An analysis of web-based formative assessment systems used in e-learning environment

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Abstract—This paper presents the comparison study of different multiple-choice web-based formative assessment; namely peer driven assessment module of the web-based assessment and test analysis system (PDA-WATA), one of the most recent web-based assessment system, named GAM-WATA, and Formative Assessment Module of WATA system (FAM-WATA) with traditionally normal web-based assessment and paper and pencil assessment. The major purpose of this study is to highlight the different strategies used in these system and effectiveness of each system in e-learning environment. In overall, the features and different strategies of systems is analyzed. It is found that PDA-WATA adopts more self-regulated learning strategies than the other systems in facilitating learners use of self-regulatory learning behavior in e-learning environment. More studies are required based on different self regulatory strategies used to improve learning effectiveness, attracting learners take participation of web-based formative assessment.

Keywords: Peer-Driven Assessment; Formative web-based assessment; self-regulated learning strategies

I. INTRODUCTION

Based on Gordon (2007) viewpoint, Self-regulated learning is considered important in improving students learning effectiveness [1]. Heikkilä and Lonka (2006) pointed out that self-regulated learners could set task oriented and reasonable goals, be responsible for their own learning, and maintain learning motivation [2]. Zimmerman, Bonner, and Kovach (1996) believed that learners self-regulated learning skill could be taught and improved by learners own efforts [3]. They suggested that teachers could facilitate learners to perform self-regulated learning by making them use self-regulated learning strategies, experiencing the advantages of using self-regulated learning. Peer-Driven Assessment Module of the Web-based Assessment and Test Analysis namely PDA-WATA system is the system developed by Wang (2012) which develops strategies to facilitate learners in using self-regulatory learning behaviors to perform self-regulated learning and improve their e-Learning effectiveness in e-Learning environment [4]. Beside PDA-WATA, there are some other modules in the WATA system, Formative Assessment Module (FAM-WATA; Wang, 2007) and Game Assessment Module (GAM-WATA; Wang, 2008), that can effectively facilitate spontaneous performance of self-assessment in an e-Learning environment [5, 6]. There is no study conducted as a comparison of all these system to demonstrate and analyze the different strategies used in these systems from web-based formative assessment perspective in the WATA systems. Hence, this paper highlights the review of the comparison among these three modules used in e-learning environment including traditional paper and pencil assessment test and ‘normal web-based assessment’ as well. The strategies and characteristics used in each system are illustrated in details in following section.

II. WEB-BASED FORMATIVE ASSESSMENT-
PDA-WATA, GAM-WATA, AND FAM-WATA

Many studies have obtained positive results with application of web-based formative assessment to e-learning environment. According to Wang (2008), Web-based formative assessment allowed students to enter the environment and practice the questions at any time and from any Internet-linked computer after e-learning. In addition, it also had significant effects on e-learning. In the following subsection, specific strategies used in these ‘web-based formative assessment’ systems are analyzed separately.

A. PDA-WATA

Based on Wang (2012) the major purpose of PDA-WATA system is to facilitate learner use of self-regulatory learning behavior to perform self-regulated learning in e-learning environment. According to Pintrich (1999), there are three kinds of self-regulated learning strategies: cognitive strategies, meta-cognitive and self-regulatory strategies, and resource management strategies. PDA-WATA develops five main strategies based on Pintrich’s strategies, Adding Answer Notes, Stating Confidence, Reading Peer Answer Notes, Recommending Peer Answer Notes, and Querying Peers[4]. Cognitive strategies include rehearsal strategy, elaboration strategy, and organizational strategy. The ‘Adding Answer Notes’ strategy facilitates learners to add notes to describe why they chose a certain option as the correct answer when performing self-assessment. This engages learners in the process of rehearsal, elaboration and organization. There are three meta-cognitive and self-
regulatory strategies: planning strategy, monitoring strategy, and regulating strategy ([7](#)). PDA-WATA enables the percentage of ‘passed’ items which can help learners set the goal of passing all items. Furthermore, PDA-WATA also includes the ‘Stating Confidence’ strategy which lets learners assess their own confidence in choosing the correct option. PDA-WATA also provides ‘Reading Peer Answer Notes,’ ‘Recommend Peer Answer Notes’ and ‘Querying Peers’ Recommendation on Personal Answer Notes’ strategies. With these strategies, learners can understand why their peers chose a certain option as the correct answer throughout peer answer notes, recommend peer answer notes and understand how peers recommended their own answer notes. These strategies consolidate the mechanism of creating, reading and recommending answer notes. This mechanism provides learners with planning strategy and monitoring strategy. By reading peer answer notes; learners can compare their own knowledge with that of peers to understand their own learning conditions. By doing this comparison, learners understand whether their own answer notes are more valuable references than those of their peers, and evaluate whether they know more than their peers. This mechanism applied in PDA-WATA not only lets learners to exchange the knowledge they learn and perform peer learning but enables learners with the opportunity to perform ‘effort regulation’.

The study of PDA-WATA was conducted among 123 participants from seventh grade junior high school students in central Taiwan. These students were randomly divided into the PDA-WATA group and the Normal web-based test (N-WBT) group. Before e-Learning instruction, all students took the pre-test of the Learning Process Inventory (LPI) survey, and the pre-test of the summative assessment. After a two-week e-Learning instruction, the students all took the post-test of the LPI and the summative assessment. As a result, this experiment resulted in effectiveness of PDA-WATA in comparison with N-WBT that facilitates learner use of self-regulatory learning behaviors to perform self-regulated learning, improves learner motivation to spontaneously take Web-based formative assessment, and increase learner’s e-Learning effectiveness.

B. GAM-WATA

Based on Game Assessment Module of the WATA system (GAM-WATA) proposed by Wang (2008), this system is designed to enable teachers administer Web-based formative assessment and interact with students ([6](#)). The exclusive strategy used in GAM-WATA is ‘Ask-Hint Strategy’, including two quiz-game-like designs: ‘Prune Strategy’ and ‘Call-in Strategy’. Rodriguez (2005) argued that the difficulty of multiple-choice items can be influenced by the number of options, so reducing the number of options will reduce the difficulty of an item ([8](#)). In addition, if the respondents of an item are in lower grades or of lower competency, the number of options should be reduced ([9](#)). Based on these arguments, ‘Prune Strategy’ is adopted in ‘Ask-Hint Strategy’ of GAM design. This strategy can be applied to reduce the difficulty of an item. Thus, ‘Prune Strategy’ eliminates one incorrect option and turns the original 4-option item into a 3-option item to reduce its difficulty. On the other hand, from socio-psychology perspective, when people do not have a clear idea about the situation and do not know what correct actions to take or proper opinions to express, they tend to collect information by observing others’ behaviors and take it as a significant guide for their own behaviors which is called ‘informational social influence. Therefore, ‘Call-in Strategy’ is used in ‘Ask-Hint Strategy’. ‘Call-in Strategy’ gives the specific rate at which different options are chosen as the correct answer by other learners for a specific item. When the less-competent students face difficulties in answering an item, they can make use of this strategy to know how their peers answer this item and take the information as reference to decide which option to choose. In this way, their motivation of actively participating in Web-based formative assessment will not be reduced by too many difficulties they encounter during the Web-based quiz game. In addition to enabling students to obtain increased feedback from Web-based formative assessment, GAM-WATA also designed to endow Web-based formative assessment with the characteristics of online quiz games and in turn encourage students to perform self-assessment spontaneously.

Kolb (2005) argued that teachers should make use of formative assessment to provide students with numerous opportunities to perform self-assessment, obtaining feedback and revising mistakes[10]. Based on this idea, GAM-WATA takes ‘repeat the test’ and ‘timely feedback’ as the key strategy in Web based formative assessment. It is believed that combining the three strategies of ‘repeat the test’, ‘correct answers are not given’, and ‘timely feedback’ will enable students to make good use of Web-based formative assessment to facilitate their learning. ‘Query scores’ and ‘ask questions’, also included in Web-based formative assessment system.

Like PDA-WATA, GAM-WATA further devises the strategies which can motivate students to actively participate in Web-based formative assessment (Warner, 2011) ([11](#)). The ‘ask questions’ function allows students to send their questions to teachers by e-mail. Based on the responses from their teacher, students can revise their mistakes. ‘Query scores’ allows students to query their own and peer scores, which help them, track their own learning status.

GAM-WATA system was evaluated among 165 fifth grade elementary students in central Taiwan. The students were then divided into three groups and each group was randomly assigned one type of formative assessment. Based on the survey conducted among participants and analysis done using SPSS for quantitative collected data, the results of proposed study of GAM-WATA demonstrated that students in the GAM-WATA group more actively participate in Web-based formative assessment than students in the N-WBT group. The ‘challenge mechanism’ and ‘game mechanism’ of GAM-WATA turning Web-based formative assessment into a Web-
based quiz game appear to promote students’ motivation to

C. FAM-WATA

According to Wang (2007), FAM-WATA module of WATA system helps teachers make multiple-choice formative assessment on the Web and construct an assessment-centered in e-learning environment [5]. Learners can use FAM-WATA to challenge and evaluate themselves immediately at any time and from any Internet-linked computer without limitation. Most web-based formative assessment strategies are similar Buchanan (2001), including ‘repeat the test’, ‘correct answers are not given’, and ‘timely feedback’ while he suggested that these strategies greatly benefit learning effectiveness among college students [12]. Wang (2007) augmented Buchanan’s three strategies (Buchanan 2000) with three new strategies: ‘query scores’, ‘monitor answering history’, and ‘all pass and then reward’. FAM-WATA includes six main strategies, Repeat the test, correct answers are not given, and ask questions, Monitor answering history, Query scores, all pass and then reward strategies. Strategies used in FAM-WATA are based on cognitive style strategy. DeTure (2004) addressed that the most widely investigated cognitive style is Witkin’s ‘field dependent/field independent’ among different dimensions of cognitive styles [13].

FAM-WATA study evaluated among total of 503 seventh-grade students in central Taiwan. WATA Formative Assessment Strategies Scale (WFASS) The WFASS was used to evaluate student’s attitude towards the strategies built into FAM-WATA. Six subscales were used to evaluate student’s attitudes towards the six strategies in FAM-WATA. All subscales used a five-point Likert scale. Based on the questionnaire conducted and analyzed data using SPSS, The results revealed that embedding web-based formative assessment in an e-learning environment (e.g. FAMWATA and N-WATA) was better than using paper and pencil formative assessment. Moreover, web-based formative assessment with FAM-WATA strategies was significantly better than web-based formative assessment without FAM-WATA strategies (N-WATA) and paper-and-pencil formative assessment (PPT). In other words, in the e-learning environment, learning effectiveness will be enhanced if traditional paper-and-pencil test are replaced by web-based formative assessment. The results also indicated that field independent students in the FAM-WATA group performed significantly better than those in the N-WATA and PPT group. Field dependent students thus could not get correct answers to rehearse directly and were likely to have trouble in making use of the FAM-WATA to facilitate their learning. The FAM-WATA appeared not to be suitable for field dependent students. By contrast, the FAM-WATA was more effective for field independent students. All in all, the actively participate in Web-based formative assessment. strategies of FAM-WATA were successful in facilitating students learning, especially for the field independent students.

III. SYSTEM COMPARISON

Different strategies used in these web based formative assessment is summarized in the following Table 1. N-WATA and PPT are traditional way of assessment and as it can be seen; most of the strategies are not supported in these two systems. ‘Repeat the test strategy’ and ‘correct answers are not given’ strategy are both provided in PDA-WATA, FAM-WATA, and GAM-WATA while ‘Stating Confidence’ strategy is only supported by PDA-WATA which let test taker rate the level of his confidence and evaluation choosing correct option in his answer notes. ‘Ask Question’ strategy is also supported in all three systems.

using another unique mechanism of ‘mutual help among peers’ which is developed in proposed system of Wang (2012) in e-learning environment, resulted in effectiveness realized by the learners to get the most out of this system in achieving their own goals through the process of learning. Among these three strategies of PDA-WATA, only querying peers which let students check their own scores and those of peers is supported by the rest of the WATA modules [4]. ‘All pass and then reward’ strategy is supported in all three systems.

I. CONCLUSION AND FUTURE ENHANCEMENT

This paper explored the different strategies used in most recent web-based formative assessment modules of WATA systems PDA-WATA, GAM-WATA, and FAM-WATA. The effectiveness of PDA-WATA in an e-Learning environment is highlighted in this paper. It is found that PDA-WATA uses more self-regulatory strategies than the other two systems and having three specific peer driven strategies as reading peer answer notes, recommending peer answer notes and querying peer’s scores which is not supported in GAM and FAM-WATA. Only querying peers’ strategies are also supported in the other two systems (Table-1) which lets students check their own scores and those of peers. The mechanism and theoretical basis of learning motivation used in these three systems still require the support of more empirical evidences and can be further enhanced.

In addition, if more strategies are used in a Web-based formative assessment system to provide feedback and enhance the human–computer interaction; it would have a positive influence on the effectiveness of the systems.
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<tr>
<td><strong>Design</strong></td>
<td>Using WATA system as the platform, it develops the Peer-Driven Assessment Module of the WATA system (PDA-WATA). It develops strategies expected to facilitate learner use of self-regulatory learning behaviors to perform self-regulated learning based on Pintrich’s strategies.</td>
<td>Cognitive-style strategy is adopted, concentrating on field students approach.</td>
<td>Ask-Hint Strategy There are two designs in the ‘Ask-Hint Strategy’, the ‘Prune Strategy’ and the ‘Call-in Strategy’</td>
<td>It is kind of Web-based formative assessment that only turns the traditional paper-and-pencil test into Web-based test.</td>
<td>Instead of Web-based assessment, all the formative assessments are administered by paper-and-pencil test</td>
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<tr>
<td><strong>Repeat the test</strong></td>
<td>1. Students may repeat the test for more practice. The system randomly chooses at most five items for students to answer each time. 2. If the students answer a given item correctly three times consecutively, the item will not appear again on the test.</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>N/A</td>
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<td><strong>Correct answers are not given</strong></td>
<td>After students submit the answers, correct answers are not given directly, but a reference is provided.</td>
<td>After students submit the answers, correct answers are not given directly, but a reference is provided.</td>
<td>Yes</td>
<td>N/A*</td>
<td>N/A*</td>
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<td><strong>Stating Confidence</strong></td>
<td>allows examinees to rate their confidence in their own answer and answer notes</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
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<tr>
<td><strong>Ask questions</strong></td>
<td>Students are allowed to ask questions of teachers asynchronously through the system.</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Students are allowed to ask questions in class.</td>
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<td><strong>Reading Peer Answer Notes</strong></td>
<td>Allows examinees to read peer answer notes.</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Query scores/peers</strong></td>
<td>Students may check their own scores and those of peers.</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Students may know their own scores and check peer scores privately.</td>
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<tr>
<td><strong>Recommending Peer Answer Notes</strong></td>
<td>Allows examinees to recommend peer answer notes.</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Monitor answering history</strong></td>
<td>Students can query personal and peer answering history of each item.</td>
<td>Yes</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
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<tr>
<td><strong>All pass and then reward</strong></td>
<td>When students reach to level of ‘pass the test’, the system will show an animation as a reward.</td>
<td>Yes</td>
<td>Yes</td>
<td>N/A</td>
<td>N/A</td>
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*Normal WATA (N-WATA) is a normal web-based formative assessment design, not equipped with any specific strategies. It uses the WATA system to simulate the normal web-based formative assessment.

b The system will provide correct answers directly, along with a reference.

c Correct answers are announced by the teacher, but the answers are not deliberately explained.
YES, equip the same strategy; N/A, not equip the strategy; PDA-WATA, Peer Driven Assessment, GAM-WATA, Game based Assessment Module FAM-WATA, Formative Assessment Module of the Web-based Assessment and Test Analysis System; NWATA, normal web-based formative assessment; PPT, paper-and pencil test.

More qualitative and quantitative researches should be conducted to extensively examine the effectiveness of systems used and understand the mechanism and theoretical basis of how learning effectiveness is promoted. In overall, the different strategies used in these web-based formative assessment is clearly demonstrated and analyzed. Based on Zimmerman self-regulatory theory (2000), it is found that only PDA-WATA strategies are all based on self-regulatory strategies of Pintrich (1999), and strategies developed by other systems is not supported in this perspective. From self-regulatory strategy theory of Zimmerman’s perspective, future studies and comparison of these ‘web-based formative assessment’ systems can be done [14].

REFERENCES