Part B Project Summary

Project Title: Enhancing Language Education with Artificial Reality Neo-platform (eLEARN) 透過人工實境的新平台來優化語文教育 (eLEARN)	Project Number 2016/0318

Name of Organisation:
Division of Information and Technology Studies, Faculty of Education, The University of Hong Kong

(1) Goals: To build the eLEARN platform mainly with Augmented Reality (AR) and Virtual Reality (VR) technology as a bundle for Primary 4 to 6 Chinese Language aligning with the local curriculum, and provide e-learning trainings for in-service language teachers in primary schools.

Objectives:
(a) Develop and implement the eLEARN platform with computer-mediated reality based on the local curriculum for language education in Hong Kong;
(b) Design e-learning activities and tasks with the eLEARN platform to enhance the learning effectiveness of Chinese language;
(c) Evaluate the effectiveness and challenges of the eLEARN platform and inform the local and international community about the future development of e-learning with computer-mediated reality;
(d) Motivate students to engage in language education with our eLEARN platform through the AR and VR technology with evidences; and
(e) Equip the local language teachers with computer mediated reality technological and pedagogical knowledge and instructional design concepts in using the eLEARN platform through professional trainings and seminars.

(2) Targets: Primary school teachers and students
Expected Number of Beneficiaries: 2700 total primary students, 870 in-service teachers, 18 local schools; More will be expected to join the project after conducting workshops and seminars in long run.

(3) Implementation Plan:
(i) Duration: November 2017 – April 2020 (30 months)
(ii) Process/Schedule: (Part C for Details)

Phase	Summary
Preliminary: (Ongoing until December 2017)	Coordinate schools and design the contents
I: January 2018 – December 2018	Develop the eLEARN platform and test it
II: January 2019 – October 2019	Fully implement the eLEARN and provide training
III: November 2019 – April 2020	Prepare and publish the project findings

(4) Products:
(i) Deliverables/outcomes: Creation of eLEARN platform with AR and VR learning environment; Publishing of eLEARN manuals and website; Publishing 15 sets of lesson and curriculum materials
(ii) Dissemination of deliverables/outcomes: Public seminars, promotion on registered website; Building a Community of Practice (CoP) through Seminars and Workshops

(5) Budget: (Part C for Details)

Staffing	Equipment	General Expenditures	Contingency	Total
$2,322,036.00	$590,774.00	$511,717.00	$19,673.00	$3,444,200.00

(6) Evaluation: (Part C for Details)
(i) Performance indicators: Design-Based Implementation Research (DBIR); pretest and post-test; Focus group interview; questionnaire on learning motivation; Quantitative and qualitative study results.
(ii) Outcome measurements: Publishing of user and technical manuals, feedback survey from users.

Enhancing Language Education with Artificial Reality Neo-platform (eLEARN)
透過人工實境的新平台來優化語文教育 (eLEARN)

Part C Project Details

1. Needs Assessment and Applicant's Capability

In the last few years, computer-mediated reality such as augmented reality (AR) and virtual reality (VR) interfaces have shown the potential to enhance teaching and learning, by combining physical and virtual worlds to form an artificial reality and leveraging the advantages of both (Azuma et. al, 2001; Yannier et al. 2015; Akçayır and Akçayır, 2016). AR technology allows the virtual objects (augmented components) to be overlaid into the real world so that user experience can be elevated (Chen et al., 2001), where VR technology brings the reality experience into a virtual environment with the help of VR devices such as VR glasses (Psotka, 1995; Huang et al., 2016b). Educators from different countries have already been experimenting this technology and applying it into education. In 2007, [redacted] school in Singapore applied an AR prototype in an upper primary school class to facilitate the learning of seed germination and plant growth, and indicated significant change in engagement and motivation (Pang et al. 2007). [redacted] Primary School in Australia engaged its students with AR resources on STEM (Science, Technology, Engineering, and Mathematics) areas (Bickers, 2016). Thus, computer-mediated reality technology has already been introduced to education and changed the learners' experience. The following sub-sections will explore the global and local needs of the new learning.

Background Works in AR and VR Technology for Education

Based on the recent systematic review of 68 related studies by Akçayır and Akçayır (2016), the report indicates that the AR technology as well as other computer-mediated reality technology and vision glasses becomes technologically mature in being applied to education to enhance learning performance. Akçayır and Akçayır found that 51% of the research projects targeted on the K-12 learners and 60% of them developed their learning tools on mobile devices since 2007. More importantly, AR can enhance learner's outcomes (e.g. learning achievement, learning motivation, attitude, confidence), pedagogical design (e.g. collaboration opportunities for students, communication between students and teachers, multi-sensory learning, self-learning), and interaction (student-student, student-material, student-teacher) (Akçayır and Akçayır, 2016; Chen et al., 2017). Despite the improvement of using this technology for learning, several major challenges have been identified in these studies, such as students' difficulty in using it due to the poor interface design (Munoz-Cristobal et al., 2015) and cognitive overloading of processing excessive information through AR (Dunleavy et al., 2009). When these issues arise during the teaching moments, teachers may need to spend more time than usual to teach a lesson. Nevertheless, these findings and other recent initiatives have informed us the future trend of the learning environment and the needs in finding out possible solutions of AR technology as a new e-learning tool particularly in the K-12 sector.

The visual cues with the computer-mediated reality, particularly AR, has already been proven helpful for students to understand difficult concepts in other non-language education domains, such as computer programming (Zünd et al., 2015) and visual concepts like the anatomy of human body (Saenz et al. 2015). Yet, this technology has not been fully studied for the application and effectiveness of use in the language teaching with only limited examples (Chen et al., 2007; Low et al., 2008; Wong et al., 2008). For instance, Su (2004) proposed a new language learning system in AR environment, which promotes Chinese phonetic alphabet learning for children at the age of 6 to 7. By introducing the children's popular cartoon characters in the exercises as both avatars and judges in 3D shapes, the children can gain the feedback from the system to motivate them to learn and stay focused. The result was compared with the traditional books reading with children learning motivation and learning achievements. Despite with these positive examples, language learning in primary education has not been fully benefited from it because of the lack of targeted curriculum-based tools developed with research support. Computer-aid learning tools should be developed constantly with advanced technology based on local curriculum, the cultural differences and learning styles, since language learning is an important part of the policy focuses in many educational systems (Luk 1991; Selinger 2004; Tan, 2006).

Unfortunately, language learning with technology is often limited due to the lack of interdisciplinary collaborations and interest of researchers in studying technology applications in language classrooms at the K-12 (Zhao, 2003). Chun et al. (2016) offered a frontier advice on how technology plays an evolutionary role and may benefit the language learning and teaching. Indeed, technology offers an innovative way for cultures and languages being represented, expressed, and understood. When using purposefully and meaningfully with clear learning goals and good understanding of the affordances, it will encourage some degree of critical reflection and engagement, and form an underlying rationale for selecting a suitable technological learning tools (Chun et al., 2016). Also, language teachers are encouraged to be more competent in teaching-aided pedagogy, but they have been given insufficient experience to explore and build up their belief in the effective use of instructional technology (Cooke-Plagwitz, 2016). Besides, Wu et al. (2013) have found that the majority of the AR technology were designed for subjects such as science and mathematics, and no existing

work has been initiated to integrate with language education. In addition, regular curricula integration has not been fully explored since most of the existing studies have been conducted in short-term and/or out of normal school curriculum (Wu et al., 2013). Since AR/VR technology offers a unique environment to allow students explore the world and other contents, language education can intuitively take a similar advantage to allow students to explore contents from a different angle. For example, during the lesson of discussing "White Sail and Wood Pulp" in Primary 4 Chinese language curriculum, we can bring the students and sail on a sea with a boat in Hong Kong through the virtual spaces by wearing the 360-degree glasses, which will never be possible for safety reason. With the advanced technology of Accelerometer and Gyroscope built on smartphone, students can view the VR contents in 360 degrees by moving around their head at their own choice. After exploring the real situations, students can be asked to use their language skills to express themselves after they experience it. It is expected that students may be motivated to extend their learning by reading related materials. Thus, it is worth it to consider bringing AR and VR into language classrooms, design these unique e-learning tools based on the local language curricular to meet to students' needs, and engage the teachers in the design of new tools which fit to their pedagogies.

Needs for Hong Kong Primary Language Education

Based on the consultation document for the Fourth Strategy on Information Technology (IT) in Education from the Education Bureau (EDB), enriching the e-learning resources and applying IT skills across school curricula should be the key focus for promoting an e-learning repertoire for schools and teachers, which meets the Hong Kong latest policy address (EDB, 2015; HKSAR, 2016). The report has constantly pointed out that there is a need to integrate e-learning associated with appropriate pedagogies in using the technology across different learning areas to strengthen students' learning achievement, and take the advantage of IT to enhance the digital literacies of students. In this eLEARN project, we propose to take the pilot step to develop a set of new mobile learning tools and promote the education value of AR and VR technology for Hong Kong primary education, particularly studying how these technologies can facilitate the Chinese language education. The project will mainly consist of three parts: (1) Design and development of AR and VR mobile learning platform for mobile devices (i.e. mobile phones, tablet devices and 3D glasses) with effective learning designs and pedagogical approaches; (2) Evaluation of the language learning effectiveness in primary schools with the usage of the eLEARN; and (3) Provide workshops and trainings to the teachers in Hong Kong on designing learning activities with eLEARN and producing contextual contents for language education.

Actually, a questionnaire has been sent to some selected primary schools in Hong Kong to find out their interest in building AR/VR learning platform together and investigate a new pedagogical design with the AR/VR contents. A total of 18 schools replied and showed their interests in actively supporting the project. Five schools were also interested in designing the contents with our project team. The schools expressed the issues about the limited choices of AR/VR contents for local primary language education from the free source and publisher's contents. Besides, they believed that a collaborative effort in joining a project together to develop the contents would provide them with more technical support and technology knowledge during the development and implementation. Therefore, instead of building different AR/VR content platforms, they believed that it is more beneficial to build a platform which can be shared by all the schools who are interested in adopting. Therefore, we have developed this proposal together with these schools to address the needs of local language education in primary schools.

In this project, we plan to work with the development team members to develop the eLEARN platform. The development team should be formed with selected primary school teachers who are experienced in language education. Preliminary works have been done to collect contents ideas from the primary schools, and we will design the platform based on the selected topics in Chinese language subject from the local curriculum (see Lesson Plan Example Appendix C). Researchers and international collaborators will serve as consultants and instructional designers for the project and help support the needs analysis and design. During the implementation and evaluation, we will conduct a rigorous study to ensure the usability and efficiency of the eLEARN platform. Pedagogical design of using the eLEARN for effective teaching in language education will be developed as well. It is expected that students in the language classes will gain benefit from the sensory experiences of the AR and VR contents in addition to their traditional approaches in learning the language skills. With the AR and VR contents plus visual glasses, it is expected that primary school students will have the immersive experience while in the classroom to explore the outside world. Reading and listening will be provided in the eLEARN contents to engage students in language learning. Intuitively, they can gain knowledge in the new contents, and learn how to express their experience and knowledge in Chinese through writing and speaking skills. In viewing that this technology and content concept is unprecedented, it is expected that the project will be innovative to introduce new learning experience.

Selection of QEF Theme and Justification

In response to these initiatives with computer-mediated technology in education, the Faculty of Education at the University of Hong Kong (HKU) is committed to lead the local and international education by collaborating with local

schools and bringing innovative ideas to change the ways of language learning and teaching through technology. This project will meet several of the priority themes for 2016/17 in the QEF application guide, yet the primary theme would be **(QEF Theme 1) Effective Learning and Teaching of Languages** – The eLEARN project targets on designing an effective technology-mediated learning and teaching platforms for schools based on the current curricula of Chinese Language. Language teachers will be involved in the design and implementation of the tools and ensure the content coherence and usefulness of the AR and VR tools. The evaluation will validate the effectiveness of this tool in enhancing the language skills of students as well as the pedagogical competence with technology of teachers. Workshops will be organized to train teachers to know how to use this tool to teach as well as creating their own AR contents for future teaching topics. On the other hand, this eLEARN project can help promote a new trendy way of e-learning for enhancing the listening, reading, writing, memorizing, and speaking skills.

Through developing the learning contents and bringing the AR and VR tools to language classrooms with mobile devices, students could experience and interact with the outside worlds while being indoor with extra information projected on mobile screens or 3D VR glasses. The computer-mediated reality removes the boundary and limitation of physical learning environment, and provides more sensory experiences to students. The effective learning can then be evaluated after the design and implementation, and the deliverables can result in a wide-range of language education benefits in local schools. The nature of the AR technological tools brings the students with different learning and sensory experiences in language education. By designing and implementing our eLEARN project, it will offer an extra support for learning diversity with educational technology.

Applicant's Capability with the Project Team

The University has long served the leading role in the teachers' training and educational reform in Hong Kong. Our teaching and research capacity, which encourages knowledge transfer, has been serving as the local and global leader due to our significant contributions to local and global education. Additionally, the Division of Information and Technology Studies (I&TS) in the Faculty is committed to develop better e-learning pedagogical design and utilize our research foundation in IT to enhance learning and teaching. Some of the selected leading research projects and training courses related to e-learning and IT in education that have been initiated by the capacity of the principal investigator (Dr. Gary Wong) include: *Flipped Learning Initiative Programme for Primary Education (FLIPPED)* (Ref: **QEF Project 2013/0944**). To highlight, the QEF project (Ref: QEF Project 2013/0944) led by the principal investigator on flipped classroom in primary schools was successful, which involved mainly five local primary schools across different subjects (Chinese Language, English Language, Mathematics, General Studies and Physical Education) to promote flipped classroom with technology. The number of served students and teachers were about 600 and 50 across these schools. Two seminars were organized to attract 104 teachers and principals from 42 different schools in the first event, and 261 from 118 different schools in the second event (where 420 registered but the actual number of invited participants were cut due to the limited spaces). This is a solid indicator that the project team has good experience (both technical and pedagogical aspects) to work with local schools and bring the innovative e-learning practices to the teachers and students.

Besides, the eLEARN project team is formed with local and international experts in education, technology and instructional design. Due to the multidisciplinary nature, these experts will serve as consultants in the project. The team members will lead the design of the eLEARN system, learning design, evaluation of learning effectiveness and professional trainings. They will also serve as supervisors to the project assistants, system developers and student assistants. The proposal is submitted through the Division of I&TS. For the administrative support, the Centre for Information Technology in Education (CITE) at HKU will provide to the project team with their numerous experiences in managing successful QEF projects (see: http://www.cite.hku.hk/projects.php).

Chinese Teachers (Primary Schools)

1. Jordan Valley St. Joseph's Catholic Primary (佐敦谷聖若瑟天主教小學)
2. St. Edward's Catholic Primary School (聖愛德華天主教小學)
3. Ping Shek Estate Catholic Primary School (坪石天主教小學)
4. Tai Kok Tsui Catholic Primary School (大角嘴天主教小學) (Hoi Fan Road 海帆道)
5. St. Matthew's Lutheran School (路德會聖馬太學校) (Sau Mau Ping 秀茂坪)

2. Goals and Objectives

The goal of this project is to build the eLEARN platform mainly with AR and VR technology as a bundle for Primary 4 - 6 Chinese Language aligning with the local curriculum. Here are the objectives of this project:

1. Develop and implement the eLEARN platform with computer-mediated reality based on the local curriculum for language education in Hong Kong;
2. Design e-learning activities and tasks with the eLEARN platform to enhance the learning effectiveness of Chinese language;
3. Evaluate the effectiveness and challenges of the eLEARN platform and inform the local and international community about the future development of e-learning with computer-mediated reality;
4. Motivate students to engage in language education with our eLEARN platform through the AR and VR technology with evidences; and
5. Equip the local language teachers with computer mediated reality technological and pedagogical knowledge and instructional design concepts in using the eLEARN platform through professional trainings and seminars.

This project adopts the Design-Based Implementation Research (DBIR) methodology to build the artifacts with AR and VR technology (Fishman et al., 2013). It involves the teachers during the design process and reflection to improve the system and pedagogical design. The learning contents will be designed based on the selection of curriculum from the local teachers and consultations from the language experts who find the needs to introduce the AR and VR contents. With the learning contents on the platform and the mobile devices to deliver them, the learning effectiveness will be measured and challenges will be identified to refine the system and learning design. Ultimately, professional trainings and workshops will be organized to transfer the knowledge to all the primary school language teachers in Hong Kong. Through the process, the teachers will improve their digital literacy and form a good community of practice in language education with e-learning practical experience.

Based on the objective 1 and 2, the eLEARN can be implemented by the open sources , which is capable to track objects, recognize square printed AR markers as marker-based AR tool. Or we can use ` . for feature-based AR, where different objects can serve as marker to show AR contents. It originally supports desktop platform but there are derivative versions that supports smartphone platform. Through smartphone, the student can view the AR/VR scene through the screen or VR glasses, and interact with the virtual object by tapping or drag-and-drop. For example, the students can view a video of Beijing when the eLEARN application recognized a picture of the Great Wall. Smartphone could provide visual and sound effect in addition to a static picture. With the advances of head-mounted devices , wearable AR/VR can be feasible in our project. Figure 1 (in Appendix B) showed one snapshot of our conceptual designing idea. In a writing lesson, the student could see through the VR glasses and a part of the classroom could be turned into the scene of a remote location (e.g. a lake in Hangzhou). The learner could obtain a first person feeling to the environment that

stimulates his/her writing motivation and ideas. In eLEARN environment, the students can still see the real classroom and communicate with the real teacher.

Wearable AR and VR technology enables intuitive interactions with virtual objects (Bai et al. 2014), and allow users to interact with virtual objects with bare hands. Depth cameras could be used for calculating the relative positions of the real objects, and hence the virtual 3D objects could be overlaid on real objects in the scene. The depth cameras can also track and recognize the hands and full-body gestures and hence capable to provide a hands-free interaction. The student can simply manipulate with the virtual object directly, such as writing a poem in the air with fingers or virtual stylus. Such capability helps the students to write down their ideas immediately otherwise they will forget when the feeling has gone with the time.

3. Targets and Expected Number of Beneficiaries

The establishment of the project will provide a beneficial not only for the partnered schools with their students and teachers, but also for the entire community.

Targets	Expected Number of Beneficiaries	Descriptions
Primary Schools	18	The project team is formed with alliance with 18 partnered primary schools to participate in the using the eLEARN platform, where the five-key backbone primary schools are the leading schools to develop the content on the project.
Primary Students	2,700	➢ As mentioned, one of the main beneficiaries of the eLEARN project will be local primary students, who will flourish from the innovative design of language learning with AR and VR technology. Students from Primary 4 to Primary 6 will gain their first-hand experience in the tools. The targeted number of students (from Primary 4 to Primary 6) is **150** people per school. ➢ For the duration of this project, the targeted number of students will be **2700** people among the first **18 schools**. The actual number of beneficiaries in local students also depends on the adoption of the platform by other schools upon their participation of dissemination seminars. Thus, it is expected that the actual number is much more than the projected number.
In-Service Teachers	690	➢ Each school is expected to have about 5 Chinese language teachers and other panel members to involve for the duration of this project. The targeted number of teachers for testing the system is **90 people** in total. From the experience of hosting sponsored workshops and seminars, it is expected to attract about **150 teachers** in each event. Suppose there will be 3 events (1 interim workshop, 1 dissemination seminar, and 1 local conference), the targeted number of participants for the events is **450 people**. ➢ Thus, the total number of teachers is approximately **690 people** during the project. Since the project is expected to produce a user guide, sample of lesson plans and the eLEARN platform, the actual number will be more than expected.
Local Schools and the Wider Community	180	➢ Through the development and implementation of the eLEARN platform, we can establish the Communities of Practice (CoP) to promote how AR and VR technology becomes the future trend in education, and foster knowledge transfer across a wider educational landscape. ➢ By building this CoP, schools can learn more about the innovative educational technology with AR/VR and gather their language knowledge to improve the platform in an ongoing basis. ➢ For the duration of this project, there will be sign-up workshops (tentatively 6 workshops, 30 participants per each, total 180 teachers) supported by this project fund to disseminate the results of the eLEARN

		platform, and provide trainings to teachers on how to design and teach language lessons with the mobile apps and tools.
Total	**~3,570**	➢ This is only an estimation based on the reachable beneficiaries, where the platform released online could provide an unlimited number. Our project website will require users to register first so that our project team can continue to monitor the growth of the users even after the project funding is ceased.

4. Innovation

Currently in Hong Kong, computer-mediated reality in education has a good potential to grow, while a project packaged with information and communication technology implemented in curriculum and professional workshops for language education in primary schools are unprecedented. This project is expected to create new opportunities for research study in both technical and educational aspects with AR and VR in language education.

Development of New Educational Technology

As we have mentioned previously, this project brings the latest technology to language education and expect to impact on the learning and teaching with technology in Hong Kong. The project on one hand implement the AR/VR contents through eLEARN, and the algorithmic methods for visualization of the AR/VR contents will also be designed by the HCI group in the project team. It is expected that the project has strong values for both educational and engineering research with numbers of publications. In this project, not only the materials would be produced, new technology in AR and VR with specific applications in education will be developed to support the learning. On the other hands, learning analytics will also be explored with the big data collected from 18 schools in the user behaviors while in the eLEARN platform so that we can analyze how children interact with the contents in the platform.

Curriculum-based Learning Contents

While public primary schools in Hong Kong follow the language curriculum from EDB, it is more realistic if the computer-mediated reality materials can be developed which can be used by all schools to match with the common curricular contents. In addition, materials should be bundled with professional trainings and workshops to support the schools in pedagogical changes, and classroom observation should be included as a part of the project by education experts. To the best of our knowledge, no local organization nor tertiary institution is currently planning to serve the local schools in this proposed approach with action design research in primary language education. In Hong Kong, there are only a few local news reports and studies on AR/VR in non-language focused education.

For example, Huang et al. (2016a) have conducted the first exploratory work on how AR can be implemented in art education for kindergarten. Researchers , have developed a learning system on how to use AR and VR to support field trip experiential learning for primary and secondary schools. The University (Mingpao, 2016) has purchased AR and VR developer equipment and explored job seeking skills through VR and AR games for students with special educational needs. T e l cation University of Hong Kong has collaborated with a secondary school (Appledaily, 2016) to develop a GeoLab with AR and VR technology to support students in learning geography. However, these initiatives are not targeting on language education in primary schools, and it is not feasible to generalize the usage of their developed learning system for language education, which deals with different learning objectives and outcomes/

Theoretical and Practical Pedagogical Design

In our eLEARN platform, it will be the first in Hong Kong to contribute to both empirical and theoretical research in language education. More importantly, the platform will provide an innovative learning environment where most students in Hong Kong have not experienced before. Although some schools have participated in some related projects, they cannot serve all the schools in Hong Kong. This project can ensure that the participating schools and other future schools can adopt this eLEARN platform where students can gain a completely different learning experience in language education.

Figure 2 (in Appendix B) shows the suggested flow of teaching and pedagogical design when allowing students to explore the AR and VR contents in the eLEARN platform. Teachers can begin with traditional teaching methods without the eLEARN platform (unplugged), and then choose the mode of learning through the eLEARN platform (plugged) for some suitable amounts of time during the classroom. While viewing the contents, it could be help students practice their listening and reading skills. Once they finish viewing the contents and experience with the artificial reality, the students should have a better sensory experience and affect their emotional change. After then, the students can back to the physical reality and practice further with their communication skills such as writing and speaking. The proposed tentative learning contents are available in the Appendices for reference.

5. Conceptual Framework

In this project, the design of the eLEARN platform adopts the Mayer's cognitive theory of multimedia learning (CTML or multimedia learning theory) founded by Richard E. Mayer and other active researchers (Mayer, 2005). Mayer explains how multimedia supports the human's learning in our brain, and how the theory can guide the development of instructional technology in assisting the learning process. In the literature, multimedia is specifically defined as the combination of words and pictures, where words can be written or spoken texts, and pictures can be any form of graphical representation such as illustration, video, photos and animation (Sorden, 2012). The theory suggests that people learn more deeply with words and pictures compared to when they learn only with words or pictures alone. Figure 3 (in Appendix B) illustrates the concept of CTML.

The CTML draws from different cognitive learning theories such as Baddeley's model of working memory, Paivio's dual coding theory, and Sweller's Theory of Cognitive Load (Sorden, 2012), and it forms the theoretical framework of the relationship between multimedia learning contents and the effectiveness of learning. Through exploring with and perceiving the presented materials in multimedia instruction, the learner as an active participant is encouraged to build a coherent mental representation and then construct new knowledge. In our project, we add on to the definition with AR and VR contents as a part of the multimedia presentation, with interactivity elements in the eLEARN platform. Research has shown an increase of the learning transfer to further knowledge or problem solving skills and learning performance with multimedia presentation (Mayer, 2009; Sorden, 2012).

Sorden (2012) summarizes the CTML into five key components that form the theory: 1) a dual-channel structure of visual and auditory channels, (b) limited processing capacity in memory, (c) three memory stores (sensory, working, long-term), (d) five cognitive processes of selecting, organizing, and integrating. Figure 3 shows the relationship among the content representation, memory store and the cognitive processes. Suppose we have the multimedia presentations of contents, which can be perceived with two channels of sensory memory. Visual sensory memory holds the pictures and printed texts, and auditory sensory memory holds the sound and spoken words. The working memory attends to bring the perceived words or images for further processing and integration in the working memory. Through selection and organization of these representation, verbal model and pictorial model can be integrated with prior knowledge (or schemas) from the long-term memory and form new content knowledge. The CTML suggests that there is a limitation of our processing capacity in these memory stores, and overload the cognitive capacity and exceeding the memory will hinder the learning progress (Sorden, 2012).

Mayer (2010) states that meaningful learning with multimedia occurs when the learner is engaged with the following five cognitive processes:

1. selecting relevant words for processing in verbal working memory;
2. selecting relevant images for processing in visual working memory;
3. organizing selected words into a verbal model;
4. organizing selected images into a pictorial model;
5. integrating the verbal and pictorial representations with each other and with prior knowledge.

Beside the science of learning in the CTML, Mayer suggests that the research on multimedia instruction should be theory-grounded and evidence-based to form the science of instruction (Mayer, 2009), which means that the development of the new instructional principles and pedagogies with multimedia should be derived from the theory, and the teaching method and conceptual framework should be supported by an empirical base of replicated findings through rigorous research studies in order to create a valid and predictable model. In our project, we agree on these principles in the theoretical framework for developing the learning platform and environment. It is our expectation that this project will benefit the local schools and contribute to the research community with evidences that computer-mediated reality may improve the learning process in language education.

Based on this CTML, it explains our learners perceive the multimedia presentation to the sensory memory, where selected words or images will be further processed in the working memory to formulate with new schemas stored in the long-term memory. In our eLEARN platform design for language learning, we have selected a set of curriculum contents (shown in Appendix C) for our design and implementation, but the actual contents may be adjustable due to the needs at the time of development. These contents are associated with the to-be-developed AR and VR contents to enrich the sensation of learners. While traditionally even with e-learning tools (e.g. 2D game on screen), learners learn language without connecting to the prior knowledge or experience in physical world to the classroom. Our eLEARN platform emphasizes the usage of visual glasses to view the AR or VR contents by providing the integrated learning environment to the students where they may feel being interacting with real nature through their eyes and ears. This immersive participatory experience will enhance the quality of multimedia presentation and mimic it as a part of the real world. This idea with computer-mediated reality can also be integrated with CTML and explained through the situated learning theory, where learning is believed to be embedded within and determined by physical settings inseparably (Dunleavy, Dede and Mitchell, 2009). Therefore, the design of contents and digital environments presented in eLEARN platform

follows the situated learning theory, while the perception and acquisition of the new language skills synthesized with the prior knowledge can be explained with CTML.

In addition to the learning theory, the project involves a substantial portion on the learning system development and implementation, which requires an appropriate software engineering process model to guide the development. In this project, Rapid Application Development (RAD) process is adopted (Pressman, 2005). One of the features of this model is to support an extremely short development cycle, where fully functional system can be delivered within very short time periods. In the RAD, the user design and construction are being done by the development team with concurrent working sub-groups after the requirement planning is well understood and the project scope is constrained. The application prototype can be tested after a few cycles of improvement and consolidation. According to Pressman (2005), the system project requires sufficient human resources with good commitment from the working team to develop the system rapidly. Also, the technical risk of this project is not high since the contents usage for users can be controllable and safe.

6. Implementation Plan with Timeline

In terms of the implementation plan, our first goal is to develop the eLEARN platform for the language education in primary schools. The project comprises with three phases in addition to the preliminary phase. The details of the project timeline are given below:

Phase	Duration	Details	Work Required
Preliminary Phase: Project Planning (Starting in November 2017 or as soon as the funding is approved – December 2017)	2 months	During this phase, the project team will initiate the project with the teachers in the partnered schools, and the contents to be developed will be finalized during this phase. Schools will identify the coordinators and language teachers to form a system development group. The recruitment of research assistants and software engineers will be conducted during this phase. An initiation seminar will be organized to introduce the project and invite all schools to attend and participate in the project.	• Recruit research assistants and software engineers • Coordinate with partnered schools and form the system development group • Review the current literature on AR/VR in education and determine the most effective plan for implementation in Hong Kong • Purchase equipment for development and system testing • Organize an initiation seminar for the partnered schools and welcome for other schools to learn more about the eLEARN project, which help increase the scale of the partnered schools • Set up our project website
Phase I: eLEARN Platform Pilot Development (January 2018 – December 2018)	12 months	This phase mainly focuses on developing the eLEARN platform based on the planned contents and testing the functions. Design-Based Implementation Research (DBIR) process is adopted to develop the platform while designing it with the team. Pilot testing in classroom is expected frequently in the partnered schools individually and selectively. Interim evaluation based on the feedback from teachers and students will be collected in this pilot study phase.	• Develop the eLEARN platform in laboratory • Test the eLEARN platform both in the laboratory and school classrooms • Observe classroom teachings and analyze the changes of pedagogical design and learning process • Collect feedback through questionnaire from students who participate in the pilot study • Reflect with teachers on the teaching experience with eLEARN platform. • Prepare training materials and release of the eLEARN platform • Organize three 3-hour interim workshops [1](inviting 6 schools per each

[1] The workshops will be organized in November/December 2018 to provide the partnered schools with tutorial-based workshops to learn how to use and control the eLEARN platform; The workshop will also include the usage of 360-degree camera and how

			workshop) and one 3-hour dissemination seminar [2]on the outcomes of the eLEARN platform and train all participating school teachers in using the tools • Update our project website and set up registration site
Phase II: eLEARN Platform Intervention and Dissemination (January 2019 – October 2019)	10 months	Phase II will extend the implementation of the eLEARN platform developed in Phase I in a full scale with the thirty partnered schools and newly invited schools, and promote the new AR + VR learning environment to the language education. Project evaluation through Action Design Research will be conducted throughout this period, and analyze on the effectiveness of learning with AR + VR technology. Conference cum workshop will be organized to disseminate the project outcomes and results. Local /international scholars and schools will be invited to deliver guest talks and parallel sessions to share their experience in AR/VR in primary education.	• Implement the eLEARN platform in partnered and other invited schools • Conduct classroom observation, project and learning effectiveness evaluation • Analyze the collected data and prepare for the sharing at the conference • Organize a local conference [3]on AR + VR in education and build a Community of Practice (CoP) where HKU can serve as the central hub for this emerging education • Conduct qualitative and quantitative study through focus group interview and questionnaire (with teachers, students/parents) concerning the future development of AR + VR in education
Phase III: Review, Evaluation, and Reporting (November 2019 – April 2020)	6 months	In this phase, the results and experience will be finalized for international publication (Book or journal articles). Extra workshops will be available for schools on-site based on their requests to train their teachers further on how to use the tools in language teaching and learning.	• Conduct extra workshop sessions where schools can invite our team to deliver the on-site training as Professional Development • Create training manuals and presentations slides and upload on the project website for public to access • Finalize the project with reports and publications

7. Teachers' and Principals' Involvement in the Project

In this project, each school will select a few representatives (language subject teachers and principal) to serve in the system development committee, where they will provide with their knowledge and experience on the AR/VR contents in the eLEARN platform. Other teachers will be involved in learning how the use the system in learning and pedagogical design for classroom use. The number of teachers and principals is projected in the previous section. Teachers will be required to participate in our workshops and seminars to learn and share their teaching experience within the partnered schools and the public.

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teachers can create their own immersive virtual reality environments for their own student. The workshops will be mainly delivered by the principal investigator (i.e. university professors), software engineers in the project team, and selected primary school teachers involved in the design of the eLEARN at the early stage.

[2] While the interim workshops are for the internal testing purpose, the dissemination seminar will be opened to all the primary school teachers to join for free, and learn about our prototype and features of the eLEARN platform. Expected learning design and pedagogical designs will be shared by the principal investigator. During the dissemination seminar, it will allow the participants to provide us with feedback through questionnaire on how the platform can be further improved and enhanced. The dissemination seminar will be mainly delivered by the principal investigator (i.e. university professors), software engineers in the project team, and selected primary school teachers involved in the design of the eLEARN at the early stage.

[3] The local conference is organized in a similar fashion of the dissemination seminar, but the conference will provide with workshops to the participants to test the eLEARN platform for Chinese language learning. The experienced teachers in using this eLEARN previously in their classrooms will be invited to deliver the workshops for the participants.

8. Budget

Our target budget for this project is HK$3,444,200.00, which will be requested to develop the eLEARN platform and all related educational activities in this project. The main expenses of the project are for staffing cost and equipment. Relief staff will not be required as the administrative workload for undertaking of this project will be shared by the research officer and other staff. The amount of funding is essential to the success and sustainability of the project. Based on the number of schools supported, our collaborative effort is reasonable so that individual school does not need to consider developing their own system. The details and justifications are listed below:

Budget Items	Details	Sub-Total Expenses
Staffing Cost		**$ 2,322,036.00**
Research Officer (One staff)	($40,620 + $1,500) x 24	$ 1,010,880.00
Research Associates (One staff)	$19,250 x 1.05 x 24	$ 485,100.00
Software Engineers (Two staff)	$16,090 x 1.05 x 24 x 2	$ 810,936.00
Research Officer (Hourly Rate) (The project team should observe relevant regulations of MPF)	$60 x 1.05 x 150	$ 9,450.00
Graphic Designer (The project team should observe relevant regulations of MPF)	$108 x 1.05 x 50	$ 5,670.00
Equipment		**$590,774.00**
Mobile phones (40 units)	$5588 x 40	$223,520
Mobile tablets (40 units)	$2928 x 40	$117,120
AR + VR Devices - - e Cardboard VR glasses (720 sets)	$12,000 $63,360	$ 75,360.00
360° Video Recording Camera (5 sets)	$2,000 x 5	$ 10,000.00
Desktop Computers (3 sets) 1	$23,388 x 2 $13,088 x 1	$59,864.00
Software License (3 sets)		$92,070.00
Camcorders (3 sets)	$3,480 x 3	$10,440.00
Apple Developer Program (3 years) - Subscribe the membership fee for uploading the eLEARN mobile app to App Store free for download.	$800 x 3	$ 2,400.00
General Expenses		**$ 511,717.00**
Miscellaneous Fee:	--	$ 25,045.00
Printing Materials for Seminars/Workshops	--	$ 25,000.00
Auditing Fee	--	$15,000.00
University Overhead Charges - This item is to cover the cost for University facilities provided to staff hired by the project, bookkeeping and management reporting, staff recruitment and retention, and tendering and purchasing of equipment and supplies.	--	$446,672.00
Contingency		**$19,673.00**
Contingency Cost	--	$19,673.00
Total Expenses		**$3,444,200.00**

Roles and Duty of the Project Teams

The principal investigator will be the chief project manager and coordinator of the entire project. He will coordinate with other scholars and consultants from universities to lead the direction of the project, including the project management, development of research objectives and methodology, offering both theoretical and technical advices, and leadership of the research associates in the team. Concerning the four full-time staffs hired for this project, the duty allocations plans and their job responsibilities/roles in the project team are described below:

Research Officer (Functional title: Project Manager):

Qualifications:

- One research officer to serve as the project manager and coordination with all the schools
- Possession of master's degree in education and teacher's license; Holder with Doctor of Education degree is preferred
- At least 5 years of working experience in education-related activities
- Have related research and project management experience in education, preferably in Chinese language education, and technology-enhanced learning models
- Good command in both English and Chinese (Cantonese and Putonghua)
- Have strong evidence on conducting academic research, such as publications and serving a supporting role in granted project

Duties:

The research officer is expected to help coordinate with all the partnered schools and provide all the administrative and research supports on behalf of the project supervisor and other members in this large-scale educational technology development and implementation project, e.g. writing invitation letters, managing the design of questionnaire, carrying out research design and method, conducting interviews, drafting progress reports, writing project proposal, etc. Specifically, this research officer is working mainly on behalf of the principal investigator to supervise the progress of the project with the research associates and the software engineers on daily basis, and coordinate with the partnered school teachers to design and implement in classroom. He/She will manage and prepare progress reports of different schools in design eLEARN platform and implement it into the different classrooms. He/she will help develop and evaluate a series of documentations for the eLEARN system development and research studies, e.g. draft template of lesson plan, manage system development documentations, analyze different psychometric measurement instruments, and prepare project reports. The major middle- to large-scale events will be organized, managed, and coordinated through this officer, e.g. room booking, registration, set up of venues, on-site technical supports, and helpers coordination. He/she will also help manage the mobile devices and other equipment for loan services to partnered schools, create and maintain project website/social media platform for the CoP, and leads some of the meetings with schools to develop the eLEARN platform. In terms of publication generated from this project, the research officer is responsible to help prepare the manuscripts and serve as the corresponding author.

Research Associate:

Qualifications:

- One research assistant on Research Assistant I rank
- Possession of bachelor's degree in education or social sciences
- Have related research experience in education, preferably in Chinese language education

Duties:

The research associate (on the Research Assistant Rank I) will be responsible for assisting the principal investigator to conduct and carry the research studies in this project based on the main research questions and project evaluation (see the description in Section 10 below). The research associate will assist the project supervisor and the research officer in conducting educational research throughout this project; Conduct literature review, draft research questions and plans, design the research methods, prepare ethical review application, design and collect consent forms, visit classroom and take photos/video, conduct interviews and administer questionnaires, run data analysis with SPSS or R language to visualize the research results. He/she will help develop or customize research instruments (e.g. questionnaire, interview guiding questions) and analyze the qualitative and quantitative data collected from this project. While the Research Officer will be responsible for the communication and scheduling with the schools, this research associate will go to schools to collect data and analyze them. He/she will assist the research officer to draft the manuscript for publication, and help maintain some of the contents on the project website/social media platform. He/she may also help manage the mobile devices and other equipment in the lab.

Software Engineers:

Qualifications:

- Two software engineers on Research Assistant II rank
- Possession of associate's degree/bachelor's degree in computer science or related disciplines
- Have related programming experience with mobile devices

Duties:

The software engineers mainly responsible for drafting the user requirement with the research officer on the eLEARN AR/VR contents, conduct use case analysis, process modeling, and data modeling. During the design phase, the two software engineers will design the eLEARN system architecture, user interface, program, data storage. They will be responsible to implement and test the eLEARN platform to ensure its' stability and compatibility with devices . They will share the workload in developing 15 modules (5 modules per each grade in Primary 4 – Primary 6) due to the nature of this project with a large amount of AR/VR graphical contents and image rendering to be generated and processed. With the computer science background, the software engineers can provide advice and technical support to the school teachers, such as installation, setting up the virtual learning environment with AR/VR, using the Cardboard to view the contents, etc. They will also present the system architecture, the requirements, and demonstration during the workshops and seminars.

Research Officer (Hourly Rate)

Student helpers to provide the basic technical and administrative supports in the workshops, seminars, and all other events;

He/she will support the full-time research assistant to conduct some of the research works, e.g. taking interview records, writing the transcripts of the focus group discussion, etc.

Graphic Designer (Hourly Rate)

The graphic designer will be responsible for design banners, posters, and other printed materials for all the public events.

Justification for Purchasing the Equipment

Mobile Devices

Mobile phones are mainly for using with Cardboard VR glasses to view the AR and VR contents, where mobile tablets can be used mainly for AR contents.

The mobile phones and mobile tablets are purchased in order to allow the project teams to test the scalability and stability in a classroom environment before bringing to the schools for experiments. Note that it is essential to build a testbed to simulate a real classroom teaching and learning, and obtain useful testing data to improve the system development. Assuming a classroom size is around 30, therefore, purchasing the sufficient number of mobile devices will be able to satisfy the requirements of testing the system application. Note that some learning modules will be used on mobile tablets (without headset) only, and some modules will be used on mobile devices (with headset). Therefore, 40 pieces on each will allow the development team to run on full scale of testing in our lab classroom in university with some variations, which is one essential step before implementing in real school environment. During the first year, it is expected that 2 – 3 primary schools will be selected as piloting schools, where we will need to bring the devices to the schools for testing. Based on our many years of experience in system development, it is not suitable to ask the schools or students to bring their own devices for a new learning platform. Otherwise, the development team has no control on the preparation as well as the outcomes. In each experimental class, we will require a full class size to test on the eLEARN platform. Therefore, it is required that we should provide one student per unit (mobile phone/tablet) during the testing phases. After the piloting and testing phases, the eLEARN platform should become more stable and reliable . Each school will then be encouraged to prepare for their own devices to participate in our project as much as possible. To our best knowledge, most primary schools are already given some funding resources to purchase their own mobile devices (especially the mobile tablet) as the mobile learning tools. Based on the project scale, it is expected that the mobile phones and tablets can be borrowed from our team on first-come-first serve basis. While this eLEARN project aims to develop the new AR/VR learning platform, instead of serving all the hardware needs in each school, we will encourage the schools to try their best to request their own extra resources to obtain more mobile devices to participate in our project as well as their future works. Upon the completion of the project, all the mobile phones and tablets will remain in the lab at the university for the usage in the future professional development workshops in the university.

In this eLEARN platform, parts of the contents are built using AR technology (i.e. the contents are viewable on mobile tablet or mobile phone without Cardboard VR Glasses), and the other parts of the contents are built using VR technology (i.e. the contents are viewable only through mobile phone with Cardboard VR Glasses). Note that we request to have at most 36 Cardboard remained in the lab at the university, the rest can be kept by each partnered school. Assuming 18 designated partnered schools will eventually participate in our project, we will kindly allow each school to keep 38 Cardboard to encourage them for easier access to the eLEARN environment, if the schools allow students to bring their own devices (BYOD) or provide with the compatible mobile phones for the virtual learning purpose. Therefore, each designated school, by the end of our project, will be given a free access to the eLEARN as well as permission to receive future new updates (if any in the future) and the 38 sets of Cardboard (without mobile phone) if they sign an agreement to continue to use the eLEARN in the schools and help improve the system by giving us feedback. While most of the partnered schools in this project should have at least compatible mobile tablet to use for the AR contents in eLEARN, it is expected that schools who are selected for testing the VR modules of eLEARN will need to be loaned with the mobile phones and Cardboard VR Glasses (i.e. bundle headset). Therefore, the mobile tablets and the bundle headsets can be scheduled for classroom experiments, and they will be transported from the lab to the schools on the day of using the equipment. The research associates and assistant will help arrange the logistic and scheduling of the usage in order to maximize the learning experience of students in the partnered schools. They will be on site and make sure the devices are appropriately used in classroom by the students. Loan agreements will need to be signed by the schools to ensure the maximal protection of the mobile devices.

AR + VR Devices

- Other than using the affordable mobile solution with Cardboard VR glasses, provides an advanced VR experience for learners to engage in the interactive learning environment;
- After the completion of the project, schools will be given some of the Cardboard for them to keep depending on individual basis and requests to encourage the schools to continue to reuse the cardboard for the students to learn, or for their teachers to learn how to teach; and at most 36 Cardboard will remain in the project lab of the university for future workshops;
- The system uses the pair of Touch controllers, and allows learners to take intuitive actions in VR feel as natural as using real hands;
- Each school can experience with one set of the for a particular lesson, and we expect to provide six concurrent experiments to the schools through scheduling the usage of devices.

360° Video Recording Camera

- The camera allows schools to capture real environment in full degrees, and provides an easy solution to teachers to bring the students to virtual field trip;
- During workshops, teachers will learn how to use the camera in making some of the learning contents for creating a VR classroom.

Desktop Computers and Software License

- The four stations are for the software engineers to design and develop the AR and VR learning contents, which require a powerful machine for the development;
- Open source software toolkits are free of charge; Paid licensed software will be purchased for making AR and VR contents with advanced virtual images and animation.

Camcorders

- The camcorders are mainly for classroom observation and collect data from interviews.

9. Expected Project Outcomes

a) Creation of eLEARN Platform with AR and VR Learning Environment – The major outcome of this project is to develop an open-source eLEARN platform for primary language education in Hong Kong. All schools can use the system for free. Since the platform is bilingual, it will be beneficial to the local and global communities. The source codes can be shared to other schools or institutions for further development and enhancement, as long as the schools agree to give credits to the QEF and our research team.

b) Publishing of eLEARN Manuals and Website – Technical and user manuals will be published on the project website, and other resources such as project timeline, access to the eLEARN platform, presentation notes/slides, related website links, and research publications. Schools who want to use the tools can register from the website with basic school information.

c) Publishing Materials for Lessons and Curriculum – 5 sets of teaching materials for each level will be developed. The total number of teaching packages would be 5 sets x 3 grades (Primary 4 – 6) with Chinese language subject = 15 sets. The materials copyright owner will be QEF, and the resources will be available to the eLEARN website where schools in public can apply for free access to the materials. In the teaching packs, teachers will find the suggested teaching guidelines, lesson plans, printable materials for the students if any, and video examples from our schools in this project in order to help the users have the basic idea of how the AR and VR materials could be used in teaching.

d) Building a Community of Practice (CoP) through Seminars and Workshops– Through organizing seminars and workshops in the project, more schools will be invited to join the interested group and form a local CoP for AR/VR in education. Other non-language subject interested schools will also be welcomed to build a wider community to promote AR/VR technology for teaching and learning. Due to the increase of the interest in the health problems potentially caused by the computer-mediated reality, e.g. how long should children at different age wear the VR glasses to view the contents without causing health problems (e.g. Vergence–accommodation conflicts), it is important that researchers from medical and psychological fields will be invited to serve as the consultants for this project.

10. Project Evaluation

In our design, we have adopted the DBIR method (Fishman et al., 2013) to study the development and intervention of AR throughout the development of the eLEARN project. The following tasks will be conducted throughout the research as a part of the evaluation processes:

Stage	Possible Tasks
Plan	• Design the eLEARN platform with the researchers and school teachers based on the contents and issues in delivering the instructions for the students in the Key Stage 2. • Identify the topics and lessons where AR and VR tools could benefit the learning effectiveness and motivation. • Develop and test the eLEARN platform to be tested on platform.
Development of Prototype	• Deploy and design suitable learning tasks with the eLEARN platform in classrooms of treatment groups. • Sequential approach will be adopted for the deployment where each topic in the language curriculum is investigated sequentially in each cycle. • Train students and teachers in using the tools in the eLEARN platform.
Iterative Testing and Refinement	• Perform classroom visit and analyze the classroom teaching (both treatment groups and control groups). • Analyze and evaluate the performance of both system and pedagogy. • Administer pre-test and post-test of each topic sequentially.
Reflect	• Collect both qualitative and quantitative data through questionnaire, focus group interviews, video recording of lessons, and pretest/posttest. • Conduct focus group interviews with the treatment group participants (teachers and students). • Improve the system and pedagogical performance. • Plan for the next development and deployment topics with eLEARN platform.

Each year the DBIR cycle will be iterated for each module in the eLEARN platform concurrently. During the first year, it will mainly focus on the system development and pilot study where some classes in each school will be selected to test and improve the platform. In the second year, the eLEARN platform will be fully implemented in the classroom teaching and evaluated, which will fulfil the Objective 1 and 2 in the Section 2.

AR/VR in education has not been well studied locally and globally for the primary language education. In order to evaluate the effectiveness and challenges behind the students' learning with this technology based on the Objective 3 and 4, three research questions are to be addressed in this project:

1. To what extent, eLEARN tools with computer-mediated reality could assist the children in learning Chinese language in primary education?
2. How eLEARN tools with computer-mediated reality tools should be designed and implemented to align language education curriculum to enhance the language proficiency?
3. What are the positive or negative effects to the children's learning motivation and achievement in Chinese language skills including the skills of listening, speaking, reading and writing in primary education?

In this project, we adopt a similar research method in Chiang, Yang and Hwang (2014). Five local primary schools are selected for the investigations. These schools have similar background in terms of the school bands, location and teacher's belief to minimize the variances of performances among the participants (students and teachers). Among the five schools, half of the participated students and teachers (150 students and 5 teachers) respectively will be selected as treatment group in order to pursue the teachings with the eLEARN platform, while another half will be taught based on the current teaching methods without the tools. Pretest and posttest will be conducted once before and after the delivery of the topic in both treatment and control groups, and their results will be analyzed quantitatively to study how significant the eLEARN platform is in helping students acquire the language skills in general. The tests will be developed by the researchers (language experts) and experienced language teachers in the project. The learning achievement will be analyzed based on these tests. Focus group interviews will be conducted in a semi-structural manner to construct the reasons of the learning achievement with and without the AR tools. Those students and teachers in the control group will also have the opportunities to explore the usage of the tools after the tests, and it is possible to experience it before the end of the academic year subject to the arrangement with each school.

Questionnaire will also be conducted to evaluate the learning motivation of students, which will be customized for our measurement originally developed by Keller (2010) based on the ARCS (Attention, Relevance, Confidence, and Satisfaction) model of motivational design (Keller, 1987). The questionnaire will help identify whether the learning activities can attract the student's attention and is relevant to the student's learning, and the students are confident and satisfied in using the platform. The cognitive load survey introduced by Sweller, van Merriënboer and Paas (1998) will also be used to measure the cognitive load of individual students (i.e. mental load and mental effort). This survey will inform us whether students feel difficult to process the information presented in eLEARN platform, and whether they are required to exert more mental effort to understand the contents in the eLEARN platform. These two questionnaires will be administered by the end of the project in the second year. Occasionally, parents will be invited to have classroom visits and interviews may be conducted upon their consent to find out their acceptance and perceived usefulness of AR/VR technology in education. However, involving parents in the project evaluation should be optional, and their feedback can be used as references for understanding the change of students in involving the language learning.

11. Sustainability of Project Outcomes

The eLEARN platform will remain in the schools, and the local researchers will continue to provide technical support to the schools one year after the end of the project to ensure that the eLEARN platform will function and perform as it is. The source codes will be available to the schools if they intend to bid for their own QEF or other project funds to continue the development. Our research teams are able to support them and provide them with consultancy. The eLEARN platform will be bundled with technical development manual and user manual for the schools to take reference. Besides, workshops and seminars will be organized to train teachers on pedagogical and learning designs with eLEARN platform.

The structure of the 3-hour workshop should contain the following contents: **(1)** Introduction of computer-mediated reality in education and eLEARN platform; **(2)** Using eLEARN platform to design learning activities; **(3)** Exploring different pedagogies in classroom with eLEARN platform; **(4)** Designing assessment tasks using the contents in eLEARN platform; and **(5)** Technical support and development of eLEARN platform. The documentations and the workshops will ensure that the project is sustainable after the project. The project team will also conduct further research projects in computer-mediated reality for education, and the eLEARN platform will be enhanced as an ongoing development to contribute to the community. Extra funding (e.g. QEF or innovative technology fund) will be acquired to support the continuous development of the eLEARN platform. Besides, the experience of building the eLEARN platform will be applicable to the contents development for other subjects such as General Studies and Mathematics, particularly for learning in STEM education.

In addition, most the - Cardboard will be freely given to the primary schools who participate in the project, while the mobile devices will be kept in the University for further trainings and workshops. The principle investigator can continue to run complimentary workshops to the schools in the University on non-profit basis and train other schools in learning how to teach with AR and VR with our eLEARN platform. The sustainable budget will be sought from the future project funding to support the ongoing. It is expected that the government will continue to provide extra funding to the schools to purchase mobile computing devices, it is not a doubt that schools who have already had mobile tablets can continue to sustain with the usage of the eLEARN.

12. Dissemination/Promotion of Project Outcomes

Teachers' Community of Practices: Schools who are not a part of the eLEARN platform can be invited to join the seminars as guest speakers to share their own experience and findings to create a Community of Practice (CoP) of AR and VR education in Hong Kong. Project website and social media platform will be built and maintained throughout the project and remains in the researcher's homepage in the University, and continues to inform the community about the progress of the current and future works. As a part of the professoriate role in knowledge transfer, the principal investigator will continue to lead this CoP to run after the official end of this QEF project. Details are given as follows:

1. *CoP School Stations:* The setup of the CoP will be mainly stationed in Jordan Valley St. Joseph's Catholic Primary and St. Edward's Catholic Primary School, where the principal investigator will partner with the school teachers to allow open classrooms in using eLEARN for Chinese language learning (P.4 – P.6). The schools will also be sponsored by the principal investigator at the HKU to organize the open classroom and workshops for the teachers who are interested in learning and teaching with the eLEARN platform.
2. *CoP Registration and Participation:* The project website with registration and the social medial platform can be managed and hosted by the principal investigator under the Division of Information and Technology Studies in the Faculty of Education, which allows the CoP to continue to share open classroom photos/video (with the consent of the students and teachers). Other schools who continue to use the eLEARN will be encouraged to share with us through the website and social network on how to improve the design and contents of the platform. Other school teachers involved in the QEF project will be honored as the consultant members in our CoP committee, and their names will be posted online for further contacts on how to use the eLEARN platform.
3. *Organizing CoP Seminar:* The principal investigator will organize at least one CoP seminar on the continuous development of eLEARN after the end of the project, and how the research of using AR/VR in Chinese language education at primary level is designed with new results. Through the seminar, it encourages the local teachers to join the CoP in the web to share experiences. Other experts will be invited as guest speakers to talk about the cutting-edge research projects in the related area, and encourage teachers to join as speakers or participants in the seminar with a free of charge and a certificate of participation.
4. *Further development:* The project team may seek financial support, such as QEF, to organise teacher professional development programme which may extend the experience of language learning in immersive virtual spaces to other subjects, such as General Studies with STEM (Science, Technology, Engineering, Mathematics) education. Similar to other educational technology, upgrade of hardware/software is expected after the project ends. Yet, the experience and theoretical contributions to language learning with technology will sustain. The results from this research-led project will confirm the value of using AR/VR in language education, which will shed insights on how it may enhance the learning of other subjects at primary school levels. It is anticipated that the CoP participation and sharing should encourage further professional interflow to sustain the experience sharing by teachers.

Seminars and Workshop: As mentioned in the project timeline and the proposal, there will be different seminars organized within the project schools and the general publics to promote and report on the project progress, and we can collect feedback from the participants to enhance the system. Researchers (local/international) will be invited to give talks on their own perspectives about AR and VR in education with both language and non-language subject related topics. The main idea of the workshop is to share the techniques of learning and pedagogical designs with eLEARN. Any workshop provided in the post-project stage will be only for non-profit educational purpose, and eLEARN will be published on the project website for public to use given the credits to the QEF funding support.

13. Asset Usage Plan

Category	Item/Description	No. of Units	Total cost (HK$)	Proposed Plan for Deployment
Equipment	mobile phones	40	$223,520.00	Toward the end of this project, the mobile devices (phones and tablets) will remain in the lab at the university for professional development workshops, and allow in-service teachers to come the university to learn how to use the platform to teach.
Equipment	mobile tablets	40	$117,120.00	

				Besides, the future project proposal may be able to take the advantage of the existing devices for further development, depending on the performance of devices. The devices will be disposed in the future by natural depreciation and malfunction.
Equipment		1	$12,000	They will be kept for upgrading the eLEARN platform upon the completion of this project. The devices will also be disposed in the future by natural depreciation and malfunction.
Equipment	Cardboard VR Glasses	720	$63,360.00	Based on the number of participating schools, a total of 38 VR glasses will be kept by the schools, which gives a total of 38 x 18 = 684, for their educational usage. The university will keep the rest of 36 VR glasses for the future professional development workshops.
Equipment	360° Video Recording Camera	5	$10,000.00	The university will keep all these equipment for future workshop purpose as long as they can still function. We will dispose them when they are malfunctioned.
Equipment	Desktop Computers	2	$46,776.00	
Equipment	Desktop Computers	1	$13,088	
Equipment	Camcorders	3	$10,440.00	

14. Report Submission Schedule

The project team commits to submit reports in strict accordance with the following schedule:

Project Management		Financial Management	
Type of Report and covering period	Report due day	Type of Report and covering period	Report due day
Progress Report 1/11/2017 – 30/4/2018	31/5/2018	Interim Financial Report 1/11/2017 – 30/4/2018	31/5/2018
Progress Report 1/5/2018 – 31/10/2018	30/11/2018	Interim Financial Report 1/5/2018 – 31/10/2018	30/11/2018
Progress Report 1/11/2018 – 30/4/2019	31/5/2019	Interim Financial Report 1/11/2018 – 30/4/2019	31/5/2019
Progress Report 1/5/2019 – 31/10/2019	30/11/2019	Interim Financial Report 1/5/2019 – 31/10/2019	30/11/2019
Final Report 1/11/2017 – 30/4/2020	31/7/2020	Final Financial Report 1/11/2019 – 30/4/2020	31/7/2020

Appendix A: References

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Appendix B: Figures

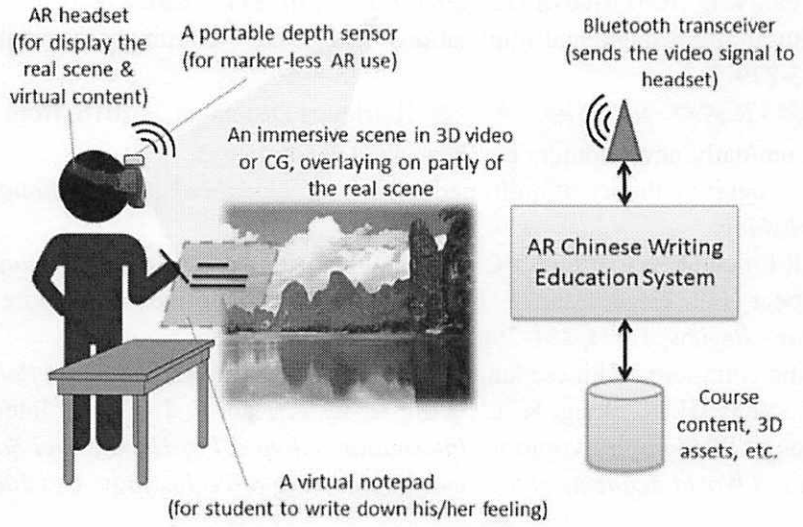

Figure 1. The proposed eLEARN system for Chinese language learning

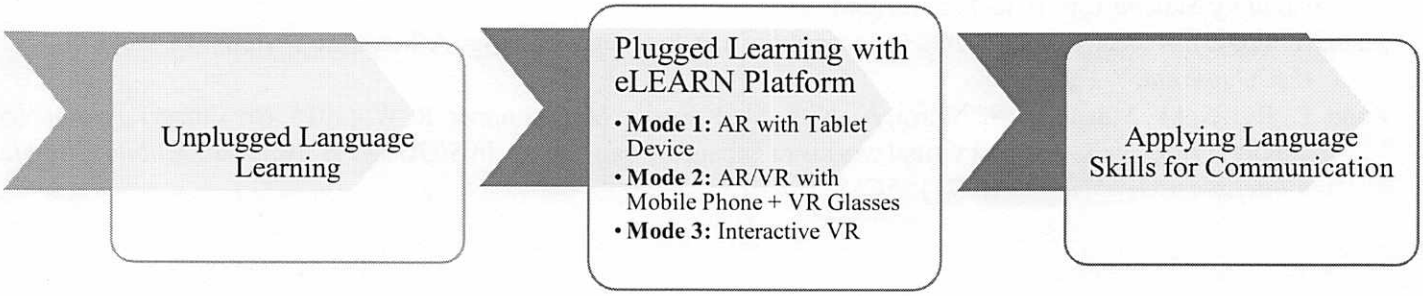

Figure 2. Teaching Flow with Three Modes in the eLEARN Platform

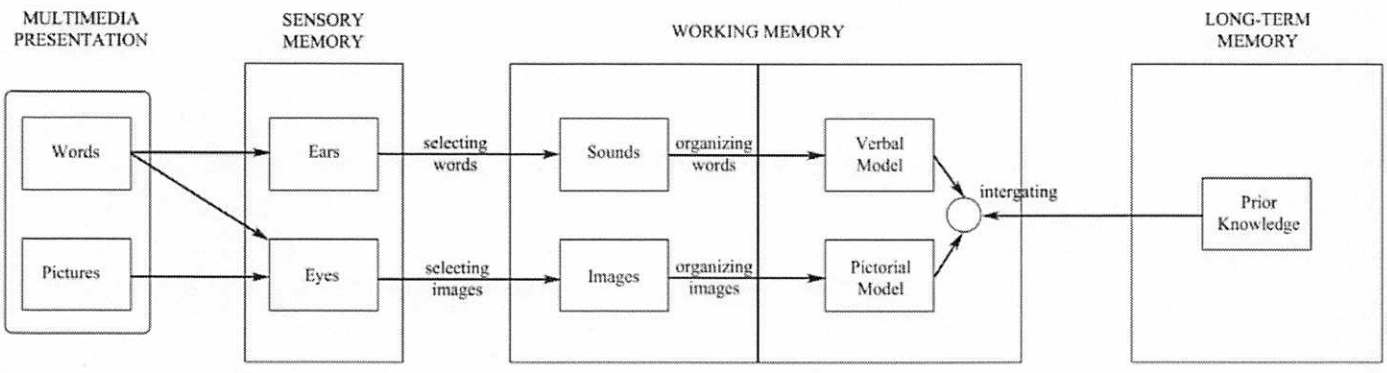

Figure 3. Mayer's Cognitive Theory of Multimedia Learning

Appendix C: Lesson Plan Example with the usage of eLEARN (Chinese Only)

春望

科　　目：	中文科
課　　題：	春望
對　　象：	小六
目　　的：	1. 學生能說出詩歌內容及所表達的情感，體會詩人的感受。 2. 學生能解釋借景抒情的寫作手法 3. 學生能運用借照抒情手法創作。
教學節數：	100分鐘
教學資源：	eLEARN 學習平台

預習活動：瀏覽網頁「燦爛的中國文明—杜甫」www.chiculture.net/0409，了解杜甫的背景資料和當時的歷史事件（可配合網上預習工作紙杜甫生平）。

時間	教學活動	備註
5'	引起動機： 跟進預習活動，老師出示學生所收集的有關杜甫生平的資料，提問學生可用什麼詞語形容/總結杜甫的一生。	板書詞語
15'	教師提問： 利用學生所提供的詞語，着學生想像一下當時社會的環境會是如何。 提問學生：能否舉出例子說說杜甫所生活的環境會是如何？ 透過使用手機並配合 VR 眼鏡，在 eLEARN 平台上觀看 360 度的虛擬情境並置身其中，了解古代詩人杜甫生活的地方和戰亂後人民生活的情況。每位學生可以安坐在椅子上戴上 VR 眼鏡觀看，而 eLEARN 內的影像仿如使學生行走在當時的地方和街道。他們可以自由望向任何方向，看到不同的景象。配合街上路人的對話和聲音，使學生可以從視聽效果感受到當時國破的情景，百姓的生活及情況。 觀看 VR 後，教師請學生互相分享所見所聞，並利用工作紙寫下最深刻的情景及其感想。	

時間	教學活動	備註
15'	內容探究 進入 eLEARN 學習平台「春望」的 VR 的學習單元環境，	

	讓學生可以 360 度觀看詩中描述的情景和人物。學生可以選擇聆聽原著古詩或現代版本的朗讀。內容會按不同的情境說讀出來，並可選擇附加詩詞句子顯示在前方，讓學生同步學習。學生能夠親身感受和體驗杜甫所經歷的情景，了解詩句中表達的情感。	
20'	觀賞完後，將學生分成每 2 人一組作小組討論，分享在 VR 環境內觀察到詩中描述的情景和景象。 教師提問： 1. 詩中所表達的是哪個季節？如何得知是那個季節？它們描寫了一種怎樣的景象？ 2. 那些句子表達了詩人的情感？ 3.「感時花濺淚，恨別鳥驚心」表達了詩人怎樣的情感？ 4.「花」、「鳥」會流淚、驚心嗎？作者的用意何在？	
10' 15'	討論「借景抒情」 討論「間接抒情：借景抒情」的寫作手法和說話技巧，並辨別「春望」中哪些詩句描寫景物，而哪些表達了詩人的情感。 教師提問：在「春望」中那些句字寫景物？那些景物的模樣是怎樣的？這樣的景物能表達怎樣的情感？ 學生創作： 利用 eLEARN 學習平台設定的景物，讓學生走進 VR 的世界仔細觀察景物的模樣。請他們具體描述該些景物，然後想想這些景物能夠表達的情感(共通之處)，請學生創作小段。 教師指引學生，先找出具體描述所看之景物，再在情感上找着與景物共通之處，然後將有關的情感透過寫景表達出來。	VR 世界內有瀑布環境、湖泊、森林、車水馬龍的街道等等。
15'	學生分享： 在 VR 虛擬實境之下，請學生模仿詩人般跟著誦讀自己的段落。eLEARN 系統會透過智能話音識別，按誦讀的表現給予評分。學生亦進行互評。	互評工作紙/平台
5'	教師總結生活中有不同的事情發生，學生能夠借用不同的景物抒發不同的情感，並鼓勵學生與家人和朋友說出自己的感受。	