Chapter 6
Augmentation Strategies for Paper-Based Content Integrated with Digital Learning Supports Using Smartphones

Nian-Shing Chen, I-Chun Hung and Wei-Chieh Fang

Abstract Up to the twenty-first century, paper is still widely adopted for recording and reading. However, paper-based materials are fully capable of presenting abstract concepts and complicated knowledge with static text and figures. Learners usually need timely and adequate supports when encountering difficulties during learning. With a consideration of applying technologies, the learning tool must have a certain mobility and accessibility for acquiring facilitative resources. Using the networking capability of smartphone to access digital content from the Internet to enrich conventional paper-based learning activities is worth investigating. This chapter introduces an augmentation-enhanced learning context with an integration of digital content into paper-based materials in order to facilitate learning. Constructive feedback, scaffolding questioning, and procedural scaffolding are three strategies applied into the instructional designs and learning system. Quasi-experiments for personal learning and collaborative learning were also conducted to evaluate the effects on learning performance. The results suggest that the three instructional designs had significantly positive effects on individual's learning performance. Team's learning performance and team's discourse levels were promoted as well. This chapter lays out a strong foundation for researchers to further explore how to better design different learning strategies for different learning subjects in the augmentation-enhanced learning context using smartphones. It is hoped that educational practitioners are able to obtain concrete ideas and solutions on how to better leverage the benefits of both paper-based content and digital learning materials in a real blended learning environment.

N.-S. Chen (✉) · I-Chun Hung · W.-C. Fang
Department of Information Management, National Sun Yat-sen University, 70 Lienhai Rd, Kaohsiung 80424, Taiwan, Republic of China
e-mail: nschen@mis.nsysu.edu.tw
URL: http://www.nschen.net

I-Chun Hung
e-mail: ichung@mis.nsysu.edu.tw
URL: http://ichung.mis.nsysu.edu.tw

W.-C. Fang
e-mail: wfjohnny@gmail.com

Kinshuk and R. Huang (eds.), *Ubiquitous Learning Environments and Technologies*,
Lecture Notes in Educational Technology, DOI 10.1007/978-3-662-44659-1_6

Keywords Paper-based materials · Digital content · Constructive feedback · Scaffolding questioning · Procedural scaffolding

6.1 Introduction

Paper-based materials have been prevalent for delivering knowledge over the past centuries (Macedo-Rouet et al. 2009). Many convenient features of paper-based materials have been widely used such as ease of reading, writing, note-taking, and carrying around. However, paper-based materials provide very limited assistance in one's reading comprehension due to static representations or lack of timely supports. Integrating digital learning supports with a pre-designed strategy into paper-based content may enhance comprehension.

Recently, smartphone is considered an educational tool and its technological features have potentials for providing additional learning supports for traditional paper-based learning context. Comprehension is the ultimate goal of reading. Reading, the foundation of learning (Berninger and Richards 2002; Cunningham and Stanovich 2001), is an active and purposeful process of understanding content and blending self-experience to construct new knowledge (Armbruster et al. 2001; Oakhill et al. 1998; Smagorinsky 2001). Reading failure may lead to long-term learning difficulties and further engender a possibility of losing their confidence and learning motivation (Armbruster et al. 2001; Nation et al. 2002). Digital content (e.g., multimedia) can help learners understand complex concepts, elicit higher self-motivation, and foster individual engagement in learning activities (de Jong et al. 2010; Lowe et al. 2010). By applying technologies into a learning activity, the digital content can be presented to learners during learning. One candidate is the smartphone because its popularity and mobility can construct such a learning environment. The cost of smartphones has been affordable and accessible to people (Chen et al. 2008). Therefore, using smartphones as educational tools for supporting instructional activities with adequate pedagogical theories and strategies is conceivable (Lan and Sie 2010; Özdemir 2010). Although paper-based materials had been used for a long time, they still suffer from some major drawbacks, such as not being able to present audio/video or animation content.

Feedback is considered essential to learning not only for cultivating learners' profession but also improving their self-efficacy, self-awareness, and enthusiasm (Bain and Swan 2011; Timmers and Veldkamp 2011; Wang and Wu 2008). Effective feedback should include constructive information (i.e., constructive feedback) which can contribute to learners' actual performance and raise it to the expected performance (Timmers and Veldkamp 2011). Instructors nowadays have to provide learners adequate and timely feedback for aligning learners with needs and expectations (Rolfe 2011; Whitelock et al. 2010). For example, feedback can be utilized as a learning facilitator for learners based on learners' assessment results (Whitelock and Watt 2008). Constructive feedback is defined in this chapter as the act of providing timely personalized learning suggestions with meaningful direction for learners according to the results of assessment, which are analyzed and measured by the learning system through smartphones.

Furthermore, scaffolding strategies, closely related to the notion of zone of proximal development (Vygotsky 1978), can be applied to the instructional designs to provide more support to learners than the constructive feedback. Hannafin et al. (1999) suggested that scaffolding can be used during learning to guide learners what to consider, how to think, how to utilize available resources, or how to approach the learning goal. Scaffolding has two types, namely hard and soft (Saye and Brush 2002). Hard scaffolding is static supports pre-designed based on common learners' difficulties in a learning activity, whereas soft scaffolding is dynamic and situational requires to provide timely supports in response to each individual learner's needs during learning (Wood and Wood 1996). Scaffolding is provided to students with necessary learning supports for facilitating what they are not fully capable of when achieving a learning goal alone (Wood et al. 1976). The learning supports in one's individual learning process enable the learner to move from the current developmental level to the level of potential development. Assisting learners with performing high-level cognitive activities, such as reading, inquiry, and problem solving, requires effective strategies (Kim and Hannafin 2011; Li and Lim 2008; Pearson and Fielding 1991). Scaffolding questioning is one of the most conventional classroom instructional activities for instructors to facilitate knowledge construction during learning (Ge and Land 2003). Providing proper scaffolding questions to learners can promote knowledge constructions, reasoning, problem solving, and metacognition (Ge and Land 2004; King 1994; McDaniel and Donnelly 1996). When learners participate in a reading activities, questions are usually applied into the pre- and post-reading phases to facilitate understanding of the whole reading materials and memorization of important concepts (King 1994).

On the other hand, collaborative learning allows learners to interact with peers and facilitate their development of thinking skills in face-to-face settings (Davidson 1985; Dillenbourg 1999; McCarthey and McMahon 1992). Constructive feedback and scaffolding questioning can benefit personal learning well. However, additional requirements have to be considered for collaborative learning such as group discourse level. In such collaborative learning context, guiding and facilitating group members to discuss and learn are also essential. Applying procedural scaffolding into a learning activity is able to improve learners' performance and create a context helpful for accomplishing a learning task (Pea 2004). Procedural scaffolding strategy for supporting group collaborative learning can be utilized to make learners think first and then discuss with other group members (Chen et al. 2011). The purpose of applying procedural scaffoldings in learning activities is to reduce social loafing and free rider effect (Janssen et al. 2007; Johnson and Johnson 1989). In a social loafing situation, group members would invest less effort in a group than they are assigned to complete tasks individually. Besides, when a learner does nothing and leave the work to other group members, the free rider effect can take place. Through procedural scaffoldings, the social loafing and free rider effect can be reduced for better knowledge construction and cognitive development (Veerman et al. 2000).

In the following sections, this chapter will explain how to utilize the three strategies (i.e., constructive feedback, scaffolding questioning, and procedural scaffolding) into real instructional activities with learning systems using smartphones. The learning performance is a key measure of goodness which shows how well learners can benefit from the augmented strategies for paper-based content enabled by smartphones. Team's learning performance and team's discourse levels were also regarded as two indexes of learning outcomes for collaborative learning.

6.2 Paper-Based Learning with Mobile Technologies

Reading activities can be enriched by using information and communication technologies (ICTs) such as electronic reader devices (Daniel and Woody 2013; Embong et al. 2012; Koike et al. 2001; Rockinson-Szapkiw et al. 2013; Woody et al. 2010). However, learners have to read on or with a specific mobile device apart from the printed materials during the whole learning process. Reading comprehension is a result of the interaction between the learners and paper-based materials in conventional reading activities. If reading assistances can be brought into the undergoing reading process on each reader's demand, the conventional reading activities can be enriched with both advantages of paper-based materials and digital content, and learners' reading experience and performance will lead to positive outcomes (Chen et al. 2011). With the support of ICTs, learners' comprehension can be maximized even in the traditional paper-based reading activities (Chen et al. 2008; Koike et al. 2001).

To efficiently facilitate learners' reading, ideal reading assistances, which are paper-based materials augmented with digital support content, enable readers to immerse in a reading process (Chen et al. 2011). Now, the question is how to leverage the benefits of both paper-based content and digital content. Weiser (1991) proposed the vision of embedded virtuality, which means a seamless integration of ICTs into real world to power human on different kinds of tasks. From the technical perceptive, learners can acquire knowledge through seamlessly integrating digital support content into paper-based learning materials through a mobile device because of its popularity and mobility. A mobile device could integrate QR code technique which features fast readability and easy reproduction. The storage capacity of QR code is larger than the conventional one-dimensional bar code. Learners can easily access digital content such as animations or other multimedia information on a smartphone right after reading the QR code on a smartphone. On the other hand, instructional designs also have to apply appropriate learning strategies to improve learners' performance. With adequate learning strategies, the educational potential of using QR codes has been examined and positive learning results have been observed (Chen et al. 2011, 2013; Huang et al. 2012; Law 2010; Ozcelik and Acarturk 2011).

6.3 The Augmentation Design and Three Applications

This chapter proposes an augmentation design for paper-based content integrated with digital learning supports using smartphones. The composition of the augmentation-enhanced learning context includes four layers, namely hardware, strategy, knowledge, and application (Fig. 6.1).

Educational practitioners can refer to the four layers for preparing and setting up an augmentation-enhanced learning context. In first layer, a digital content distribution server, a smartphone with a QR code reader app, and a wireless network infrastructure are the hardware as the foundation. The digital content distribution server can be a self-owned computer with networking capability or a cloud service over the Internet. The smartphone is used to decode a QR code with a reader app (i.e., a software tool for the smartphone). The learning environment has to be equipped with a wireless Internet infrastructure. The second layer is about the strategies for facilitating learning activities. The third layer consists of paper-based materials and digital content as the source of knowledge. Paper-based material is the main learning media such as a textbook or a lecture, while the digital content is the learning support on demand for further elaboration. Besides, the digital content can be provided as personalized assistance depending on what strategy is adopted for the learning activity. The upper, last layer is the application which forms a learning activity by combining the previous three layers. Different combinations of layer components create different learning activities. In the following sections, three applications will be provided for the augmentation-enhanced learning context, including self-learning with constructive feedback, self-learning with scaffolding questioning, and collaborative learning with procedural scaffolding.

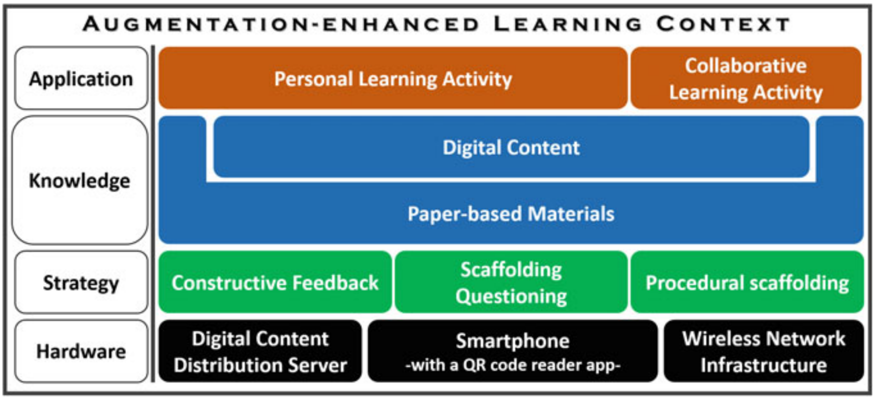

Fig. 6.1 The components of the augmentation-enhanced learning context

6.3.1 Application 1: Self-learning with Constructive Feedback

The first application was designed for self-learning with the support strategy of constructive feedback (Chen et al. 2013). An instructional experiment was conducted in a university course entitled Computer Networks regarding Internet protocol (IP) to evaluate the effectiveness of the scaffolding questioning strategy on learning performance in the augmentation-enhanced learning context. A learning unit of IP addresses was chosen as the topic.

6.3.1.1 Participants

A total of 80 students were recruited to participate in this instructional experiment. The participants were randomly assigned to two groups with or without constructive feedback strategy respectively. A pre-test as well as a post-test included 20 question items, which were used for assessing students' prior knowledge and learning performance, respectively.

6.3.1.2 System Design

In application 1, a self-owned digital content distribution server was deployed to manage updates of supplemental materials, video lectures, and self-evaluation quizzes (Fig. 6.2). The digital content can be accessed through a smartphone by decoding a QR code printed on paper-based materials (Fig. 6.3). Supplemental materials were additional/up-to-date information not included in the paper-based materials. Video lectures consisted of instructional recordings made by instructors

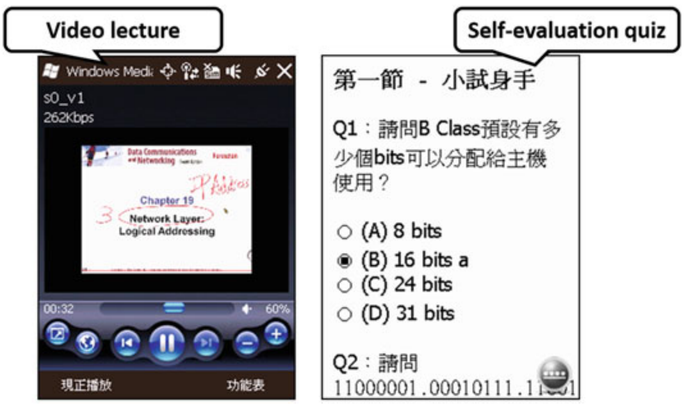

Fig. 6.2 The smartphone accessible digital content

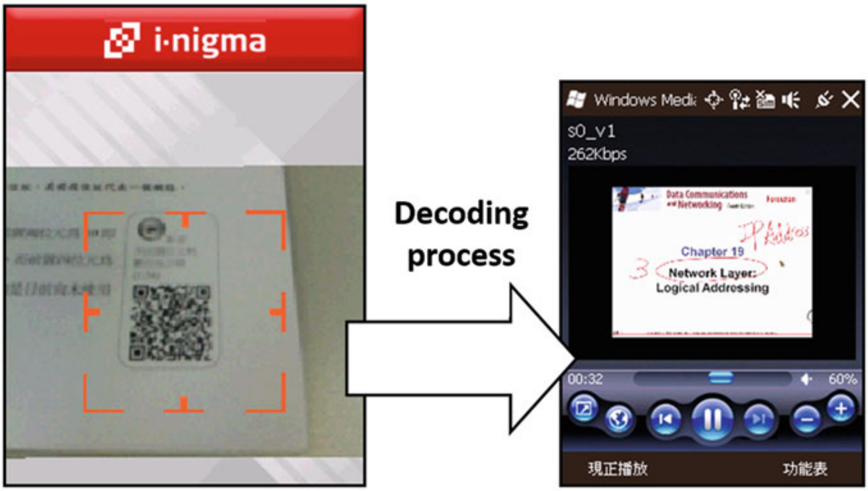

Fig. 6.3 A decoding process to play a video lecture

for further elaborations of the learning topic. Self-evaluation quizzes provided by a computer-supported learning system are capable of facilitating learners' reflection (Whitelock 2009; Whitelock and Watt 2008).

Application 1 used the self-evaluation quizzes to assess how well each learner learned with the strategy of constructive feedback. Two types of constructive feedback (Fig. 6.4) was automatically generated and provided timely to each learner based on the learning activity and the result of self-evaluation quizzes. Such fast delivered learning assistances benefit learners when learning a new concept (Timmers and Veldkamp 2011; Whitelock et al. 2010). One is to suggest unread

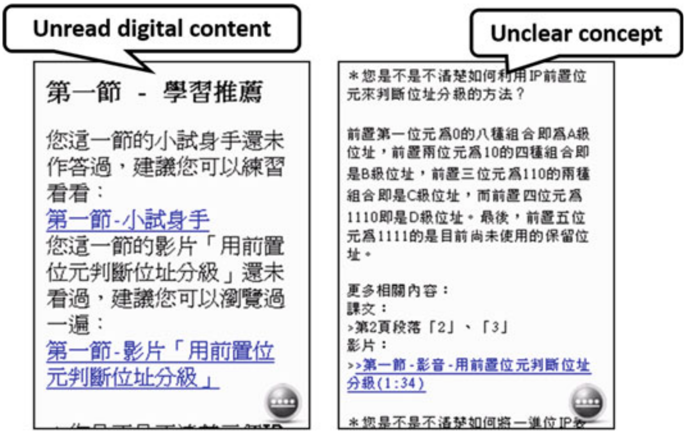

Fig. 6.4 Examples of the constructive feedback to a learner

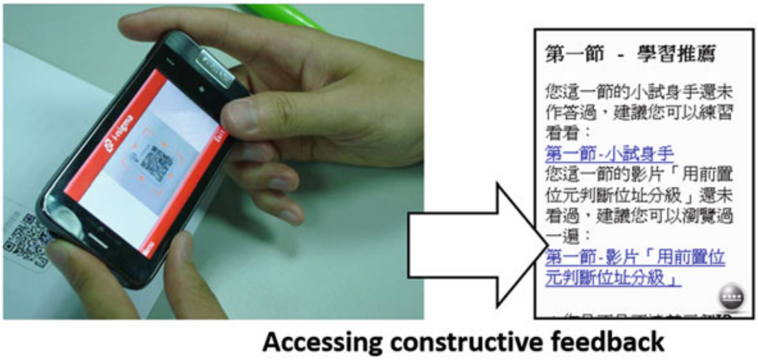

Fig. 6.5 Accessing constructive feedback through a smartphone

digital content which may be visited. The other is to make a recommendation according to the result of self-evaluation quizzes for further understanding the unclear concepts. Learners can easily and quickly access the constructive feedback provided by the learning system (Fig. 6.5).

6.3.1.3 Experimental Procedure

The chosen learning topic requires certain prior knowledge to comprehend the advanced materials. Therefore, a total of 80 students were recruited from two computer networking courses for this instructional experiment. They were 47 male (58.75 %) and 33 female (41.25 %); 45 % was undergraduate students and the rest were graduate students. The experimental procedure included five steps. Firstly, participants were given orientation and briefed about the experiment. Secondly, participants took a pre-test. Thirdly, participants hold a smartphone and received paper-based materials. Fourthly, participants studied the learning unit regarding IP address. One group was with constructive feedback; the other was not. Finally, participants took a post-test. The entire experiment took 110 min.

6.3.1.4 Result

A statistical test was conducted to examine the main effect of constructive feedback on learning performance. The findings revealed that the strategy of constructive feedback had a significant influence on learning performance ($F = 5.647$, $p = 0.02$). The strategy of constructive feedback can help learners improve their learning outcomes in the augmentation-enhanced learning context.

6.3.2 Application 2: Self-learning with Scaffolding Questioning

The second application was designed for self-learning with the support strategy of scaffolding questioning (Chen et al. 2011). An instructional experiment was conducted in a university course entitled Advanced Business English and Communications to evaluate the effectiveness of the scaffolding questioning strategy on learners' English reading comprehension in the augmentation learning context.

6.3.2.1 Participants

A total of 77 students (8 sophomores, 14 juniors, 9 seniors, and 46 graduate students) were recruited to participate in this instructional experiment. The participants were randomly assigned to two groups with or without scaffolding questioning strategy respectively. A pre-test and a post-test were used to evaluate the change of students' reading comprehension. The pre-test had a total of 12 comprehension questions for two articles before the instructional experiment. The post-test had 18 comprehension questions for the other two articles after the instructional experiment.

6.3.2.2 System Design

In application 2, a self-owned digital content distribution server was deployed to deliver the pre-designed digital content, including additional learning materials and scaffolding questions. QR codes printed on paper-based materials were used to help learners quickly access digital content. Articles, selected from textbooks as the reading materials, were further rearranged along with QR codes for this instructional experiment (Fig. 6.6). The main text was represented on the left side of a page. The QR codes were printed on the right side of the page according to the availability of the supplementary digital content related to the main text. If the digital content was available, related words of the main text were highlighted in yellow color with different colors of QR codes and different types of icons.

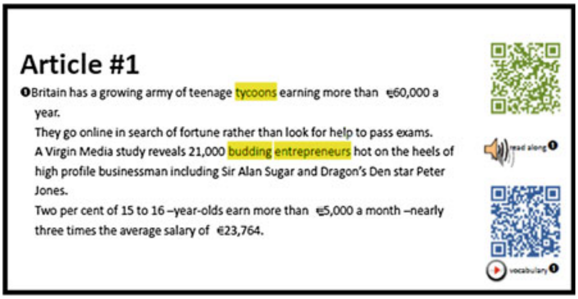

Fig. 6.6 The QR codes printed on the paper-based materials

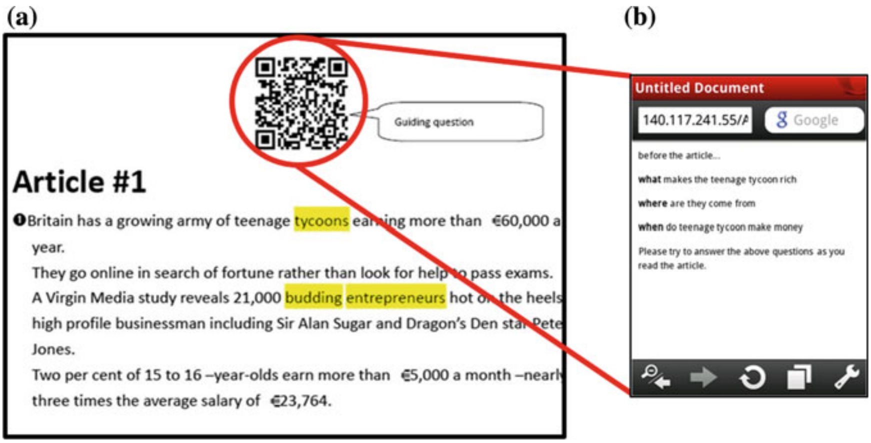

Fig. 6.7 **a** A QR code for a pre-reading questions. **b** A pre-reading question shown in the smartphone

The strategy of scaffolding questioning provided learners with question-based digital content along with QR codes, printed at the center of the page. The locations of the QR codes were before the first paragraph, in-between paragraphs, and after the last paragraph for pre-reading, during-reading, and post-reading questions, respectively. These scaffolding questions were designed to facilitate students' understanding of the learning materials. Figure 6.7a shows the QR code for pre-reading questions. Pre-reading questions were used for briefing the key points to students before reading the article, and students can receive the pre-reading questions using a smartphone to quickly finish the decoding process (Fig. 6.7b).

After students read a certain part of the main text (e.g., a paragraph), the during-reading questions were given to students for helping them reflect on what had been read and evaluate how well they comprehend the content they read (Fig. 6.8a). A few multiple-choice questions were showed on the smartphone one by one after the

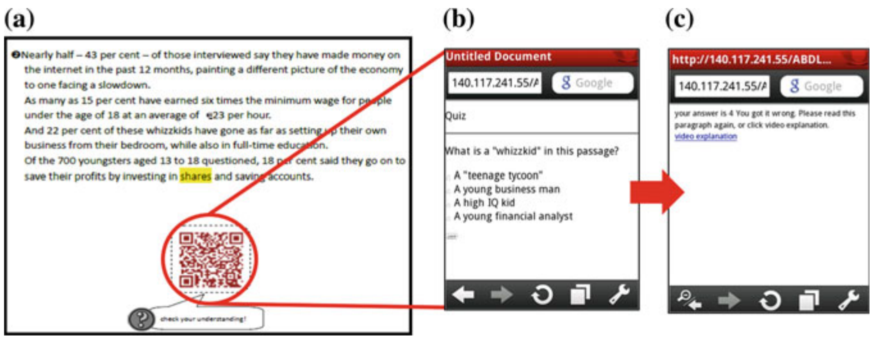

Fig. 6.8 **a** A QR code for a during-reading question. **b** A during-reading question shown in the smartphone. **c** System feedback after students gave their answer

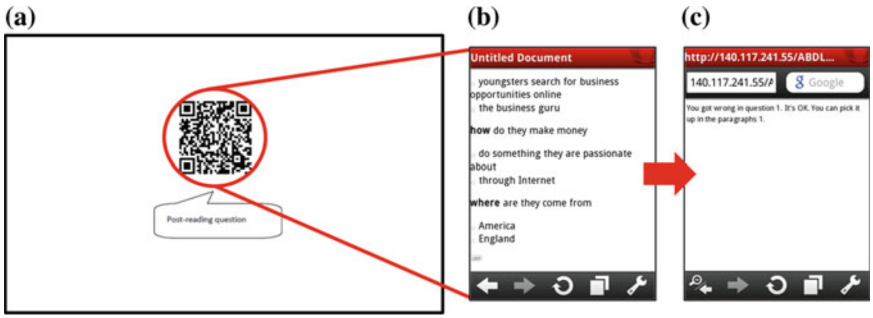

Fig. 6.9 **a** A QR code for an post-reading question. **b** An post-reading question shown in the smartphone. **c** System feedback after students gave their answer

decoding process of the QR code (Fig. 6.8b). Students could continue to read the next paragraph when they answered the question correctly. If they had a wrong answer, the learning system would prompt them to read the related paragraph(s) again or provide them associated digital content for further clarification (Fig. 6.8c).

After students finished the whole main text, the last page of the paper-based materials only printed a QR code of the post-reading questions (Fig. 6.9a). These post-reading questions, which were accessed through scanning the QR code, helped students review what they have learned (Fig. 6.9b), and then the learning system would give them corresponding suggestions based on their answers (Fig. 6.9c).

6.3.2.3 Experimental Procedure

Participants took a 15-minute pre-test at the beginning of the instructional experiment. Then, a 10-minute briefing and instruction on the experimental procedure and learning system operation were given. All participants were then randomly assigned to the two groups with or without scaffolding questioning strategy respectively. Each participant received paper-based materials and a smartphone. The reading activity lasted 50 min and then participants took a comprehension test (i.e., post-test). The total length of the instructional experiment was 90 min.

6.3.2.4 Result

A statistical test was conducted to examine the main effect of scaffolding questioning on learning performance of English article reading. The results suggested that the reading strategy of scaffolding questioning significantly improves students' understanding of the English reading materials ($F = 4.15$, $p = 0.04$). The strategy of scaffolding questioning can help learners improve their English reading performance in the augmentation-enhanced learning context.

6.3.3 *Application 3: Collaborative Learning with Procedural Scaffolding*

The third application was designed for collaborative learning with the support strategy of procedural scaffolding (Huang et al. 2012). An instructional experiment was to evaluate the effectiveness of using procedural scaffoldings in fostering students' team's discourse levels and individual learning performance in the augmentation-enhanced learning context.

6.3.3.1 Participants

A total of 60 students, 27 males and 33 female, were recruited from a university to participate in this instructional experiment. The participants (11 undergraduates and 49 graduate students) were randomly assigned to two groups with or without procedural scaffolding strategy respectively. The participants self-selected their teams. Two groups of 10 teams were formed to proceed with the collaborative learning activity in this instructional experiment.

6.3.3.2 System Design

In application 3, a self-owned digital content distribution server was deployed to deliver the predesigned digital content and to record the responses of individual learners and teams. QR codes printed on paper-based materials were used to help learners quickly login to the learning system (Fig. 6.10), access digital content

Fig. 6.10 The cover page of the paper-based materials with a login QR code for the collaborative learning activity

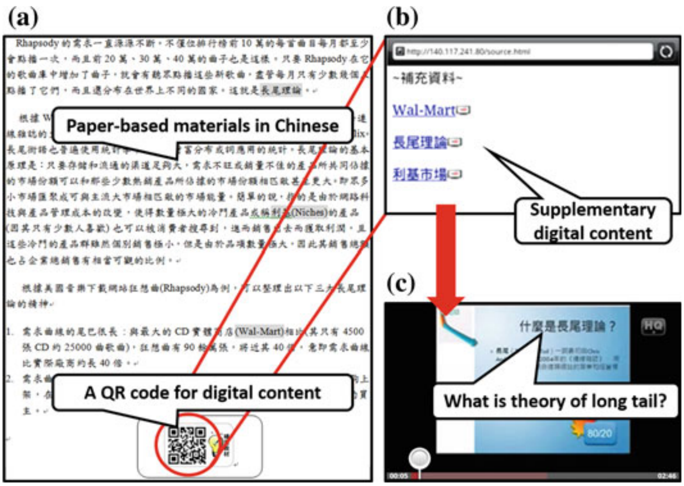

Fig. 6.11 **a** A QR code printed on the paper-based materials for accessing the digital content. **b** A list of available options of digital content. **c** A screenshot of playing a supplementary video for elaborating theory of long tail

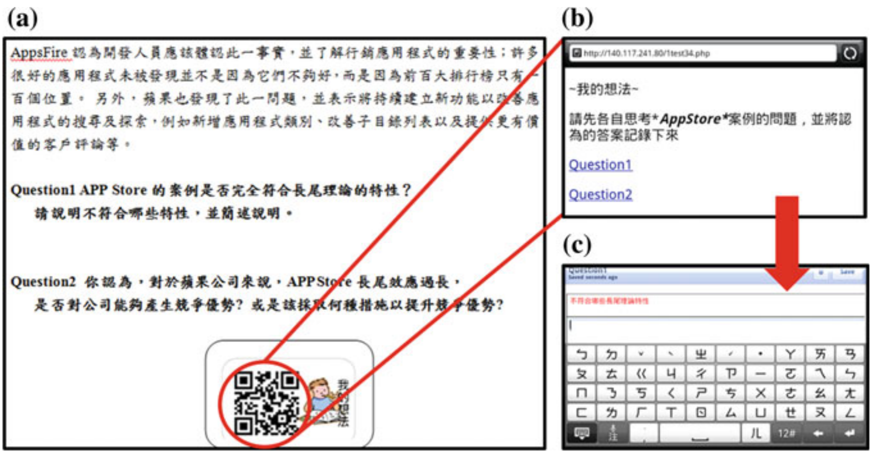

Fig. 6.12 **a** Two questions for learners with a QR code to enter individual responses. **b** A screenshot after decoding process. **c** A smartphone interface for entering responses in Chinese

(Fig. 6.11), and enter the responses of individual learners and teams (Figs. 6.12 and 6.13). The learning unit in this instructional experiment was theory of long tail for collaborative learning.

One type of the QR codes printed on the paper-based materials was to provide supplementary digital content (Fig. 6.11a). After the decoding process, options of

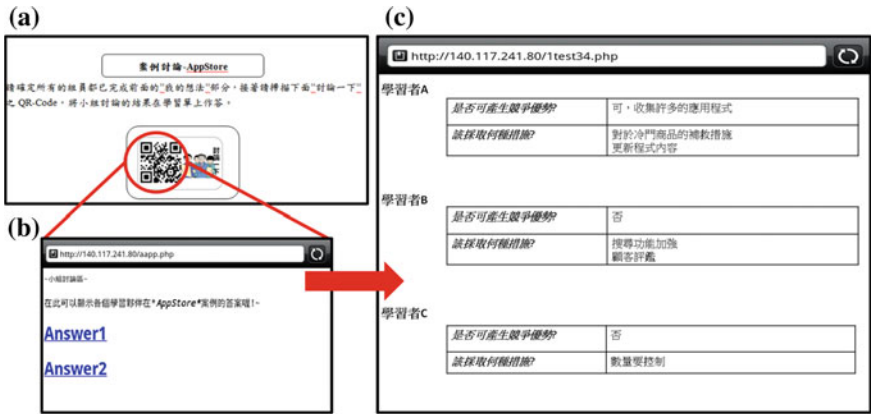

Fig. 6.13 **a** A QR code for starting a collaborative discussion in a team. **b** A screenshot after decoding process. **c** Team members' responses to the question

the supplementary digital content related to the learning materials of the scanned page were available (Fig. 6.11b). Figure 6.11c shows an example that a learner decided to play a supplementary video for further elaborating the theory of long tail.

The strategy of procedural scaffolding includes three steps, problem statement, individual response, and group discussion. In the problem statement step, questions regarding the read learning materials were given to help learners reflect what they have learned and stimulate their deep thinking (Fig. 6.12a). In the individual response step, participants in the group with procedural scaffolding were asked to answer the questions (Fig. 6.12b) and to enter the individual responses to the questions after scanning the QR code (Fig. 6.12c). All the individual responses were stored in the learning system simultaneously. Participants in the group without procedural scaffolding did not enter or receive any information about other team member's answers on their smartphone screen. In the group discussion step, every team member scanned the QR code to initiate a group discussion (Fig. 6.13a). Every team started discussing (Fig. 6.13b) and negotiating (Fig. 6.13c) each team member's responses. All team members' answers were showed on the each team member's smartphone screen. Participants in the group without procedural scaffolding only had verbal discussions in this step. All teams' responses were recorded on a paper-based team learning sheet.

6.3.3.3 Experimental Procedure

A pre-test was conducted to evaluate the participants' entry-level performance on the concept of long tail theory. Then, all participants at-tended a 15-minute training session to learn how to use a smartphone to scan a QR code printed on the paper-based materials. No additional instruction or support was provided at the beginning of the instructional experiment. After participants completed the pre-test, they were randomly assigned to two groups with and without procedural scaffolding strategy respectively. All participants then read a four-page paper-based materials on the long tail effect for 15 min. After reading, participants in the group with procedural scaffolding strategy were asked to enter individual and team responses for 30 min. Participants in the other group had 15 min because they only had to enter team's responses. Before ending the instructional experiment, all teams were required to hand in their paper-based team learning sheets and then completed a 20-minute post-test.

6.3.3.4 Result

Statistical tests were conducted to examine the main effect of procedural scaffolding on collaborative learning. The findings suggest that participants in the group with procedural scaffolding strategy achieved better team's discourse levels (test 1: χ^2 (3, 192) = 9.15, p = 0.027; test 2: χ^2 (3, 234) = 15.09, p = 0.002), team's learning performance (t = 2.68, p = 0.015), and individual learning performance (F = 9.68, p = 0.003).

6.4 Implications for Educational Practices

The augmentation-enhanced learning context with three strategies (i.e., constructive feedback, scaffolding questioning, and procedural scaffolding) can positively contribute to personal learning and collaborative learning. A seamless integration of supplementary digital content into paper-based materials was proven to improve learning performance on personal and collaborative reading activities.

For personal learning, the augmentation learning context with constructive feedback and scaffolding questioning strategies is suitable for helping learners in reviewing a lesson. The advancement of mobile technologies makes a smartphone affordable for daily communication with family, friends, and so on. By well-utilizing the functionalities of a handy smartphone, educational practitioners can further add values to extracurricular learning activities. No additional hardware is required for learners to buy in. A smartphone, the Internet access device, can help learners retrieve a lot of supplementary digital content. Although the mobile devices are already there, learners still need a well-design instructional activity to form an authentic augmentation-enhanced learning context. Thus, instructors have to provide learners adequate paper-based materials with effective supplementary digital content using right strategies for delivering knowledge and improving learning performance. The QR code printed on the paper-based materials can be regarded as a portal to access the digital content. Instructors can keep updating the latest digital content to the Internet without reprinting a new QR code to each individual learner. Learners, who already have the paper-based materials, can learn with the latest supplementary digital content easily.

For collaborative learning, this chapter suggests that educational practitioners can apply procedural scaffolding strategy to facilitate a team's discourse levels and learning performance (i.e., individual and group). Literature suggests that effective group discussion require appropriate guidance, instruction, and training (Blatchford et al. 2003; Chen et al. 2011; Nussbaum et al. 2009; Pea 2004). The result of application 3 shows that a team's collaborative discussion was not satisfactory because the team members did not have a chance to reflect on the reading materials before the discussion. Obviously, procedural scaffolding strategy (i.e., thinking before talking) can facilitate collaborative discussion and learning in a well-prepared condition.

Instructors can refer to the applications to design different representations of the paper-based materials and the digital content. Applying the strategies of constructive feedback, scaffolding questioning, and procedural scaffolding in authentic learning environments is also worth investigating, such as nature science observation activities. Instructors can pre-design paper-based materials with supplementary digital content for indoor or outdoor observational activities. Then, learners can situate themselves in a real environment and learn in such an augmentation-enhanced learning context. More personalized feedback and questions can be applied for instructors to utilize the augmentation-enhanced learning context in the future instructional designs. Learners' characteristics, such as longitudinal learning portfolio, learning style and cognitive style, can also be the basis of the provision of the personalized feedback and questions.

6.5 Conclusion

This chapter proposes an augmentation-enhanced learning context for paper-based content integrated with digital learning supports using smartphones. Three strategies are designed and implemented for real educational practices that have been observed to enhance individual learner's reading comprehension and a team's discourse levels for specific subjects. The way of integrating paper-based content with digital learning supports using smartphones has been demonstrated to be a well-structured design and effective for enhancing learning performance.

Acknowledgements This chapter is supported by the National Science Council, Taiwan under project numbers NSC 102-2911-I-110-501, NSC 101-2511-S-110-003-MY3, NSC 100-2511-S-110-001-MY3, and NSC 99-2511-S-110-004-MY3.

References

Armbruster, B. B., Lehr, F., & Osbom, J. (2001). *Put reading first: The research building blocks for teaching children to read* (3rd ed.). Jessup: National Institute for Literacy.

Bain, A., & Swan, G. (2011). Technology enhanced feedback tools as a knowledge management mechanism for supporting professional growth and school reform. *Educational Technology Research and Development, 59*(5), 673–685. doi:10.1007/s11423-011-9201-x.

Berninger, V. W., & Richards, T. L. (2002). *Brain literacy for educators and psychologists*. New York: Academic Press.

Blatchford, P., Kutnick, P., Baines, E., & Galton, M. (2003). Toward a social pedagogy of classroom group work. *International Journal of Educational Research, 39*(1–2), 153–172. doi:10.1016/S0883-0355(03)00078-8.

Chen, N.-S., Teng, D. C.-E., Lee, C.-H., & Kinshuk, (2011). Augmenting paper-based reading activity with direct access to digital materials and scaffolded questioning. *Computers & Education, 57*(2), 1705–1715. doi:10.1016/j.compedu.2011.03.013.

Chen, N.-S., Wei, C.-W., Huang, Y.-C., & Kinshuk, (2013). The integration of print and digital content for providing learners with constructive feedback using smartphones. *British Journal of Educational Technology, 44*(5), 837–845. doi:10.1111/j.1467-8535.2012.01371.x.

Chen, N. S., Kinshuk, Wei, C. W., & Yang, S. J. W. (2008). Designing a self-contained group area network for ubiquitous learning. *Educational Technology & Society, 11*(2), 16–26.

Cunningham, A. E., & Stanovich, K. E. (2001). What reading does for mind. *Journal of Direct Instruction, 1*(2), 137–149.

Daniel, D. B., & Woody, W. D. (2013). E-textbooks at what cost? Performance and use of electronic v. print texts. *Computers & Education, 62*, 18–23. doi:10.1016/j.compedu.2012.10.016.

Davidson, N. (1985). Small-group learning and teaching in mathematics: A selective review of the research. In R. E. Slavin, S. Sharan, S. Kagan, R. Hertz-Lazarowitz, C. Webb, & R. Schmuck (Eds.), *Learning to cooperating to learn* (pp. 211–230). New York: Plenum Press.

de Jong, T., Specht, M., & Koper, R. (2010). A study of contextualised mobile information delivery for language learning. *Educational Technology & Society, 13*(3), 110–125.

Dillenbourg, P. (1999). What do you mean by collaborative learning? In P. Dillenbourg (Ed.), *Collaborative learning: Cognitive and computational approaches* (pp. 1–19). Oxford: Elsevier.

Embong, A. M., Noor, A. M., Hashim, H. M., Ali, R. M., & Shaari, Z. H. (2012). E-books as textbooks in the classroom. *Procedia—Social and Behavioral Sciences, 47*, 1802–1809. doi:10.1016/j.sbspro.2012.06.903.

Ge, S., & Land, S. M. (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.

Ge, S., & Land, S. M. (2004). A conceptual framework for scaffolding ill-structured problem-solving processes using question prompts and peer interactions. *Educational Technology Research and Development, 52*(2), 5–22.

Hannafin, M., Land, S., & Oliver, K. (1999). Open learning environments: Foundations, methods, and models. In C. M. Reigeluth (Ed.), *Instructional-design theories and models: A new paradigm of instructional theory* (Vol. II, pp. 115–140). Mahway: Lawrence Erlbaum Associates.

Huang, H. -W., Wu, C. -W., & Chen, N. -S. (2012). The effectiveness of using procedural scaffoldings in a paper-plus-smartphone collaborative learning context. *Computers and Education, 59*(2), 250–259. doi:10.1016/j.compedu.2012.01.015.

Janssen, J., Erkens, G., Kanselaar, G., & Jaspers, J. (2007). Visualization of participation: Does it contribute to successful computer-supported collaborative learning? *Computers & Education, 49*(4), 1037–1065. doi:10.1016/j.compedu.2006.01.004.

Johnson, D. W., & Johnson, R. T. (1989). *Leading the cooperative school*. Edina: Interaction Book Co.

Kim, M. C., & Hannafin, M. J. (2011). Scaffolding problem solving in technology-enhanced learning environments (TELEs): Bridging research and theory with practice. *Computers & Education, 56*(2), 403–417.

King, A. (1994). Guiding knowledge construction in the classroom: Effects of teaching children how to question and how to explain. *American Educational Research Journal, 31*(2), 338–368.

Koike, H., Sato, Y., & Kobayashi, Y. (2001). Integrating paper and digital information on EnhancedDesk: A method for realtime finger tracking on an augmented desk system. *ACM Transactions on Computer-Human Interaction, 8*(4), 307–322.

Lan, Y. -F., & Sie, Y. -S. (2010). Using RSS to support mobile learning based on media richness theory. *Computers & Education, 55*(2), 723–732. doi:10.1016/j.compedu.2010.03.005.

Law, C. -Y., & So, S. (2010). QR codes in education. *Journal of Educational Technology Development and Exchange, 3*(1), 85–100.

Li, D. D., & Lim, C. P. (2008). Scaffolding online historical inquiry tasks: A case study of two secondary school classrooms. *Computers & Education, 50*(4), 1394–1410.

Lowe, K., Lee, L., Schibeci, R., Cummings, R., Phillips, R., & Lake, D. (2010). Learning objects and engagement of students in Australian and New Zealand schools. *British Journal of Educational Technology, 41*(2), 227–241. doi:10.1111/j.1467-8535.2009.00964.x.

Macedo-Rouet, M., Ney, M., Charles, S., & Lallich-Boidin, G. (2009). Students' performance and satisfaction with Web vs. paper-based practice quizzes and lecture notes. *Computers & Education, 53*(2), 375–384. doi:10.1016/j.compedu.2009.02.013.

McCarthey, S. J., & McMahon, S. (1992). From convention to invention: Three approaches to peer interaction during writing. In R. Hertz-Lazarowitz & N. Miller (Eds.), *Proceedings of interaction in cooperative groups* (pp. 17–53). New York: Cambridge University Press.

McDaniel, M. A., & Donnelly, C. M. (1996). Learning with analogy and elaborative interrogation. *Journal of Educational Psychology, 88*(3), 508–519.

Nation, K., Clarke, P., & Snowling, M. J. (2002). General cognitive ability in children with reading comprehension difficulties. *British Journal of Educational Psychology, 72*, 549–560.

Nussbaum, M., Alvarez, C., McFarlane, A., Gomez, F., Claro, S., & Radovic, D. (2009). Technology as small group face-to-face collaborative scaffolding. *Computers & Education, 52*(1), 147–153. doi:10.1016/j.compedu.2008.07.005.

Oakhill, J., Cain, K., & Yuill, N. (1998). Individual differences in children's comprehension skill: Toward an integrated model. In C. Hulme & R. Joshi (Eds.), *Reading and spelling: Development and disorder* (pp. 343–368). Mahwah: Lawrence Erlbaum Associates.

Ozcelik, E., & Acarturk, C. (2011). Reducing the spatial distance between printed and online information sources by means of mobile technology enhances learning: Using 2D barcodes. *Computers & Education, 57*(3), 2077–2085. doi:10.1016/j.compedu.2011.05.019.

Özdemir, S. (2010). Supporting printed books with multimedia: A new way to use mobile technology for learning. *British Journal of Educational Technology, 41*(6), E135–E138. doi:10.1111/j.1467-8535.2010.01071.x.

Pea, R. D. (2004). The social and technological dimensions of scaffolding and related theoretical concepts for learning, education, and human activity. *Journal of the Learning Sciences, 13*(3), 423–451. doi:10.1207/s15327809jls1303_6.

Pearson, P. D., & Fielding, L. (1991). Comprehension instruction. In R. Barr, M. L. Kamil, P. Mosenthal, & P. D. Pearson (Eds.), *Handbook of reading research* (Vol. II, pp. 815–860). Mahwah: Lawrence Erlbaum Associates.

Rockinson-Szapkiw, A. J., Courduff, J., Carter, K., & Bennett, D. (2013). Electronic versus traditional print textbooks: A comparison study on the influence of university students' learning. *Computers & Education, 63*, 259–266. doi:10.1016/j.compedu.2012.11.022.

Rolfe, V. (2011). Can Turnitin be used to provide instant formative feedback? *British Journal of Educational Technology, 42*(4), 701–710. doi:10.1111/j.1467-8535.2010.01091.x.

Saye, J. W., & Brush, T. (2002). Scaffolding critical reasoning about history and social issues in multimedia-supported learning environments. *Educational Technology Research and Development, 50*(3), 77–95.

Smagorinsky, P. (2001). If meaning is constructed, what is it made from? Toward a cultural theory of reading. *Review of Educational Research, 71*(1), 133–169.

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. doi:10.1016/j.compedu.2010.11.007.

Veerman, A. L., Andriessen, J. E. B., & Kanselaar, G. (2000). Learning through synchronous electronic discussion. *Computers & Education, 34*(3–4), 269–290. doi:10.1016/S0360-1315(99)00050-0.

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Cambridge: Harvard University Press.

Wang, S. -L., & Wu, P. -Y. (2008). The role of feedback and self-efficacy on web-based learning: The social cognitive perspective. *Computers & Education, 51*(4), 1589–1598. doi:10.1016/j.compedu.2008.03.004.

Weiser, M. (1991). The computer for the 21st century. *Scientific American, 265*(3), 94–104.

Whitelock, D. (2009). Editorial: E-assessment: Developing new dialogues for the digital age. *British Journal of Educational Technology, 40*(2), 199–202. doi:10.1111/j.1467-8535.2008.00932.x.

Whitelock, D., Pinto, R., & Saez, Ml. (2010). Modelling the teachers' feedback process for the design of an electronic interactive science tool with automatic feedback. *International Journal of Continuing Engineering Education and Life-Long Learning, 20*(2), 189–207.

Whitelock, D., & Watt, S. (2008). Reframing e-assessment: Adopting new media and adapting old frameworks. *Learning, Media and Technology, 33*(3), 151–154.

Wood, D., Bruner, J. S., & Ross, G. (1976). The role of tutoring in problem solving. *Journal of Child Psychology and Psychiatry, 17*(2), 89–100.

Wood, D., & Wood, H. (1996). Vygotsky, tutoring and learning. *Oxford Review of Education, 22*(1), 5–16.

Woody, W. D., Daniel, D. B., & Baker, C. A. (2010). E-books or textbooks: Students prefer textbooks. *Computers & Education, 55*(3), 945–948. doi:10.1016/j.compedu.2010.04.005.

Authors Biography

Nian-Shing Chen is Chair Professor at the Department of Information Management in the National Sun Yat-sen University, Taiwan. He has published over 350 papers in the international referred journals, conferences, and book chapters. One of his papers published in Innovations in Education and Teaching International was awarded as the top cited article in 2010. He is the author of three books with one textbook entitled "e-Learning Theory and Practice." Prof. Chen received the distinguished research awards from the National Science Council, Taiwan in 2008 and 2011–2013. His current research interests include assessing e-Learning course performance; online synchronous teaching and learning; mobile and ubiquitous learning; natural user interface and game-based learning. Prof. Chen is serving as an editorial board member for many international journals and guest editors for more than 10 special issues of international journals. He has also organized and chaired numerous international conferences and workshops in the area of advanced learning technologies. Professor Chen is a senior member of IEEE, ACM, and the Chair of the IEEE Technical Committee on Learning Technology (http://lttf.ieee.org/). He is Co-Editor-In-Chief of the SSCI-indexed Journal of Educational Technology and Society.

I-Chun Hung is currently a Ph.D. candidate at the Department of Information Management in the National Sun Yat-sen University, Taiwan. His research interests include natural learning, natural user interface, learning experience, educational robot, mobile and ubiquitous learning, game-based learning, and e-learning. In 2012–2013, he received a one-year grant from National Science Council, Taiwan and performed research regarding human-computer interaction at the University of Washington (UW), Seattle, Washington, USA. He earned BBA and MBA degrees in Information Management at National Sun Yat-sen University, Taiwan in 2007 and 2009 respectively.

Wei-Chieh Fang is currently a research assistant in the Department of Information Management at the National Sun Yat-sen University (NSYS), Taiwan. He received his Master's degree in Cognitive Psychology at National Taiwan University of Science and Technology. He is interested in experimental psychology involving learning and memory. He studied testing effect with an emphasis on retrieval-enhanced retention in associate learning. His recent research interest is gesture-based learning, specifically in the exploration of the potential use of embodied technology, such as motion-sensing technology, in different learning contexts.