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Development and Preliminary Evaluation of the Learning Potential of an Online System in Support of a Student-Generated Testlets Learning Activity

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Abstract: Currently, around fifty online learning systems have been developed to support student-generated questions (SGQ) activities, highlighting the various affordances of computers and networked technologies. While a variety of question types are commonly supported in these online SGQ systems, no systems are in existence that support student generation of the testlet format — an attractive test format that is becoming increasingly prevalent and prominent in contemporary testing and assessment practices. In view of this research gap, this study is aimed toward two research goals: first, to develop an online learning system in support of student-generated testlets learning activities, and second, to preliminarily assess its learning potential. Two general design principles that guide the development of the student-generated testlets online learning system (i.e., flexibility and cognitive support) are described first. Afterwards, the evaluation study used to assess the learning potential of student-generated testlets as compared to SGQ is presented. Based on the data collected from a sixth-grade class of students (n = 28), it was found that significantly more participants felt the online testlet-generation task as better promoting learning as compared to SGQ, $X^2 = 9.93$, $p < .01$. Furthermore, based on the result of the constant comparative method done on the participants' provided explanatory reasons, the distinct feature of student-generated testlets, specifically, the situation/scenario, and its possible positive and negative effects on learning were highlighted to provide suggestions for future studies.

Keywords: Design principles, development of online learning systems, evaluation study, student-generated questions, student-generated testlets

1. Introduction

Characterized by students generating questions and their corresponding answers (explanations) in response to an exposed instructional event (e.g., a given problem, a focal topic, reading material, a learning activity, and so on) for learning and assessment purposes (Yu, Wu, Hung, 2014), student-generated questions (hereinafter, SQG) is regarded as a cognitively and metacognitively engaging learning activity (Rosenshine, Meister, & Chapman, 1996). Empirical evidence on the effects of SGQ on the promotion of student cognitive and affective effects have generally been positive (Rosenshine et al., 1996; Rosli, Capraro, & Capraro, 2014; Zuya, 2017).

Since the turn of the twentieth century, in light of the distinctive affordances of computers and networked technologies (e.g., time- and place-independence, immense data storage capability, fast processing speed, multi-mode interaction, and multimedia representation, among others) (Yu, 2009; Yu & Su, 2015), around fifty online learning systems in support of SGQ activities have been developed around the world. With question-generation as the core function, existing online SGQ systems usually support the generation of different question types (e.g., true/false, multiple-choice, short-answer, matching, fill-in-the-blank, etc.). However, to the best of the author's knowledge, currently, no systems support student generation of a testlet format.

In essence, testlet involves the formulation of a group of related question items on the basis of a given situation or scenario. Because of its efficiency in terms of item development and test administration, a testlet is an attractive test format among test developers (Keng, Ho, Chen & Dodd,

2008; Lane, Raymond & Haladyna, 2016), and its presence in contemporary testing and assessment practice is becoming increasingly prevalent and prominent.

At present, online systems supporting the formulation and sharing of student-generated testlets are not in existence, and the learning potential of student-generated testlets is yet to be realized. In view of these research gaps, in this study, the design and development of an online learning system in support of student-generated testlets is described, and its learning potential is evaluated by a preliminary study.

2. Design Principles Guiding the Development of an Online Student-Generated Testlets Learning System

To enable the developed system to be integrated for classroom use and to make it possible to support a versatile, scaffolded learning environment, design principles were set up in advance to guide its development. Explicitly, two general design principles were set up to guide the development of the student-generated testlets online learning system — flexibility and cognitive support. Each of the two principles are further broken down into sub-guidelines to help attain the system goals (i.e., creating a versatile, scaffolded learning space).

2.1 Flexibility in Testlet Generation

In terms of flexibility, three aspects of testlet-generation are highlighted: multiple-presentation of situations/scenarios, re-use and editability, and opportunity for self-expression.

Multiple-presentation of situations/scenarios (the top portion of Figure 1): Since the situations/scenarios in testlets in both text- and graphics-based formats (e.g., graphs, maps, diagrams, tables, charts, etc.) are commonly used in testing and assessment, the student-generated testlets online learning system allows situations/scenarios presented in either text or graphics form to support various stimuli deemed suitable by the testlet-author.

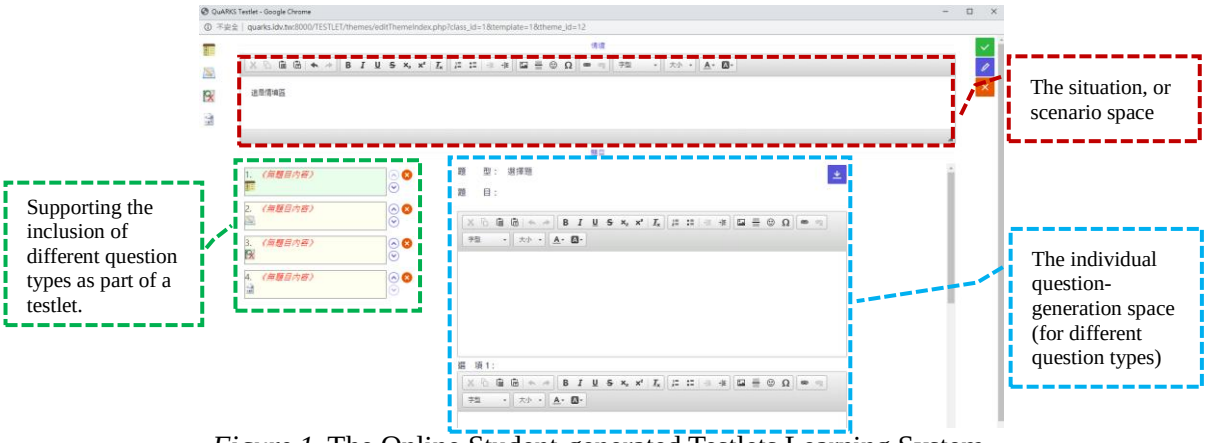

Figure 1. The Online Student-generated Testlets Learning System.

Re-use and editability: To reflect and actualize the core concepts and value of Web 2.0 (essentially, innovation in assembly and the remixing of data) (Anderson, 2007), rather than limiting the learners to generating a set of question items based on a given, fixed situation/scenario, the system allows the learners to (a) edit a given situation/scenario (by deleting, re-arranging, or adding the conditions given within) before proceeding to the task of generating a set of question items or to (b) work from a given situation/scenario with a set of related question items. For this purpose, the system supports transfer of a set of testlets from different sources (i.e., peers and the teacher) as a start or reference point for student-generated testlets.

Opportunity for self-expression: To enable the creative writing opportunity to be better actualized, the system allows learners to create their own situations/scenarios (before proceeding to generating the corresponding question items set) rather than working from a given situation/scenario. With this, the system supports a more open, less constrained testlet generation learning space that is promotive of self-expression.

2.2 Cognitive Support for Testlet Generation

To help students generate meaningful, relevant situations/scenarios and the corresponding interconnected set of question items, cognitive support mechanisms are envisioned. Specifically, two types of cognitive support are embedded in the system — conceptual framework for scenarios and item set generation and context-dependent examples.

For the conceptual framework for the scenarios and item set generation, a set of existing frameworks, such as the story grammar category (Nolte & Singer, 1985; Knudson, 1988) and main ideas schemes (Ritchie, 1985) is provided to guide the creation of scenarios whereas the "what if" strategy (Brown & Walter, 2005) is offered for editing given scenarios and question items sets.

At the same time, spaces for the provision of context-dependent examples by individual instructors to assist student-generated testlet activities are also built in.

3. The Preliminary Study Assessing the Learning Potential of the Developed Online Student-Generated Testlets Learning System

The learning potential of the developed online student-generated testlets learning system is the focus of this evaluative study. In particular, student perceptions of the comparative learning usefulness of student-generated testlets and student-generated questions (SGQ) are examined.

3.1 Methods

Students from a sixth-grade class (N = 28) in a single primary school in the southern part of Taiwan participated in this preliminary evaluation study for eight consecutive weeks. As a routine, each week after attending five 40-minute instructional sessions on Chinese, the participants used iPads to access the developed online learning systems for practice sessions on the Chinese lesson covered in the current week during their weekly 40-minute alternative curriculum. For the weekly practice session, the participants first engaged in question- and testlet-answering activities on the currently learned Chinese lesson (see Figure 2) before moving on to question- or testlet-generation activities.

Figure 2. Question-answering (left) and Testlet-answering (Middle and Right).

To enable the participants to make comparisons of question- and testlet-generation, this evaluation study consisted of two main phases: online question/testlet-answering activities with question-generation (Phase I) and online question/testlet-answering activities with testlet-generation (Phase II). Two online learning systems were adopted to support online drill-and-practice, question-generation, and testlet-generation activities — QuARKS for the first two activities (Yu, 2009) and the newly developed online system for the last one.

At the beginning of Phases I and II, orientation and training sessions on essential knowledge and skills to ensure meaningful engagement and successful completion of the integrated learning task were arranged. Specifically, during Phase I orientation and training session, question-generation techniques, including main ideas, target words proposed by Yu and Pan (2014), and what if/what if not proposed by Brown and Walter (2005) were explained after introduction to the online drill-and-practice function in QuARKS. In addition, the criteria for high-quality student-generated questions and the operational procedures involved for question-generation in QuARKS were explicated before the

participants proceeded to question-generation activities. For each question-generation activity, at least three questions of any of the three question types of the participants' choice were suggested (i.e., true-false, multiple-choice, or short-answer) (see Figure 3).

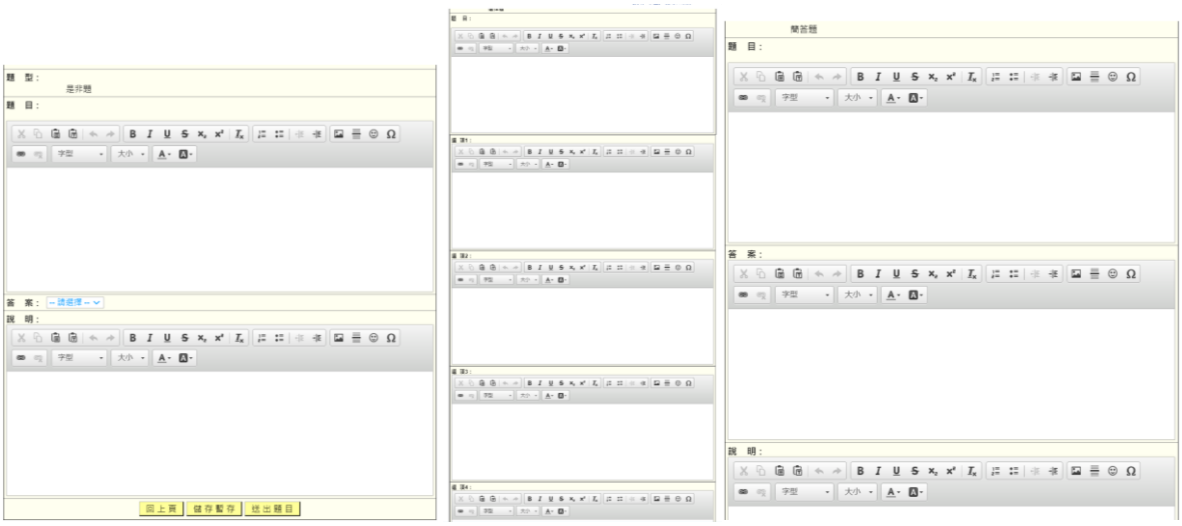

Figure 3. Generation of Different Question Types in Quarks in the Preliminary Evaluation Study: true/false (left), multiple-choice (middle), and short-answer (right).

As for Phase II orientation and training session, techniques and criteria associated with testlet-generation and the navigating procedures within the newly developed system were described. For each testlet-generation activity, the participants were directed to generate at least one testlet consisting of the scenario and at least two question items that were either true-false, multiple-choice, or short-answer (see Figure 1).

After the conclusion of the last session, one closed-ended question with explanations for their selection was distributed to collect the participants' thoughts on the relative learning usefulness of online SGQ and testlet-generation — which of the two activities do you think better help your learning of Chinese: online question-generation, online testlet-generation, two at about the same level. Please explain your selection.

3.2 Results and Discussion

As shown in Table 1, more than half of the participants perceived 'online testlet-generation' as better promoting their learning of the focal subject matter (i.e., Chinese). Comparatively, significantly fewer participants voted for 'online question-generation,' and one-fourth of the participants felt that the two activities were at about the same level in terms of learning usefulness. Furthermore, an X^2 test on the observed frequency distribution among the three options conducted was statistically significant, $X^2 = 9.93$, $p < .01$.

Table 1. *Descriptive and Inferential Statistics of Perceived Learning Usefulness of Online Question-Generation and Online Testlet-Generation* ($N = 28$)

	Online question-generation *f* (%)	Online testlet-generation *f* (%)	About the same level *f* (%)	X^2	*p*
Learning usefulness	4 (14.29%)	17 (60.71%)	7 (25%)	9.93	.007

The constant comparative method proposed by Lincoln and Guba (1985) was adopted to analyze the descriptive explanations provided by the participants for their selections. The results in respect to the three options were presented and discussed separately.

First, for those four rooting for online question-generation, one major theme emerged. The four explanatory responses all pointed to the '*less restrictive*' nature of question-generation. As the participants succinctly explained, '*without the restriction of the given situation/scenario, more*

questions with a different focus can be generated' and '*time and effort can be invested and focused on the main ideas covered in the Chinese lesson*,' not on '*writing up or revising the given scenario*.'

As for those supporting online testlet-generation, two major themes emerged. First, five out of the seventeen participants pointed out the fact that there are essentially two tasks involved in testlet-generation, namely scenario- and question-writing, which '*naturally led to deeper, better, and more learning*.' Second, another five in this group of participants pointed to the idea that the given *situation/*scenario served as an anchoring point and helped '*set a premise*' or '*reference point*.' Of these, two respondents further added that the situation/scenario made the task '*more difficult, cognitively demanding, yet helped lead to deeper and better learning*.' Alternatively, two others felt the situation/scenario made the task '*easier, as it helped direct attention*' and led to '*the learning of the important aspects of the material*.' Disregarding whether the situation/scenario made the task harder or easier as the respondents perceived it, it reflected some ideas related to anchored instruction proposed by The Cognition and Technology Group at Vanderbilt University (1990). Anchored instruction emphasizes tasks intended to engage learners (i.e., the question-generation task in this study, whereas it is the problem-solving task in anchored instruction) would base on or tie around a presented scenario, which serves as an anchor to help build meaningful connections with the instructional content (The Cognition and Technology Group at Vanderbilt, 1990).

Finally, for those who felt question- and testlet-generation provided a similar level of learning usefulness (N = 7), despite the fact that three noted the differences in task requirements between these two activities (i.e., testlets having the extra given situation/scenario to work on), the thought that both activities '*essentially dealt with the core act of question-generation*' such that both helped Chinese learning to about the same degree was commonly shared by this group of respondents.

4. Conclusions

In this study, an online learning system in support of testlet-generation was developed, following a set of pre-set design guidelines. A preliminary study was conducted to evaluate its learning potential, as compared to the increasingly accepted and empirically proven SGQ. As revealed in this study, significantly more participants rooted for the online testlet-generation task as better promoting learning. Despite this, interesting phenomenon was revealed from the explanatory responses provided by the participants. While some valued the situation/scenario given in testlets for serving as an anchoring point and help '*set a premise*' or '*reference point*,' others felt strongly about '*the restrictions the scenario* may impose on' which may inadvertently affect the fluency of the learning and thinking process. With such contrasting perceptions towards given situations/scenarios, which is one essential, distinct component of testlets, and the preliminary nature of this evaluation study, issues regarding if there are differential learning effects between online testlet-generation and question-generation would be a topic worthy of examination via a more stringent experimental research method. Specifically, with the insights gained from the responses provided by the participants, learning effects on perceived task value, perceived task difficulty, learning motivation, task performance, and academic performance would be worthwhile areas to be targeted in future research.

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