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The effects of an online student-constructed test strategy on knowledge construction

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ABSTRACT

The differential effects of online student-constructed tests (SCT) and student-generated questions (SGQ) strategies on knowledge construction in term of the breadth, depth, interconnectivity and elaboration of knowledge were examined via a quasi-experimental research design. Two classes of undergraduates (N = 65) participated and were randomly assigned to two different treatment groups. An online system supporting the associated learning activities for the respective groups was developed. The results from the ANCOVA showed that students who engaged in SCT activities generated questions that covered significantly more concepts, involved significantly more levels of subordinate concepts, and built significantly more links between clusters of study topics, as compared to those in the SGQ group. Moreover, significantly more students in the SCT group engaged in item revision behavior than those in the SGQ group, and a majority of students in the SCT group exhibited item sequencing behavior, both of which are deemed indicative of knowledge elaboration. Suggestions and implications for instructional implementation, online system development and future studies are offered.

1. Introduction

Engaging students in discovering what they view as relevant and important in the material they have learned, and in generating question items around this, have spurred both researcher and practitioner interest since the turn of the 21st century (Yu, 2012). This learning approach, a notable cognitive and meta-cognitive strategy (Rosenshine, Meister, & Chapman, 1996), is known as student-generated questions, problem posing, student item construction, student-developed assessment items, and so on (hereafter called SGQ) (Yu, Wu, & Hung, 2014). While different approaches to SGQ have been proposed to attain specific learning purposes (e.g., structured problem-posing situations for exploring and understanding particular problems, solution structures and interrelationships, see Stoyanova & Ellerton, 1996), and definitions of SGQ vary along with the focal contexts and arrangements (Yu et al., 2014), by emphasizing self-reflection and self-regulated learning, SGQ helps to cultivate a learning environment that prompts and mobilizes higher-order thinking on the part of the learner (Yu & Liu, 2008). To fit the goals and contexts of most levels of school education, SGQ is defined as a learning activity during which students generate a set of questions corresponding to specific previous instruction or experiences they deem educationally important and relevant for self- and peer-assessment purposes.

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The learning benefits of SGQ have been well-documented, and empirical studies on SGQ have generally yielded supportive findings (Akay & Boz, 2010; Belanich, Wisher, & Orvis, 2004; Berry & Chew, 2008; Brown & Walter, 2005; Chin, Brown, & Bruce, 2002; Chiu, Wu, & Cheng, 2013; Dori & Herscovitz, 1999; English, 1997; Kojima & Miwa, 2008; Nardone & Lee, 2011; Perez, 1985; Silver & Cai, 1996; Yu & Liu, 2008). Recently, in an attempt to further promote the versatility and learning potential of SGQ, a group of researchers have been experimenting with the idea of having students construct tests around the study material (i.e., the student-constructed tests approach, called SCT), and have found promising evidence for its support of both learning and assessment. For instance, Yu (2013) investigated undergraduates' preferences for and perceptions of SCT and teacher-constructed tests. The preliminary results showed that the distribution of student preferences for and perceptions of these two approaches were statistically significant at $p < 0.01$ ($X^2 = 48.11$, $X^2 = 22.11$), with more than three-quarters of the participants selecting SCT as their preferred assessment approach and more than 60% of the participants regarding SCT as better promoting learning, highlighting its cognitive and affective potential. Further qualitative analysis of the descriptive responses of participating students after they were exposed to SGQ and SCT activities for a semester underlined the pedagogical potential of SCT for the promotion of knowledge integration and elaboration (Yu & Su, 2013a). Specifically, rather than treating concepts in individual units as capsulated, unrelated parts, SCT helped students to note the integration and inter-connectedness of the study material, and thus to develop a more a '*comprehensive*,' '*integrative*' and '*holistic*' view of the material learned during the course of the study, as a result of '*further review of all course materials*' and '*evaluation of what has been learned as a whole*,' as triggered by the SCT process. Finally, the results from the content analysis of all question items contained in the SCT revealed that nearly three-quarters (74%) of the participants generated items involving cross-topic materials, and almost all students (98%) engaged in item refinement and revision to some extent (Yu & Su, 2013b). The empirical evidence reviewed above all supports the pedagogical potential of SCT on learning.

While SCT emphasizes the same learning goals and concept as SGQ – the promotion of self-reflection and self-regulated learning of the study material and exposed experiences – it involves some planning and preparation in addition to the question-generation task (Corpus, 2013; Devine & Yaghlian, n.d.). Accordingly, on top of the criteria frequently associated with SGQ, such as the clarity of meaning and logic, the relevancy of each question generated, the correctness of wording and punctuation (Yu & Wu, 2013), additional performance criteria, including complete and appropriate coverage of main ideas and adequate item sequencing, are also emphasized during SCT.

Since preliminary studies based mainly on qualitative research methods, and examining the participants' perspectives regarding SCT, have found that a more holistic view of the study content and an integrated and elaborated knowledge structure may be obtained (Yu & Su, 2013a,b), the learning effects of SCT, as compared to SGQ, on knowledge construction were examined in the current study using a more robust research design, a quasi-experimental research method (Shadish & Luellen, 2006), to yield more rigid results and thus serve as the focus of this study. A hypothesis is proposed that SCT may have differential effects on knowledge construction in terms of breadth, depth, interconnectivity, and elaboration of knowledge, as compared to SGQ.

1.1. Theoretical foundations supporting student-constructed test learning activities—cognitive elaboration theory

In terms of the learning tasks that are involved, both SGQ and SCT include question-generation activities intended to engage students in various cognitive and metacognitive strategies, such as attending to and locating materials in the study content that are deemed personally important and relevant; writing questions to assess the targeted learning outcomes; providing answers for the questions that are generated; building linkages between the current study material and previously learned topics/units; creating examples of one's own for any focal concept; deriving plans and strategies for completing the question-generation task in compliance with certain criteria; monitoring comprehension; modifying plans and/or strategies to amend unsatisfactory learning performance at question-generation; and assessing personal understanding of the study material (Yu, 2005; Yu & Hung, 2006). While both information processing and metacognitive theories can help to conceptualize why the mental processes enacted during question-generation (e.g., rehearsal, organization, elaboration, planning, monitoring, revision, and evaluation) may help learners in their cognitive and metacognitive development (Yu & Liu, 2008), the additional tasks and performance criteria associated with SCT may encourage greater and deeper active manipulation of the received information, leading to knowledge growth. In other words, some planning and setting work ahead of and after the question-generation is needed to ensure that the constructed test covers and assesses all subject-matter content of importance, and that all included items are adequately arranged (Corpus, 2013; Devine & Yaghlian, n.d.). In the following sections cognitive elaboration theory is briefly described, followed by its implications for SCT as a learning activity.

Researchers in cognitive psychology have long held to the theory that to aid cognitive processing and structuring, learners must engage in a process that has been labeled cognitive elaboration. Examples of effective elaboration techniques include: re-chunking of content, providing explanatory descriptions or examples, constructing synthesis in various formats (e.g., in prose, graphics, or tabular form), relating newly acquired information to that already stored in the memory, and highlighting critical differences among closely related concepts (Hoffman, 1997; Reigeluth, 1992, 1999; Smith & Savenye, 1991). Studies on elaboration techniques have generally found supportive evidence for their positive effects on memory retention (Pressley, McDaniel, Turnure, Wood, & Ahmad, 1987; Reigeluth, 1983; Seifert, 1994), reading comprehension (Mohammad, 2011; Oh, 2001), and clarification of the relationships among pieces of information (Wittrock, 1978).

During SCT students are asked to carry out some additional learning tasks and alerted to additional performance criteria, and this may activate further cognitive and metacognitive processes of a different nature and intensity, thus promoting