Rodrigo, M. M. T. et al. (Eds.) (2021). Proceedings of the 29th International Conference on Computers in Education. Asia-Pacific Society for Computers in Education

The Learning Potential of Online Student-Generated Questions Based on Given Graphics for English Language Learning

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Abstract: The student-generated questions approach has received increasing attention over recent decades, and empirical evidence has generally substantiated its positive learning effects. Despite this, existing evidence mostly comes from studies involving students generating questions based on a given text. Since different structures and information specifications are revealed when materials are presented graphically and textually, the learning potential of student-generated questions based on given graphics was the focus of this study. Specifically, both quantitative and qualitative data on the relative learning usefulness of student-generated questions based on given graphics versus text was collected from two classes of sixth-graders (N=47) learning English. Five major findings were obtained. First, comparatively, significantly more participants voted for student-generated questions based on given graphics as better supporting their learning of English as compared to student-generated questions based on given text. Second, the X^2 test on the perceived learning usefulness of the two approaches was statistically significant, $X^2 = 8.34$, $p < .001$. Thirdly, the constant comparative method conducted on the explanatory reasons highlighted two learning effects associated with student-generated questions based on given graphics: facilitating the target word to be better understood and memorized, with 'associative links' and 'prompting' noted as the underlying mechanism. Fourth, the learning usefulness associated with student-generated questions based on text focused on its facilitating effects on memorizing the spelling of the target word. Finally, the distinct affordances associated with student-generated questions based on stimulus given in graphics and text forms, respectively, were recognized by those expressing similar perceptions toward the two forms, which tap into different important aspects of the learning of vocabulary in second language learning, namely, pronunciation, spelling, and meaning. Limitations of this study, including order effects, data obtained mainly based subjective evaluation, and vocabulary as the content-to-be-learned are highlighted, and suggestions for future studies are provided.

Keywords: English language learning, graphics as a stimulus, online learning activity, perceived learning potential, student-generated questions

1. Introduction

Currently, the idea of enabling learners to be knowledge producers (rather than knowledge consumers) has been embraced by educators at various educational levels (Persada, Ivanovski, Miraj, Nadlifatin, Mufidah, Chin, & Redi, 2020; Snowball & McKenna, 2017). Studies involving learner production of instructional materials and learning objects (i.e., the learner-generated content approach) have evidenced increasingly wide acceptance of the student populations in different educational contexts (Hubbard, Jones, & Gallardo-Williams, 2019; Orús, Barlés, Belanche, Casaló, Fraj, Gurrea, 2016). Over recent decades, among the various possible forms, student-generated questions have received growing attention from both practitioners and researchers as an efficacious approach for teaching, learning and assessment (Yu, Wu, & Hung, 2014).

Rather than relying on teachers as the question-author as has been conventionally done, the student-generated questions approach accentuates the pedagogical value of having students play the role of the question-author for a benign change (Yu & Wu, 2020). Being entrusted with this empowering role and new task, students are believed to focus on areas of importance and relevance in the learning material as targets of question-generation throughout the learning process (Yu, Wu, & Hung, 2014). In

general, empirical evidence has substantiated the positive effects of learner-generated questions in terms of promoting cognitive, affective, and social development (Yu & Wu, 2020). Despite its overwhelming success, an analysis of existing studies reveals that most research on student-generated questions deals with situations where students were directed to generate questions based on a given text (e.g., a specific given question, a reading passage, etc.). The learning potential of question-generation based on a picture, chart, or table (that is, the semi-structured problem-posing situation as classified by Stoyanova and Ellerton) (1996) is yet to be exploited and fully understood.

As suggested and substantiated by researchers in the communication and multimedia field, message conveyed in text and graphics forms tend to elicit different cognitive and emotional reactions in the message-receivers (Clark & Mayer, 2011). Non-verbal information is distinctive in terms of attracting attention, illustrating complex processes, and visualizing abstract content (Burnye, Ditman, Augustyn, & Mahoney, 2009; Lenzner, Schnotz, & Müller, 2013; Wylie & Chi, 2014). In light of their differences, instructional materials usually contain verbal as well as non-verbal content (Ainsworth, 1999).

Taking into consideration that different information structures and specifications will be revealed by stimulus materials presented in the form of graphics and text, as well as the fact that today's learners are born in the digital age and are thus used to a media-rich learning environment (Prensky, 2001), the learning potential of student-generated questions based on given graphics serves as the focus of this study. Specifically, students' perceptions of the learning usefulness of student-generated questions based on given graphics versus text are examined in the present work.

2. Methods

2.1 Participants and Context

A group of students from two sixth-grade classes (N = 47) in a single elementary school were invited to participate in an online student-generated questions activity during their normal 40-minute computer literacy class. The integrated online learning activity was introduced to help enrich student English learning. Particularly, vocabulary was targeted in these sessions in view of its instrumental role in learning a foreign language (El-Nekhely, El-Dien, Al-Hadi, & Khodary, 2019; Folse, 2004), its facilitating effects for the mastery of four language skills (Herman & Dole, 1988), and its importance to school overall academic performance (Blachowicz, Fisher, Ogle, & Watts-Taffe, 2006).

2.2 Online Learning Activity and Study Procedures

An online learning system developed by the research team led by the author (Yu, 2021) was adopted to support the learning activity for a duration of nine weeks. As a routine, after attending four 40-minute instructional sessions on English in a two-week time-frame, the participants headed to the participating school's computer lab for the online learning activity.

This study consisted of three main phases: training (Phase I), student-generated questions based on given text (i.e., a set of vocabulary covered in the current lesson) (Phase II), and student-generated questions based on given graphics (i.e., the same set of vocabulary covered in the current lesson but depicted in a pictorial form) (Phase III). Each of the phases was briefly explained.

During Phase I (i.e., the training session), firstly, an explicit framework devised by the author was introduced, and steps involved in generating questions (in the form of three hints) by referring to this framework for vocabulary of one's choice was explained. As can be seen, the devised framework aims to help the participants focus on the various important aspects of English vocabulary — spelling, pronunciation, meaning, and related words (i.e., at least three words or phrases that would be meaningfully associated with the vocabulary).

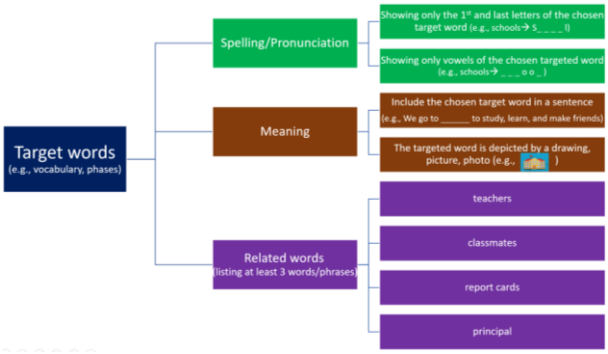

Figure 1. The Framework Devised in Support of Student-generated Questions (in the Form of Hints) for English Learning.

As shown in Figure 1, a set of three hints generated for the vocabulary of 'school' could be (1) s_ _ _ _ l or _ _ _oo__; (2) We go to _ _ _ _ _ _ to study, learn, and make friends, or a graphics of student's choice to depict schools; (3) teachers, classmates, report cards, and principal. Another illustrative example generated by one of the study participants for the vocabulary of 'play basketball' was:

(1) p_ _y b_ _ _ _ _ _ _ _ _l

(2) 

(3) NBA, dribble, shoot, Michael Jordan

Afterwards, the criteria for good student-generated questions and the operational procedures involved in navigating the adopted online system were explained. Criteria of good student-generated questions introduced during the training session include: correct spelling, no grammatical errors, and hints helping build meaningful word links to the vocabulary, among others. The training session concluded with a brief practice session on student-generated questions in the system.

During both Phases II and III (a total of four sessions), for each session the participants were directed to generate three questions, each of which consisted of a set of three hints for the vocabulary covered in English class. The only difference is that during Phase II, the vocabulary for question-generation were presented in text form (the left of Figure 2), whereas during Phase III, they were presented in a graphics form (the right of Figure 2). In other words, the participants in this study generated questions with reference to a set of vocabulary, which served as stimuli and were presented in either text or graphics forms.

Figure 2. Phase II: Online student-generated questions based on given text (left); Phase III: online student-generated questions based on given graphics (right).

After the conclusion of the last online student-generated questions session, one closed-ended question with explanations for one's selection was distributed to solicit the participants' views towards the relative learning usefulness of online student-generated questions based on given text and graphics — which of the two question-generation approaches do you think better promote your learning of English vocabulary covered during this study: student-generated questions based on given text, student-generated questions based on given graphics, both at about the same level. Explain your selection.

3. Results and Discussion

As shown in Table 1, nearly half of the participants regarded 'online student-generated questions based on given graphics' as better promoting their learning of English vocabulary. Comparatively, significantly fewer participants voted for 'online student-generated questions based on given text,' and more than one-third of the participants felt that the two approaches 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, $X^2 = 8.34$, $p < .001$.

Table 1. *Descriptive and Inferential Statistics for Student-Perceived Learning Usefulness of Online Student-Generated Questions Based on Given Text and Graphics* (*N*=47)

	SGQ* based on given text *f* (%)	SGQ* based on given graphics *f* (%)	About the same level *f* (%)	X^2	*p*
Learning usefulness	7 (14.89%)	23 (48.94%)	17 (36.17%)	8.34	.01

*SGQ: student-generated questions

The constant comparative method proposed by Lincoln and Guba (1985) was adopted to analyze the descriptive explanations provided by the participants accompanying their selections. Mainly, two processes were involved for the analysis of the descriptive data collected — unitizing and categorizing, for which several steps were involved. First, each and every data entry was read closely and repeatedly to gain a broad sense of the rendered responses. Second, the words, phrases, and/or sentences that captured the key ideas/concepts of individual messages were highlighted (by underlying or circling), and the first impression or thoughts on the data were written on the side of each entry. Third, individual code labels that emerged from the text as the initial coding scheme with definitions were compiled. Fourth, the derived coding scheme underwent several rounds of revisions/refinement, and a final set of categories was set until the resultant categorizations were mutually exclusive, and complete consistency was achieved. The main themes emerged for each of the three options are presented and discussed separately below.

First, for those rooting for student-generated questions based on given graphics, two salient features emerged, and both evolved around learning effects. Specifically, more than half of this group of participants (*N*=13) highlighted the beneficial effects of graphics for helping the vocabulary in target to be 'better understood' while more than one-fourth of this group (*N*=6) noted graphics facilitating effects for 'memorization.' Although most of the respondents did not elaborate on the underlying mechanism for the perceived learning gains, three made explicit remarks on 'the associative link' that graphics offered, and two wrote about graphics prompting them to the question-generation task that they would not otherwise do. The associative link noted by the participants reflected on the 'referential connections' put forth in Paivio's (2001) dual coding theory. Simply put, dual coding theory highlights the essential role of forming and establishment of referential connections between verbal and nonverbal representations for facilitating future retrieval from memory and better comprehension and learning on the part of learners (Clark & Paivio, 1991). The prompting effects noted by the participants resonated well with what multimedia researchers have noted about the ability of non-verbal messages to attract attention (Wylie & Chi, 2014) and elicit emotional reactions (Clark & Mayer, 2011).

As for those supporting student-generated questions based on given text, one major theme emerged. Specifically, more than half of this group of participants (i.e., four out of seven) pinpointed that a given text (acting as a stimulus for online student-generated questions) helped them memorize the spelling of the target word. It should be noted that two participants from this group commented on the explicit nature of the text, which helped eliminate a lack of clarity, which may be the case for graphics. In other words, the definite and explicit nature of the text in terms of directing the learners' attention to the task (i.e., generating questions for vocabulary) was noted and appreciated by those leaning toward student-generated questions based on text acting as stimuli.

Finally, for those feeling both forms provided similar support for learning, one major theme was revealed, pointing to the benefits provided by the respective forms. Specifically, five of this group of participants revealed that the text form helped the spelling and pronunciation of vocabulary to be better learned while the graphics form helped vocabulary to be 'easier,' 'better understood,' or

remembered due to 'the situational context revealing within the graphics.' In other words, the meaning aspect of language learning was supported better by the graphics whereas the spelling and pronunciation aspects of language learning were tapped better by the text.

4. Conclusions

As found in this study, comparatively significantly more participants voted for student-generated questions based on given graphics as better supporting their learning as compared to given text. The explanatory reasons the participants provided shed further light on the distinct affordances associated with student-generated questions based on a given text and graphics. To summarize, as revealed based on the constant comparative method, two learning effects were highlighted by the participants voting for the graphics form: facilitating the target word to be better understood and memorized, with associative links and prompting noted as the underlying mechanism. Alternatively, the learning usefulness of the text form centered on helping students to memorize the spelling of the target word. Finally, the benefits associated with the two different forms were recognized by those expressing similar perceptions towards the two forms, which helped to tap into different important aspects of vocabulary learning in second language learning, namely, pronunciation, spelling, and meaning.

4.1 Limitations of This Study

Although the results of this study revealed some distinctive aspects of online student-generated questions based on given text and graphics, and the participants were found to associate different learning gains related to question-generation based on the two different given stimuli, some limitations of this study should be noted.

First, order effects may be in existence. As described, Phase 2 (student-generated questions based on give text) and Phase 3 (student-generated questions based on graphic) in this study were fixed. It is possible that after exposure to Phase 2, the participants may naturally become more familiar and proficient at the question-generation task during Phase 3, and thus regarded student-generated questions based on graphic as more effective.

Second, data in this study were based on the participants' subjective rather than objective evaluation.

Third, in this study, English vocabulary learning was the focus. As can be expected, if grammars (i.e., subjects of an abstract nature) were the to-be-learned content, the perceived learning usefulness of text versus graphics may alter. This is especially relevant when noting the respective distinct features of text and picture representations. As pointed out by Schnotz (2014), text is suited for description and explication of abstract concepts whereas graphics are equipped at portraying and depicting concrete objects in a holistic matter (e.g., the size, color, details of the targeted object).

4.2 Suggestions for Future Study

In light of the preliminary nature of this study and the findings obtained, suggestions for future study are offered. First, studies attending to order effect (via conducting Phase II and Phase III alternately), collecting data on learning performance based on objective assessment (e.g., academic achievement, student question-generation performance, etc.), and extending to different focus of language learning (e.g., grammar) would be warranted.

Additionally, issues regarding if there are any differential learning outcomes between the text and graphics forms await further investigation in the future. As noted by the participants in this study, student-generated questions based on given graphics and text may reveal different degrees of information specifications, which may prompt learners to engage at different levels. Therefore, their comparative effects on engagement with a task, learning motivation, academic emotions, and academic performance would be a topic worthy of examination via an experimental research method.

Finally, this study examined the relative learning potential of student-generated questions based on a given text and graphics. Considering that instructional materials usually contain both verbal and non-verbal content for the purpose of better communication while striving to attain complementary or mutually reinforcing functions (Ainsworth, 1999), the effects of student-generated questions based on a given text, graphics, and text alongside graphics on learning would be an interesting extension to be

examined in the future.

Acknowledgements

This study was supported by the Ministry of Science and Technology in Taiwan (MOST 108-2511-H-006-007-MY3). Thanks are extended to Zi-Yu Hsu for serving as the research assistant to collect the data reported in this work.

References

Ainsworth, S. (1999). The functions of multiple representations. *Computers & Education, 33*, 131-152.

Blachowicz, C., Fisher, P., Ogle, D., & Watts-Taffe, S. (2006). Theory and research into practice: Vocabulary: Questions from the classroom. *Reading Research Quarterly, 41*(4), 524-539.

Burnye, T. T., Ditman, T., Augustyn, J. S., & Mahoney, JC. R. (2009). Spatial and nonspatial integration in learning and training with multimedia system. Zheng, R. Z (Ed), In *Cognitive effects of multimedia learning* (pp. 108~133). Hershey, PA: Information Science Reference.

Clark, R., & Mayer, R. (2011). *E-learning and the science of instruction*: *Proven guidelines for consumers and designers of multimedia learning* (3rd ed.). San Francisco, CA: John Wiley & Sons.

Clark, J. M., & Paivio, A. (1991). Dual coding theory and education. *Educational Psychology Review, 3*, 149-210.

El-Nekhely, M. A. E., El-Dien, A. H. S., Al-Hadi, T. M. & Khodary, M. M. (2019). Using pictorial stories for the acquisition and retention of English vocabulary in kindergarten. Retrieved from https://journals.ekb.eg/article_87526_e8d3815c0517edf1074d2e0fbe2d711c.pdf DOI: 10.21608/jfes.2019.87526

Folse, K. (2004). The underestimated importance of vocabulary in the foreign language classroom. *Language Teaching Research, 12*(3), 329–363.

Herman, A. & Dole, J. (1988). Theory and practice in vocabulary learning and instruction. *The Elementary School Journal, 89*(1). https://doi.org/10.1086/461561

Hubbard, B. A., Jones, G. C., & Gallardo-Williams, M. T. (2019). Student-generated digital tutorials in an introductory organic chemistry course. *Journal of Chemical Education, 96*(3), 597-600.

Lenzner, A., Schnotz, W., & Müller, A. (2013). The role of decorative pictures in learning. *Instructional Science, 41*, 811-831.

Lincoln, Y. S. & Guba, E. G. (1985). *Naturalistic inquiry*. Beverly Hills, CA: Sage Publications.

Orús, C., Barlés, M. J., Belanche, D., Casaló, L., Fraj, E., Gurrea, R. (2016). The effects of learner-generated videos for YouTube on learning outcomes and satisfaction. *Computers & Education, 95*, 254-269.

Paivio, A. (2001). *Mind and its evolution: A dual-coding approach*. Mahwah, NJ: Erlbaum.

Persada, S. F., Ivanovski, J., Miraj, B. A., Nadlifatin, R., Mufidah, J., Chin, J., & Redi, A. A. N. P. (2020). Investigating generation Z' intention to use learners' generated content for learning activity: A theory of planned behavior approach. *International Journal of Emerging Technologies in Learning, 15*(4), 179-194

Prensky, M. (2001). Digital natives, digital immigrants. *On the Horizon 9*(5), 1-6.

Schnotz, W. (2014). Integrated model of text and picture comprehension. In R. E. Mayer (Ed.), *The Cambridge handbook of multimedia learning* (pp. 72–104). (2nd ed.). Cambridge: Cambridge University Press.

Snowball, J. D., & McKenna, S. (2017). Student-generated content: An approach to harnessing the power of diversity in higher education. *Teaching in Higher Education, 22*(5), 604-618.

Stoyanova, E. & Ellerton, N. F. (1996). A framework for research into students' problem posing in school mathematics. *Proceedings of the 19th Annual Conference of the Mathematics Education Research Group of Australasia* (MERGA), June 30 - July 3, 1996 at the University of Melbourne.

Wylie, R., & Chi, M. T. H. (2014). The self-explanation principle in multimedia learning. In R. E. Mayer (Ed.), *The Cambridge handbook of multimedia learning* (pp. 413–432). Cambridge University Press.

Yu, F. Y. (2021). Development and preliminary evaluation of the learning potential of an online system in support of a student-generated testlets learning activity. *Proceedings of the 29th International Conference on Computers in Education*. November 22-26, Bangkok, Thailand.

Yu, F. Y. & Wu, W. S. (2020). Effects of student-generated feedback corresponding to answers to online student-generated questions on learning: What, why, and how? *Computers & Education, 145*, 103723.

Yu, F. Y., Wu, C. P., & Hung, C-C (2014). Are there any joint effects of online student question generation and cooperative learning? *The Asia-Pacific Education Researcher, 23*(3), 367-378.