (CE), Reflective Observation (RO), Abstract Conceptualization (AC), and D_4-Active Experimentation (AE)) and contains 9 items. Each student is asked to respond a numeral "4" indicating most like student, a "3" indicating second most like student, a "2" indicating third most like student, and a "1" indicating least like student. After the students submit the answer, the system will analyze learning experience of each student. For example, the student S_1 has CE; S_2 has AE, S_n has AC.

Phase 3: Knowledge Integration phase: This phase is used to integrate the information of learning style (LS) and learning experience (LE) from individual students (S_i). In this study, a set of rules is defined to match corresponding personal learning activity (PLA). In the following, part of the rules and the corresponding descriptions are presented.

Rule 1:

If LS (S_i) = “Active” and LE (S_i) = “Diverger”

Then PLA(S_i) = “Collaborative Hand-on-based Discovery Learning”

Rule 1 is used to handle the case that the student is identified the active leaner with diverger learning. In this case, the physically hands-on-based material with working together in small groups is adopted as the personal learning activity.

Rule 2:

If LS (S_i) = “Visual” and LE (S_i) = “Assimilator”

Then PLA(S_i) = “Individual Simulation-based Discovery Learning”

Rule 2 is used to handle the case that the student is identified the visual leaner with assimilator learning. In this case, the physically simulation-based material with working individually is adopted as the personal learning activity.

Rule 3:

If LS (S_i) = “Sensing” and LE (S_i) = “Diverger”

Then PLA(S_i) = “Collaborative Hybrid-based Discovery Learning”

Rule 3 is used to handle the case that the student is identified the sensing leaner with diverger learning. In this case, both physically and virtually, with hand-on and simulation-based materials with working together in small groups is adopted as the personal learning activity.

4. System Implementation and Results

Based on the rule-based approach, an adaptive web-based learning system was implemented on a physics lesson to demonstrate the effectiveness of this innovative approach as shown in Figure 1. An experiment was conducted on simple electricity in secondary school science curriculum. The participants of this experiment were two classes of 11th-grade students in northeast Thailand. A total of 77 students were recruited in this study. The two classes were randomly divided into two groups (i.e., experimental group and control group). The experimental group included 36 students, while the control group had 41 students. In this study, the same teachers facilitated the students in the two classes in order to avoid the influence of different experienced teachers on the experimental results. The students in experimental group participated in the lesson supplemented by the developed system, while those in the control group learned with the same lesson in conventional web-based learning environment. Before the experiment, the students took a pretest, KR-20 reliability = 0.83, for evaluating their prior knowledge of the simple electricity. The system automatically generates personal learning activity for individuals after submitting learning style and learning experience test sheets. The learning activities lasted 150 minutes. After the learning activity, both groups took a posttest, the same physics knowledge test, for examining their learning improvement. The total score of the pretest and posttest is 12.

In the following discussions, the results of pretest and posttest are presented. To ensure that they had equal prior knowledge in the topic, the *t*-test was used. It was found that the mean ± standard deviation of pretest of the experimental group was 3.44 ± 1.63, and of control group was 4.29 ± 1.60. There was, that means, significant difference between the mean score of pretest of the control and the experimental groups ($t = 2.30$, $p = 0.024$), indicating that the students in both the groups had different level of physics knowledge about simple electricity before participating this study. After finishing the learning activity, the two groups took a posttest to examine how the learning achievement was affected by the treatments. The posttest scores of both control and experimental groups were analyzed with ANCOVA, as shown in Table 6.

Table 6: ANCOVA results of the posttest

Groups	N	Mean ± SD	Adjusted mean	SE.	F(1,74)	d
Control	41	6.71 ± 1.91	6.70	.27	8.343^{*}	0.81
Experimental	36	7.86 ± 1.46	7.87	.29		

* $p < 0.05$

The result in Table 6 shows that there is significant difference of the posttest scores between the experimental group and the control group ($F_{(1,74)} = 8.343$, $p < 0.05$). In other words, the mean score of posttest for the experimental group was significantly higher than that for the control group. In addition, the effect size d was computed to measure the strength of the ANCOVA result. In Cohen's definition, "d = 0.2" indicates "small" effect size; "d = 0.5" represents "medium" effect size, and "d = 0.8" means "large" effect size (Cohen, 1988). In this study, the d value of 0.81 indicates a large effect size, suggesting that the developed web-based learning system based on the personal learning activity approach could help the students in improving their learning achievement in the topic.

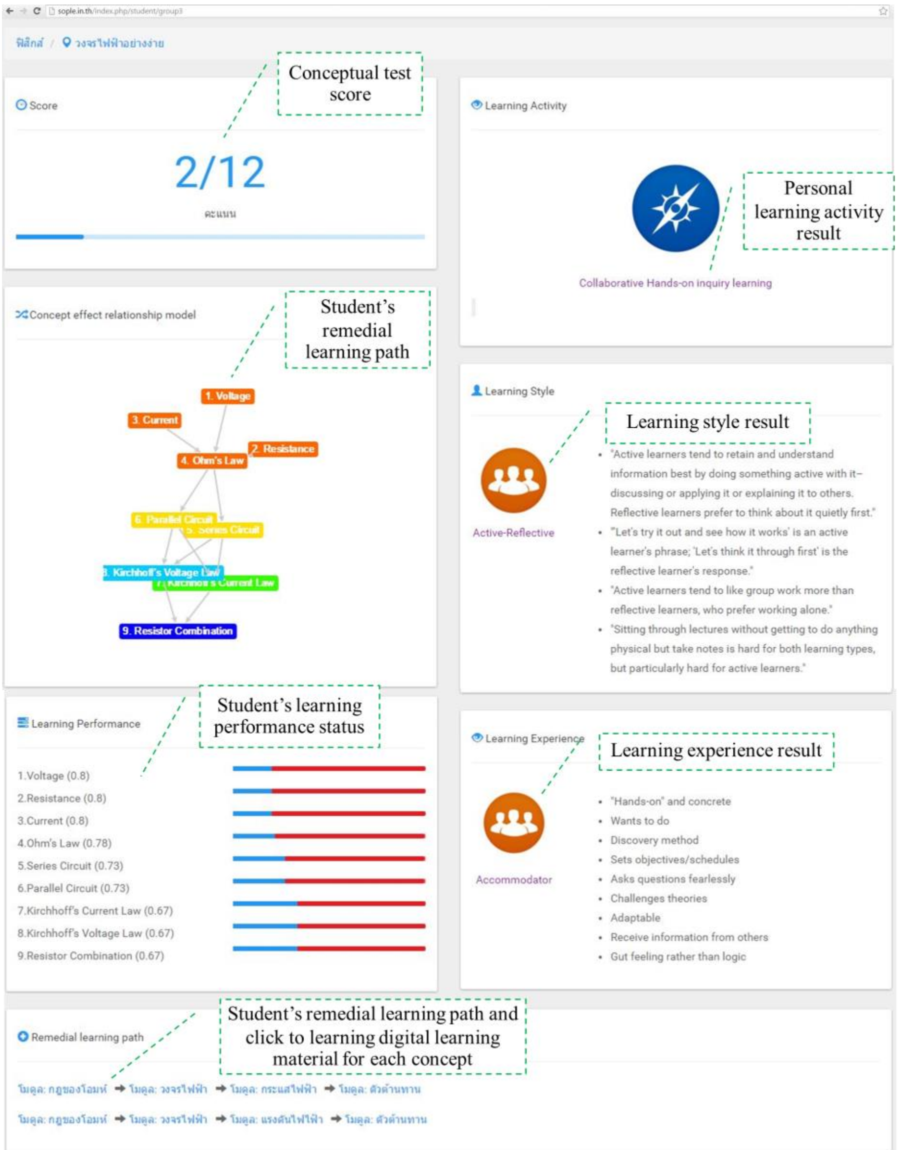

Figure 1. Illustrative example of an adaptive web-based learning system based a personal learning activity approach

5. Conclusion and Discussions

This paper presents an innovative approach for integrating the learning style and learning experience from individual students. Based on the proposed approach, an adaptive web-based learning system was implemented. The system can give personal learning activity to individual students based on their learning style and experience. It also can be used to predict the learning activity of students for an in-class course.

To evaluate the performance of this innovative approach, an experiment on Basic Electric Circuit in Physics course of a secondary school student was conducted. 77 11th-grade students were recruited to compare the performance of the conventional web-based learning system and our enhanced approach. As adaptive web-based learning system based on learning style or pedagogical aspect/learning experience has been proven to be helpful to students in improving their learning efficacy, the success of this study plays an important role in enhancing the effectiveness of the entire adaptive web-based learning environment.

Acknowledgements

This research project is supported by Mahidol University under Grant Numbers 67/2557 and 103/2558.

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