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The Effects of Student Question-Generation with Online Prompts on Learning

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ABSTRACT

The focus of this study was to investigate the effects of student-question generation with online prompts on student academic achievement, question-generation performance, learning satisfaction and learning anxiety. This study adopted a quasi-experimental research design. Two classes of eighth grade students (N = 64) from one middle school participated in weekly 45-minute online question-generation learning sessions for 6 consecutive weeks. Data analyzed using ANCOVA indicated statistically significant differences between the two groups in regard to academic performance and question-generation performance with students assigned to the online prompts group performing significantly better than their counterparts assigned to the without prompts group. However, there were no statistically significant differences between the two groups in the areas of learning satisfaction and anxiety. Empirical and pedagogical significance of this study together with its implications for instructional implementation, system development, and future studies are provided.

Keywords

Attention capacity, Learning effects, Online prompts, Scaffolding, Student question-generation

Introduction

Student question-generation (hereinafter named SQG), grounded in constructivism, information-processing theory, metacognitive theory and self-determination, is an instructional and learning strategy. While definitions vary in regard to specificity, SQG is applied in most subjects as a process by which students reformulate given questions (from textbooks or teachers) or generate new questions around areas of the study material or in response to their previous classroom activities or experiences (Yu, Wu & Hung, 2013). During SQG, students are directed to be creative and motivated to construct, organize, connect and interact with information and personal experience so that higher-order cognitive competencies are targeted (Yu, Liu & Chan, 2005) rather than the lower level of Bloom taxonomy (i.e. memorization). Evidence from existing studies for the past few decades has supported the use of SQG for the enhancement of comprehension of learned content (Brown & Walter, 2005; Drake & Barlow, 2008) and the promotion of motivation (Chin, Brown & Bruce, 2002), group communication (Yu & Liu, 2005) and higher-order cognitive skills (Brown & Walter, 2005; Dori & Herscovitz, 1999; Yu & Liu, 2008).

Even though empirical studies generally have supported the positive effects of SQG, obstacles affecting its wide-spread diffusion and swift adoption in the classroom have been noted. Specifically, it has been found that an extensive proportion of students did not have experience in SQG during their formal schooling years (Moses, Bjork & Goldenberg, 1993; Vreman-de Olde & de Jong, 2004), and that students have had concerns about their capability and performance as related to this task (Yu & Liu, 2005). Additionally, a majority of students have considered SQG to be either difficult or very difficult (Yu, 2009). As such, issues pertaining to how to include theoretically sound designs to support SQG activities and build an empirical basis for its effectiveness should be a topic of great relevance.

With the distinct features of computers and network technologies, more than a dozen online learning systems with SQG as the focus have been developed during the last decade (Yu & Liu, 2009). While recently developed systems have come to recognize the need for incorporating scaffolds with a theoretical basis to support the task, the efficacy of these built-in support mechanisms has yet to be substantiated (Yu, Tsai & Wu, 2013).

The need for building up solid empirical evidence is compelling in light of recent findings indicating that some of these scaffolding designs are not as potent as they are purported to be. For instance, the effects of online access to

peer-generated questions during SQG activities were examined in one study (Yu & Yang, in press). Contrary to its strong theoretical underpinning in observational learning theory and scaffolding, significant differences in academic performance and weekly question-generation performance were not found between groups with and without online access to peer-generated questions. Another example of a counter-theoretical argument was found in Yu, Wu and Hung's study (2013). In light of its sound theoretical grounds in motivational theory and social construction of knowledge, the potential of cooperative learning intended to ease the concerns and anxiety associated with SQG was examined. To the researchers' surprise, student engagement in SQG while working with a partner cooperatively was not found to lead to lessened learning anxiety, nor did it promote student perceptions of the value of the activity for enhancing self-competence, as compared to the individual SQG mode.

Research purpose and questions of this study

Along this line of research, empirical investigation into "if and how theoretically-derived online support will hold up" served as the focus of this study. In particular, the effects of online prompts in the form of key terms along SQG on learning were examined. To provide a comprehensive view of the issue under current examination, both cognitive and affective effects were investigated. Specifically, in addition to academic achievement and SQG performance, taking into consideration that intervention that leads to increased performance but induces negative affective responses from students is not optimal, and that affective components, including satisfaction toward past learning experiences and learning anxiety, have been suggested to have a decisive impact on successful learning (Krashen, 1988), data on these affective areas were collected. In sum, three research hypotheses are proposed:

- There will be significant differences in student academic performance between the group receiving online prompts and the group receiving no online prompts along SQG.
- There will be significant differences in SQG performance between groups receiving versus not receiving online prompts along SQG.
- There will be significant differences in students' past learning experiences and learning anxiety between the two different groups.

In the following sections, the theoretical foundations of the provision of online prompts for learning (i.e., scaffolding, and limited attention capacity and selective attention) are briefly described below before proceeding to the methodology section of this study.

Scaffolding

Scaffolding is support offered alongside a task to help learners attain pedagogical goals they might not otherwise be able to accomplish (van de Pol, Volman & Beishuizen, 2010). It is aimed at bridging the cognitive gap between a learner's current ability level and potential developmental level.

Scaffolding has often been suggested as an effective instructional method (Cole, 2006; Pawan, 2008). In practice, various types of scaffolding, each with a distinct purpose, have been designed. For instance, supportive or procedural scaffolding in the form of suggestions and examples alongside a task emphasizes its function as providing guidance, coaching, and modeling (Hannafin, Land & Oliver, 1999; Jackson, Krajcik & Soloway, 1998). Reflective or metacognitive scaffolding, on the other hand, is intended to prompt learners to reflect back on their thinking processes and to promote better execution and management of self-regulatory strategies and self-reflection during the process (Ge & Land, 2004; Hannafin et al., 1999; Jackson et al., 1998). Elaboration scaffolding is geared toward engaging learners in articulating thoughts, constructing explanations, and making justifications (Ge & Land, 2004). Intrinsic scaffolding is aimed at reducing the complexity of a task (Jackson et al., 1998). Strategic scaffolding provides learners with alternative techniques for approaching tasks (Jackson et al., 1998). Despite their differences in terms of functions and foci, overall, scaffolding acts to decrease working memory load while dealing with novel information (Kirschner, Sweller, & Clark, 2006; Myhill & Warren, 2005; Van Merriënboer, Kirschner, & Kester, 2003), to minimize frustration on the part of learners (Rummel & Kramer, 2010; Wood et al., 1976), and to clarify misunderstandings or fill in incomplete information pertaining to targeted operations or concepts (Sharma & Hannafin, 2007).

Scaffolding is a frequently studied concept (van de Pol et al., 2010). Empirically, scaffolding has been found to have a facilitative effect in regard to supporting students' metacognitive and cognitive activities (Azevedo, Winters & Moos, 2004; Belland, Walker, Olsen & Leary, 2012; Berthold, Nuckles & Renkl, 2007; Ge, Chen & Davis, 2005; Hmelo, Holton & Kolodner, 2000; Wolf, Brush & Saye, 2003). Based on a meta-analysis of 180 research studies, Swanson (1999) concluded that scaffolding is one of the nine most effective instructional interventions. In addition, based on a review of the past decade of research (from 1998-2009) on scaffolding in teacher-student interaction, the conclusion that scaffolding is effective was reached (van de Pol et al., 2010). More recently, the effects of scaffolding on student cognitive outcomes were demonstrated by a meta-analysis of STEM education at the K-12, college, graduate, and adult levels, and the results showed that scaffolding positively impacts student learning, producing an average effect size of .53 (Belland et al., 2012).

While researchers have been successful in devising different forms and means of scaffolding (Tharp & Gallimore, 1988; Wood et al, 1976; van de Pol et al., 2010) to support various learning activities and contexts, its effects for SQG have yet to be fully realized and understood. Hence, it serves as the focus of this study.

Limited attention capacity and selective attention

In most learning scenarios, a great deal amount of information is presented continuously, which needs to be effectively and efficiently processed. Because people have a definite attention capacity at any given time, only a restricted portion of the thousands of stimuli reaching our senses can be attended to (Ruz & Lupiáñez, 2002).

According to Treisman's attenuation theory (1964), the attention to some incoming information from different sensory channels and sources will be selectively processed to various extents so as to prevent the information-processing system from becoming overloaded (McLeod, 2008). With this limited capacity constraint, issues regarding "how to better direct learner attention to promote further processing of relevant information" should be topics of great importance.

Previous research shows that learners can use information about an upcoming target or event to enhance task performance (Moher & Egeth, 2009; Simons, 2000). To enable materials deemed important and relevant being attended to and processed as intended, several strategies have been proposed and effects attested to. Specifically, a great deal of attention was given to the influence of directing learner focus of attention by inducing pre-instructional strategies, such as objectives, overview/outlines of keywords, and advance organizer on subsequent learning in the sixties and seventies (Hartley & Davies, 1976). Their function to alert students to aspects of the learning material that might be overlooked while reducing time and attention allocated on irrelevancies has been acknowledged, and their significant effects on aiding learning have generally been supported (Hartley & Davies, 1976).

In light of the predominately discernible effects of pre-instructional strategies used to preface the teaching to come, in this study, the effects of providing students with online prompts to preface SQG to come is examined in this study. It is well-known that goal-directed attention, one of the two determinant factors of selective attention (Chun, Golomb, & Turk-Browne, 2011; Ruz & Lupiáñez, 2002; Yantis, 2000), is affected by a subject's expectancies and requires conscious awareness (Ruz & Lupiáñez, 2002). The authors hypothesized that a clear set of key terms could act as informative cues for SQG, and could therefore help modulate and orient learner goal-directed attention to important areas for further processing to yield positive learning effects.

Methods

Study context and participants

This study was conducted in a middle school in Tainan, Taiwan. While attaining high performance on exams is still imperative to enter top-tier universities, in response to the many impending challenges nation- and world-wide, the Ministry of Education in Taiwan has undertaken a series of educational reforms, where core competencies are identified. Among these, problem-solving, creativity, ICT skills, and independent thinking as part of the ten identified core competencies for 1st to 9th grade students (Ministry of Education, 2012) resonated well with online SQG. As such, the online SQG activity implemented in this study was well received. The activity was introduced to support

student learning of civics and citizenship, part of social studies curriculum, at the secondary school level. Two eighth grade classes (N = 64) taught by the same instructor were randomly selected to participate in this study for 6 consecutive weeks.

The integrated online learning activity was held in social studies weekly study sessions in the school's computer lab to accompany the weekly 45-minute instructional session allocated for civics and citizenship education. As multiple-choice is the only question type used in the school-wide and high school entrance examination for social studies, it was chosen as the question type for the online SQG activities.

Instructional content

Two chapters were covered during the study. The first chapter is about "civil laws and life", with four lessons that cover topics including the governing of civil laws, principles regarding the exercising of civil laws, civil law liability, and the capacity of civil laws. The second chapter is on "criminal law and administrative regulations", with four lessons. Topics covered include crime and punishment, elements of crime, basic knowledge of criminal law, and administrative regulations and responsibilities.

Experimental design and treatment groups

A quasi-experimental research method was adopted for this study. For the purpose of this study, two treatment conditions were devised: the online prompts (experimental) group and the without prompts (contrast) group. Except for the online prompts that were accessible only to the experimental group, all instructional elements and procedures were kept the same for both groups.

For the experimental group, prompts were included in the system and made accessible to students as part of the SQG function for the duration of this study (see Figure 2). Prompts were included in an attempt to simplify the SQG task for the student (Tharp & Gallimore, 1988) and for better attention management (McLeod, 2008; Ruz & Lupiáñez, 2002). Essentially, the online prompts were in the form of a set of key terms related to the study material and were derived from the "the answer is" approach, which was first proposed by Stoyanova & Ellerton (1996) for SQG. By encouraging the construction of questions matched with 'the answer' (i.e., targeted key terms), not only the language, concept, and structure with regard to the 'target' may have a better chance of being recognized and understood (Stoyanova, 2003), but also different aspects of the target as observed in daily life can be linked and appreciated (Silver, 1994). Simply taking 'civil law' as the target, the following question exemplifies how SQG enables students to construct contextual questions and interconnect different concepts related to the target: Chi-Hong and Shu-Hwa (1) are getting married, so (2) they took out a loan of 2 million dollars from a bank, (3) bought an apartment in the An-Ping district in Tainan, and (4) paid property taxes on time. Which of the above behaviors are governed by "civil law?" (a) 123 (b) 124 (c) 234 (d) 134 (answer key: a). As for the contrast group, no prompts were provided while the students completed the SQG task throughout the study.

In sum, the main difference between the two groups lies in the fact that students in the experimental group were advised to generate questions around key terms in reference to a set of online prompts plus the study material, while students in the contrast group were instructed to generate questions around key terms only with reference to the study material.

Online learning system

An online learning system with a focus on SQG, called QuARKS, was adopted (Yu, 2009). Like all similar online systems on the market, QuARKS enables multimedia files to be included as parts of the question; text with different fonts, sizes, and styles can be used, and questions can be constructed to be saved, retrieved, revised, and deleted with ease by users. Nevertheless, QuARKS is different from other systems in at least one way. To the authors' knowledge, it is the only system that supports customizability in terms of specific function(s) available to students and provides context-sensitive scaffolding at any pre-specified time or in real time.

For this study, both SQG and drill-and-practice (D&P) functions were activated for both groups, but the online prompts function was only made accessible to the experimental group along with SQG. With QuARKS's customizability, different sets of online prompts (in the form of a set of key terms related to the current study content) can be incorporated, updated, and made available in a timely fashion by individual instructors. In the following sections, the activated functions and associated online learning space are briefly explained.

SQG function. After logging into QuARKS and specifying the course, unit, and class (step 1), students simply click on the SQG function button (step 2) and the multiple-choice question icon (step 3, Figure 1) to be directed to the multiple-choice SQG space. For multiple-choice SQG, students simply compose the question-stem (step 1), provide four alternative options (step 2), identify the correct answer key (step 3), and list the key term(s) to be tested (step 4) in the respective fields. After finishing, they click on the "Submit" or "Temporarily save" button (step 5). For the experimental group, students may click on the "Prompts" button placed on top of the "question" field to be directed to a set of online prompts on the current learned content for reference for SQG (see Figure 2).

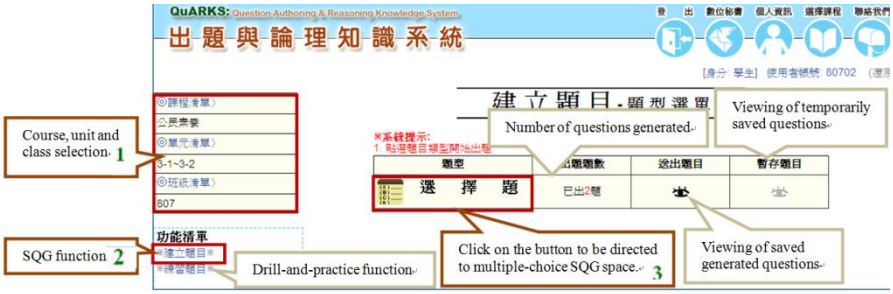

Figure 1. SQG function space

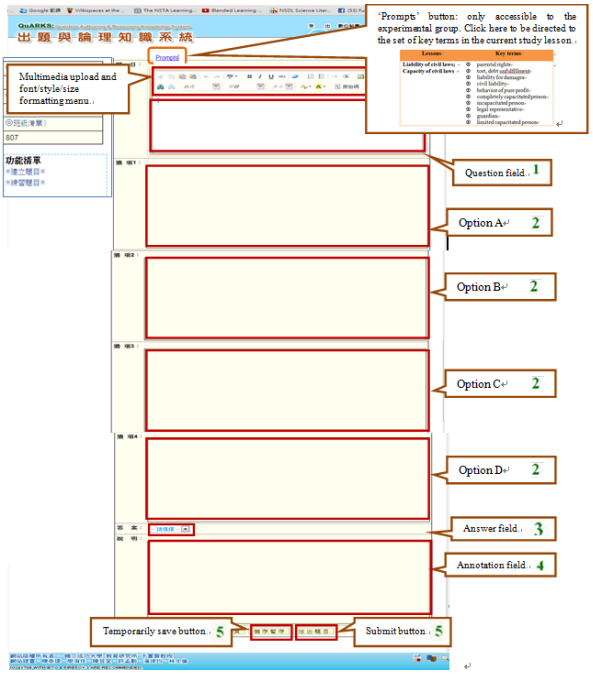

Figure 2. Multiple-choice SQG space for both treatment groups (the "Prompts" button to be directed to a set of keywords is only visible and accessible to the experimental group)

For D&P, students simply click on the D&P function (step 1) and specify the number of items to answer (step 2, Figure 3) to proceed. At the conclusion of each D&P activity, the correct answer key to each question is shown, and the average accuracy rate is calculated (Figure 4). If time permits, students can choose to engage in the D&P activity again by re-entering the number of questions to answer. The system will then randomly re-select the specified number of questions from the online database and re-sequence the order of the questions and options within the multiple-choice questions.

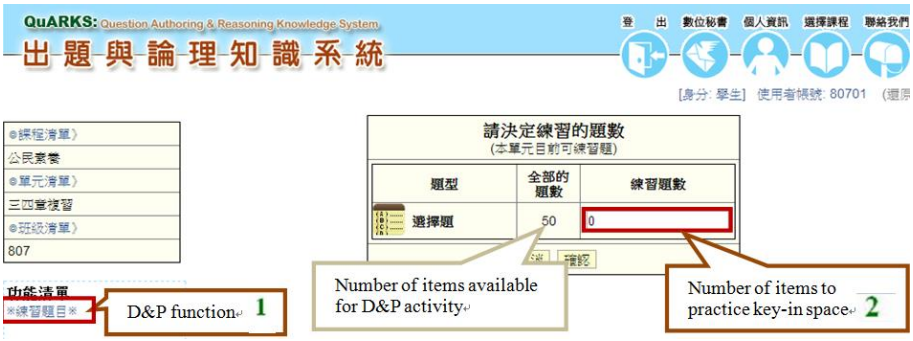

Figure 3. D&P function space

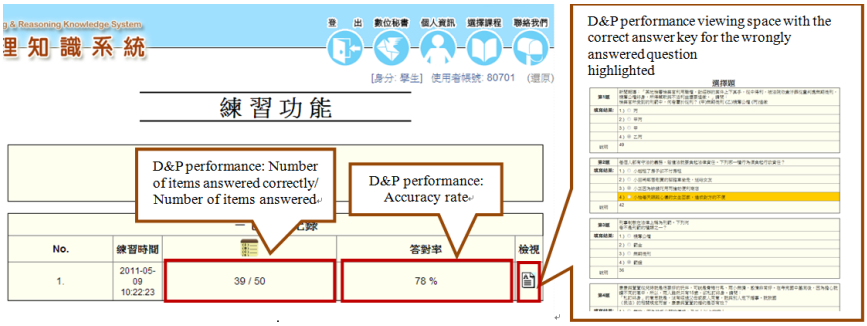

Figure 4. D&P performance review space

Experimental procedures

The experimental procedure is delineated in Figure 5. A pilot study involving one eighth-grade class in the participating school (N = 29) was conducted to ensure that the planned procedures and time allocation for various activities were appropriate, and that the instruction for experimental implementation was clear prior to the actual study.

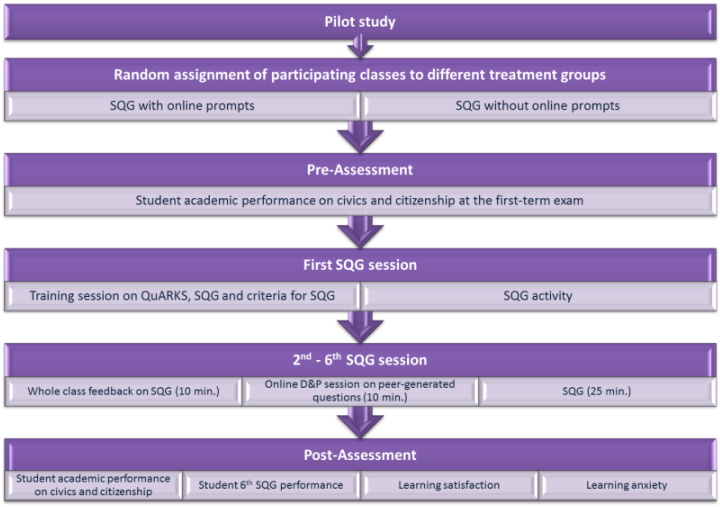

Figure 5. Experimental procedures of this study

This study took place right after the school-wide first-term exam. Participating classes were randomly assigned to the two treatment groups. Data on participants' academic performance on the exam in regard to civics and citizenship was collected.

At the first class session, adopting the suggestions of Rosenshine, Meister and Chapman (1996), elements supporting SQG including the following were included and explained first: (a) the set of criteria that the teacher would use to assess SQG performance (see measurement section for details), and (b) models of appropriate questions. Emphasis was placed on various possible ways of generating questions targeting any key term(s) in such a way that significant details (e.g., important features, conditions, characteristics) could be addressed. For instance, for 'abandoned inheritance,' two examples were provided as models. Example #1: When her father died, Mei-Ling decided not to inherit either the estate or debts. Which of the following inheritance types is Mei-Ling practicing? (a) Unconditional inheritance (b) Limited inheritance (c) Abandoned inheritance (d) None of the above (answer key: c). Example #2: When turning 20, Mai-Li could inherit from her father 5 million dollars in estate and 7 million in debts. If Mai-Li wants to abandon inheritance, when should she file the claim to the court? (a) within 2 months upon the known fact (b) within 3 months upon the known fact (c) within 2 months of the death of her father (d) within 3 months of the death of her father (answer key: b).

In addition, rules of thumb for generating multiple-choice question items and the operational procedures for the adopted system were demonstrated before having students practice generating questions on one paragraph of the study material. Then, students assigned to both treatment groups were instructed to generate as many multiple-choice questions as possible on key terms learned in civics and citizenship class in the current week in the corresponding spaces in the QuARKS interface during the remaining time allotted. Students were encouraged to refer to the study materials and supplementary handouts, including the SQG criteria given during the SQG activities.

Each week, starting from the second SQG activity, whole-class feedback on SQG was provided first by highlighting the strengths and weaknesses of three purposefully selected pieces of student-generated questions (10 minutes). This was followed by a 10-minute D&P activity on peer-generated questions selected by the instructor before the SQG activity for the remainder of the class time (25 minutes). At the end of the sixth SQG session, students were advised to complete a posttest and a questionnaire to collect data on outcome measures.

Measurements

Academic performance on civics and citizenship

A posttest developed by the participating teacher was used to assess student academic performance on the covered content. It included 50 multiple-choice question items consisting of both teacher-generated questions and student-generated questions selected from the two respective participating classes. To eliminate the practice effect on student-generated questions, only teacher-generated questions (27 items) were included for data analysis. Based on item analysis, the quality of the posttest was satisfactory, with test difficulty averaged at .73 and discrimination index averaged at .43.

SQG performance

To assess SQG performance, the set of criteria developed by Yu and Wu (2013) was referred to and adapted, which entails the following six dimensions:

- Fluency (0-3): question stem and options free from typos (1); precise meaning with one correct answer key (1); complete: question-stem, four options, answer key and annotation (1)
- Complexity (0-2): question involves one key term (0), two key terms (1), more than two terms (2)
- Elaboration (0-3): interconnectedness between the currently study topic/unit and prior topics/units (1); interconnectedness among topics within the currently studied lesson (1); plausibility of alternatives (1)
- Originality (0-2): link to personal life experience or current news (1); scenario-based with contrived characters and story (1)
- Cognitive level (0-2): use of language taken directly from the learned materials (0); use of one's own words to define or describe learned content (1); link across topics/lessons/chapters and inference is needed (2)
- Importance (0-1): important concepts of the study material (1)

All questions that students generated during SQG during the first and last activities were analyzed, scored, and summed up according to the defined criteria. For inter-rater consistency, one civics and citizenship education teacher

from the participating school was recruited and trained to use the criteria. The Pearson correlation efficient between the two raters was .92, based on SQG performance assessment of 20% randomly drawn student-generated questions. Definitions and examples of each of the six dimensions of SQG performance were explained to students during the training session. With an explicit scoring scheme for SQG performance assessment coupled with weekly whole-class feedback to students, constructing questions that tap into higher-level cognitive skills (e.g., comprehension, application and analysis), as opposed to memorization, were made clear to participating students.

Satisfaction toward the past learning experience and learning anxiety

Hung's (2000) Learning Satisfaction Scale (nine items, Cronbach's α r .91) and Learning Anxiety Scale (nine items, Cronbach's α = .85) were adopted. On the 'Learning Satisfaction Scale,' students were asked to assess their satisfaction toward the activity they were engaged in. Sample items on this scale included: It was enjoyable to be able to participate in this activity; I like to learn via this kind of learning arrangement; I am satisfied with my performance in this activity.

With regard to learning anxiety, students were asked to gauge their emotional states during the activity, such as their level of tension, restlessness, uneasiness, concern, and insecurity. Sample items were: I felt uneasy and confused in this kind of learning arrangement; I would become upset if I knew I would have to participate in similar activities again in the future; I felt pressure learning in this way; it terrified me to learn in this way.

Each statement on the scales was rated on a six-part discrete scale with corresponding verbal descriptions ranging from very inconsistent, through inconsistent, somewhat inconsistent, somewhat consistent, consistent, to very consistent (each response received a weight of 1, 2, 3, 4, 5, or 6, respectively). Both positive and negative statements were included in the scales to counteract possible response-set tendencies. As such, scoring on the statements was adjusted so that negative and positive responses could be summed and analysed, with higher scores reflecting more satisfied feelings and higher anxiety toward the exposed learning experience. Internal consistency reliability values calculated after the actual study were .91 and .85 for 'Learning Satisfaction Scale,' and 'Learning Anxiety Scale,' respectively.

Data analysis

An analysis of covariance technique (ANCOVA) was used to test whether there were significant differences in academic and SQG performance between the two treatment groups. Scores from the first-term exam on civics and citizenship and the 1st SQG performance were used as the covariates. Finally, student satisfaction and learning anxiety were compared using independent-group *t*-tests.

Results

Academic achievement on civics and citizenship

Table 1 summarizes the descriptive statistics for both groups' academic achievement on civics and citizenship. The assumption of the homogeneity of the regression was satisfied, $F(1,62) = 0.05$, $p = .82 > .05$, before proceeding to ANCOVA. Results of ANCOVA revealed significant differences between the two treatment groups, $F(1,63) = 7.86$, $p = .01 < .05$, $\eta^2 = 0.48$.

SQG performance

Student SQG performance for the first and last sessions is listed in Table 1. The assumption of the homogeneity of the regression was satisfied, $F(1,62) = 0.931$, $p = .338 > .05$, before proceeding to ANCOVA. Results of ANCOVA revealed significant differences between the two treatment groups, $F(1,63) = 12.683$, $p = .01 < .05$, $\eta^2 = 0.168$.

Table 1. Descriptive and *F*-test statistics for academic and SQG performance

Treatment groups (n)		With prompts (n = 32)	Without prompts(n = 34)	F	*p*	η^2
Observed variables						
Academic	Pre[1] M (SD)	9.78 (3.09)	10.38 (3.11)	7.86**	.01	0.48
	Post[2] M (SD)	10.38 (3.16)	9.20 (3.21)			
	Adjusted M	10.60	8.90			
SQG	1st, M (SD)	15.72 (8.80)	11.38 (9.63)	12.683*	.000	0.168
	6th , M (SD)	22.94 (14.94)	10.29 (9.50)			
	Adjusted M	21.86	11.3			

Note. [1]1st school-wide exam on civics and citizenship; maximum possible score: 16. [2] Teacher-designed test on civics and citizenship; maximum possible score: 27.
** $p < .01$.

Satisfaction toward past learning experience and learning anxiety

The descriptive statistics of both groups' responses to the Learning Satisfaction Scale and Learning Anxiety Scale are presented in Table 2. Data analysis indicated that student satisfaction toward past learning experience was not statistically significant, $t(66) = 0.88$, $p = .57 > .05$, nor was it for learning anxiety, $t(66) = 0.50$, $p = .34 > .05$.

Table 2. Descriptive and *t*-test statistics for learning satisfaction and anxiety

Observed variables	With prompts	Without prompts	*t*(66)	*p*	95% CI	
	m[1], M[2] (SD)	m[1], M[2] (SD)			*LL*	*UL*
Satisfaction	4.81, 43.31 (7.52)	4.64, 41.79 (6.47)	0.88	.57	-1.94	4.98
Learning anxiety	4.73, 42.56 (8.06)	4.73, 41.62 (7.11)	0.50	.34	-2.81	4.69

Note. [1]m: mean/item; maximum possible score: 6. [2]M: Mean/scale; maximum possible score: 54.

Discussion and conclusions

By allowing students to generate questions around the study material, many self-regulatory processes (e.g., rehearsal, organization, elaboration, planning, monitoring, evaluation, revision, reflecting, and on so) are mobilized by the many sub-tasks that SQG entails (Yu & Liu, 2008). Associated sub-tasks may include: identifying important concepts as well as significant details around important concepts, building linkages or distinguishing among related concepts, writing up questions of adequate quality, solving the generated questions, and so on.

As is evident, any task composed of complex sub-tasks, each involving the activation and use of complex processes, as is the case with SQG, will benefit from some type of supportive structuring to help the learner proceed in an effective way. This kind of support is compelling in such learning situations in view of the fact that learners with finite attention and cognitive capacity are frequently challenged to process a vast amount of information. To attain better learning effects, the use of instructional measures intended to enable learners to deploy limited available attention and cognitive capacity to relevant content during learning to bring out expectant learning outcomes while directing attention away from less relevant and sometimes excessive, redundant or even unnecessary signals (attenuating attentional capture phenomena) is important.

In this study, the effects of online prompts to preface SQG were examined. The results indicated that the provision of online prompts helped enhance student academic and SQG performance better, as compared to the without prompts group. Nevertheless, both groups were not distinguished from each other in terms of learning satisfaction and anxiety. The underlying mechanism by which online prompts in this study worked for the benefit of student cognitive growth seemed to manifest at several levels. This can be understood with reference to scaffolding and limited attention capacity and selective attention, as follows:

First, as suggested by van de Pol et al. (2010), Kirschner et al. (2006), Myhill and Warren (2005) and van Merriënboer et al. (2003), the provided prompts, acting as scaffolding, helped reduce the learner's cognitive load; thus, limited capacity can be devoted to other important aspects of the learning task at hand. Second, they helped

simplify the task for the student by reduction in the degrees of freedom (Tharp & Gallimore, 1988). Third, they functioned as direction maintenance (Wood et al., 1976), or informational cues (Moher & Egeth, 2009; Simons, 2000) for better attention management (McLeod, 2008; Ruz & Lupiáñez, 2002), which aids in keeping the learning on target when a student is pursuing a particular objective.

Briefly explained, locating key terms in the study material will be one of the first tasks, if not the first task, to be attended to when engaged in SQG activities. Plausibly, each student might come up with a different set of key terms out of any specified study content. With key terms highlighted upfront for students, not only can time and effort spent on identifying key terms be saved (i.e., cognitive capacity reduction, task simplification, reduction in the degrees of freedom), students' attention and available cognitive capacity can be focused on understanding, building linkages, and constructing questions around essential content (i.e., direction maintenance, attention management).

As hypothesized, being prompted with a set of key terms along with SQG activities should help modulate and orient learner goal-directed attention. Students restricted by finite attention and cognitive capacity thus will be better able to be directed to key areas of the study material for further processing, and in turn, this will positively influence learning. As was found, students in the online prompts group performed significantly better than those in the without prompts group in terms of academic and SQG performance.

Significance of this study

This work has some empirical and pedagogical significance. First, this study empirically attested to the supportive effects of online prompts based on "the answer is" approach for learning. While evidence substantiating the positive effects of SQG prompts was available decades ago (Rosenshine et al., 1996), its pedagogical values have been mostly examined through comparisons to other instructional arrangements (e.g., summarization, note-taking and review, as done by King, 1992), rather than through a "without prompts" contrast group. To the best of the authors' knowledge, this is the first study empirically substantiating the superiority of online prompts in the form of a set of key terms to preface SQG.

Second, "the answer is" approach, since proposed by Stoyanova and Ellerton (1996), has been applied exclusively in math. Its applicability beyond its originally designed domain area where mastering vocabulary and terminologies is one essential learning objective (such as language learning, sciences, and social sciences) is legitimate. As demonstrated, its use in civics and citizenship education was explored, and its effects for promoting academic and SQG performance were substantiated. This study demonstrates its uses beyond the currently applied context and helps broaden its pedagogical use.

Implications of this study

Suggestions for instruction, system designs, and future studies are provided on the basis of the current findings and previous studies supporting the pedagogical benefits of SQG strategy. First, instructors interested in SQG are advised to include online prompts in the form of a list of key terms along with SQG. As found, the online prompts devised in this study acted effectively as scaffolding and informative cues to preface SQG and could lead to escalated cognitive effects.

Second, while more than a dozen online learning systems with SQG as the focus have been developed during the past decade, few systems have recognized the need for building up support for complex tasks. Online prompts in the form of a set of key terms were confirmed in this study to be a beneficial design to preface SQG. Yet, to allow context-sensible scaffolds to be incorporated, systems with scaffolding along with SQG should adopt a dynamic rather than a fixed structure. This way, the supports provided can accommodate the current study material and the learner's cognitive developmental state, as the instructor sees fit, to reflect the notion of scaffolding (Pea, 2004).

Finally, several types of prompts have been proposed to assist the learning and use of a SQG strategy. This study examined the effect of one specific type of prompt (i.e., the answer is) for civics and citizenship education. Because each prompt type has its intended use context and is different in terms of level of concreteness, specifics of focus, and demands on cognitive capacity (Rosenshine et al., 1996), the generalizability of the effects found in this study to

other contexts (e.g., different subject matter, age groups, prompt types) will need to be exercised with caution. Investigations along this line should be fruitful avenues for future research.

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