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Promoting science learning in game-based learning with question prompts and feedback

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ABSTRACT

The purpose of this study was to examine the effects of the types of question prompts (Knowledge vs. Application Prompts) and feedback types (Knowledge of Correct Response (KCR) vs. Elaborated Response (ER) on science learning outcomes in a game-based learning environment. One hundred and five students from a secondary school in Taiwan were randomly assigned into four conditions: Knowledge-KCR, Knowledge-ER, Application-KCR, and Application-ER in a game-based learning environment to learn the concepts of force and motion. The results suggested that students with the knowledge prompts outperformed students with application prompts. In addition, we found that the types of question prompts and the types of feedback had an interaction effect on students' learning. Specifically, students with ER feedback performed better than those with KCR feedback when knowledge prompts were given; however, students with KCR feedback performed better than those with ER feedback when application prompts were given.

1. Introduction

Although game-based learning (GBL) have received a lot of attention in education, the effectiveness of games on learning is still unclear. Some educational researchers support the use of educational games, (e.g., Tüzün, Yilmaz-Soylu, Karakus, Inal, & Kızılkaya, 2009), but others argue that game-based learning environments may not allow enough articulation and reflection on the target content knowledge for learning purposes (e.g., van der Meij, Albers, & Leemkuil, 2011). In a meta-analysis of GBL, Young et al. (2012) found inconsistent findings in GBL research in the context of science education. Some of the studies found that games had significant impacts on science learning, while some studies found insignificant relationships between GBL and science learning. They argued that the disconnection between games and actual science leads to those non-significant results. Therefore, it is important to include scaffold in educational games to encourage students to reflect on the content knowledge and bridge the knowledge between the game and real life (Young et al., 2012).

Young's conclusion of inclusion of scaffold in GBL is confirmed by other meta-analyses of GBL. For example, Ke (2009) suggested that instructional support features are necessary to foster learning in game-based learning environments; otherwise, learners will focus on the game, but not the knowledge to be learned through gameplays. Wouters, van Nimwegen, van Oostendorp, and van der Spek (2013) also found that games are more effective when they were supplemented with other

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instructions. They argued additional instructions in games including explicit practices could enable learners to articulate their knowledge. As a result, gamers would be able to integrate new knowledge with their prior knowledge. In another meta-analysis of instructional games, Sitzmann (2011) also found similar results that supplemental instructional methods could increase the learning effects of simulation games.

Recently, Barzilai and Blau (2014) examined the effect of external scaffold on game-based learning. In their study, students were provided two different types of external scaffolds. First, external study units (outside of the game) that explained the key underlying concepts of the game were given. Moreover, students were also provided the mathematical formula of relationships among the variables. They found that external scaffolds which were provided after the gameplay reduced perceived learning, and the learning outcomes of the groups with question prompts after gameplay was not significantly different from the control groups. Their study suggested that providing external scaffold such as question prompts in a GBL environment may or may not necessarily work. In order to strengthen the effects of external scaffolds, in the current study, we provided two types of question prompts and two types of feedback within question prompts to examine the effect of question prompts and feedback on science learning in a GBL environment.

1.1. Question prompts in GBL

Scaffolds embedded in games, such as cues and in-game feedback, have been found to be frequently used in GBL literature (Ke, 2016). Besides in-game scaffolds, external scaffolds, such as concept maps and classroom discussion outside of the game, have also been used to connect the game with the underlying knowledge of the game (e.g., Neulight, Kafai, Kao, Foley, & Galas, 2006; Peters and Vissers, 2004). One type of external scaffolds in GBL is question prompts. Question prompts can be used to guide learners to focus on specific tasks, to articulate thoughts, and to reflect their learning processes (Ge & Land, 2003). However, it is unclear what kinds of prompts should be provided and when to provide prompts to the students in game-based learning environments.

The use of question prompts has been found successful to support students' learning and problem solving (e.g., Choi, Land, & Turgeon, 2008; Ge & Land, 2003). Different kinds of questions prompts, such as process prompts, elaboration prompts, and reflection prompts have been discussed in question prompt literature (e.g., Ge & Land, 2003). Specifically, reflection prompts have been found effective in knowledge integration (Davis & Linn, 2000), math learning, (Lee & Chen, 2009), self-regulated learning competence (van den Boom, Paas, van Merriënboer, & van Gog, 2004), and problem solving (Kauffman, Ge, Xie, & Chen, 2008). In a GBL study that compared the effectiveness of procedural prompts and reflection prompts, Lee and Chen (2009) found that students who were prompted to elaborate and reflect performed better than the students who were prompted with game procedures. The above results confirmed the effectiveness of external prompts, especially those that require students to reflect on the game knowledge and prompt them to apply the knowledge to real life contexts.

What can we prompt students to reflect in a learning environment? For instance, Papadopoulos, Demetriadis, Stamelos, and Tsoukalas (2009, 2011) suggested the use of context-oriented question prompts in authentic learning environments to prompt students to reflect on the target conceptual knowledge, as well as applying the knowledge in different situations. They found that the combination of providing different prompts improved learning outcomes. However, it was unclear which kind of reflection prompts led to better learning outcomes. In GBL research, we observed that *knowledge prompts* were given to guide students to reflect on the conceptual understandings the underlying knowledge within the game context (e.g., Tsai, Kinzer, Hung, Chen, & Hsu, 2013). To allow students to practice the transfer of game knowledge, some studies provided *application prompts* that guide students to reflect the conceptual understandings the underlying knowledge of the game and apply them outside of the game contexts (e.g., Barzilai & Blau, 2014).

Besides the content of the prompts, some researchers also examined the timing of external scaffold in GBL (Barzilai & Blau, 2014; Tsai et al., 2013). Those studies found that students who were provided scaffolds *before* and *within* the game performed better than those who had the scaffold without the games or those who were not provided scaffolds. Those results suggested that it is important to prompt some content knowledge *before* the game as well as allow students to reflect on the content knowledge *during* the game. Thus, the game we developed for the current study included some instructional materials that students have to go over before playing the game, and additional external scaffolds provided during the game.

1.2. Feedback in GBL

Embedded external scaffolds in the game-based learning seem to promote the use of in-game contents (Tsai et al., 2013). Some researchers found that provision of direct and immediate feedback to the external scaffolds can reduce players' frustrations and prevent them from getting illusions of understanding (e.g., Hsu & Tsai, 2013). Feedback helps learners to understand the conceptual knowledge and give them clear guidance on how to improve their learning. Researchers have found correlation between feedback and achievement in computer learning environments (e.g., Corbalan, Kester, & van Merriënboer, 2009; Lee, Lim, & Grabowski, 2010). Generally, feedback types can be varied depending on their length, timing and complexity (Shute, 2008). In the current study, we focused on the *knowledge of correct response* (KCR) feedback and *elaborated response* (ER) feedback as they have been shown to facilitate learners' learning effectively in the field of multimedia learning (Corbalan et al. (2009). KCR provides learners with the correct answer following an incorrect response, and it has been found to improve learners' ability to retain information and perform deeper cognitive processing (Mealor & Dienes, 2013; Scott & Dienes, 2008). Timmers and Veldkamp (2011) also found that learners reported higher utility and more positive attitude towards KCR. ER provides an explanation of the feedback. ER has found to produce higher scores for low ability students, while KCR produces higher scores for high ability students (Narciss & Huth, 2004). Moreover, ER provides descriptions of what, how, and/or why of a given problem, which is typically more effective than KCR (Bangert-Drowns, Kulik, Kulik, & Morgan, 1991; Shute, 2006).

Rather than focusing on the feedback that was provided by the game itself, researchers have turned their attentions to how feedback interplays with given instruction within GBL. For example, Mayer and Johnson (2010) examined the effectiveness of feedback and self-explanation mechanisms that were directly integrated into the gameplay as students make correct and incorrect choices about circuit mechanisms. As a result, the given feedback helped learners to become more aware of their cognitive processing (Erhel & Jamet, 2013). Tsai, Tsai, and Lin (2015) found that immediate elaborated feedback facilitated the enhancement of conceptual knowledge compared with no immediate feedback. While researchers tend to lean towards more positive effect of elaborated feedback, few has examined whether such elaborative feedback may hinder students' learning by affecting game flow. Since elaborated feedback requires players to take time to reflect upon, KCR may be more efficient. In the current study, we set out to determine whether the presence of KCR and ER feedback in scaffolded GBL can influence students' learning. Specifically, the current study examined how different feedback interacts with different scaffolds (i.e., knowledge prompts and application prompts).

1.3. Purpose of the study and research questions

The purpose of the current study was to examine the effects of question prompt types and feedback types on students' learning outcomes in a game-based learning environment. The following questions were investigated:

1. Do types of question prompts influence students' learning in a game-based learning environment?
2. Do types of feedback influence students' learning in a game-based learning environment?
3. Do types of feedback moderate the effect between types of question prompts and students' learning outcomes in a game-based learning environment?

2. Methods

2.1. Participants and design

Four intact classes consisted of one hundred and five seventh grade students from a vocational education secondary school in Taiwan participated in the current study. Each class represented one treatment group: Knowledge-KCR ($N = 25$), Knowledge-ER ($N = 27$), Application-KCR ($N = 26$), and Application-ER ($N = 27$). Although the teachers were not the same across classes, our pre-test showed no significant difference in the performance across all groups. The independent variables of the study were two types of question prompts (knowledge and application) and two types of feedback (knowledge of correct response and elaborated response). The dependent variable was learning performance. The control variables, which have been shown to be related to learning, were cognitive load, engagement, and perceived ability (Eseryel, Law, Ifenthaler, Ge, & Miller, 2014; Paas, Van Gog, & Sweller, 2010).

2.2. Learning environments and materials

An instructional game named “Carrot Land” was used for the current study. The game was built to align with four major learning objects contained with the national curriculum standards: (1) to understand the effects of force, (2) to understand the types of force, (3) to describe the force equilibrium condition, and (4) to understand the impact force generated by the object(s). Game-based learning activities were created to help students achieve those learning goals. Before the game, an introduction of the concept of forces was provided to review the general foundation knowledge behind the game. Literature suggested that providing some scaffolds *before the game* enhanced students' learning (e.g., Barzilai & Blau, 2014; Tsai et al., 2013). The game included three levels of tasks, and the difficulty increased from one level to the next. For example, as shown in Fig. 1 and Fig. 2, in game level two, different rabbits were given to the students and they needed to locate appropriate sizes of carrots concerning the weights of rabbits. After locating the carrot, students need to make a decision on the best way to pull the carrot out of the ground using the concept of force and balance. In our previous studies, we have found that the Carrot Land successfully fostered students' understanding of science concepts and increased their motivation (Chen & Law, 2016; Chen, Wang, & Lin, 2015). In the current study, we have designed instructional scaffolds that intend to further understand how different scaffolds and feedback facilitate knowledge acquisition and scientific understanding. Instructional scaffolds included question prompts, such as knowledge prompts and application prompts, and feedbacks, namely knowledge of correct response (KCR) and elaborated response (ER). Question prompts, that were not part of the gameplay, were given with periods in between 15 and 20 s during the gameplay. Students were required to respond to the given question prompts with four possible answers without time limits. Students would choose and submit one answer. Then, the feedback to the question prompts would appear (see Fig. 3), and the students could click OK to continue the gameplay. The question prompts

Fig. 1. An example of gameplay – A rabbit was locating the carrots.

Fig. 2. An example of the gameplay- choosing the best way to pull the carrots.

allowed students to connect game knowledge to the targeted content knowledge (Tsai et al., 2013). The details and descriptions about instructional scaffolds are provided next.

2.2.1. *Knowledge prompts*

As defined by Bloom and Krathwohl (1956), the cognitive domain involves knowledge and the development of intellectual skills. Clark and Chopeta (2008) further identified that the cognitive domain should include facts, concepts, and processes. Facts refer to specific and unique data or instance. Concepts refer to a class of items, words, or ideas that are known by a common name including multiple specific examples. Processes refer to the flow of events or activities that describe how things work rather than how to do things. The design rationale for the knowledge prompts was to guide the learning to reflect the facts, concepts, and processes that the students could learn within the GBL environment. Prompts were a series of step-by-step actions and decisions that resulted in the achievement of a task. While specific guidelines, rules, and parameters were not supplied in the game, knowledge prompts in the game intended to include not only what should be attentive to, but also what should be known or learned. In other words, knowledge prompts resembled the basic building blocks of the target conceptual knowledge. As shown in Fig. 3, an example of knowledge prompt with four possible answers appears on the top of the screen. A translated knowledge prompt refers to Appendix A.

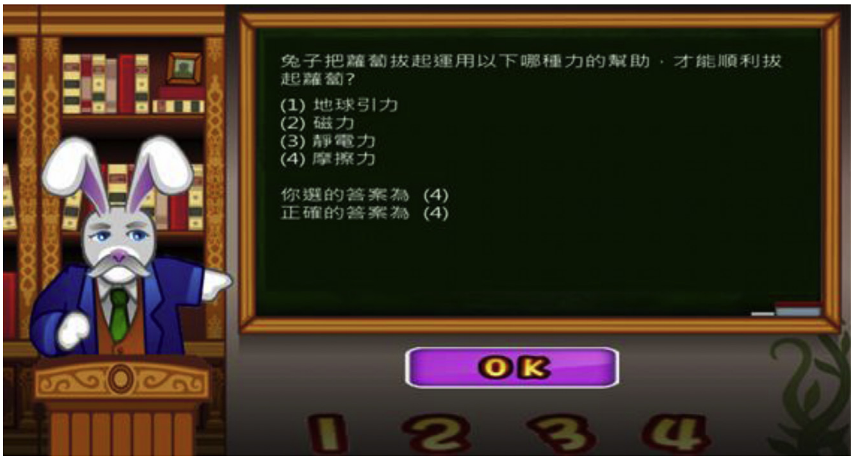

Fig. 3. Screenshot for KCR feedback.

2.2.2. *Application prompts*

Young et al. (2012) argued that many students are not able to connect the game knowledge in real life situations. Therefore, we developed application prompts that require students to use a concept in a new situation and apply what was learned in the game to novel situations. An example of application prompt is given in Appendix A.

2.2.3. *Knowledge of corrected responses (KCR) feedback*

Two types of feedback were given to answers of knowledge and application prompts. As shown in Fig. 3, KCR feedback gives students the correct answer regardless if students have answered it correctly or incorrectly. Examples of KCR for knowledge and application prompts are provided in Appendix A.

2.2.4. *Elaborated responses (ER) feedback*

Different from KCR feedback that only gives students correct answer, ER feedback provides students detail information for every answer. ER feedback provides the reasons or rationales for why the correct answer is best answer for a given question, and why other answers are not correct. Examples of ER feedback for knowledge and application prompts are given in Appendix A.

2.3. *Instruments*

2.3.1. *Pre-test and post-test*

Validated by previous studies (Chen & Law, 2016; Chen et al., 2015), a performance test was used to assess students' understanding of force and motion. The performance test was originally developed by two experienced science teachers and included twenty multiple-choice questions. It assessed students' conceptual understanding of force and motion and also their ability to apply the concepts in real life contexts. Sample test questions are shown in Appendix B.

2.3.2. *Cognitive load*

The cognitive load measures were originally adopted from Gerjets, Scheiter, and Catrambone (2004), and were modified for our study application. The instrument included five questions to assess students' cognitive load (sample questions are shown in Appendix C). Each question utilized a Likert-type rating scale from 1 (very low cognitive load) to 9 (very high cognitive load). Cronbach's alpha for the measure was 0.673.

2.3.3. *Engagement*

The 12-item engagement instrument was adapted from (Skinner, Kindermann, & Furrer, 2009). The modified version of the 7-point Likert scale included two dimensions of engagement: behavioral and emotional. Cronbach's alpha for the engagement measure was 0.917. Sample questions are shown in Appendix C.

2.3.4. *Perceived ability*

Students' perceived ability was measured by the 5-point Likert scales (5 items). The scale was validated by Miller and his colleagues (Miller, Greene, Montalvo, Ravindran, & Nichols, 1996). Cronbach's alpha for the measure was 0.685. Sample questions are shown in Appendix C.

2.4. *Procedures*

Upon completion of a pre-test, students were instructed to play the game using a desktop computer in the computer lab. The students were given approximately 40 min to play the game. Depending on the assigned condition, students received different types of question prompts (Knowledge or Application) and feedback (KCR or ER) during the gameplay. Upon their completion of the gameplay, students took the performance post-tests and follow-up questionnaires.

3. Results

Descriptive statistics, including minimums, maximums, means and standard deviations, and Cronbach alphas are presented in Table 1.

2 × 2 ANCOVA was employed to examine the main effects and interaction effect of question prompts and feedback on students' learning outcomes. Four control variables were included in the model: pre-test scores, cognitive load, perceived ability, and engagement. Our results suggested that the types of question prompts had a significant effect on students' performance ($F(1,97) = 5.652$, $p = 0.03$, eta sq $= 0.089$). Students with knowledge prompts performed better than the students with application prompts. Nevertheless, the types of feedback did not have a significant effect on students' performance ($F(1,97) = 0.204$, $p = 6.52$, eta sq $= 0.02$).

In addition to the main effects, the ANCOVA results suggested that there was an interaction effect between types of question prompts and types of feedback on students' performance ($F(1,97) = 3.944$, $p = 0.05$, eta sq $= 0.039$). Fig. 4 shows that students with ER and knowledge question prompts performed better than the students KCR and knowledge question prompts. However, this relationship reversed when application prompts were provided. Students with KCR and application prompts performed better than the students with ER and application prompts. The control variables, pre-test and cognitive load, had significant effects on students' performance ($F(1,97) = 20.625$, $p = 0.00$, eta sq $= 0.175$; $F(1,97) = 4.414$, $p = 0.38$, eta sq $= 0.044$). The above results confirmed previous literature that students' cognitive load may influence students' learning in complex subject matters (e.g., Huang, 2011; van Bruggen, Kirschner, & Jochems, 2002).

4. Discussion

The prior GBL literature suggested that it is important to include instructional support in game-based learning environments to connect students' game knowledge to real life situations (e.g., Ke, 2009; Sitzmann, 2011; Wouters et al., 2013). Therefore, we developed two types of prompts, knowledge prompts and application prompts, to support students' application of game knowledge, and compared the effects of those two types of prompts. Although some game literature suggested that providing question prompts in educational games may promote students' learning (e.g., Lee & Chen, 2009), it is unclear whether the types of question prompts may promote learning differently in GBL. Consistent with the findings of other question prompts literature (e.g., Bulu & Pedersen, 2010), our results suggest that different types of question prompts may support students' learning differently in GBL. Specifically, students who were provided knowledge prompts performed better than those were provided with application prompts. Giving question prompts that are outside of the game context may not foster students' learning.

Besides question prompts, feedback is another key feature that we examined. This study examined beyond the feedback mechanics in the game itself, but feedback mechanics to support external scaffold s embedded in GBL. Although existing research demonstrated that ER feedback facilitated the learning effectiveness (e.g., Erhel & Jamet, 2013; Tsai et al., 2015), the findings of the current study did not suggest significant differences between KCR or ER feedback. Such contradiction may due to the differences on the difficulty of question prompts and the complexity of feedback used in the study. Yet current study contributes to the existing literature, in that we found non-significant finding. We suggest that non-significant finding could be due to the interaction effects between the types of question prompts and the types of feedback. Students with ER performed better than those with KCR when knowledge prompts were given. On the contrary, students with KCR performed better than those with ER when application prompts were given. As a result, the main effect model was not able to capture the effects of feedback on students' learning.

The other findings of the current study suggested an interaction effect between the types of prompts and the types of feedback. Although literature suggested that providing prompts that connect students with real life context allows students to engage with the learning materials meaningfully (e.g., Papadopoulos et al., 2009), our results indicated that providing application prompts with elaborated feedback may impede students' learning. It is possible that the application prompts with elaborated feedback were too complex and difficult for the students to comprehend. As a results, students might not spend enough time to really understand the feedback and how it was related to the question prompts. Indeed, our results showed that students who received knowledge prompts with elaborated feedback performed the best. Therefore, to maximize the effects of the questions prompts, game designers should consider providing knowledge prompts with elaborated feedback.

Table 1
Descriptive statistics and reliability coefficients.

Variables	Min	Max	Mean	SD	α
Pre-test	5.00	80.00	33.86	14.1	n.a.
Post-test	20.00	80.00	48.76	14.39	n.a.
Cognitive load	1.00	8.00	4.61	1.55	0.67
Engagement	1.75	6.92	5.23	0.99	0.92
Perceived ability	2.29	4.86	3.76	0.62	0.69

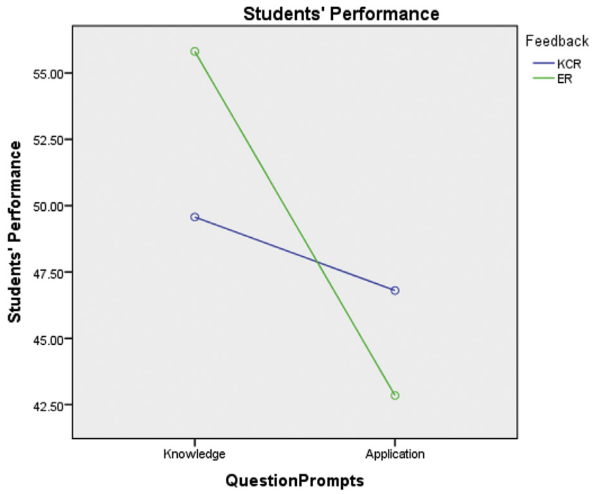

Fig. 4. The interaction effect between types of question prompts and types of feedback on students' performance.

5. Conclusion and future study

The current study extended our previous studies to examine the effect of GBL on vocational middle school students' learning in science (Chen & Law, 2016; Chen, Wang, & Lin, 2015), particularly when different question prompts and feedback were built in the game. The results showed that knowledge prompts significantly enhance students learning when comparing with application prompts. While KCR or ER did not make significantly differences on students' learning, the current study found that types of question prompts and the types of feedback had an interaction effect on students' learning. Students with ER performed better than those with KCR when knowledge prompts were given. Students with KCR performed better than those with ER when application prompts were given.

While the results provided some interesting insights in GBL, limitations exist in the design of our experiment. First, we only compared the effects of two types of question prompts. There was no control group that received no question prompts. As a result, the experiment did not answer whether these kinds of questions prompts would have a positive effect of game-based learning or not. Some educational game researchers argued that external scaffold may negatively influence game flow (e.g., Tsai et al., 2013). However, other educational game literature suggested that external scaffold can enhance learning (e.g., Neulight et al., 2006). Future research should make a comparison between the scaffold and no-scaffold conditions in GBL and examine the differences on the feedback that is based on gameplay decisions instead of to the external scaffolds. In addition, we may collect and analyze game log data to gauge complete pictures of how students interact with or react to different scaffolds, and how those external scaffolds influence learning. Other research efforts may involve examining the transfer effect of question prompts and feedback on students' understanding of complex science concepts and how game performance influence students' learning. Finally, future studies may investigate the effect of question prompts and feedback using a sample of students with different characteristics and a larger number of sample size.

Appendix A. Samples for knowledge prompts, application prompts, KCR for knowledge prompts, KCR for application prompts, ER for knowledge prompts, and ER for application prompts

Knowledge prompts

Which kind of force the rabbit was used to pull the carrots?

(1) Gravity
(2) Magnetic force
(3) Electric force
(4) Friction

Application prompts

In a pole climbing contest, which kind of force is used to present them from falling off the pole.

(1) The gravity between the body and the earth
(2) The friction between the body and the pole
(3) The force between the pole and the earth
(4) The gravity between the body and the pole

KCR for knowledge prompts

The correct answer is (4).

KCR for application prompts

The correct answer is (2).

ER for knowledge prompts

(1) To pull the carrots from the ground, the rabbit is required to use contact forces that acts at the point of contact between two objects. Gravitational force is not a contact force. Objects on the earth are subject to the gravity. Therefore, this is not the correct answer.
(2) To pull the carrots from the ground, the rabbit is required to use contact forces that acts at the point of contact between two objects. Magnetic force is not a contact force. Therefore, the rabbit did not use magnetic force. As a result, this is not the correct answer.
(3) To pull the carrots from the ground, the rabbit is required to use contact forces that acts at the point of contact between two objects. Electric force is not a contact force. Therefore, the rabbit did not use electric force. As a result, this is not the correct answer.
(4) To pull the carrots from the ground, the rabbit is required to use contact forces that acts at the point of contact between two objects. Friction is a contact force. Therefore, the rabbit used friction to pull the carrot. As a result, this is the correct answer.

ER for application prompts

(1) During the pole climbing process, the pole provides friction to support the body weight and prevent the body from falling. The force between the body and the earth is gravity, which pull the person down. Therefore, it is not the correct answer.
(2) During the pole climbing process, the pole provides friction to support the body weight and prevent the body from falling. Therefore, it is the correct answer.
(3) During the pole climbing process, the pole provides friction to support the body weight and prevent the body from falling. The force between the pole and the earth does not act upon the body. Therefore, it is not the correct answer.
(4) During the pole climbing process, the pole provides friction to support the body weight and prevent the body from falling. No gravitation force is acted upon between the pole and the body. Therefore, it is not the correct answer.

Appendix B. Sample questions of performance test

1. Which of the following is a contact force?

A The buoyancy that allows the rising of a hot air balloon
B Magnetically Levitated train floats on the track
C The gravitational force between the earth and the sun
D The force that allows plastic wrap to cling

2. There are two types of forces: contact force and action-at-distance. Which of the following force is different from the other three?

A Gravitational force
B Electrical force
C Magnetic force
D Friction

Appendix C. Samples for cognitive load, engagement, and perceived ability measures

Cognitive load

1. I felt that I had to spend a lot of energy in order to finish the learning task.
2. I felt that I had to put effort to concentrate on the learning task in order to finish it.

Engagement

1. I work as hard as I can in the learning task.
2. I am glad to participate in the learning task.
3. The learning task is fun.

Perceived ability

1. I am confident I have the ability to understand the ideas taught in this game.
2. I am confident about my ability to solve the problem in this game.
3. I am certain I understand the science presented in this game.

References

Bangert-Drowns, R. L., Kulik, C.-L. C., Kulik, J. A., & Morgan, M. (1991). The instructional effect of feedback in test-like events. *Review of Educational Research, 61*(2), 213–238. http://dx.doi.org/10.3102/00346543061002213.

Barzilai, S., & Blau, I. (2014). Scaffolding game-based learning: Impact on learning achievements, perceived learning, and game experiences. *Computers & Education, 70*, 65–79. http://dx.doi.org/10.1016/j.compedu.2013.08.003.

Bloom, B. S., & Krathwohl, D. (1956). *Taxonomy of educational objectives: The classification of educational goals, by a committee of college and university examiners. Handbook 1: Cognitive domain*. New York: Longmans.

van den Boom, G., Paas, F., van Merriënboer, J. J. G., & van Gog, T. (2004). Reflection prompts and tutor feedback in a web-based learning environment: Effects on students' self-regulated learning competence. *Computers in Human Behavior, 20*(4), 551–567.

van Bruggen, J. M., Kirschner, P. A., & Jochems, W. (2002). External representation of argumentation in cscl and the management of cognitive load. *Learning and Instruction, 12*(1), 121–138.

Bulu, S., & Pedersen, S. (2010). Scaffolding middle school students' content knowledge and ill-structured problem solving in a problem-based hypermedia learning environment. *Educational Technology Research and Development, 58*(5), 507–529. http://dx.doi.org/10.1007/s11423-010-9150-9.

Chen, C.-H., & Law, V. (2016). Scaffolding individual and collaborative game-based learning in learning performance and intrinsic motivation. *Computers in Human Behavior, 55*, 1201–1212. http://dx.doi.org/10.1016/j.chb.2015.03.010.

Chen, C.-H., Wang, K. C., & Lin, Y. S. (2015). The comparison of solitary and collaborative modes of game-based learning on students' science learning and motivation. *Educational Technology and Society, 18*(2), 237–248.

Choi, I., Land, S. M., & Turgeon, A. (2008). Instructor modeling and online question prompts for supporting peer-questioning during online discussion. *Journal of Educational Technology Systems, 36*(3), 255–275.

Clark, R. E., & Mayer, R. E. (2008). *E-learning and the science of instruction* (2nd ed.). San Francisco: Jossey-Bass.

Corbalan, G., Kester, L., & van Merriënboer, J. G. (2009). Dynamic task selection: Effects of feedback and learner control on efficiency and motivation. *Learning and Instruction, 19*(6), 455–465. http://dx.doi.org/10.1016/j.learninstruc.2008.07.002.

Davis, E. A., & Linn, M. C. (2000). Scaffolding students' knowledge integration: Prompts for reflection in kie. *International Journal of Science Education, 22*(8), 819–837. http://dx.doi.org/10.1080/095006900412293.

Erhel, S., & Jamet, E. (2013). Digital game-based learning: Impact of instructions and feedback on motivation and learning effectiveness. *Computers & Education, 67*, 156–167. http://dx.doi.org/10.1016/j.compedu.2013.02.019.

Eseryel, D., Law, V., Ifenthaler, D., Ge, X., & Miller, R. (2014). An investigation of the interrelationships between motivation, engagement, and complex problem solving in game-based learning. *Journal of Educational Technology & Society, 17*(1), 42–53.

Ge, X., & Land, S. (2003). Scaffolding students' problem-solving processes in an ill-structured task using question prompts and peer interactions. *Educational Technology Research and Development, 51*(1), 21–38. http://dx.doi.org/10.1007/BF02504515.

Gerjets, P., Scheiter, K., & Catrambone, R. (2004). Designing instructional examples to reduce intrinsic cognitive load: Molar versus modular presentation of solution procedures. *Instructional Science, 32*, 33–58.

Hsu, C.-Y., & Tsai, C.-C. (2013). Examing the effects of combining self-explanation principles with an educational game on learning science concepts. *Interactive Learning Environments, 21*(2), 104–115.

Huang, W.-H. (2011). Evaluating learners' motivational and cognitive processing in an online game-based learning environment. *Computers in Human Behavior, 27*(2), 694–704. http://dx.doi.org/10.1016/j.chb.2010.07.021.

Kauffman, D., Ge, X., Xie, K., & Chen, C.-H. (2008). Prompting in web-based environments: Supporting self-monitoring and problem solving skills in college students. *Journal of Educational Computing Research, 38*(2), 115–137. http://dx.doi.org/10.2190/EC.38.2.a.

Ke, F. (2009). A qualitative meta-analysis of computer games as learning tools. In E. F. Richard (Ed.), *Handbook of research on effective electronic gaming in education* (pp. 1–32). Hershey, PA: IGI Global.

Ke, F. (2016). Designing and integrating purposeful learning in game play: A systematic review. *Educational Technology Research and Development, 64*(2), 219–244. http://dx.doi.org/10.1007/s11423-015-9418-1.

Lee, C.-Y., & Chen, M.-P. (2009). A computer game as a context for non-routine mathematical problem solving: The effects of type of question prompt and level of prior knowledge. *Computers & Education, 52*(3), 530–542. http://dx.doi.org/10.1016/j.compedu.2008.10.008.

Lee, H., Lim, K., & Grabowski, B. (2010). Improving self-regulation, learning strategy use, and achievement with metacognitive feedback. *Educational Technology Research & Development, 58*(6), 629–648. http://dx.doi.org/10.1007/s11423-010-9153-6.

Mayer, R. E., & Johnson, C. I. (2010). Adding instructional features that promote learning in a game-like environment. *Journal of Educational Computing Research, 42*, 241–265.

Mealor, A. D., & Dienes, Z. (2013). Explicit feedback maintains implicit knowledge. *Consciousness and Cognition, 22*, 822–832.

van der Meij, H., Albers, E., & Leemkuil, H. (2011). Learning from games: Does collaboration help? *British Journal of Educational Technology, 42*(4), 655–664. http://dx.doi.org/10.1111/j.1467-8535.2010.01067.x.
Miller, R. B., Greene, B. A., Montalvo, G. P., Ravindran, B., & Nichols, J. D. (1996). Engagement in Academic Work: The Role of Learning Goals, Future Consequences, Pleasing Others, and Perceived Ability. *Contemporary Educational Psychology, 21*, 388–422.
Narciss, S., & Huth, K. (2004). How to design informative tutoring feedback for multimedia learning. In H. M. Niegemann, D. Leutner, & R. Brunken (Eds.), *Instructional design for multimedia learning* (pp. 181–195). Munster, New York: Waxmann.
Neulight, N., Kafai, Y. B., Kao, L., Foley, B., & Galas, C. (2006). Children's participation in a virtual epidemic in the science classroom: Making connections to natural infectious diseases. *Journal of Science Education and Technology, 16*(1), 47–58. http://dx.doi.org/10.1007/s10956-006-9029-z.
Paas, F., Van Gog, T., & Sweller, J. (2010). Cognitive load theory: New conceptualizations, specifications, and integrated research perspectives. *Educational Psychology Review, 22*(2), 115–121. http://dx.doi.org/10.1007/s10648-010-9133-8.
Papadopoulos, P., Demetriadis, S., Stamelos, I., & Tsoukalas, I. (2009). Prompting students' context-generating cognitive activity in ill-structured domains: Does the prompting mode affect learning? *Educational Technology Research and Development, 57*(2), 193–210. http://dx.doi.org/10.1007/s11423-008-9105-6.
Papadopoulos, P., Demetriadis, S., Stamelos, I., & Tsoukalas, I. (2011). The value of writing-to-learn when using question prompts to support web-based learning in ill-structured domains. *Educational Technology Research and Development, 59*(1), 71–90. http://dx.doi.org/10.1007/s11423-010-9167-0.
Peters, V. A. M., & Vissers, G. A. N. (2004). A simple classification model for debriefing simulation games. *Simulation & Gaming, 35*(1), 70–84. http://dx.doi.org/10.1177/1046878103253719.
Scott, R. B., & Dienes, Z. (Sep 2008). The conscious, the unconscious, and familiarity. *Journal of Experimental Psychology, 34*(5), 1264–1288. http://dx.doi.org/10.1037/a0012943.
Shute, V. J. (2008). Focus on formative feedback. *Review of Educational Research, 78*, 153–189.
Shute, V. J. (2006). Assessments for learning: Great idea, but do they work? Paper presented at the annual meeting of the American Educational Research Association, San Francisco, CA.
Sitzmann, T. (2011). A meta-analytic examination of the instructional effectiveness of computer-based simulation games. *Personnel Psychology, 64*(2), 489–528. http://dx.doi.org/10.1111/j.1744-6570.2011.01190.x.
Skinner, E. A., Kindermann, T. A., & Furrer, C. J. (2009). A motivational perspective on engagement and disaffection: Conceptualization and assessment of children's behavioral and emotional participation in academic activities in the classroom. *Educational and Psychological Measurement, 69*(3), 493–525. http://dx.doi.org/10.1177/0013164408323233.
Timmers, C., & Veldkamp, B. (2011). Attention paid to feedback provided by a computer-based assessment for learning on information literacy. *Computers & Education, 56*(3), 923–930. http://dx.doi.org/10.1016/j.compedu.2010.11.007.
Tsai, F.-H., Kinzer, C., Hung, K.-H., Chen, C.-L., & Hsu, I.-Y. (2013). The importance and use of targeted content knowledge with scaffolding aid in educational simulation games. *Interactive Learning Environments, 21*(2), 116–128.
Tsai, F.-H., Tsai, C.-C., & Lin, K.-Y. (2015). The evaluation of different gaming modes and feedback types on game-based formative assessment in an online learning environment. *Computers & Education, 81*, 259–269.
Tüzün, H., Yilmaz-Soylu, M., Karakus, T., Inal, Y., & Kızılkaya, G. (2009). The effects of computer games on primary school students' achievement and motivation in geography learning. *Computers & Education, 52*(1), 68–77. http://dx.doi.org/10.1016/j.compedu.2008.06.008.
Wouters, P., van Nimwegen, C., van Oostendorp, H., & van der Spek, E. D. (2013). A meta-analysis of the cognitive and motivational effects of serious games. *Journal of Educational Psychology, 105*(2), 249–265. http://dx.doi.org/10.1037/a0031311.
Young, M. F., Slota, S., Cutter, A. B., Jalette, G., Mullin, G., Lai, B., … Yukhymenko, M. (2012). Our princess is in another castle: A review of trends in serious gaming for education. *Review of Educational Research, 82*(1), 61–89. http://dx.doi.org/10.3102/0034654312436980.