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Application-driven Educational Game to Assist Young Children in Learning English Vocabulary

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ABSTRACT

This paper describes the development of an educational game, named My-Pet-Shop, to enhance young children's learning of English vocabulary. The educational game is underpinned by an application-driven model, which consists of three components: application scenario, subject learning, and learning regulation. An empirical study is further conducted with 30 fourth-grade students to examine its influence on the aspects of performance, flow, self-regulation, and behavior related to learning. The results demonstrated that the system contributed to enhanced flow experience and better learning self-regulation when compared to using a quiz game system without the support of the application-driven model. In addition, behavior analysis revealed that the component of learning regulation played a critical role. Some implications about the application-driven model and its future development are also discussed.

Keywords

Application-driven model, Vocabulary learning, Educational games, Children

Introduction

The learning of new vocabulary items plays a fundamental role in mastering any foreign language, including students struggling to learn English as a second language (Nguyen & Khuat, 2005). However, it has been found that rote learning can be boring and it is difficult for students to remain interested and engaged in such learning activities. In addition, it has also been reported that it is better for knowledge acquisition to occur in meaningful contexts, not separated from the learning situations. To overcome these types of problems, more and more studies (Huang & Yang, 2012; Yip & Kwan, 2006) seek to incorporate digital games with learning scenarios to support language learning, which often involves a virtual world to allow students to explore every place or interact with each other (Toscano et al., 2015; Chien et al., 2013). In other words, such an interactive environment can create various scenarios to enrich students' learning experience (Lin & Lan, 2015). In this way, students can be situated in a 3D multi-user environment to communicate with computer-simulated characters or interact with other students for learning foreign language (Di Blas & Paolini, 2014; Ibáñez et al., 2011).

These types of educational games have the potential to enhance students' participatory motivation and provide meaningful contexts (Schultz & Fisher, 1988). Thus, research efforts are made to apply digital games to English language learning and to systematically examine their influence and benefits. For instance, Chen and Yang (2013) developed an adventure game aimed at assisting college students with second language acquisition. Their results indicated that such games could stimulate student motivation and further foster their reading, listening, and vocabulary skills. In another study, a multiplayer game was developed for the promotion of English language learning, where native and non-native adolescent speakers interacted through avatar-embodied collaboration (Zheng et al., 2009). The results demonstrated several potential benefits for students in the game-based environment. Chen and Tsai (2009) developed a location-based game for the promotion of English learning at the college level, where as part of the game students received learning scenes based on their locations with mobile devices. The results indicated that using this type of game-based system could increase students' interest and willingness to learn.

Although the aforementioned studies do offer encouraging findings, most studies have primarily examined the influences on student motivation and performance (Pesare et al., 2016; Toscano et al., 2015; Tsai, Yu, & Hsiao, 2012; Kebritchi, Hirumi, & Bai, 2010; Papastergiou, 2009), ignoring learning behavior and meta-cognition aspects. In addition, most of them focused on learning by adolescent or college students, rather than young students. Thus, there is a need to extend this type of investigation to understand how game-based learning can support young students' English language learning, especially from the aspects of learning behavior and self-regulated learning. More specifically, self-regulated learning (Schunk & Zimmerman, 1998) has been attracting increasing attention because it offers a theoretical foundation for the development of metacognitive strategies. Its significance has led to the incorporation of self-regulation into different learning technologies. For instance, some studies have used the Internet and hypermedia technologies to promote the application of strategies of self-regulated learning in a web-based learning system (Narciss et al., 2007). Social media and communication technologies have also been adapted to provide the necessary support for promoting self-regulated learning (Shih et al., 2010; Elgort et al., 2008). In addition, several researchers have investigated the application of mobile and wireless technologies to explore new learning possibilities from the perspective of self-regulated learning (Sha, Looi, Chen, & Zhang, 2012; Sha et al., 2012; Shih et al., 2010).

Although digital games have come to be accepted as a useful learning technology (Qian & Clark, 2016; Jabbar, & Felicia, 2015; Gee, 2003), it is still unclear how digital games can support self-regulated learning in younger students, and what their comprehensive influence on student learning would be. In this vein and to address some of these issues, an educational game-based system, My-Pet-Shop, is developed to assist elementary students with the learning of English vocabulary. The study examines the use of a digital game to offer students more opportunities to practice English vocabulary. Additionally, an empirical study is conducted to investigate its comprehensive influence. Specifically, this study seeks to answer two questions: (1) *How do we develop a learning system to support young students' English vocabulary learning?* (2) *What are the comprehensive influences of such a learning system in terms of performance, flow, self-regulation, and behavior?*

My-Pet-Shop system

The My-Pet-Shop system is developed based on an application-driven model comprised of three components: application context, subject learning, and learning regulation, as illustrated in Figure 1. More specifically, the model first assesses students' applicability in set of learning scenarios, and then promotes their awareness of learning status via visual representation, and encourages them to improve learning status.

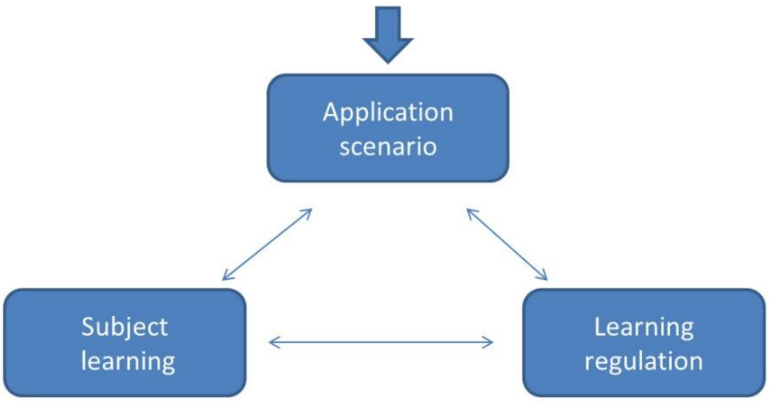

Figure 1. Conceptual diagram for the application-driven model

Application scenario

For application scenario, the purpose is to drive student learning through scenario-based learning (Clarke, & Mayer, 2011; Clark, 2009; Kindley, 2002). It is assumed that learning should be situated in a specific context, or embedded in a particular social and physical environment, rather than carried on out of context (Kindley, 2002). Underpinned by situated learning theory (Lave & Wenger, 1991), scenario-based learning first offers students in authentic scenarios, allowing them to integrate the knowledge and skills needed in this context, instead of offering decontextualized knowledge such as is the case with rote learning (Clarke, & Mayer, 2011). Scenario-based learning advocates learning in concrete situations and by examples. Such attempt is realized by two mechanisms: pet-shop scenarios and response tracing.

- Pet-shop scenarios: the students in the My-Pet-Shop system play the role of "shop manager" who needs to satisfy the needs of computer-simulated customers, and interact with them in different scenarios. Specifically, customers go to the pet-shop to ask for different services, such as buying food to feed their pets, taking their pets for grooming, or seeking medical attention (see Figure 2). In other words, in these situations, the students are required to apply appropriate vocabulary to respond to the customers via a set of multiple-choice questions. The students need to choose the correct word in the given scenario. Therefore, the application scenario offers situations for the students to apply what they have learned.

- Response tracking: while the students choose a word as an answer in the multiple-choice question, whether their choices are correct or not are recorded. Those responses could serve as indicators to further analyze students' learning status and understanding. More specifically, the mechanism of response tracking is a fundamental function that enables the My-Pet-Shop system to conduct data analysis, and show in a visual way (see data visualization), or offer possible warning (see color-coded warning), suggestions for improving the learning status (see learning suggestions)

Figure 2. Snapshot of some of the application scenarios in My-Pet-Shop

Learning regulation

The purpose of learning regulation is to promote students' awareness of self-regulated learning (Schunk & Zimmerman, 1998) by emphasizing the regulation of effort in three cyclic phases: forethought, performance, and self-reflection. More specifically, the forethought phase involves goal-setting, strategy selection and resource allocation. In the performance phase students monitor task performance, while in the self-reflection phase they assess their learning outcomes and regulate their learning efforts. Self-regulation is a significant learning strategy, because it can contribute to students' meta-cognition. Such attempt is realized by two mechanisms: data visualization and color-coded warning.

- Data visualization: to enhance the student's awareness of regulated learning, the My-Pet-Shop system allows students to monitor their learning status via visualization tools: a reporting table that illustrates their learning status based on the system logs for students' answers in the application scenarios. For instance, their responses (correct or incorrect) are analyzed to further present their mastery level of vocabulary knowledge in this reporting table (see Figure 3). More specifically, this mechanism will show students' learning status based on the mechanism of response tracking to make students easily understand their learning status.

- Color-coded warning: to empower the data visualization, a color-coded warning mechanism is further used to present students' the mastery levels of vocabulary knowledge in different colors: green means "mastered"; yellow means "could-be-better"; red means "not mastered," and gray indicates "not attempted." This warning mechanism offers a complete picture so that the students can quickly and easily understand their learning status, and regulate their learning. In addition, students can also observe what they have learned and have not learned, which might deliberate the gap between what they have planned (goal), what they do (performance), and what they obtain (outcomes). Thus, they are encouraged to become self-regulated learners.

Figure 3. Snapshot of the learning regulation table used in My-Pet-Shop

Subject learning

The purpose of subject learning component is to offer students more opportunities for distributed practice (Kapp, 2012), where the learning materials are broken up into a set of short sessions. Distributed practice is widely used in the gamified learning or instruction settings, emphasizing students' learning efforts over multiple sessions, where each session focuses on the subject matter to be learned, instead of rote memorization or cramming. Such attempt is realized by two mechanisms: theme-based tasks and learning suggestions.

- Theme-based tasks: in the My-Pet-Shop system, each English word item is designed as pet goods requiring to be packed (see Figure 4). Thus, to have better quality goods for their management, the students need to learn these English word items. Additionally, according to dual-coding theory (Clark & Paivio, 1991), materials are easier to learn when presented visually and verbally. Thus, in addition to illustrating the pictures of word items (i.e., imagery channel), the pronunciation (i.e., verbal channel) is also offered in the theme-based learning. When students click the vocabularies in the list, they can see the illustration of the word and hear the pronunciation. Although both of application scenarios and subject learning offer opportunities for students to learn, a major difference between them lies in that the former focuses on the application usage of words in specific situation, and the latter highlights the basic learning and practice for each word one-by-one.

Figure 4. Snapshot of a subject learning scenario in My-Pet-Shop

- Learning suggestions: in addition to the learning flows based on the themes, the students can also learn these words according to the learning suggestions, which are analyzed based on the aforementioned color-coded warning mechanism. Precisely, the list will show the words that belong to the master level of yellow (i.e., could-be-better) and red (i.e., not mastered) to suggest students master them first. In this way, they can have better performance in the application scenarios in the future.

Method

A quasi-empirical experiment was conducted to investigate the influence of the My-Pet-Shop system. Two different learning systems (i.e., the My-Pet-Shop system and a quiz game) were developed and their influence on student learning was examined.

Participants

In total, 30 fourth-grade elementary students (approximately 10-years-old on average) from two classes at an elementary school in Taiwan participated in the quasi-experiment. The elementary school had a policy of normal distribution and randomly assigned students on that basis to classes at the start of the school year to make sure that each class included students with various levels of background and knowledge. Accordingly, it can be assumed that the students in each of the two classes had uniform learning backgrounds and learning abilities. The two classes were randomly assigned to either an experimental group (EG, n = 15) who used the My-Pet-Shop, or the control group (CG, n = 15) who used a quiz game. Table 1 shows the number of students in the two groups.

Table 1. Number of students in the two groups

Groups	Number of students
Experimental group (EG)	15
Control group (CG)	15

System instruments

Both of the learning systems used in the experiment included 60 English words as the subject domain. The major difference between the two systems lay in the type of game it was. Thus, the My-Pet-Shop system used in EG was developed based on the application-driven model, where the pet-shop scenarios drove students to master English vocabulary items. On the other hand, the quiz game (My-Pet-Rush) used in CG was developed with the same subject learning. The differences between the two systems are summarized in Table 2 and Figure 5.

Table 2. Interventions between the two systems

	My-Pet-Shop	My-Pet-Rush
Application scenario	O	X
Learning regulation	O	X
Subject learning	O	O

Figure 5. Use of the two different systems

Procedures

The procedures employed are illustrated in Figure 6: (1) before the experiment, students were asked to take a performance pre-test. Then, they were given 5 minutes of instruction on how to use the system; (2) as noted above the two groups used different systems. The experimental group used the My-Pet-Shop for two 35-minute sessions over two weeks while the control students used My-Pet-Rush for the same number and length of sessions; (3) at the end of the experiment, students were asked to take another performance test, the post-test. In addition, they were also asked to fill out the flow and self-regulation scales.

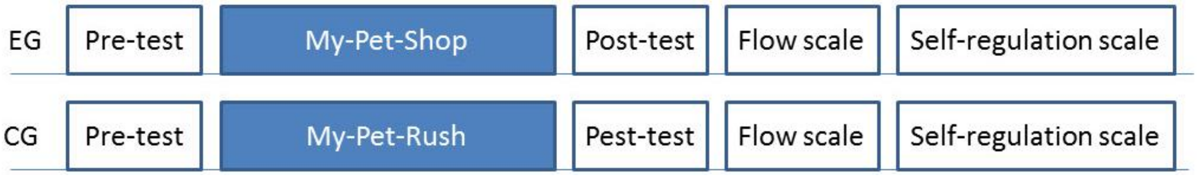

Figure 6. Experimental design

Data collection

- Performance: To measure the participants' learning performance, two performance tests were developed by the second author of this paper, a pre-test and post-test. Each test contained 18 items, where students were asked to choose the correct answer from four choices for a given picture. To prevent rote learning, the items in the two tests had similar levels of difficulty but were different. The tests were scored in the range from 0 to 100. In addition, to increase the validity of the achievement test, a pre-service elementary school teacher was asked to proof-read the sentences, to make sure that items were appropriate and that students could easily understand them.

- Flow experience: To assess the students' motivation status, a flow scale modified from EGameFlow (Fu et al., 2009) was used. The scale consisted of six dimensions: concentration (2 items), goal clarity (2 items), feedback (2 items), challenge (2 items), autonomy (2 items), and immersion (2 items). Each item was scored on the 7-point Likert scale, ranging from "strongly disagree" (point = 1) to "strongly agree" (point = 7). The reliability (Cronbach's alpha) of the scale was 0.79.

- Self-regulation: To understand the influence of self-regulation, we adopted a Chinese version of the self-regulation scale used by Lee (2006) for fourth-grade elementary student English learning. The scale contained three dimensions, including forethought (14 items), performance (12 items), and self-reflection (5 items). Each item was scaled on the 5-point Likert scale, ranging from "strongly disagree" (point = 1) to "strongly agree" (point = 5). The Chinese version of the self-regulation scale had an appropriate reliability (Cronbach's alpha = .85).

- Behavior: To trace behavior patterns in the My-Pet-Shop system, the students' behaviors were further recorded in system logs using the "index-user-behavior" format, where "index" is an automatically increasing number that identifies the order of the behaviors; "user" refers to the name of the student; "behavior" refers to the function that the student has used. The system logs are further analyzed using a coding scheme to record their behaviors in the three components. To be more specific, the coding scheme contains three codes that represent students' locations and actions in the three components, including Application scenario (A), Subject learning (S), and Learning regulation (L). For a detailed description see Table 3.

Table 3. Coding scheme used in this study

Code	Behavior	Description
A	Application scenario	Students complete the task-based activities and accomplish the given learning tasks.
S	Subject learning	Students buy pet food, items, or related services that can make their virtual pets healthy and strong.
L	Learning regulation	Students feed or equip their pets so that their pets have a greater chance of winning the competition.

Data analysis

The independent variable was the learning system, each with two levels, whereas the dependent variables were the influences of the systems on student learning, including performance, flow, self-regulation, and behavior. Three different analyses were carried out: (1) paired-sample *t*-tests for the two groups were conducted to examine the differences regarding the performance tests, the flow scale, and the self-regulation scale. (2) In addition to t-tests, a performance test was further carried out by one-way analysis of covariance (ANCOVA) to examine the differences between the two groups, with system instruments as the independent variable, pre-test scores as the covariant, and post-test scores as the dependent variable. (3) Sequential analysis of coded behaviors based on a time sequence (Jeong, 2005; Bakeman & Gottman, 1997) was conducted to explore behavior patterns.

Results

Performance

The means and standard deviations (*SD*) for the pre-tests and the post-tests in each group are presented in Table 4. The results of the *t*-tests revealed that the scores of the post-test were significantly higher than those of the pre-test in both EG ($t = 6.72$, $p < .01$) and CG ($t = 7.72$, $p < .01$). The result implies that both of the systems were beneficial for enhancing student performance. In addition, a further ANCOVA results shows no significant difference between the post-test scores of the two groups. In other words, the My-Pet-Shop system did not have more enhanced impact on learning performance than the other system.

A possible explanation was that both of the systems contained theme-based materials, which might offer students opportunities to effectively improve their vocabulary learning. Thus, both of the students in EG and CG obtained significant improvement in the performance tests. This might be the reason why no significant difference existed between the two groups. In addition, although My-Pet-Shop had additional components (i.e., scenario application and learning regulation) that might be helpful for students' goal setting and reflection, this study is a short-duration experiment (only two 35 minutes sessions). It might be a possible reason for not revealing significant difference between the two groups.

Table 4. *t*-test performance test results

	Pre-test		Post-test		*t*
	Means	*SD*	Means	*SD*	
EG	79.33	12.93	95.67	7.71	6.72^{**}
CG	72.00	11.14	93.33	6.23	7.72^{**}

Note. $^{**}p < .01$.

Flow experience

Table 5 displays the mean and the *SD* for the six dimensions of the flow scale. Further *t*-tests were conducted to assess the impact of the two learning systems, and the results showed significant differences for four of the measures – Goal clarity, Feedback, Autonomy, and Immersion – between the two groups ($t = 2.48$, $p < .05$; $t = 2.52$, $p < .05$; $t = 2.49$, $p < .05$; $t = 3.10$, $p < .01$, respectively). The findings demonstrated that the My-Pet-Shop provided students with enhanced goals, feedback, autonomy, and immersion over the My-Pet-Rush system.

Table 5. *t*-test results for flow scale in terms of six dimensions

	EG		CG		*t*
	Means	*SD*	Means	*SD*	
Concentration	4.30	0.77	4.06	0.77	0.82
Goal clarity	4.56	0.53	4.03	0.63	2.48^{*}
Feedback	4.83	0.36	4.43	0.49	2.52^{*}
Challenge	4.56	0.49	4.40	0.78	0.69
Autonomy	4.40	0.71	3.73	0.75	2.49^{*}
Immersion	4.60	0.54	3.63	1.07	3.10^{**}

Note. $^{*}p < .05$; $^{**}p < .01$.

A possible explanation for this result was that various game types between the two learning systems (i.e., management and quiz games) resulted in such differences. More specifically, since the My-Pet-Rush (i.e., quiz game) asked students to choose a correct answer and then gave the feedback, students' positive perceptions might be thus enhanced. However, the My-Pet-Shop (i.e., management game) offered students two levels of goals: immediate and long-term goal. The immediate goal was to choose a correct answer for the given scenario, which was similar with what the quiz game provided. The long-term goal was concerning the management of the shop, which involved the status monitoring and effort regulation. The two levels of goal might make students perceive greater intensity of goal clarity, feedback, and autonomy, which, in turn, contributed to enhanced level of immersion.

Self-regulation

The mean and *SD* for the three dimensions of the self-regulation scale in the two groups are presented in Table 6. *t*-tests were conducted to evaluate the impact of the two learning systems on the three dimensions. The results showed a significant difference in two of the measures – Forethought and Performance – between the two systems ($t = 2.34$, $p < .05$; $t = 2.78$, $p < .05$, respectively). In other words, the findings demonstrated that the My-Pet-Shop system enhanced students' self-regulation in comparison to My-Pet-Rush in terms of forethought and performance.

A possible explanation was that the finding resulted from the major differences between the two systems: application scenarios and learning regulation, as illustrated in Table 2. More specifically, the My-Pet-Shop offered scenario-based learning, which offered students a global view to think what the requirements were, and what actions they needed to take. The scenario-based learning and the global view might benefit students' forethought. In addition, the My-Pet-Shop also offered students visualization-based report that could help students obtain more comprehensive understanding and monitoring on their learning status, which, in turn, resulted in better control and performance. This might be the reason why the performance aspect was enhanced in the My-Pet-Shop system. However, regarding the self-reflection aspect, although the means of two groups did not exist a significant difference, the mean of EG (i.e., 4.37) was greater than that of CG (i.e., 4.02), suggesting that students' self-awareness might be enhanced, but the intensity of self-reflection did not contribute to a significant difference in such a short period of time.

Table 6. *t*-test results for the self-regulation scale in terms of three dimensions

	EG		CG		*t*
	Means	*SD*	Means	*SD*	
Forethought	4.29	0.39	3.95	0.39	2.34^{*}
Performance	4.01	0.40	3.46	0.64	2.78^{*}
Self-reflection	4.37	0.41	4.02	0.96	1.28

Note. $^{*}p < .05$.

Behavior

Table 7 illustrates the transitional probabilities of student behaviors, with the starting behaviors appearing in the rows, and the subsequent behaviors in the columns. A Z-value greater than 2.32 implies that a behavior sequence has reached a level of significance of $p < .01$. The sequential behavior patterns are further illustrated in a transition diagram, as can be seen in Figure 7. The results indicated that (1) Application scenario → learning regulation forms an obvious pattern, and so does learning regulation → application scenario. Since the patterns involve the opportunities for application, it implies that such application scenarios would drive students to observe their learning status. (2) Subject learning → learning regulation forms an obvious pattern, as does learning regulation → subject learning. It appears that the reporting table acts as motivation encouraging students' vocabulary learning.

A possible reason to explain why no behavior pattern occurred between application scenario and subject learning was: learning regulation offered more information to guide them to improve learning. More specifically, on one hand, under the application-driven model, students would be first notified whether they were able to apply what they had learned to related situations. Thus, they naturally would like to comprehensively understand what their learning statuses were because it can help them regulate efforts to improve learning. On the other hand, learning regulation not only provided students a global view to monitor their status (i.e., data visualization), but also a micro view to highlight the vocabularies that need to be further remedial (i.e., color-coded warning). Thus, students preferred to use learning regulation after using the application scenario. This might be the reason why a behavior pattern occurred between application scenario and learning regulation, instead of that and subject learning.

Table 7. Transitional probabilities for the My-Pet-Shop system

	Learning regulation	Subject learning	Application scenario
Learning regulation	0.34	0.31	0.31
Subject learning	1	0	0
Application scenario	0.19	0.78	0.78

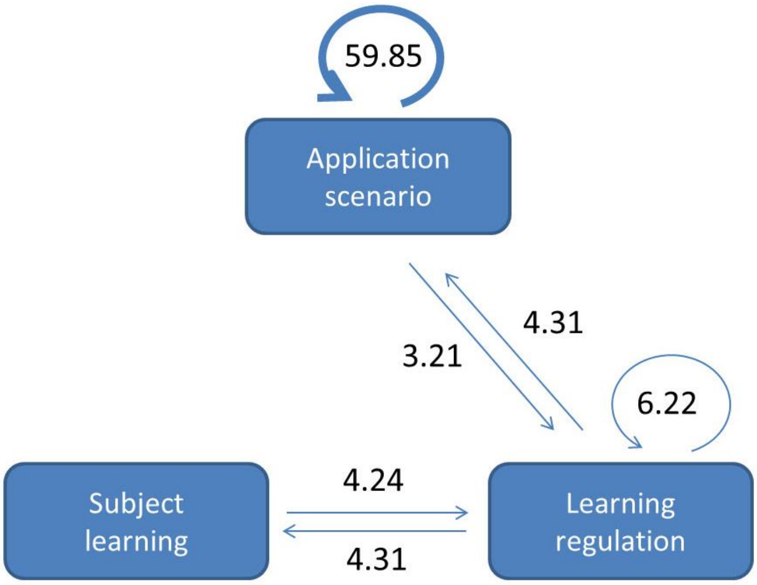

Figure 7. Behavior transfer diagram for the experimental group

Discussion

Impact of the application-driven model

Previous studies indicate that management games can help cultivate responsible attitudes in students, and encourage them to think, do, and regulate their learning (Griffiths, 2002; Keys & Wolfe, 1990). In the My-Pet-Shop system, students are asked to play the role of "managers" running a pet-shop in different application scenarios, which encourages them to learn how to be more responsible for what they do, and what they want to do. To be more specific, they need to plan their goals (e.g., to what extent do they want to master the vocabulary items), monitor their progress (e.g., whether they have used the appropriate vocabulary to respond to customers), and evaluate their results (e.g., how satisfied are the customers). They also need to judge the gap between the goal and the outcome, and further regulate their learning direction and effort exerted.

The findings of this study reveal that the application-driven model is helpful to facilitate the student flow experience (in terms of the goal clarity, feedback, autonomy, and immersion aspects), but does not contribute to learning performance. The application-driven model offers a variety of scenarios for students to apply what they have learned. Students can perceive clear goals and receive immediate feedback. Goals and feedback are key game elements (Paras, 2005) which are helpful to facilitating the flow and immersive experience, and also contribute to control and autonomy. All of this enhances the students' engagement experience.

Role of information visualization

In addition, the findings of this study also reveal that the application-driven model contributes to students' self-regulation in terms of the forethought and performance aspects. A close look into the analysis of behavior patterns shows that learning regulation is significantly related to both the application scenario and subject learning. In other words, this component (i.e., learning regulation) plays a significant role acting as the "bridge" between two other components. Actually, the learning regulation component provides an information visualization tool (i.e., color-coded reporting table) which enhances student awareness of their own learning. The results indicate the significance of this component in making students understand their current status which is critical in the process of self-regulation. This might be due to the fact that students need sufficient information to support their planning, decision-making, and strategy selection. When students are more aware of what they have and what they lack, they will have a clearer picture of where their future efforts should be directed—which is closely related to forethought and performance. Thus, harnessing the design of information visualization to promote students' forethought and performance might be a useful added-value feature for future development.

Moreover, the design of the color-coded reporting table is related to the technique of information visualization for the purpose of allowing students to easily interpret data for self-awareness (Bienkowski, 2012; Verbert, 2012; Duval, 2011; Govaerts, 2012). This is significant because making students be aware of their leaning status is critical to improving their learning (Bull & Kay, 2007), as in the open student model (Bull et al., 2009; Velez et al., 2009; Chen et al., 2007) where the data collected by educational systems are opened up to the students themselves. This "open" feature can help students be more aware of their current learning status and progress, so they can further reflect on what they have and have not learned. Thus, collecting and presenting more open data to students might be another future direction for system development.

Conclusion

This paper attempts to answer the two questions mentioned above. In response to the first (i.e., *How do we develop a learning system to support young students' English vocabulary learning?*), the My-Pet-Shop system is developed based on the application-driven model to support English vocabulary learning. The second question (i.e., *What are the comprehensive influences of such a learning system in terms of performance, flow, self-regulation, and behavior?*) is answered using the My-Pet-Shop system as an example. Its influence is evaluated by comparison with a quiz game system without the support of the application-driven model. The results showed that (1) the application-driven model offered students enhanced motivation in terms of the goal, feedback, autonomy, and immersion aspects; (2) the model was also beneficial to students' self-regulation in terms of the forethought and performance aspects; and (3) two obvious behavior patterns exist, both of which suggest that the learning regulation component plays a significant role.

The contribution of this study covers two aspects: theory and application. In terms of the theory, this study deepens the understanding of the importance of scenarios and visualization in the development of vocabulary learning systems. The findings of this study indicated that the two components could benefit young students' flow experience and self-regulation in some aspects. In terms of the application, this study proposes an application-driven model that can be practically used in educational settings. The model first assesses students' applicability (i.e., applying what they have learned to real situations), and then promotes their awareness of learning status (i.e., using visual representation to make them understand easily), and guides them to improve learning status.

However, this study has some limitations that should be further investigated in the future. First, the sample size is small, thus, further investigations with larger sample sizes are required. Second, although the results showed the learning systems to have a positive impact on students, this was merely a short-term study. The long-term effects are still unclear. Third, My-Pet-Shop is used as an example of an application-driven model, but cannot reflect the effects of all such learning system types although it does offer a starting point to investigate their impact. More learning systems and the consistency of the results should be examined in the future.

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