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Yun Wen · Yi-ju Wu · Grace Qi ·
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Expanding Global Horizons Through Technology Enhanced Language Learning

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Preface

We have known for a long time that technology is changing the way we live, work and learn, but nothing has made this understanding clearer than the global coronavirus pandemic in the past few months. We have never relied on Internet technology as much to connect one another. Despite unprecedented challenges, we are delighted that the 3rd Pan-Pacific Technology Enhance Language Learning (PPTELL 2020) & Critical Thinking Meeting can be held as scheduled online during the COVID-19 pandemic.

This year, the conference is jointly organized by the University of North Texas (UNT) and National Taiwan Normal University (NTNU). This is the first time that PPTELL is hosted outside of Asia. The conference theme is "Expanding Global Horizon through Technology Enhanced Language Learning and Critical Thinking". A total of 29 papers authored by scholars from six countries will be presented in PPTELL 2020. After a rigorous review process, 13 papers among the accepted submissions, with authors from Taiwan, the USA, Singapore, Turkey and China are selected and included in the proceeding. All the papers included were double-blind peer-reviewed by at least three reviewers from the 40 Program Committee Members from 13 countries. We want to thank all the Program Committee Members for their time and contribution to making the proceeding an important reference for future research on TELL and critical thinking.

The focus of the contributions in this proceeding is the important issues in learning/teaching language and critical thinking in the intelligent and digital era. Today's language learning and teaching is facing unprecedented opportunities and challenges; thus, mastering critical thinking skills is essential for solving real-world problems. The connection of the physical and digital worlds and the participatory culture of cross-disciplinary dialogues will lead to substantial development of technology-enhanced language learning and teaching and learning critical thinking. We sincerely thank all the authors and speakers from diverse disciplines and backgrounds who contributed to the conference.

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Part I
Technology Enhanced Language Learning (TELL)

Chapter 1
Investigating Pupils' Cognitive Engagement in Augmented Reality-Supported Second Language Learning Classrooms

Yun Wen and Sin Yee Lau

Abstract Augmented Reality (AR) is one of the promising technologies that has been used in the educational field. It helps to increase learners' motivation, establish links with real-life experiences, and create contextual awareness. Yet current research in AR for education is still in its infancy and there are few studies regarding the integration of AR in language learning classroom. This study is part of an on-going pedagogical innovation project on AR-enhanced creating and sharing activities for pupils' Chinese character learning. The study concentrates on examining the effectiveness of the designed AR activities by focusing on students' cognitive engagement, in terms of the ICAP framework which helps to assess cognitive engagement with behavioural metric. A total of 53 grade two students from a government primary school in Singapore participated in this study. The findings of the study provide insights into designing and assessing AR-enabled activities in language classrooms.

Keywords Augmented reality · Chinese character learning · Cognitive engagement · Collaborative learning

1.1 Introduction

Chinese character learning is a major hurdle for Singapore local students whose first language is English, because Chinese, as a kind of logographic language, is distinctive from English and other alphabetic languages. In Chinese, distinguishable types of strokes combine in different ways to form components (some of them are radicals) that are the fundamental elements to construct characters. Memorizing those strokes and various components and how they make up every character is one of the major challenges of learning Chinese. School teachers and researchers in the field

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of teaching Chinese strive to find optimal ways to teach Chinese characters beyond rote memorizing.

Augmented reality (AR), as one kind of technologies that combine or supplement real-world objects with virtual objects, has been widely developed for education (Bacca, Baldiris, Fabregat, Graf, & Kinshuk, 2014; Cuendet, Bonnard, Do-Lenh, & Dillenbourg, 2013). The possibility of combining augmented information with contextual information may provide new experiences in language learning (Santos, Lübke, & Taketomi, 2016; Wen, 2018). Bacca et al. (2014) summarized in their review paper that research on AR has demonstrated its advantages for increasing students' motivation, learning gains, interaction and collaboration. Yet they also pointed out that current research in AR for education is still in its infancy, few AR systems have been developed into real classrooms, and a majority of studies examining the effectiveness of system or learning experience via users' perception data. Furthermore, the integration of the pedagogical design with AR in language learning is relatively less, compared within science or mathematics learning (Wen & Looi, 2019).

This study is part of an on-going pedagogical innovation project, augmented reality-enhanced creating and sharing, which employs AR applications ARIS and HP Reveal to investigate the effect of primary school students' radical-derived Chinese character learning in classrooms. The study concentrates on examining the effectiveness of the designed AR activities by focusing on students' cognitive engagement. Cognitive engagement refers to learners' cognitive involvement in learning activities (Fredricks, Blumenfeld, & Paris, 2004). It is usually positively correlated with students' academic performance (Wang, Wen, & Rose, 2016). Researchers in AR-supported mobile learning have been studying how these modes for learning aid students' engagement and understanding for decades (Squire & Klopfer, 2007). In this study, students' cognitive engagement is analysed in terms of the ICAP (Interactive, Constructive, Active or Passive) framework (Chi, 2009; Chi & Wylie, 2014), which helps to analyse cognitive engagement with behavioural metric. Focus group discussion of students and teacher interview data are used to triangulate observation data, unveiling the significant social interactions and contextual factors that represent students' engagement and verifying the proposed coding scheme. The study seeks to provide insights into designing and assessing AR-enabled activities in language classrooms to leverage its potential to motivate and engage students in second language learning.

1.2 Literature Review

1.2.1 AR-Enhanced Active Chinese Character Learning

Shen and Ke (2007) compared three types of encoding strategies used in character learning: rote memorization, student self-motivated elaboration, and teacher-guided elaboration. Their findings indicated that elaboration resulted in significantly better retention for sound and meaning of characters than rote memorization. Between student self-motivated elaboration and teacher-guided elaboration, retention of sound and meaning was significantly better with teacher-guided elaboration in study intervals of 20 minutes, but this advantage disappeared at 48 hours recall interval. In a recent study, Shen and Xu (2015) further provided empirical evidence to support the effectiveness of active learning in classroom vocabulary learning for beginning-level Chinese L2 learners. In other words, student self-directed elaboration can be deemed as an effective approach to learning Chinese characters. Although we have to point out that, the subjects of their study are college students, the findings are consistent with the feedback that we obtained from Singapore local senior CL teachers.

Innovations in language education have been targeted towards ways of enhancing learners' structural understanding of the logographic system beyond rote learning and mechanical practice (Lam et al., 2001). Classroom pedagogy has gradually shifted from knowledge transmission to knowledge construction, Chinese character learning is no exception. Computers and the Internet have been put into use in assisting language learning, and their positive effect on developing vocabulary acquisition or Chinese character learning has been reported in a large number of studies (e.g. Lam et al., 2001; Spiri, 2008; Sung, 2014). In the context of Singapore, the effectiveness of collaborative Chinese character learning has also been elucidated in Wen's study (2018) on a Chinese character composition game with paper interfaces.

AR, as one kind of technologies that combine or supplement real-world objects with virtual objects, has been widely developed for education (Bacca et al., 2014; Cuendet et al., 2013). AR not only provides each individual with a new interactive approach to human and computer interaction but also integrates human–computer context interactions that may provide new experiences in language learning. Beyond content delivery, this study pays more attention to exploring how we can enhance the interactions between learners and the contextual information through pedagogical content design. The link between virtual information and authentic environments is emphasized in the design. As Klopfer and Squire (2008) pointed out in their early study, successful AR applications require learners to solve complex problems in which they have to use a combination of real collected evidence and virtual information. One mechanism for achieving this is to design context-aware applications on mobile devices. Meanwhile, the integration of pedagogical designs (such as collaborative problem solving) with AR can also help to create authentic learning contexts where participants need to solve problems or complete tasks together.

1.2.2 Cognitive Engagement

Cole and Chan (1994) defined students' engagement as "the extent of students' involvement and active participation in learning activities" (p. 259). Fredricks et al. (2004) identified three dimensions of students' engagement, namely behavioural engagement, emotional engagement, and cognitive engagement. Cognitive engagement is understood as the psychological investment in, effort to comprehend and master challenging concepts, and the willingness to complete difficult tasks across domains, and in which self-regulated and other regulatory strategies of guiding one's cognitive efforts is emphasized (Fredricks et al., 2004; Kahu, 2013).

The ICAP framework was developed by Chi (2009) and Chi and Wylie (2014) to define cognitive engagement activities on the basis of students' overt behaviours. They proposed that learning activities and their resulting overt engagement behaviours can be differentiated into one of four modes: Interactive, Constructive, Active or Passive. In terms of the knowledge-changing process, interactive mode of engagement achieves the greatest level of learning, greater than the constructive mode, which is greater than the active mode, which in turn is greater than the passive mode. The framework has been used to analyse cognitive engagement in online environments via analysing online discourses automatically (e.g. Atapattu et al., 2019; Wang et al., 2016). Although the framework initially developed for face-to-face learning, there are few reported cases on exploring the factors on students' cognitive engagement in AR-supported learning environment based on the framework. ICAP in this study can be used to identify and examine effectiveness of a new learning environment, in which human-computer-context interactions are supposed to be integrated and augmented by AR techniques, and higher-level students' cognitive engagement may take place.

1.3 Methodology

The purpose of this study is to examine learner's cognitive engagement in the AR-supported collaborative Chinese character learning activities. The guiding research question is whether and how the AR-supported context-based language learning activities help to improve students' cognitive engagement, as well as how to assess students' cognitive engagement in the AR-supported language learning classroom.

1.3.1 Participants

This study involved a total of 53 (Grade 2, 8–9 years old) students from a government primary school in Singapore. The students were from 2 different classes taught by 2 Chinese language teachers (Teacher E for the AR experimental class and Teacher C for the non-AR control class). Both classes received an equivalent amount of invention time and participated in the similar activities, but the experimental class used AR applications ($N = 28$), and the control class did not ($N = 27$). Besides, both classes exhibited similar Chinese radical's knowledge (in terms of the pre-test before intervention) and so were Teacher E's and Teacher C's teaching experience. In each class, we randomly selected two groups (3–4 students) as target groups to capture their entire learning processes with video cameras and they were interviewed after the holistic intervention.

1.3.2 Activity Design

The school-based intervention spanned for three months, from August 2019 to October 2019. The content of the study followed the school syllabus and ran parallel with the school curriculum. In addition to the technical trainings for the teachers and students, three iterative lessons were designed and implemented in the experimental and control classes, respectively. Each lesson lasted for 60 mins. In both classes, every group was provided an iPad to carry out the group activities. The intervention procedure in the two classes is illustrated in Fig. 1.1. A total of three rounds of intervention was conducted.

Every single intervention lesson in both classes began with the instruction provided by the teachers. After that, in the activity of ***acquisition***, the students of the experimental class completed group tasks based on ARIS. ARIS (n.d.) is a mobile application builder which targets educators looking to develop AR education game (Field Day, 2020). In the ARIS system, all AR features are powered by Vuforia engine, by which developer can easily add advanced computer vision functionality of image recognition, and in this way it allows users to interact with spaces in the real world. In our study, this function was used to recognize radical cards we designed for students in terms of their curriculum. Using the AR feature in ARIS, students scanned the physical radical cards with their device's camera to trigger an animation (Fig. 1.2a). Students were then asked to answer questions regarding the Chinese radical they selected. In each lesson, the students of the experimental class completed the game in groups to master 15–18 target radicals at their own pace. In contrast, the students of the control class were led by their teacher to learn the same target radicals by using the same pictures and animations (Fig. 1.2b). Teacher C also asked the same questions about the Chinese radicals and her students answered them by rising their arm or speaking out.

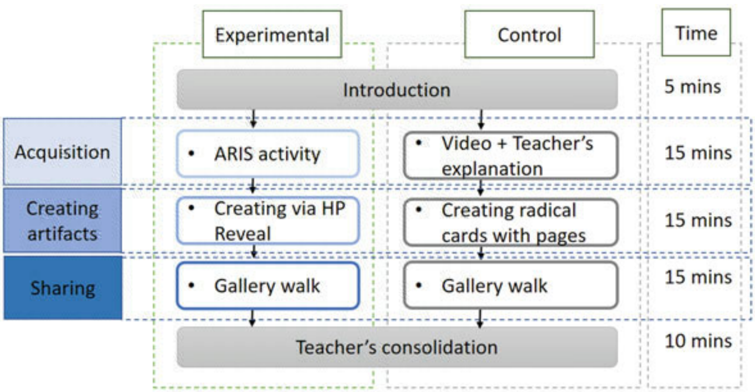


Fig. 1.1 Activity processes of the experimental and control classes

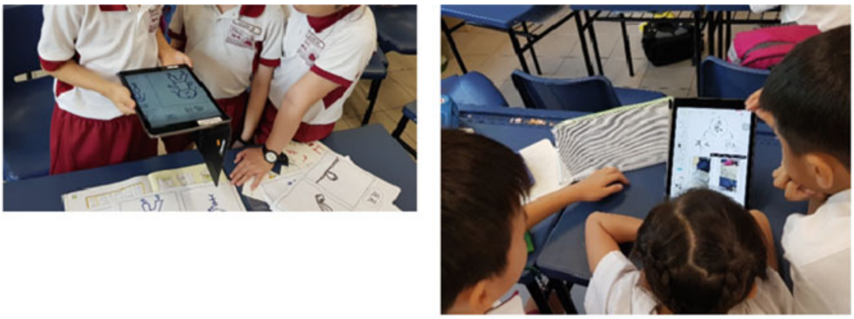
a. ARIS with AR feature to trigger a Chinese radical animation

b. Teacher C using PowerPoint slides to present Chinese radical animations

Fig. 1.2 Learning scenarios in the activity of acquisition

After completion of the first activity, students proceeded to the second activity—***creating artefacts***, in which they generated their own AR artefacts using HP Reveal. The procedure as follows: (1) completing the AR paper to illustrate the semantics of the radicals; (2) uploading AR papers to HP Reveal by taking a photo through the application; (3) filming a video of themselves reciting a sentence they constructed using the phrase they formed using the targeted Chinese radical while acting out the constructed sentence; and lastly (4) uploading the recording to superimpose it on the virtual AR paper which was uploaded earlier. Different from the experimental class, the control class was not able to superimpose their video recording to a physical paper. Students completed the same tasks using Apple Pages.

At the stage of **sharing**, students from both experimental and control classes did a gallery walk to view other groups' artefacts (Fig. 1.3). The sharing activity consisted of 2 segments, student-led and teacher-led session. During student-led segment, a student from each group stayed behind with their artefacts while the rest of the



a. Demonstrating artefacts via HP Reveal in the experimental class

b. Watching video recordings from Apple Pages in the control class

Fig. 1.3 Sharing group artefacts in the experimental and control classes members went around the class to look at the other artefacts created by the rest of the class. The duty of the member who stayed behind with the artefacts was to introduce their artefacts to the visiting classmates and answer their enquiries. The rest of the members were to learn and comment about the artefacts made by the others.

1.3.3 Data Sources and Analyses

This study aimed at investigating whether students could be cognitively engaged better in AR-supported language learning activities, and what strategies could enhance their cognitive engagement. We focused on analysing their learning processes in the last lesson in which the teachers and students have been familiar with the learning design. The main data sources included:

1. the two target groups' learning processes in each class;
2. focus group discussion with the target group students;
3. post-interview data from the teachers.

For both the experimental and control classes, two video cameras were set up to record the two target groups, by which face-to-face interactions among peers and their interactions with the apps were recorded. Additionally, their discourse and iPad related actions were recorded by iPad's screen recording. We analysed and assessed students' cognitive engagement levels in terms of Chi's ICAP framework. For the sake of consistency, two authors watched and transcribed all the video data and identified behavioural indicators according to ICAP, as shown in Table 1.1, the coding scheme was designed to capture the cognitive engagement of the three main activities: (1) acquisition of Chinese radical's knowledge; (2) creation of students self-generated AR-artefacts and (3) sharing of students self-generated AR-artefacts. As tangible interfaces were used in the study, the coding scheme took into account of 2 different modes of overt behaviours: communicative discourse and action-based learning behaviour. Next, the transcribed data was segmented into units of "theme". In this study, one theme referred to one radical-related activity. Finally, the learning process data was coded according to the coding scheme. The coding scheme was developed through an interactive process of creating codes, coding, modifying and refining codes, and recording consistent with Miles and Huberman's (1994) recommendations for rigorous and meaningful qualitative data analysis.

The focus group discussion and teacher's post-interview were conducted to address how the participants perceived the learning and teaching experience using AR tools and without using AR tools. To make sure the reliability of the data analysis, during the entire coding process, two researchers examined the data, completed the coding independently, and then collaborated and built a consensus on their coding.

Table 1.1 Coding scheme for assessing cognitive engagement

Level	Modes	Type of activities		
		Acquisition	Marking artefacts	Sharing
I	Hands-on Discourse	Discuss the similarities or differences of the radicals. Debate with teacher or peer about their comment/statement about the semantic or form of the radical Ask and answer comprehension questions relating to Chinese language	Two or more group members having constructive discussion on what Chinese radical, character and phrases to be written and what kind of drawing to represent the writings on the AR paper or how they should film, what to do and say during the video recording to best portray the phrase (co-constructing) Both parties must make transactive contributions. Student A talks about his/her ideas and Students B/C question or build on Student A's comments to come out with better ideas	Both the owner and visitors are involved in constructive discussion on how to improve the language aspect of the artefacts Both parties made transactive contributions. Student A talks about his/her ideas and Students B/C question or build on Student A's comments to come out with better language usage or better presentation of artefacts
C	Hands-on Discourse	Read the question and interpret the question. Explain a radical to a peer who gave a substantive comment Explain concepts in the video, compare or contrast to prior knowledge or other materials	Represent an idea either from his/her teacher or peer in their own words without challenging the idea, such as coming out from a drawing based on his/her peer's explanation, or drawing something different from the radical cards on the AR paper During a dyads conservation, Students B gives substantive comments on Student A's ideas, or corrects grammar errors, either implicitly or explicitly	Compare artefact artefacts to build on how they depict the given radical During a dyads conservation, Students B gives substantive comments on Student A's ideas, or corrects grammar errors, either implicitly or explicitly
A	Hands-on	Pause, stop or repeat video; select an answer from a menu of choices Control: Raise up hands to response to teacher's question, but without explanation	Replicate a presented idea without providing new knowledge, including writing a phrase or drawing as instructed, or copying picture from textbook or radical cards	Mimic the action shown and repeat what is said in the recording
	Discourse	Repeat a statement or take verbatim notes without providing any new inferences or describing a scenario	Repeating a statement, taking verbatim notes that do not provide any new inferences, describing a scenario	Ask about the language aspect of the artefacts but did not contribute any thoughts thereafter
P	Hands-on Discourse	Take no overt actions other than attending, like touching the iPad or cards or listening to teacher	Take no overt actions other than attending, like touching the iPad or cards	Watch and laugh without comments

1.4 Findings

1.4.1 Learning Process

The learning activity of acquisition was further segmented into units of the individual Chinese radicals' acquisition. The experimental class had 6 units and the control class had 18 units. The difference in the number of units was due to the design of the learning activities. For the experimental students, they were assigned with 6 radicals to work with right at the start of the class. On the other hand, control students attended to a more traditional class where their teacher used PowerPoint slides to introduce all the radicals, total up to 18 radicals (Fig. 1.4).

In this stage of activity, both focus groups from the experimental class managed to participate actively, with 83% at the active level and 17% at the constructive level in total. In the designed AR activity, students were required to search and scan for the corresponding radical card before they were allowed to move on. This design germinated students' active participation. The actions of searching and scanning made learning more active as the students needed to be consciously seeking their knowledge to make sense between the cards in their deck and the questions. The weaker students who might not know the answer to the question would also benefit from the process. It was observed that the stronger asked the weaker to search and scan the correct cards, and as a result, the weaker would learn from the process. While the experimental groups were able to engage in active learning, the control groups had a higher percentage of higher levels of active learning experiences. They were 8% at the interactive level, 64% at the constructive level and 22% at the active level in total.

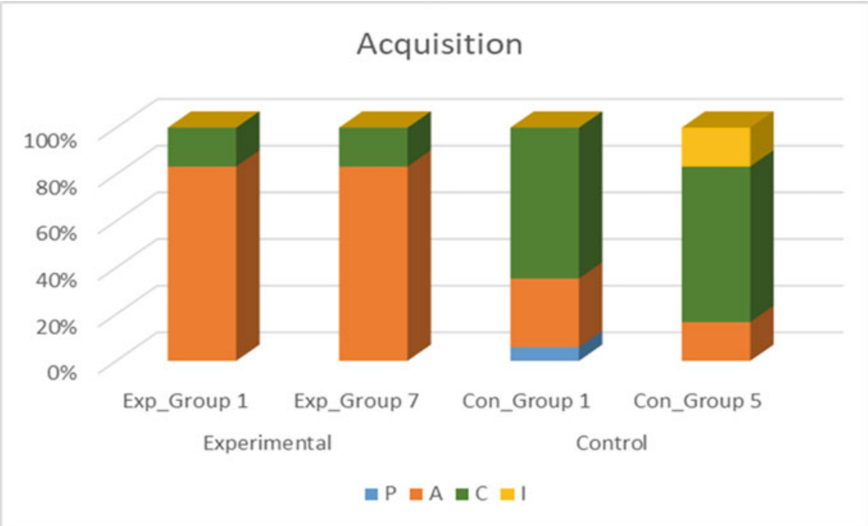


Fig. 1.4 Comparison of cognitive engagement in acquisition

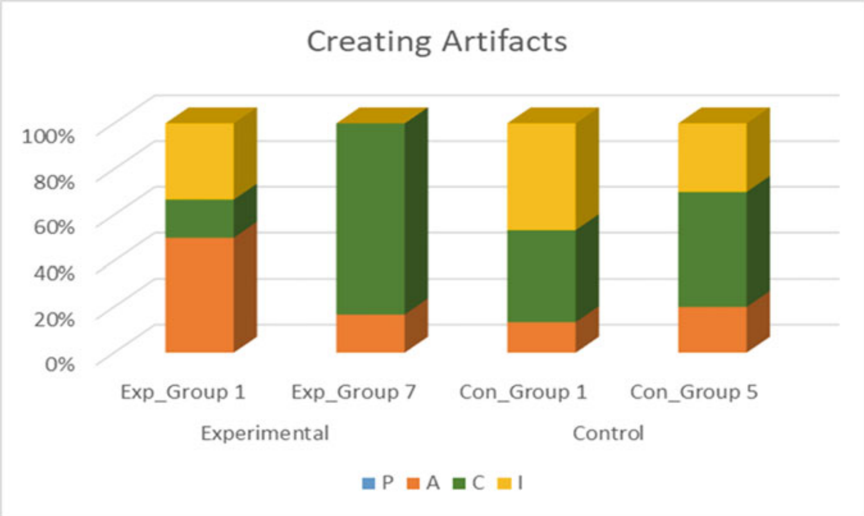


Fig. 1.5 Comparison of cognitive engagement in making artefacts

That was because Teacher C had good questioning skills. She kept asking students questions and her students were very delighted to share their thoughts (Fig. 1.5).

In the learning activity of making artefacts, the unit of analysis was the episode of making every single artefact. The experimental groups produced 6 artefacts each, but Teacher C emphasized on creating as many as artefacts as the students could, that resulted to more artefacts generated in the control groups (15 artefacts in Group 1 and 10 artefacts in Group 5). In the activity, as all the groups had created their own artefacts, passive learning did not exist. Active learning process included writing a phrase as instructed, replicating drawings from other materials such as the textbook or the radical cards, without making any new inferences and providing new knowledge. At the constructive level, students presented their ideas with their depictions; provided substantive comments and corrected language error or any other non-technical errors. At the interactive level, students co-constructed the group artefacts. They built on or corrected the other party's ideas to increase the quality of the artefacts or language use.

Both focus groups from the experimental class managed to participate more actively in this activity compared to the activity of acquisition. As students were required to illustrate their thinking into drawings, they were observed working as a group to generate their group artefacts. Nevertheless, the level of engagement varied among groups. Moreover, the control groups had a higher percentage of superior active learning experiences with 40% at the interactive level and 44% at the constructive level. This might be because making an AR-related artefact was more time-consuming, students in the experimental class were rushing to finish the assigned tasks. Though they were mind-engaged beyond hand-engaged, but not in depth. Another reason might be that the original collaborative learning culture of the