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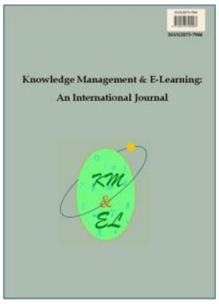

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Cognitive diffusion model with user-oriented context-to-text recognition for learning to promote high level cognitive processes

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Abstract: There is a large number of studies on how to promote students' cognitive processes and learning achievements through various learning activities supported by advanced learning technologies. However, not many of them focus on applying the knowledge that students learn in school to solve authentic daily life problems. This study aims to propose a cognitive diffusion model called User-oriented Context-to-Text Recognition for Learning (U-CTRL) to facilitate and improve students' learning and cognitive processes from lower levels (i.e., Remember and Understand) to higher levels (i.e., Apply and above) through an innovative approach, called User-Oriented Context-to-Text Recognition for Learning (U-CTRL). With U-CTRL, students participate in learning activities in which they capture the learning context that can be scanned and recognized by a computer application as text. Furthermore, this study proposes the use of an innovative model, called Cognitive Diffusion Model, to investigate the diffusion and transition of students' cognitive processes in different learning stages including pre-schooling, after-schooling, crossing the chasm, and higher cognitive processing. Finally, two cases are presented to demonstrate how the U-CTRL approach can be used to facilitate student cognition in their learning of English and Natural science.

Keywords: Cognitive diffusion model; User-oriented context-to-text recognition for learning; Cognitive processes; Sustainability; Scalability

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1. Introduction

After learning at school, most students usually remember and understand knowledge taught by the teacher (Hwang & Chen, 2013; Hwang, Chen, Shadiev, Huang, & Chen, 2012; Hwang, Shadiev, & Huang, 2011), however, only a few of them can apply it in real-life situations (Hwang & Chen, 2013; Hwang, Chen, Shadiev, Huang, & Chen, 2012a; Hwang, Chen, Shadiev, & Li, 2011). According to Anderson and Krathwohl (2001), and the revised Bloom's cognitive taxonomy, Remember and Understand are lower-level cognitive processes while Apply, Analyze, Evaluate, and Create are higher-level cognitive processes (see Fig. 1). What should teachers do to ensure students to obtain and retain knowledge and also engage in the higher level cognitive processes? This question is one of the priorities that contemporary education has been trying to answer (Hwang & Chen, 2013; Hwang, Chen, Shadiev, Huang, & Chen, 2012; Hwang, Shadiev, & Huang, 2011). The Apply level of the cognitive processes plays an important role as it locates in the middle of the taxonomy and we assume it separates the cognitive domain into higher and lower level processes. After students remember and understand knowledge taught at school, enabling students to apply that knowledge in real-life situations is the goal that instructors aim to reach. Applying knowledge is a necessary cognitive process that needs to be cultivated in students as it promotes higher-level cognitive processes, such as Analyze, Evaluate, and Create (Krathwohl, 2002).

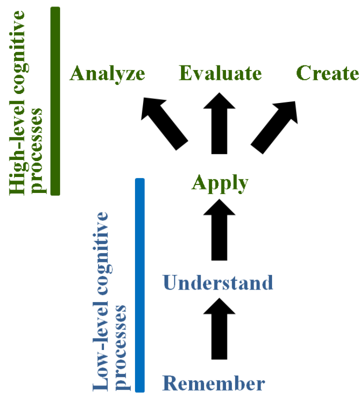

Fig. 1. Low and high level cognitive processes. Adapted from Anderson and Krathwohl (2001)

Accordingly, it is important that students not only learn at school but also are able to apply what they learned outside of school, i.e., learning should not be confined to the classroom but should take place in a wide range of situations. What kind of changes will occur in the future learning environment? Perhaps, learning environment will have a broader meaning "territory", including realm of time and space as well as "state of mind"? Will the walls of the classroom disappear in the future? Will there be a classroom where students learn basic knowledge and concepts, however, apply this learning actively outside of this environment? What will the process of applying knowledge be? How will applying knowledge be linked to outside situational and authentic environments? These are the questions that teaching and research communities need to consider and find possible solutions so that both communities will be better prepared for teaching and research in the future classroom. Perhaps, shapes and definitions of schools will be rebuilt, for example, school "walls" may disappear. That is, students may be able to apply the knowledge taught at school in school-like environment, such as outside of school or at home, after class time, to explore and verify knowledge in daily life situational context.

In this way, students may learn useful knowledge and utilize it in different real-life situations, e.g., paper-based PISA assessment (PISA, n.d.). PISA is the Programme for International Student Assessment that tests the skills and knowledge of high school students on reading, science, and mathematics. One feature that distinguishes PISA from other assessments is that "it is designed to assess to what extent students at the end of compulsory education, can apply their knowledge to real-life situations and be equipped for full participation in society" (PISA, n.d.).

2. Literature review

2.1. Innovation diffusion model

According to Rogers (2003, p.5), "diffusion is the process by which an innovation is communicated through certain channels over time among the members of a social system." In a social system, members are those who adopt an innovation, and Rogers divided them into five categories: innovators, early adopters, early majority, late majority, and laggards (Rogers, 2003, p.37). Innovators and early adapters who usually first accept a new technology take up about 16% of the social system. Innovators are the risk takers and creators; they are first to adapt new ideas. While early adopters like to be seen as leaders and they are usually first in line to buy new technologies. Rogers further noted that early adopters are followed by early majority (about 34%) who usually want to be sure a technology works and is useful before adopting it; therefore, they wait until they understand the utility of a new technology.

Moore (1999) argued that a chasm exists between the early adopters and the early majority due to different expectations they have. Crossing the chasm is a very difficult task that any innovation or innovative company must successfully accomplish to reach wide market success. In the related literature, several techniques to successfully cross the "chasm" were suggested, which include "choosing a target market, understanding the whole product concept, positioning the product, building a marketing strategy, choosing the most appropriate distribution channel and pricing" (van de Rijt & Santema, 2012, p.150).

2.2. The cognitive domain for learning, teaching, and assessment

Having designed the well-known Bloom's Taxonomy of educational objects (Bloom, 1956), Anderson and Krathwohl (2001) proposed a revised taxonomy version for learning, teaching, and assessing. Anderson and Krathwohl's revised taxonomy includes the processes and knowledge dimensions of the cognitive domain. Teachers who apply this taxonomy can set objectives, design activities, and evaluate assessments of a particular course. Then teachers can monitor, assess, and understand the complex cognitive processes of students by using the taxonomy. Based on students' understanding and using the taxonomy, teacher can be aware of weaknesses in students' attainment and of issues with the instruction. The taxonomy can also help teachers to improve planning and delivery of a course. The cognitive domain for learning, teaching, and assessing consists of six levels which increase in complexity as the learner moves up through the levels, from lower order thinking skills to higher order thinking skills. The following are the levels of cognition as per Anderson and Krathwohl (2001, p. 30) and the corresponding definitions:

1. Remember (the lowest level) - Retrieve relevant knowledge from long-term memory;
2. Understand - Construct meaning from instructional messages, including oral, written, and graphic communication;
3. Apply - Carry out or use a procedure in a given situation;
4. Analyze - Break material into its constituent parts and determine how the parts relate to one another and to an overall structure or purpose;
5. Evaluate - Make judgments based on criteria and standards;
6. Create (the highest level) - Put elements together to form a novel, coherent whole or to make an original product.

3. Foundations of the proposed approaches

3.1. The cognitive diffusion model

In order to enhance students' cognitive processes from lower to higher levels, this study proposes the cognitive diffusion model. In the model (Fig. 2), students' cognitive processes are distributed into six different levels, based on the cognitive process dimensions of the taxonomy for learning, teaching and assessing (Anderson & Krathwohl, 2001). The first and highest level (according to the taxonomy) of the model is Create and the last and lowest level (according to the taxonomy) is Remember or Do Not Remember.

Crossing the chasm was adopted in the presented cognitive Diffusion Model here; the principle is that students need to be instructed in a way so that most of them are successfully able to cross the chasm and for them to reach a higher cognitive level (i.e., Apply, Analyze, Evaluate, and Create).

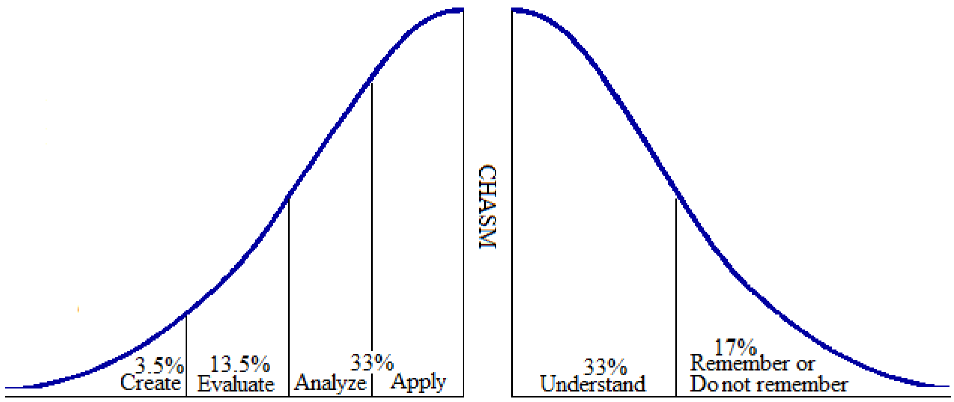

Fig. 2. The cognitive diffusion model (modified from the innovation diffusion model of Rogers (2003))

Fig. 2 shows a chasm located between the Apply and Understand levels. It is very important and critical for educators to find a way for students to cross the chasm, i.e., find ways to promote the cognitive processes from the lower to the higher levels. That is, after learning, students are able not only remember and understand knowledge but apply it to real-life situations. However, in context, such as paper and pencil tests or exercises, in which learning takes place but not is applied, it hardly can be achieved (Lave & Wenger, 1991). How to best design appropriate teaching and learning activities that enable the chasm crossing needs to be discussed. In particular, efforts by educators are required to help assist students so that the majority of them are able to reach at least the Apply level, i.e., when they are able to apply their knowledge to real-life situations.

The distribution of students within the different levels of cognitive process was defined based on data obtained from a study by Azar (2005), and Kocakaya and Gönen (2010). Studies of Azar (2005), and Kocakaya and Gönen (2010) aimed to compare physics questions of high-school examination with ones of university entrance exams by using Blooms' taxonomy. Questions designed for high-school and university were collected in both studies and then examined according to cognitive levels of Blooms' taxonomy. According to the results, a distribution of physics questions of high-school exams and university entrance exams was proposed with respect to Bloom's taxonomy. The results of the study showed that questions of university entrance exams were designed to measure cognitive development of enrollees on application, analysis, synthesis, and evaluation levels, meanwhile questions of high-school examination measured only knowledge, comprehension, and application levels of students' cognitive development. Based on our assumption, Fig. 2 depicts that half of the students (i.e., 50%) crossed the chasm of the cognitive diffusion model. We believe that the cognitive processes of 3.5% of these students are at the Create level, 13.5% at the Evaluate level, and 33% on the Apply and Analyze level. Furthermore, we suppose that 33% of students are at the Understand level and 17% of students at the Remember or do not remember level after having crossed the chasm. In this proposed cognitive diffusion model, the distribution of cognitive processes is ideal as it is based on our assumption. However, there can be a difference between the distribution of a real case and of our proposed model. Therefore, it will be examined in the future study and perhaps a difference in the distribution will be slight.

Although, the cognitive diffusion model was designed based on Rogers's Innovation diffusion model (Rogers, 2003), there are several features that distinguishes the two models from each other. First, the Innovation diffusion model starts with Innovators and ends with Laggards. The cognitive diffusion model, on the other hand, starts with the Remember or do not remember level and ends with the Create level. That is, members of a social system who adopt an innovation, as per the innovation diffusion model, pass from the highest to the lowest level of categories while in the cognitive diffusion model students pass from the lowest cognitive level to the highest. Further, the chasm of the innovation diffusion model is located between early adopters and early majority, while it is located between the Understand and Apply levels of the cognitive diffusion model.

3.2. Four learning periods

Next, this study further explores the distribution of students in the six levels of cognitive diffusion model according to four different learning periods, such as pre-schooling, after schooling, crossing the chasm, and high cognitive process.

On the basis of our assumption, in the first period, i.e. pre-schooling, most students usually do or do not remember certain knowledge and only a small number of students can understand it. Therefore, students' cognitive processes in this period are only on the lowest level, i.e. remember and understand. The second period is after schooling, it is when students were instructed about the knowledge and they carried out some related exercises, assignments, and examinations. In this period, students' cognitive process level is increased so that most students not only remember knowledge taught at school but also understand it. With further practice, completing assignments or exams, some students even became able to apply knowledge in real-life situations. Therefore, in this period, most of students remember or do not remember and understand knowledge taught at school, a few students know how to apply and analyze it, and very few students can reach more advanced levels of cognitive processes, such as evaluate and create (Azar, 2005; Kocakaya & Gönen, 2010). The third period, crossing the chasm, is a critical period as during it most students' (at least 50%) cognitive processes transforms from the lowest level, such as Remember and Understand to higher one, i.e. at least Apply. During the fourth period, called high cognitive processes, most students' (70-80%) cognitive processes reach the highest level, i.e. equal or higher then Apply.

In order to better understand why there are four learning stages, some real examples are given with respect to different subjects such as English as a foreign language (EFL), natural science, and math. For example, high grade elementary school students in Taiwan aged between 10 and 12, who learn EFL, know English words, how to spell them and their phonetic, but only a small part of them can apply these words in real-life situations, e.g. dialogue and communication (Hwang & Chen, 2013; Hwang et al., 2012a; Hwang, Chen, Shadiev, & Li, 2011). As for mathematics learning, students of the same age and culture can understand math arithmetic operations and simple geometric concepts and operations. Although most students can apply such knowledge for problem-solving items in the exam, we assume that usually only a small number of them are able to apply such knowledge to solve practical problems in real-life situations. Therefore, based on our assumption, even after school learning, most students (more than 50%) are still in the second stage (after school learning) and level of their cognitive processes cannot be high. That is, we assume that these students cannot apply learnt knowledge in daily life situations or authentic context.

This study proposes the distribution model, shown in Fig. 3, which demonstrates elementary school students' levels of cognitive processes for different learning periods. Yellow curve stands for pre-schooling period while blue curve for after schooling period.

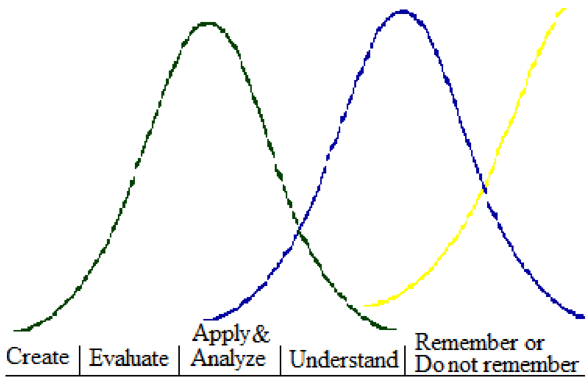

Fig. 3. Distribution of levels of cognitive processes

On a contrary, most senior grade elementary school students in Taiwan, whose native language is Chinese, have good knowledge of Chinese and they can easily use it for daily conversation, speaking, listening, reading, and even meaningful writing. Thus, we may conclude that instruction of Chinese in elementary school can enable crossing the chasm so that most students (more than 50%) reach high level of cognitive processes.

However, why is there such a big difference in students' cognitive processes while learning English as a foreign language? Is it because the environment to teach different subjects in school is different? Or is it due to ineffective teaching? Or is it because students do not work hard enough on particular subjects? In fact, these reasons are not the answers to the question, but it is because current educational system puts too much emphasis on concept learning and acquisition of knowledge. A little attention is paid on application of knowledge in real life situations. In most classes, students are requested to do assignments or answer test questions after class to test knowledge learned. Little attention is paid to make students to apply knowledge of English or natural science to solve their daily life problems. Therefore, most students still have low level of cognitive processes. As for Chinese, obviously, as it is native language for students, they got used to apply it in daily life conversation or writing. Therefore, in term of learning Chinese, students has crossed the chasm and reached at least Apply level of cognitive processes. Green curve in Fig. 3 is the distribution of cognitive processes of elementary school students for learning Chinese.

Next, this paper examines how to cross the chasm and reach higher level of cognitive processes. There are many meaningful pedagogical approaches designed so far to facilitate learning and cognition, for example, project-based learning, peer assessment, reciprocal teaching, and etc. However, after schooling of some subjects, for example EFL or natural science, cognitive processes of students still remain in the second stage; that is level of cognitive processes of most students cannot cross the chasm and reach higher level.

What should we do to overcome this issue? This study suggests that content of curriculum should be changed (Hwang & Chen, 2013; Hwang et al., 2012a). That is, the focus should not be only on traditional learning at schools but also on practical application of knowledge outside of school, i.e., so-called life-long learning without limit of space and time and with a "change of mind" in the learning environment of the future. What will change? Will walls of classroom disappear and students learn basic knowledge and concepts and apply them outside classroom? What can be done in order to enable students to verify and apply knowledge in daily life situations (the practical application)? How to link knowledge application with authentic surrounding and daily life situations? Perhaps, disappearance of some parts of school (e.g. walls), learning in-class combined with learning in out-of-class context, applications of knowledge, exploration, verification, and interaction of knowledge with daily life situations and surrounding will lead to learning of really useful knowledge and ability to its further utilization.

3.3. Sustainability and scalability

Traditional learning at school (i.e. with pen and paper) needs to be extended to after-school learning, where senior grade elementary school students can learn some concepts and have an opportunity to practically apply knowledge in real-life situation, i.e., life-long learning. How to apply knowledge in daily life situations? Sustainability and Scalability need to be taken into account. Sustainability was defined as ability of an innovation to remain in use (Clarke, Dede, Ketelhut, & Nelson, 2006). According to Century and Levy (2002), sustainability is the ability of a program to maintain its core beliefs and values and use them to guide program adaptations to changes and pressures over time. Scalability was defined as an ability of an innovation to be adapted in a wide variety of context (Clarke, Dede, Ketelhut, & Nelson, 2006).

In most cases, technology integrated into learning activity at school context is just for special occasions, specific time or specific discipline. At the end of such studies, technology is withdrawn because some discipline issues occur, and students cannot use it for learning anymore. Yet, in theory, students creating leaning content by themselves "persistently" in real-life learning environment can be called "sustainability" (Shadiev, 2007). Thus, students will sustain their motivation because they feel ownership of learning content and belonging to learning community (Lave & Wenger, 1991; Shadiev, 2007). The amount of content that is being created is constantly being updated and increased (scalability) (Hwang, Shadiev, Hsu, Lin, & Hsu, 2012b; Kumpulainen, Mikkola, & Jaatinen, 2014; Shadiev, 2007; Shadiev & Hwang, 2012); quality of content is also being improved and developed (Lee & McLoughlin, 2007; Shadiev, 2007). The quantity and quality of link between knowledge and its application in real-life situation is being expanded and extended continually (Shadiev, 2007). In such case, we believe that instructional approach, when students learn and then apply new knowledge in real-life situations with appropriate scaffolding by technology, enables crossing the chasm and learning with technology, which is defined as Sustainable and Scalable.

4. User-oriented context-to-text recognition for learning (U-CTRL)

4.1. Difference between U-CTRL and context-aware learning

What is the difference between user-oriented context-to-text recognition for learning (U-CTRL) and context-aware learning? In context-aware learning, a system detects students' location and then provides appropriate information or services based on situational factors; it is also called as scenario-oriented guided learning (Schilit & Theimer, 1994). However, context-aware learning is limited; that is, contextual learning information is usually prepared by experts in advance (Huang, Chiu, Liu, & Chen, 2011; Huang, Huang, Huang, & Lin, 2012; Leone & Leo, 2011; Lu, Chang, Kinshuk, Huang, & Chen, 2011), it is provided at a slow rate as students need to use sensing technologies, e.g. radio-frequency identification (RFID) or quick response code (QR code) (Baldauf, Dustdar, & Rosenberg, 2007; Leone & Leo, 2011; Lu et al., 2011). Besides, using such technologies requires to setup QR barcode labels or RFID tags in learning environment in advance (Huang, Chiu, Liu, & Chen, 2011; Huang, Huang, Huang, & Lin, 2012; Leone & Leo, 2011; Lu et al., 2011). If students use Global Positioning System (GPS), a space-based satellite navigation system, it provides location and time information in all weather conditions, however, only anywhere on the Earth where there is an unobstructed line of sight to GPS satellites (Baldauf, Dustdar, & Rosenberg, 2007). That is, if learning activity takes place indoor then GPS provides inaccurate information or cannot provide it at all.

This study proposes User-Oriented Context-to-Text Recognition for Learning (U-CTRL) mechanism, using situational recognition technology such as photo & search. Students take photos of objects in the real-life situation using a photo camera of their portable devices, then they converted into learning text by U-CTRL. Therefore, user-oriented context-to-text recognition for learning (U-CTRL) and context-aware learning have many differences. First, core concept of U-CTRL is a type of active learning in which students choose learning objects they are interested in. On the other hand, for context-aware learning, teachers design and prepare learning material in certain environment in advance (i.e., guided learning) (Huang, Chiu, Liu, & Chen, 2011; Huang, Huang, Huang, & Lin, 2012). Second, U-CTRL allows students to explore wider learning area where they are able to fine more diverse learning objects. On the other hand, students have limited learning area and access to a few learning objects in context-aware learning (Huang, Chiu, Liu, & Chen, 2011; Huang, Huang, Huang, & Lin, 2012). Third, U-CTRL environment enables many students to be involved in learning activities, such as capturing objects, thus, resulting in continuous growth and accumulation of their experience and knowledge. On the other hand, context-aware learning is planned by experts and therefore, learning information is prepared and provided by experts in advance and it is limited (Huang, Chiu, Liu, & Chen, 2011; Huang, Huang, Huang, & Lin, 2012); therefore, students' experience and knowledge may grow slower.

4.2. Scalability and sustainability of U-CTRL

There is much research on digital learning that develop innovative mechanisms to facilitate learning with promising results, however, most of them are short-term (Cheng, Hwang, Wu, Shadiev, & Xie, 2010; Huang, Chiu, Liu, & Chen, 2011; Huang, Huang, Huang, & Lin, 2012; Hwang & Chen, 2013; Hwang et al., 2012a; Hwang, Chen, Shadiev, & Li, 2011; Hwang, Huang, Shadiev, Wu, & Chen, 2014; Hwang, Shadiev, & Huang, 2011). We believe that U-CTRL creates a learning environment which enables students to learn effectively and it is also sustainable and scalable. Why? We assume that application of U-CTRL highly correlates with students' learning; particularly, U-CTRL motivates students' interests and it is useful for learning in familiar to students surrounding. Students capture learning objects of their interest and then they recognized as learning text by U-CTRL (Hwang, Shadiev, Kuo, & Chen, 2012; Kuo, Shadiev, Hwang, & Chen, 2012; Shadiev, Hwang, & Huang, 2014). Users create individual learning content and on their own that can strengthen students' feeling of learning content ownership and belonging to learning community (Lave & Wenger, 1991). In this way, it is likely that learning content created by students will be increased steadily and easily and therefore, scalability of U-CTRL will be expanded. Furthermore, U-CTRL enables peer sharing (i.e., learning content created by students is distributed in school and its district) and promotes interaction and cooperation among students which may positively influence on their motivation to persistently acquire and apply new knowledge.

4.3. U-CTRL for crossing the chasm

This study proposed U-CTRL to help majority of students to reach high level of cognitive processes (i.e. at least Apply level). How to do it? This study proposes four phases (Fig. 4), and with each has an incentive to encourage students to become familiar with U-CTRL first and then use U-CTRL for learning. Phase 1: Training students (around 3.5%) with high level of cognitive processes (at least Apply) about U-CTRL and how to apply what they learned in familiar situational context, such as school district, by using U-CTRL. Phase 2: Students (around 3.5%) with high level of cognitive processes (at least Apply) tutor students (13.5%) with lower level of cognitive processes (at least Understand) about U-CTRL and how to apply what they learned in familiar situational context by using U-CTRL; approximate proportion of students with higher level to students with lower level will be 1/4. Phase 3: In this phase, students who were trained in phase 1 and 2 (all together 17%) have at least Apply level of cognition and they tutor students with at least Understand level (33%) about U-CTRL and how to apply what they learned in familiar situational context by using U-CTRL; approximate proportion of students with at least Apply level to students with Understand level will be one half. At the end of three phases, percentage of students that crossed the chasm will reach 50%. Phase four: Students who were trained in phase 1, 2, and 3 (50%) have at least Apply level of cognition, they tutor the rest students with Remember level (50%) about U-CTRL and how to apply what they learned in familiar situational context by using U-CTRL. In this way, we believe that the level of cognitive processes of the most remaining students will be promoted to at least Apply level (Fig. 5). After crossing the chasm, to follow-up and keep on students' cognitive processes on high level, different learning activities and challenges need to be introduced.

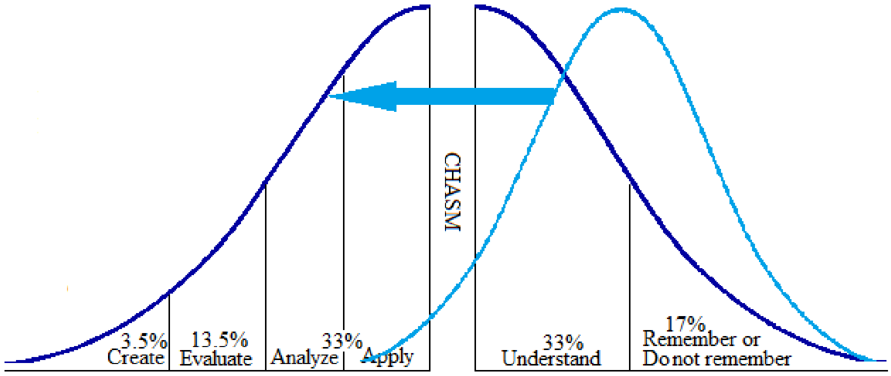

Fig. 4. Crossing the chasm

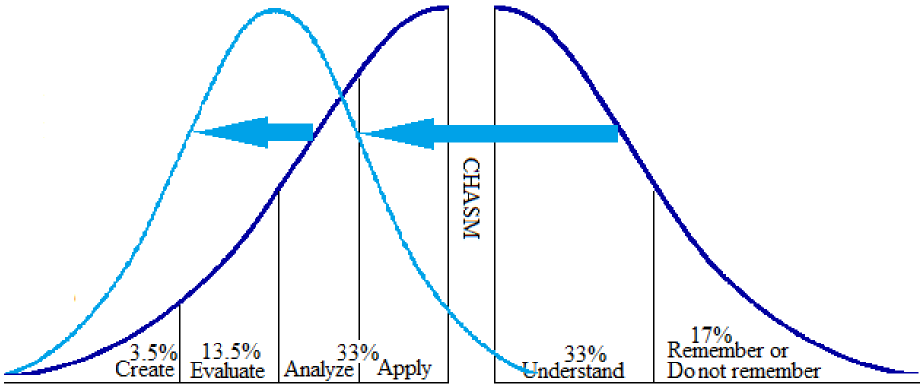

Fig. 5. After crossing the chasm

5. Applications of U-CTRL

5.1. Case one: U-CTRL for learning English as a foreign language

To enhance EFL skills of elementary school students, there were many efforts made to immerse students in the English learning environment and to strengthen the effect of learning the language (Cheng et al., 2010; Huang, Chiu, Liu, & Chen, 2011; Huang, Huang, Huang, & Lin, 2012; Hwang & Chen, 2013; Hwang et al., 2012a; Hwang et al., 2014; Hwang, Shadiev, & Huang, 2011). Related studies have also shown that parent-teacher interaction and parental involvement in students' learning can facilitate learning achievement (Harris & Goodall, 2008; Ho & Kwong, 2013; Williams, Williams, & Ullman, 2002). Therefore, in addition to classroom learning, this study suggests that application of what students learned at school in daily life situations will be beneficial for learning (Cheng et al., 2010; Hwang & Chen, 2013; Hwang et al., 2012a; Hwang et al., 2014). This study suggests extending boundaries of current learning environment from classroom to outside of it; that is, students who learn language in classroom can apply it by practicing in authentic environment and in real-life situations. With recent rapid development of cloud computing, many researchers have considered that it will have an impact on education of the future (Fernández, Peralta, Herrera & Benítez, 2012; Masud & Huang, 2012). Most studies discussed application of this technology for learning from technical aspects but rarely from pedagogical point of view (Fernández, Peralta, Herrera & Benítez, 2012; Masud & Huang, 2012). This study proposes a design of learning activities based on usage of U-CTRL, e-books with VPen multimedia annotation and reading tool (Hwang, Chen, Shadiev, & Li, 2011; Hwang, Shadiev, & Huang, 2011), combined with the cloud computing technology to help students to learn and apply English in real-life situation and in authentic context.

This study provides an opportunity for students to capture learning objects in real-life situation using a photo camera of their portable devices, identify them using cloud computing technology, and then recognize as learning text (Hwang, Shadiev, Kuo, & Chen, 2012; Kuo, Shadiev, Hwang, & Chen, 2012; Shadiev, Hwang, & Huang, 2014), i.e., photo and learning. On this basis, this study will design EFL learning activity that is sufficient to provide students with opportunity to learn and practice EFL in real-life situation. Learning activity will include elements of parent-teacher interaction and parental involvement in students' learning process in order to improve learning achievement of students. The design will be tested against its potential to contribute to academic achievement of students.

User-oriented context-to-text recognition for English learning activity described as follows. The first step includes activity to remember and understand new vocabulary.

Students freely explore context surrounding them in school district (i.e., discovery strategy). Students learn new vocabulary through taking photos of learning objects in authentic contexts then the system identify objects and provide their names in English and Chinese (e.g. air conditioner, chair, table, and etc.). In order to better understand pronunciation and meaning of new vocabulary, learning activity may also include interaction of students with their teacher and other students about new vocabulary.

Students capture learning objects and use meaning discovery and memory reinforcement strategies. Students learn in real-life situation and in different authentic areas of school district (e.g., school playground, living room, kitchen or bedroom in home); students take photos of learning objects, the system identify them and recognize into learning text (Hwang, Shadiev, Kuo, & Chen, 2012; Kuo, Shadiev, Hwang, & Chen, 2012; Shadiev, Hwang, & Huang, 2014) so that students can learn these texts as new vocabulary. Students need to collect different objects in particular areas and show how these objects relate to a particular situation in that area (meaning discovery strategy). Besides, students will be engaged in vocabulary learning and memorizing new words (memory reinforcement strategy). The main focus of this activity is to make students learn new words. Students take advantage of user-oriented context-to-text recognition, so that it recognizes learning objects captured by students into text (i.e., corresponding vocabulary) and then students learn it. In this situation, classroom learning is combined with creating individual text annotation so that learning content in classroom and students' individual real-life experience can be strengthened. The system identifies captured learning objects and provides their names in English, meaning, pronunciation, and different sentence patterns including these words. Students practice new vocabulary repeatedly to facilitate their recall and understanding of new words and the system provides students with self-assessment feature so that students can monitor their learning process and progress. The system will remind students some words that they could not remember or understand and provide appropriate exercises for that so that students can practice more with these words and master them. The following are some potential learning activities:

1. Words: Provide students with a picture, name, pronunciation and meaning of a word so that students can exercise with it.
2. Vocabulary: Provide students with a picture, and name of a word and then students need to give correct meaning of a word.
3. Listening: Provide students with a picture and pronunciation of a word and then students need to give correct meaning of a word.
4. Pronunciation: Provide students with a picture of a word and name recognized by the system, and then students need to speak it out.
5. Spelling: Provide students with a picture and pronunciation of a word, and then students need to spell it out.
6. Matching: Provide students with five pictures and five names of words and then students need to match pictures with names of words.
7. Using name of objects in sentences: Students capture objects in learning environment first, the system recognize name of these objects as text, and then students need to use name of objects in sentences.

The second step includes activities to apply new vocabulary in daily life situations.

Application of user-oriented context-to-text recognition for learning combined with annotating learning content. This study suggests using electronic books (e-books) for strengthening learning outcomes of the first step, i.e. mastering new vocabulary with memory reinforcement strategy. E-books feature multimedia annotation and can be carried everywhere to achieve seamless learning (Huang, 2013; Huang, Liang, Su, & Chen, 2012). Besides, students are able to take e-books home where their parents may take part in the learning process by helping their children to learn EFL. Particularly, parents may assist their children to apply what they learned at school in daily life interaction at home with family members. This study designed two learning activities to carry out in daily life situations. One activity is "Introducing family members" and another is "Introducing a menu of the dinner today". In the activities students expected to use simple English sentences to introduce family members and a menu of the dinner. Students can use multimedia annotation tool of e-books to record their own voices and of family members. For introducing a menu of the dinner, students may also use annotation tool of e-books to describe the dinner at home and to record an interaction with family members regarding the dinner.

In addition, teachers will still teach in traditional way and assign regular homework as well as ask students to use e-books for annotating learning material (e.g., pictures or text) and completing homework. Students will recall learning content covered in school and then complete homework at home, for example, describe various assigned topics with text and recorded speech. The teacher will evaluate homework on regular base.

5.2. Case two: U-CTRL for learning natural sciences

This study suggests that students participate in learning activity such as plant observation by using U-CTRL. Students take photos of plants with a camera of their portable devices and then the system recognizes plants and identifies their characteristics (i.e., a group, classification, and description). If the system cannot recognize some plants, then students can mark features of these plants in the system or find their name using particular characteristics by themselves using other methods (e.g., web-based search engines). Information about plants of school district can be accumulated over time. Since students can create knowledge related to their learning content and topic by capturing learning objects surrounding them, it allows them taking active part to establish learning content by themselves. Such design of learning activity may foster more active learning which is opposed to context-aware guided learning.

Students usually observe common plants outdoor, around school district, and therefore, there are several constraints that limit such learning activity if it takes place in traditional way (i.e. pen and paper). One of them is seasonal constraint, when students cannot observe some natural processes that plants undergo due to particular season, e.g., students cannot observe blossoming flowers process in autumn or winter. Another constraint relates to training of a big number of students about plants that usually happens in traditional classroom.

In order to provide more meaningful learning and improve students' self-learning ability, this study proposes to use tablet computers (i.e., mobile computer). Tablet computers enable to create a learning environment, which covers school district (i.e., outside of school and home area), so that students can easily learn about learning objects surrounding them, particularly, plants. This study proposes applying U-CTRL technology and cloud computing to search photos related to learning topics (i.e., photo and search). The technology will convert learning objects captured by students in real-life situation into learning text.

Students who learn with U-CTRL that is supported by various technologies such as augmented reality (Hsu, Hwang, & Shadiev, 2013), cloud computing (Fernández, Peralta, Herrera & Benítez, 2012; Masud & Huang, 2012), multimedia annotation system (Cheng et al., 2010; Huang, 2013; Hwang & Chen, 2013; Hwang et al., 2012a; Hwang, Chen, Shadiev, & Li, 2011; Hwang, Shadiev, & Huang, 2011), concept mapping (Wu, Hwang, Milrad, Ke, & Huang, 2012), and GPS and use Big6 strategies (Eisenberg, Johnson, & Berkowitz, 2010), will be engaged in active learning in real-life situations, observing plants without abovementioned restriction. In this way their cognitive processes will be promoted to higher level. This study suggests that students will capture learning objects in school district, upload captured learning content and store it online in database of cloud computing; thus students' experience and knowledge will be accumulated and tend to be more abundant.

6. Proposed learning scenarios with U-CTRL

6.1. User-oriented context-to-text recognition for learning

Students' learn and apply what they learned in their daily life situations and surrounding context, and gain experience. Situated learning emphasizes that knowledge must be presented in real-life situation, in order to stimulate students' cognitive and learning needs in real or virtual context through observation, interaction, and problem solving. With U-

CTRL approach, relevant learning content is available students in school and its district so that students can capture surrounding them learning objects they are interested in actively (i.e., active learning). In this way their motivation and interest are promoted. On the other hand, U-CTRL enables capturing learning objects and recognizing them (e.g., items from the menu of dinner for EFL or diverse types of plants for natural science learning) which make learning context richer. Proposed technological approach provides students with the context of real-life learning situations, so students are able not only to construct meaningful knowledge but also to apply this knowledge to solve real-life problems, to strengthen a link between knowledge and its application in daily life situation, and to foster understanding of relationship between human and surrounding context (e.g., to facilitate students to care for the environment, its resources preservation, and students' attitude of respect for life in natural science learning).

6.2. User-oriented content-to-text recognition and augmented reality technologies for self-learning

With more powerful hardware capabilities of mobile technology, this study will exploit cloud computing, user-oriented content-to-text recognition (e.g., images of items of dinner's menu or plants of school district), and augmented reality technologies by using mobile portable devices. Students will take pictures of learning objects in real-life situations, identify learning objects using cloud computing, and then convert images into text by using content-to-text recognition technology. This approach is breakthrough comparing to use of RFID or QR code technologies which need to be set up in learning environment in advance (e.g. to locate barcode labels or tags) and it is more context-aware richer comparing to information provided by experts to students. User can easily interact with learning objects in augmented, virtual or real world (i.e., context). Technological support enables students to capture learning objects related to different topics and establish relevant content in the database at the same time. Students' experience and knowledge will be constantly accumulated in cloud computing database, making the database become increasingly rich. Interactive design may foster more active learning, as opposed to general guide-based context-aware learning.

6.3. BIG6 activities designed to enhance students' ability of self-learning and data analysis

Self-directed learning provides students with the opportunity to set learning targets, plan, and then control own learning process. Therefore, students have opportunity to be self-determined and their sense of control and autonomy can be increased. Self-directed learning can increase students' intrinsic motivation and guide them to become active learners. In this study, students will be taught how to use self-learning strategies and online guidelines with BIG6 strategies (Eisenberg, Johnson, & Berkowitz, 2010) will be available, so that students can follow them during learning activities. In this study, as a first step, U-CTRL system will be combined with BIG6 pedagogy and emerging technologies by using tablet computers to promote students' ability of self-learning. In the second step, this study will build a combination of BIG6 strategy with multimedia annotation system to guide students' self-learning. Proposed in this study self-learning system will be installed on tablet computers, so that students will be able to check their progress on each step of self-learning anytime and anywhere, and to promote and improve students' self-learning and data analysis ability. And also the system will provide a concept map to help students to classify their observation, to immediately record observations, and collect information that will help students develop independent thinking and problem-solving skills, and inspire creative potential.

6.4. Tablet computers with multimedia annotation tool to assist self-learning

With rapid development of information technology, mobile devices, such as personal digital assistants (PDAs), smart phones, and tablet computers, are widely integrated into teaching and learning activities nowadays (Cheng et al., 2010; Huang, Chiu, Liu, & Chen, 2011; Huang, Huang, Huang, & Lin, 2012; Hwang & Chen, 2013; Hwang et al., 2012a; Hwang, Chen, Shadiev, & Li, 2011; Hwang, Shadiev, & Huang, 2011). Students' learning is no longer confined to the classroom; instead, students learn anytime and anywhere (Cheng et al., 2010; Huang, Chiu, Liu, & Chen, 2011; Huang, Huang, Huang, & Lin, 2012; Hwang & Chen, 2013; Hwang et al., 2014). Portability of these devices helps to learn outdoor. Moreover, students are able to input text using screen keyboard, voice or handwriting, input images and annotate them in order to carry out individual and collaborative learning. Global positioning system (GPS) allows obtaining students' location in the network environment (Baldauf, Dustdar, & Rosenberg, 2007; Huang, Huang, Huang, & Lin, 2012). When students use the system, it displays the current location of students in school district. When students capture learning objects (e.g. items of dinner's menu at home or plants in school district), the system automatically records a location of learning objects and displays them on a map. Then students know statistical distribution of different learning objects in school district. Finally, students share learning content with peers and it enhances their capabilities to search for information, process, and analyzing it. Moreover, the system demonstrates students' ability to apply knowledge in real-life situation.

7. Evaluation

This study will design learning activities and carry out an empirical study to evaluate the effects of U-CRTL on learning achievement and cognitive processes, to analyze learning behaviors of students, and to investigate students' perceptions and acceptance of the innovative approach.

A quasi-experimental design, following the general recommendations of Creswell (2002), will be used in this study. That is, the study will adopt a nonequivalent control group design and conduct an experiment to evaluate differences in the control and experimental groups' learning performance. Two classes of high grade elementary school students will be invited to participate in the experiment. One class with around thirty randomly assigned students will be the control group (with no treatment) and the other class with around thirty randomly assigned students will be the experimental group (with treatment). This study will administer a pre-test at the beginning of the experiment to assess a prior knowledge and prior cognitive processes of students. Furthermore, this study will administer post-test to assess learning achievement and cognitive processes of students at the end of the experiment (i.e., after the treatment). A pretest–intervention–posttest design will allow evaluating effects of U-CRTL on learning achievement and cognitive processes of students. The targets of pre-test and post-test will focus on evaluating students' cognitive level, rather than scores, by designing test items based on the six levels of Bloom cognition. Therefore, the transition of students' cognitive processes could be analyzed to validate whether U-CTRL could facilitate them to cross the chasm and reach higher cognitive levels. There will be several question items in the test and students' answers to each of them may represent different level of cognition;

therefore it is not easy to estimate cognitive level of students based on the test. Therefore, this study will use two possible approaches to estimate cognitive level of students. In the first approach, a student is viewed to reach a certain level based on his answer to any question that represents the highest level. For example, if the highest level that correspond to a student's answers is 4 (Analyze), it will be considered that a student researched that level. However, if the highest level that correspond to a student's answers is 3 (Apply), it will be considered that a student researched Apply level and so on. In the second approach, a student's level of cognition will be derived as an average of all levels of cognition (i.e. scores) that corresponds to his all answers to the test. For example, a student's answers to the test with 15 items represent the following cognitive levels: 2, 3, 4, 5, 0, 2, 4, 3, 4, 3, 3, 3, 2, 4, and 4; based on an average of these numbers, it will be considered that his cognitive level is 3 (Apply). In addition, to derive cognitive level more precisely, each question will be given a weight.

This study will also assign homework for students throughout the experiment. It will help students and the teacher to monitor the learning progress and qualitative changes in performance, such as increase in level of cognitive development. In homework students will be asked to include outcomes of how they applied what they learned at school in daily life situation. The teacher will evaluate homework based on the six levels of the taxonomy (Anderson & Krathwohl, 2001).

Meanwhile, regarding evaluating learning behaviors during U-CTRL activities, students will be motivated to capture learning objects, recognize them into text (Hwang, Shadiev, Kuo, & Chen, 2012; Kuo, Shadiev, Hwang, & Chen, 2012; Shadiev, Hwang, & Huang, 2014), and use both images and text for learning, e.g., speak out text in English or classify plants of school district for natural science learning. All such learning behavior will be recorded and accumulated by students in learning portfolio (Huang, Yang, Chiang, & Tzeng, 2012). This study will explore students' learning behavior and analyze their portfolios to evaluate the transition of cognitive processes and their learning performance throughout the experiment.

Finally, this study will conduct a questionnaire survey and interviews with students to investigate students' perceptions, acceptance, and potential effectiveness of the innovative approach for learning.

It is expected that integration of U-CRTL will enable students to observe learning objects in real-life context, have authentic experience through real interaction with learning objects as well as to facilitate students' active self-learning and to create a link between knowledge and its application in daily life situations.

8. Conclusion

This study proposes the Cognitive Diffusion Model to facilitate and improve students' learning and cognitive processes from lower levels to higher levels. The Cognitive Diffusion Model is useful to investigate the diffusion and transition of students' cognitive processes in different learning periods, such as in pre-schooling, after-schooling, crossing the chasm, and in higher cognitive processing. Crossing the chasm is a very critical period as it promotes cognitive processes of the majority of students from lower level to higher levels (it is desirable that they reach at least the Apply level). This study proposed that the four phases supported by User-Oriented Context-to-Text Recognition for Learning (U-CTRL) approach can help facilitate crossing the chasm. Incorporating U-CTRL, students participate in learning activities that are specifically designed to help apply the knowledge learned in class to solve problems in an authentic context. This takes place through capturing learning context, recognizing it into text, and employing for learning. This study proposed two case studies using U-CTRL, one related to EFL and another to natural science learning, discussing how to evaluate effectiveness of the U-CTRL approach in learning and the cognitive processes, learning behaviors of students to study with U-CTRL, and their perceptions and acceptance of U-CTRL. Moreover, this study also discussed how the U-CTRL approach can be sustainable and scalable. One limitation of this study is that our assumption and proposed model (i.e. the distribution of levels of different cognitive processes in different learning periods) were not tested as a case study. Therefore, in the nearest future we will conduct an experiment to obtain sufficient evidences to support our proposed approach.

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References

Anderson, L. W., & Krathwohl, D. R. (Eds.). (2001). *A taxonomy for learning, teaching and assessing: A revision of Bloom's Taxonomy of educational objectives: Complete edition*. New York: Longman.

Azar, A. (2005). Analysis of Turkish high-school physics-examination questions and university entrance exams questions according to Bloom's Taxonomy. *Journal of Turkish Science Education, 2*(2), 144–150.

Baldauf, M., Dustdar, S., & Rosenberg, F. (2007). A survey on context-aware systems. *International Journal of Ad Hoc and Ubiquitous Computing, 2*(4), 263–277.

Bloom, B. (1956). *Taxonomy of educational objectives, Handbook 1: The cognitive domain*. New York: Longman.

Century, J. R., & Levy, A. J. (2002). *Sustaining change: A study of nine school districts with enduring programs*. paper presented at the Annual Meeting of the American Educational Research Association, New Orleans, Louisiana.

Cheng, S. C., Hwang, W. Y., Wu, S. Y., Shadiev, R., & Xie, C. H. (2010). A mobile device and online system with contextual familiarity and its effects on English learning on campus. *Educational Technology & Society, 13*(3), 93–109.

Clarke, J., Dede, C., Ketelhut, D. J., & Nelson, B. (2006). A design-based research strategy to promote scalability for educational innovations. *Educational Technology, 46*(3), 27–36.

Creswell, J. W. (2002). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research*. Upper Saddle Creek, NJ: Pearson Education.

Eisenberg, M., Johnson, D., & Berkowitz, B. (2010). Information, communications, and technology (ICT) skills curriculum based on the big6 skills approach to information problem-solving. *Library Media Connection, 28*(6), 24–27.

Fernández, A., Peralta, D., Herrera, F., & Benítez, J. M. (2012). An overview of e-learning in cloud computing. *Advances in Intelligent Systems and Computing, 173*, 35–46. Springer Berlin Heidelberg.

Harris, A., & Goodall, J. (2008). Do parents know they matter? Engaging all parents in learning. *Educational Research, 50*(3), 277–289.

Ho, E. S. C., & Kwong, W. M. (2013). Elucidating the complexity of parental involvement in primary schools: Three ethnographic case studies. In *Parental*

Involvement on Children's Education (pp. 19–58). Singapore: Springer.

Hsu, J. L., Hwang, W. Y., & Shadiev, R. (2013). Displaying digital annotations on physical material: An application of augmented reality. In *Proceedings of the International Conference on Collaboration Technologies and Systems (CTS)* (pp. 611–612).

Huang, J. J. S., Yang, S. J. H., Chiang, P. Y. F., & Tzeng, L. S. Y. (2012). Building an e-portfolio learning model: Goal orientation and metacognitive strategies. *Knowledge Management & E-Learning (KM&EL), 4*(1), 16–36.

Huang, J. W. (2013). *The effects of learning behavior and duration of time on learning with annotation sharing mechanisms in annotatable multimedia e-readers*. (Unpublished Master thesis). National Central University, Taiwan.

Huang, Y. M., Chiu, P. S., Liu, T. C., & Chen, T. S. (2011). The design and implementation of a meaningful learning-based evaluation method for ubiquitous learning. *Computers & Education, 57*(4), 2291–2302.

Huang, Y. M., Huang, Y. M., Huang, S. H., & Lin, Y. T. (2012). A ubiquitous English vocabulary learning system: Evidence of active/passive attitudes vs. usefulness/ease-of-use. *Computers & Education, 58*(1), 273–282.

Huang, Y. M., Liang, T. H., Su, Y. N., & Chen, N. S. (2012). Empowering personalized learning with an interactive e-book learning system for elementary school students. *Educational Technology Research and Development, 60*(4), 703–722.

Hwang, W. Y., & Chen, H. S. L. (2013). Users' familiar situational contexts facilitate the practice of EFL in elementary schools with mobile devices. *Computer Assisted Language Learning, 26*(2), 101–125.

Hwang, W. Y., Chen, H. S. L., Shadiev, R., Huang, Y. M., & Chen, C. Y. (2012a). Improving English as a foreign language writing in elementary schools using mobile devices in familiar situational contexts. *Computer Assisted Language Learning*. doi:10.1080/09588221.2012.733711

Hwang, W. Y., Chen, N. S., Shadiev, R., & Li, J. S. (2011). Effects of reviewing annotations and homework solutions on math learning achievement. *British Journal of Educational Technology, 42*(6), 1016–1028.

Hwang, W. Y., Huang, Y. M., Shadiev, R., Wu, S. Y., & Chen, S. L. (2014). Effects of using mobile devices on English listening diversity and speaking for EFL elementary students. *Australasian Journal of Educational Technology,* in press.

Hwang, W. Y., Shadiev, R., Hsu, J. L., Lin, Y. C., & Hsu, G. L. (2012b). Effects of storytelling using web-based multimedia system on English as foreign language speaking. In *Proceedings of the 5th IET International Conference on Ubi-media Computing (U-MEDIA)*. Xining, China: IET.

Hwang, W. Y., Shadiev, R., & Huang, S. M. (2011). A study of a multimedia web annotation system and its effect on the EFL writing and speaking performance of junior high school students. *ReCALL, 23*(2), 160–180.

Hwang, W. Y., Shadiev, R., Kuo, T. C. T., & Chen, N. S. (2012). Effects of speech-to-text recognition application on learning performance in synchronous cyber classrooms. *Educational Technology & Society, 15*(1), 367–380.

Kocakaya, S., & Gönen, S. (2010). Analysis of Turkish high-school physics-examination questions according to Bloom's taxonomy. *Asia-Pacific Forum on Science Learning and Teaching, 11*(1), 1–14.

Krathwohl, D. R. (2002). A revision of Bloom's taxonomy: An overview. *Theory into practice, 41*(4), 212–218.

Kumpulainen, K., Mikkola, A., & Jaatinen, A. M. (2014). The chronotopes of technology-mediated creative learning practices in an elementary school community. *Learning, Media and Technology, 39*(1), 53–74.

Kuo, T. C. T., Shadiev, R., Hwang, W. Y., & Chen, N.S . (2012). Effects of applying STR for group learning activities on learning performance in a synchronous cyber classroom. *Computers & Education, 58*(1), 600–608.

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge, UK: Cambridge University.

Lee, M. J. W., & McLoughlin, C. (2007). Teaching and learning in the Web 2.0 era: Empowering students through learner-generated content. *International Journal of Instructional Technology and Distance Learning, 4*(10), 21–34.

Masud, M. A. H., & Huang, X. (2012). An e-learning system architecture based on cloud computing. *World Academy of Science, Engineering and Technology, 62*, 74–78.

Moore, G. A. (1999). *Crossing the chasm: Marketing and selling high-tech products to mainstream customers* (Rev. ed.). New York: HarperBusiness.

PISA. (n.d.). *OECD program for international student assessment*. Retrieved from http://www.oecd.org/pisa/aboutpisa

Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). New York: Free Press.

Leone, S., & Leo, T. (2011). The synergy of paper-based and digital material for ubiquitous foreign language learners. *Knowledge Management & E-Learning (KM&EL), 3*(3), 319–341.

Lu, C., Chang, M., Kinshuk, Huang, E., & Chen, C. W. (2011). Usability of context-aware mobile educational game. *Knowledge Management & E-Learning (KM&EL), 3*(3), 448–477.

Schilit, B. N., & Theimer, M. M. (1994). Disseminating active map information to mobile hosts. *IEEE Network, 8*(5), 22–32.

Shadiev, R. (2007). Informational technologies in solving the social issues of school communities in Uzbekistan. In *Proceeding of the Interactive Computer Aided Learning Conference (ICL)*. Kassel, Germany: Kassel University Press.

Shadiev, R., & Hwang, W. Y. (2012). A pilot study of facilitating cross-cultural understanding in blended online environment using project-based collaborative learning activity. In *Proceedings of the International Conference of Educational Innovation through Technology (EITT)* (pp. 289–297). Beijing, China: Tsinghua University Press.

Shadiev, R., Hwang, W. Y., & Huang, Y. M. (2014). Investigating applications of speech-to-text recognition to assist learning in online and traditional classrooms. *International Journal of Humanities and Art Computing, 8*, 179–189.

van de Rijt, J., & Santema, S. (2012). The best value approach in the Netherlands: A reflection on past, present and future. *Journal for the Advancement of Performance Information & Value, 4*(2), 147–160.

Williams, B., Williams, J., & Ullman, A. (2002). *Parental involvement in education* (Research report No 332). London: Department for Education and Skills.

Wu, P. H., Hwang, G. J., Milrad, M., Ke, H. R., & Huang, Y. M. (2012). An innovative concept map approach for improving students' learning performance with an instant feedback mechanism. *British Journal of Educational Technology, 43*(2), 217–232.