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The Effects of Different Procedural Prompts on Online Student-Generated Question Performance in terms of Cognitive Levels

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Abstract: The main purpose of this study was to examine the effects of two different procedural prompts on online student-generated question performance in terms of cognitive levels. A total of 41 undergraduates enrolled in an English as a foreign language class participated in this study for four weeks. Questions the participants generated corresponding to the learning material in Zuvio, an online instant interactive system, were analyzed using the revised Bloom's taxonomy to examine the cognitive level dispersion of student-generated questions. Four important findings were obtained. First, as a whole, students-generated questions spread across low, medium, and high cognitive levels, with more than 60% of the generated questions falling in the medium and high cognitive levels. Second, the majority of the questions generated along the 'signal words plus the answer is' procedural prompts were at the medium level whereas most of the questions generated along the 'question stems' procedural prompt were at the low level. Third, the result of the chi-square test found a significant difference between the two different procedural prompts in terms of cognitive level dispersion. Finally, despite that the 'signal words plus the answer is' procedural prompt appeared to be more effective in inducing a comparatively greater percentage of higher-level thinking questions, as compared to the 'question stem' prompt, no questions generated along the 'signal words plus the answer is' procedure prompt were at the highest create level. Suggestions for instructors and future studies are provided.

Keywords: Cognitive levels, online learning activity, procedural prompts, question-stem, signal words, student-generated questions

1. Introduction

Evidence from existing studies for the past decades has provided ample evidence validating the effects of the student-generated questions approach (SGQ) on the promotion of comprehension of the study material (Brown & Walter, 2005; Drake & Barlow, 2008; Hardy, Bates, Casey, Galloway, Galloway, Kay, & McQueen, 2014; Song, 2014), learning motivation (Chin, Brown & Bruce, 2002), and higher-order thinking (Brown & Walter, 2005; Yu & Liu, 2008). Despite SGQ's positive learning effects, obstacles affecting its integration in the classroom have been noted, mainly students' lack of experience with (Moses, Bjork & Goldenberg, 1993; Vreman-de Olde & de Jong, 2004) and confidence in the SGQ task (Yu, 2009).

In light of these obstacles, researchers have proposed different procedural prompts for the support of SGQ activities and have investigated their effects (Rosenshine, Meister, & Chapman, 1996). For instance, King proposed a set of generic question stems targeted to prompt the activation and use of higher-level cognitive processing (e.g., comparison, analysis, prediction, and evaluation, among others) and connection-building between prior and existing knowledge on the part of the learner (King, 1990, 1995). A series of King's studies found the set of question stems (for example, how would you use... to... ? what is a new example of. .. ? how does... affect ... ? what is the difference between ... and... ? what conclusions can you draw about. . . ? how is...related to... that we studied earlier? and so on) to influence elaborated responses and the generation of high-order thinking questions from the students as compared to unguided questioning (King, 1990, 1992). Yu and Pan (2014) found that students provided with 'the answer is' online procedural prompt performed significantly better than their counterparts assigned to

the without prompts group. Yu, Tsai, and Wu (2013) attested the immediate positive effects of immediate scaffolding in the form of generic question stems for the support of online student question-generation activities.

While empirical evidence substantiating the value of the provision of procedural prompts for the support of student learning during SGQ, issues regarding whether there are any differential learning effects among the procedural prompts await investigation. In light of the innate difference associated with different procedural prompts in terms of levels of easiness, concreteness, explicitness, and so on, this study has instructional relevance as well as empirical significance. Specifically, the research question posed in this study is: Are there differences between various procedural prompts in terms of directing students to generate questions at different cognitive levels?

2. Methods

2.1 Participants and Study Context

For the purpose of this study, forty-one intermediate-level sophomores (males: 22; females: 19) enrolled in an English as a foreign language class from the College of Management at a National University in southern Taiwan were invited to participate in a 4-week study. Specifically, two types of procedural prompts were targeted: the first one was Stoyanova and Ellerton's (1996) 'the answer is' coupled with signal words (i.e., one of the most frequently used and easily learned procedural prompts) (Rosenshine, Meister, & Chapman, 1996), and the second one was King's (1990, 1992) generic question stems (suggested to prompt higher-order thinking and questioning on the part of the learner). The procedural prompts for SGQ were introduced to the participants to support their language learning.

Zuvio, an online instant interactive system, was adopted for the SGQ activity via smart-phones, where the students generated questions of different types. The 'Inventions and Discoveries' Unit with four lessons (including a photo story, vocabulary, grammar, and an article relevant to inventions and discoveries, technology, past unreal conditional, and antibiotics) was covered during this study. A brief training session on SGQ with examples and elaborated explanations were provided before the students engaged in the SGQ activities so that they were equipped with the essential knowledge and skills associated with SGQ in the online system.

During the study, two SGQ activities were arranged, with the 'signal words plus the answer is' procedural prompt introduced after the 1st and 2nd lessons for the first SGQ activity and the 'question stems' procedural prompt introduced after the 3rd and 4th lessons for the second SGQ activity. During the first SGQ activity, each of the participants was directed to generate one question corresponding to the two lessons specified along the provided procedural prompt and instruction (see Figure 1), whereas for the second SGQ activity, two questions were suggested to be generated along the provided prompt and instruction (see Figure 2).

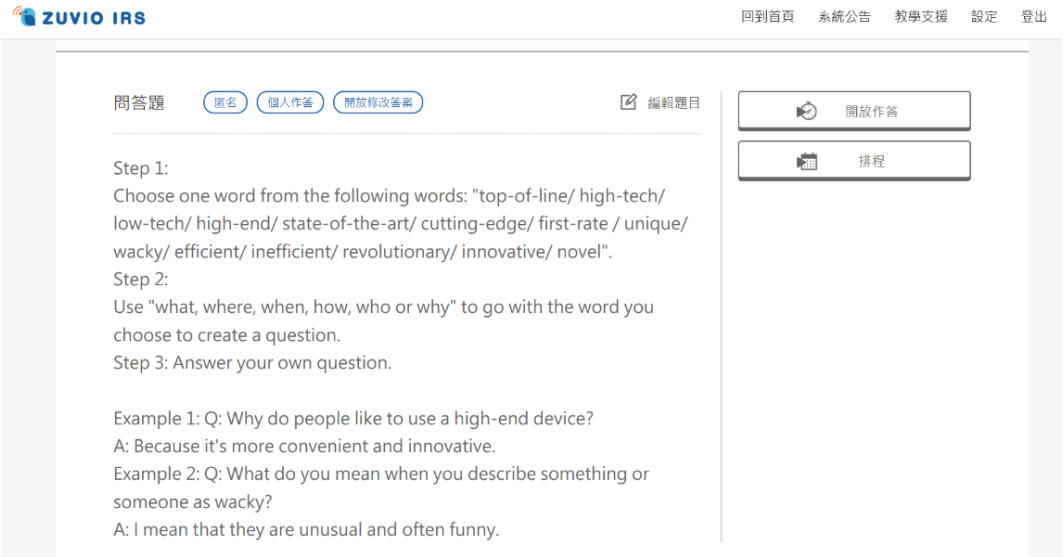

Figure 1. Instruction and Procedural Prompt Provided for the 1st SGQ Activity

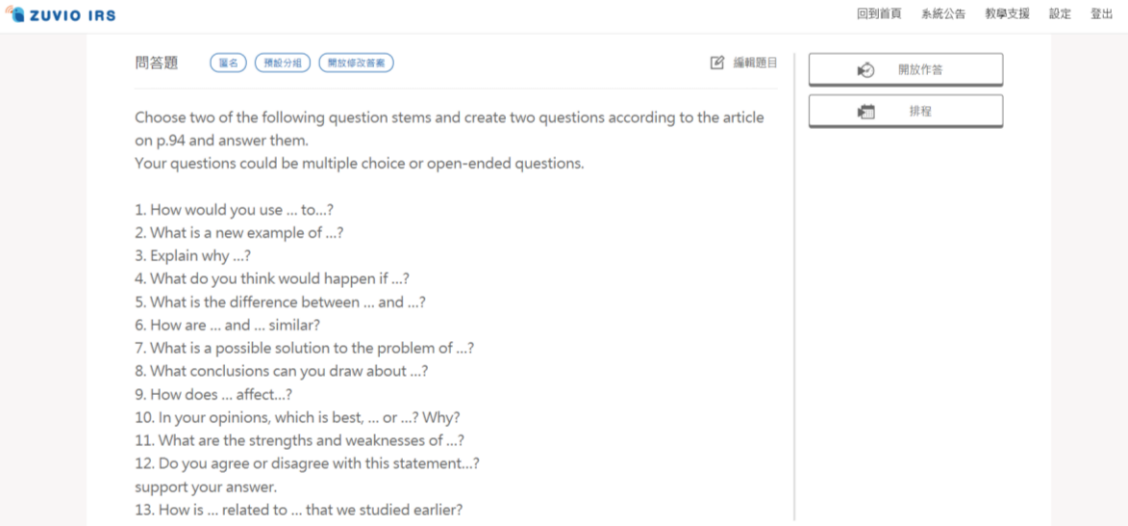

Figure 2. Instruction and Procedural Prompt Provided for the 2nd SGQ Activity

2.2 Classification of SGQ

The revised version of Bloom's Taxonomy (Krathwohl & Anderson, 2009), which has been widely used for evaluating the cognitive levels of questions in textbooks (Assaly & Smadi, 2015; Tarman, & Kuran, 2015) and assessing SGQ performance (Lameese, Madalyn, Keli, Matthew, Jakob, Christina, 2015) was adopted and operationalized (see Table 1). Two experienced English teachers independently categorized each of the questions the participants generated during the two SGQ sessions along the revised Bloom's taxonomy. To ensure inter-rater reliability, percent of agreement was adopted, which was 82.96% and 84.38% for the 1st and 2nd SGQ activities, respectively.

Table 1
Categories and Operationalized Definitions for the Six Cognitive Levels of SGQ

Dimensions	Definition
Remember	Complete questions with answers by recalling learned information or concepts in the textbook.
Understand	Complete questions with answers by describing learned information or concepts in the textbook.
Apply	Complete questions with answers by using learned information in new examples or situations.
Analyze	Complete questions with answers by identifying causes or analyzing a problem.
Evaluate	Complete questions with answers by making judgments about the information.
Create	Complete questions with answers by synthesizing multiple units of information into new patterns or providing new solution.

2.3 Data Analysis of SGQ

The chi-square test was adopted to analyze if the two integrated procedural prompts directed students to generate questions at different cognitive level distributions. In view of the fact that 33.33% of the cells in the contingency table had a number less than 5, to ensure valid chi-square tests and to comply with the calculation rule (i.e., requiring at least 80% of the cells to have an expected count greater than 5), the cognitive levels were grouped into a low level (by combining the remember and understand levels), a medium level (by combining the apply and analyze levels), and a high level (by combining the evaluate and create levels).

3. Results

3.1 Quantitative Data on SGQ along the Two Procedures Prompts

In total, 123 questions were generated by the participants during the two SGQ sessions. Four important findings were obtained. First, as shown in Table 2, as a whole, while students-generated questions spread across the low to high cognitive levels, more than 60% of the generated questions fell in the medium and high cognitive levels (61%). Second, the majority of the questions generated along the 'signal words plus the answer is' procedural prompt were at the medium level (63.4%), whereas most of the questions generated along the 'question stems' procedural prompt were at the low level (51.2%). Third, the highest cognitive level students generated along the 'signal words plus the answer is' procedural prompt was at the 'evaluate' level, and no questions were generated at the highest 'create' level. Fourth, the results of the chi-square tests further found a significant interaction, x^2 (2, n = 41) = 15.381, p < .001, Somers' D = .369, indicating that different procedural prompts for SGQ had significant effects on the cognitive level dispersion of the student-generated questions.

Table 2
The Cognitive Levels of SGQ Based on Bloom's Taxonomy

		Low level		Medium Level		High Level	
		remember	understand	apply	analyze	evaluate	create
signal words plus the answer is	*f*	0	6	0	26	9	0
	f	6		26		9	
	%	14.6%		63.4%		22%	
question stems	*f*	6	36	0	30	6	4
	f	42		30		10	
	%	51.2%		36.6%		12.2%	
Total	(*f*, %)	48 (39%)		56 (45.5%)		19 (15.5%)	

3.2 SGQ along the 'Signal Words plus the Answer is' Procedure Prompt

Despite the fact that the chi-square tests found different procedural prompts leading to different cognitive level dispersion, as illustrated in Table 3, the participants managed to generate quality questions along the 'signal words plus the answer is' procedure prompt. In addition, students were capable of utilizing the signal words (i.e., what, who, when, where, why, and how) and the different terminologies covered in the lesson for SGQ.

Table 3
Examples of SGQ along the 'Signal Words plus the Answer is' Procedure Prompt

Cognitive levels	Examples of SGQs	Signal words	The answer is
Low (Remember/Understand)	Q: What is your favorite high-tech product in the textbook? A: My favorite product in the textbook is the Robot Vacuum cleaner.	What	high-tech
	Q: Why do people like to use a high-end device? A: Because it's more convenient and innovative.	Why	high-end
Medium (Apply/Analyze)	Why do people think this statue is unique? A: Because it is made of a special material.	Why	unique
High (Evaluate/Create)	Q: How does the robot vacuum work? Is it efficient? A: Yes. I don't waste time on sweeping the floor after I bought it.	How	efficient

3.3 SGQ along the 'Question Stems' Procedure Prompt

It was shown that the participants could generate quality questions along the 'question stems' procedure prompt by referring to the list of generic question stems (see Figure 2 and Table 4).

Table 4
Examples of SGQ along the 'Question Stems' Procedure Prompt

Cognitive levels	Examples of SGQs	Question stem
Low (Remember/ Understand)	Q: Explain how Dutch scientist Antonie discovered the existence of microorganisms? A: He used a microscope to discover the existence of microorganisms.	Explain how…?
	Q: What is the difference between a bacteria and a virus? A: A bacteria can be killed by antibiotics, but a virus can't be killed by antibiotics.	What is the difference between …and…?
Medium (Apply/Analyze)	Q: Explain why antibiotics are not effective against some diseases such as the common cold and sore throats. A: Because antibiotics can't heal diseases resulting from viruses such as the common cold and sore throat.	Explain why…?
High (Evaluate/Create)	Q: Do you agree or disagree with the statement that AIDS will be cured in the future?" "A: I agree AIDS will be cured in the future, but there is still a long way to go.	Do you agree or disagree with this statement about…
	Q: How would you use a vaccine to prevent diseases? A: We can use a vaccine to protect people who suffer from diseases caused by viruses.	How would you use…to…?

4. Discussion and Conclusion

The results of this study confirmed the meta-analysis study of Rosenshine, Meister, and Chapman (1996) indicating that procedural prompts including question stems and signal words are effective in supporting SGQ activities. Through the content analysis of the generated questions, it was further found in this study that the provided procedural prompts are effective in promoting the generation of questions spanning across different cognitive levels. In addition, the two procedural prompts were found to have different effects in terms of directing students to generate questions at various cognitive levels, with the 'signal words plus the answer is' procedural prompt appeared to be more effective in inducing a comparatively greater percentage of higher-level thinking questions (i.e., analyze, evaluate, create), as compared to the question stem prompt. Nonetheless, the fact that no questions generated along the 'signal words plus the answer is' procedure prompt were at the highest create level should be noted.

4.1 Suggestions for Instructors and future Studies

Based on the findings of this study, instructors are advised to carefully consider the integration of a specific procedural prompt while remaining attentive to the level of experience of the students and their degree of familiarity with the SGQ activity.

Due to the small sample size and short duration of this study, the generalizability of the results obtained may be limited. Future studies with a larger sample size, longer duration, and possible order effects can be examined. Moreover, the fact that a high percentage of questions generated along the question stem procedural prompt fell in the low cognitive level (i.e., remember and understand) deserves to be understood because it contradicted what would be expected from generic question stems — prompting higher-order thinking and questioning on the part of the learner (King, 1990, 1995). Also could be further examined is the cognitive levels of SGQs and the generic question stems adopted. In addition, besides the currently investigated procedural prompts, the comparative effects of other

procedural prompts such as 'main idea, 'question types,' and the 'story grammar category' suggested by Rosenshine, Meister, and Chapman (1996) and the 'what if' strategy suggested by Brown and Walter (2005) in terms of inducing students to generate high cognitive level questions in an SGQ activity are worthy of examination. Finally, possible person effects, that is, the effects of different procedural prompts on learners at different academic achievement levels (e.g., English language ability) can be explored.

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