Mobile Technologies and Augmented Reality in Open Education

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Chapter 11
Design Principles for an Intelligent-Augmented-Reality-Based M-Learning Application to Improve Engineering Students' English Language Skills

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ABSTRACT

Introducing an intelligent augmented reality based M-learning application designed and developed for improving engineering students' English language skills, this chapter reports a work-in-progress that focuses on system design procedure. The application consists of Artificial Intelligence (AI) based functions to ensure an effective learning flow while taking advantages of game-based learning by providing a story board structure with a content tree. Four design principles "fair use, flexible use, fault tolerance, educational climate" by Elias in addition to Stockwell and Hubbard's principles for mobile supported language learning have been taken into account. Furthermore, the proposed system here employs an effective approach combining both real and virtual environments to achieve an Augmented Reality based learning experiences for students. After the introduction of the application, the chapter outlines how it will be processed in the future.

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INTRODUCTION

Rapid developments and changes in technology have affected mostly the way of providing education. Since the introduction of computer technology and also Internet, especially educational research has gained a remarkable momentum and many different approaches, methods, and techniques on delivering educational processes thanks to computer and Internet environments were introduced to the associated literature. Today, e-learning is the most popular technology-oriented educational technique as an effective and efficient way of distance education approach. In time, e-learning has also gone through many developments and it is currently used in different forms according to environments, platforms, or devices over which teaching-learning is experienced.

It can be said that because there are many dynamic environmental factors affecting the whole M-Learning process, there will be always an effort on searching for better language education supported by mobile technologies. Furthermore, it is also a good way to adapt the literature of M-Learning with the latest technological improvements by taking the real-world based problems into consideration. Here, it is clear that supporting M-Learning based language teaching – learning processes with the latest technological components will take the effectiveness and efficiency of M-Learning one step away, by shaping also the future of this research area. In this context, two popular approaches: Augmented Reality and Artificial Intelligence are strong candidates to support M-Learning and so Mobile Assisted Language Learning studies.

Augmented Reality (AR) is an effective interaction oriented approach, which employs both virtual environment and real world in a common platform. Since its first introduction AR and its applications have become popular among different fields and employed in the context of especially multimedia based platforms to ensure highly interactive, effective using solutions for different fields like education, health, natural sciences, economy, military...etc (Chen, & Chung, 2007; Kose, 2015; Kose, Koc, & Yucesoy, 2013). Because AR provides interactive aspects and an adaptive working function interacting with the real time environments, there is a remarkable interest on performing scientific research studies in which practical, immediate solutions for real-world based problems are tried to be achieved (Kose, 2015; Kose et al., 2013). Because of its effectiveness on enabling people to interact with the real-world while still in contact with digital elements, AR has been a popular approach for educational studies.

Regarding to educational studies, Artificial Intelligence (AI) is another research approach, which is widely used. Because AI comes with a multidisciplinary approach by achieving a logical and mathematical way of enabling computer based systems to solve real-world problems, it employs a great potential for even future of research studies. So, adding some 'intelligent' working mechanisms to educational software systems has become a popular trend over the intersection of education and AI.

Associated with the explanations above, this chapter is based on an application combining some popular approaches to provide a better way of teaching – learning English. Introducing an intelligent Augmented Reality based M-Learning application designed and developed for improving engineering students' English language skills, this chapter reports a work-in-progress that focuses on system design procedure. The application consists of Artificial Intelligence based functions to ensure an effective learning flow while taking advantages of game-based learning by providing a story board structure with a content tree. Four design principles "fair use, flexible use, fault tolerance, educational climate" by Elias (2011) in addition to Stockwell and Hubbard's (2013) principles for Mobile Assisted Language Learning have been taken into account. Furthermore, the proposed system here employs an effective approach combining both real and virtual environments to achieve an Augmented Reality based learning

experiences for students. In this way, it is aimed to improve students' learning experiences with two approaches based on intelligent working mechanism and interaction with both real and virtual world. Some starting points of the application is introduced in this chapter. After the introduction of the application, the chapter outlines how it will be processed in the future.

In the context of the chapter subject, remaining sections of the paper are organized as follows: The next section is devoted to essential educational motivations considered along the application introduced in this study. After this section, the third section explains general setting of the application and its importance. Following to this section, the fourth section explains the further methodology that was planned to be followed along next steps of the study. After this section, design principles regarding to the application have been explained under the fifth section. Under next two sections, potential risks – challenges and also future research regarding to the study are discussed. Finally, the paper ends with the final section discussing about conclusions.

EDUCATIONAL MOTIVATIONS

Broadly in education, defined as non-spatial, personalized learning technique engaging learners via mobile devices such as smart phones or tablets, mobile learning (M-Learning) gets the attention of researchers (Ally, 2009; Kukulska-Hulme, 2005; Motiwalla, 2007). Specifically, in language learning, Mobile Assisted Language Learning (MALL) integrates Mobile Learning Environments (MLEs) into language teaching – learning (Beatty, 2003; Bozdogan, 2015; Colpaert, 2004) with features of mobility, content flexibility, immediacy, individuality, and interaction opportunities (Attewell, & Webster, 2005; Chinnery, 2006). So, it is an important way to employ M-Learning for language teaching – learning. But on the other hand, there is still a remarkable interest in improving the literature associated with this subject.

Introducing learners to learning opportunities via mobile devices has already proven its educational benefits. The theoretical framework of this study links MALL to game-based learning in an ESP (English for Specific Purposes) context with attempts to convert it to a CLIL (Content and Language Integrated Learning) setting. While MALL allows learners to study in a contextualized learning environment in their own pace (Silberman, & Biech, 2015), Game-Based Learning (GBL) enables interaction with the subject in a fun and intriguing way (Demirel, Seferoglu, & Yagci, 2003). Language-wise, CLIL "a dual-focused teaching approach where content is taught through a language other than the mother-tongue." (Marsh, 2002) promises necessary language support in content classes.

Games in M-Learning function as a new world where learner ubiquitously play and learn within the scope of defined learning objectives. What attracts learners the most as listed by Bayirtepe and Tuzun (2007) are the competitiveness and mystery to unlock. Games provide learners with the opportunity to practice knowledge transferring their prior knowledge into a new reality (Bottino, Ferlino, Ott, & Travella, 2007; Ebner, & Holzinger, 2007). Additionally, GBL poses a challenge to mobile application developers as to include learners into learning process in an enjoyable, challenging and encouraging (Gee, 2005). One of its basic principles portrays the nature of gaming: The more challenging games are, the better learning outcomes will be. So far, research on game-based M-Learning presents positive outcomes (Dabbagh et al., 2016; Hamari et al., 2016; Chee, 2016; Van der Wal, de Kraker, Kroeze, Kirschner, & Valkering 2016).

Adopted by the European Union as part of the multilinguality principle, any content can be taught using CLIL; however, the focus may shift slightly between content and language according to the objectives

in the curriculum. Studies indicate CLIL success in Europe (O'Driscoll, 2004; Schreppegrell, Achugar, & Oteiza 2004; Shamsudin, & Nesi, 2006) supporting its claim to facilitate meaningful contextualized language learning (Kincheloe, Slattery, & Steinberg, 2000). CLIL in higher education needs attention as learners seek language guidance and support in content classes (Hanesova, 2015). In the Turkish higher education context, British Council (2015) reports the issues and recommends CLIL incorporation as an aid to boost both content and language instruction. However, studies from Turkey focus mainly on project based, CBI (Content-Based Instruction) and specifically theme-based approach at the primary and secondary levels (Arslan, & Saka, 2010; Kiziltan, & Ersanli, 2007).

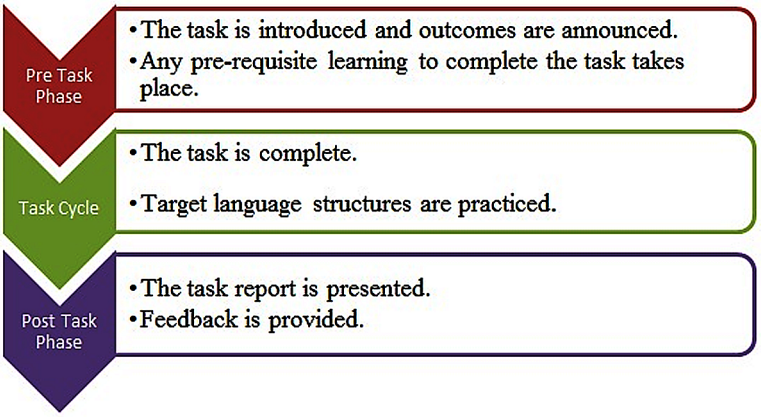
Task-based Language Teaching (TBLT) promotes a student-centered learning environment where meaningful language learning takes place (Willis, 1996). Language becomes a concrete means to accomplish a real task from students' lives. To do so, students improve their thinking skills such as inference, analytical thinking, creative thinking, planning (Gunes, 2012).

The framework of TBLT is shown in Figure 1.

In addition to the mentioned educational approaches, methods, and techniques explained under previous paragraphs, Augmented Reality (AR) has the main mechanism of the application by enabling students to interact with the 'mixed reality' (Milgrami, & Kishino, 1994) along their learning processes. In the literature, Chang, Morreale, & Medicherla (2010) indicates that learners can improve their motivation for learning and it is also possible for them to enhance their educational practices via AR. Also, Johnson, Levine, Smith and Stone (2010) think that the AR can provide strong, contextual, onsite learning experiences with also serendipitous exploration and discovery of the connected nature of the information over the real world. On the other hand, Cascales, Laguna, Pérez-López, Perona, & Contero (2013) explain that the AR is an emerging technology for educational activities because it affects students' many senses. Briefly, success of AR in educational studies has encouraged the authors to include in the application introduced here.

Nowadays, it is also a remarkable interest to employ Artificial Intelligence in many fields of modern life including education. Running intelligent mechanisms in educational applications have improved effectiveness and efficiency of educational works and made it easier for both teachers and students to take active part in teaching-learning processes. At this point, using intelligent educational software systems is an important approach that is followed by educational institutions. It can be observed from the as-

Figure 1. Task-based Language Teaching framework (Willis, 1996)



sociated literature that Artificial Intelligence is widely employed to develop such educational software systems (Aleven, 2013; Carpio Cañada, Mateo Sanguino, Merelo Guervós, & Rivas Santos, 2015; Nye, 2015; Peña-Ayala, 2013; Vera, Breis, Sánchez, & Espinosa, 2013; Zatarain-Cabada, Barron-Estrada, Alor-Hernandez, & Reyes-Garcia, 2014). In addition to that, improving such intelligent educational software systems more with additional interactive components (i.e., Augmented Reality) is a remarkable key factor in forming more advanced educational processes.

SETTING OF THE APPLICATION AND IMPORTANCE

In order to understand more about design principles of the application, it is a good way to explain general setting though for it and shaping the importance of the research done with the application.

General Setting

This study aims to analyze the content instruction context following the EMI policy and to align higher education language instruction with the 21th century learning skills and requirements. Though numerous reforms have been initiated in Turkish higher education, undergraduate students in Turkey were ranked among the last ten countries in Europe for language competence (British Council, 2015). Such a devastating failure in higher education can be associated with the foreign language teaching policy and low student motivation.

Undergraduate programmes in Turkey display classification in three groups according to their medium of instruction: English as a medium of instruction (EMI), Turkish as a medium of instruction (TMI), and Turkish and English as a medium of instruction (T-EMI). In practice, students' proficiency level and lack of interest, and faculty's inefficiency and reluctance to deliver EMI classes pose challenges. Moreover, monotonous and difficult to access instructional materials and the scarcity of international students/relations add to these issues that can be handled with a needs analysis for identification purposes, and a curriculum and material revision (Cheon & Reeve, 2014). Hence, a transition from EMI to CLIL with dual focus on language and content improvement seem to meet such a demand and challenge (Arkin, 2013; British Council, 2015).

Ankara University, where the study takes place, promotes EMI policy in some of its programmes including Electrical and Electronical Engineering department. The 4-year program includes basic sciences, engineering, English language (general and genre-specific) and a range of elective courses. The number of students per class is approximately 30-40 and based on their preparatory class exit level, B1-B2 identify their language proficiency. This study concentrates on a second-year, fall semester content course and develop a game-based mobile app in support of their course and foreign language proficiency.

Importance of the Application

A needs analysis based curriculum improvement and game-based MALL integrated CLIL approach form the strengths and pillars of the study. This attempt to integrate game-based MALL and CLIL in higher education level is believed to contribute to the content classes in terms of affective factors like motivation and attitude and achievement both in content and language (Dornyei, MacIntyre, & Henry, 2015; Finn, 2015). A thorough needs analysis triangulated with qualitative and quantitative data collec-

tion identified student and teacher perspectives on EMI, learning styles, course material evaluation and the content and language balance in the classrooms. In a complementary manner, a game-based mobile application is being developed believing its contribution in the curricular and pedagogical issues. Additionally, in the Turkish context where language and content learning are treated separately, "a dual focus" (Marsh, 2002) would promote both.

METHODOLOGY

Grounded on the needs analysis executed in the previous research project in the same setting, this system design of the mobile application, utilized both qualitative and quantitative methods. The second year undergraduate course ELE218 Microprocessor materials and syllabus will be revised with the integration mobile app. Initially, both the EEE academic staff including the course instructor and students will be informed about the study, its theoretical background and potential outcomes while getting their consent to participate. First, corpus concordance will be performed to form the professional English bilingual dictionary app providing word meanings, examples, connotations and visuals. In a similar context, to underline the power of visuals, the study of Saran, Cagiltay, and Seferoglu (2008) suggests including pronunciation and usage in sentence as well as visuals to clarify meaning.

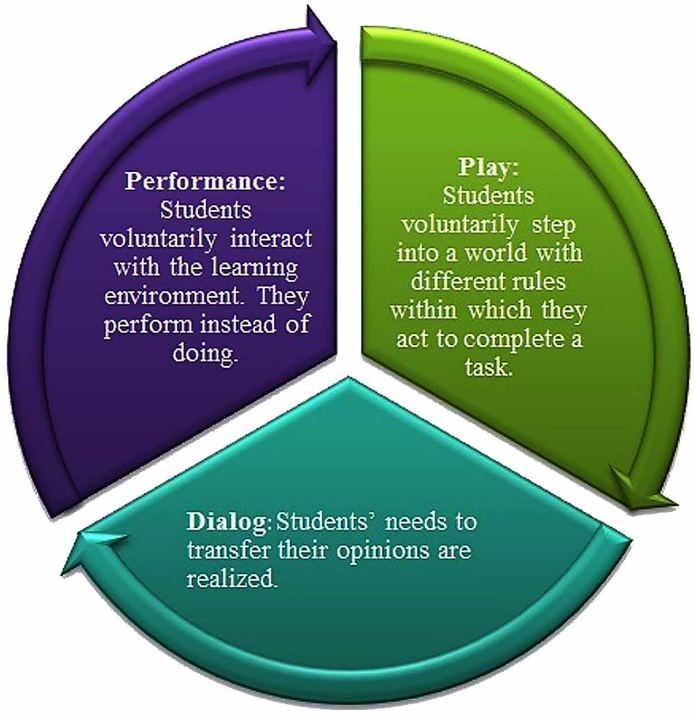
The textbook 'Digital Design with an Introduction to Verilog HDL (5th edition)' (Mano, & Ciletti, 2013) is chosen to be analyzed to identify content-specific vocabulary. For reference purposes, monolingual and bilingual hardcover and mobile dictionaries are taken into consideration. Along the further steps of the research – study, it is planned to gather some data about M-Learning with a questionnaire developed by the authors focusing on general and educational uses of mobile phone and related perceptions. After consulting the course instructor and students, the game based themes will be conceptualized for the tasks following the framework for MALL by Stockwell and Hubbard (2013) that offer key principles like creating short and clear activities considering characteristics of students' smart phone use, user environments, and learning styles. All in all, ten tasks will be developed for students to interact with artificial intelligent-expert systems in the M-Learning application. In order to better infuse tasks into MALL, four characteristics of tasks by Ellis (2003) for Task-Based Language Teaching (TBLT) are taken into consideration:

- Each task has a meaningful primary focus.
- Each task aims to address a need.
- Students are required to use certain language structures to accomplish each task.
- Each task has a real life-like outcome other than language learning.

Kalantzis and Cope (2005) suggest Performance- Play- Dialog model (PPD) for GBL. With PPD, students become active players rather than passive doers in the MLEs. The basic principles of PPD are these (Figure 2):

In addition to the dictionary and tasks, the third component of the application includes an avatar section, where students edit their avatars, store their achievement tokens and interact with other online users simultaneously. Students identify with their avatars and struggle to complete the tasks while performing

Figure 2. Basic principles of PPD (Kalantzis & Cope, 2005)



meaningful language use in context. Ab Hamid and Yu Fung (2007) in a similar game-based M-Learning platform identify user attentiveness in the game-based tasks reporting an 80% MLE interaction every day. Student achievement correlates highly the amount of MLE interaction and the extent of motivation out of game-based challenging tasks (Schawabe, & Göth, 2005). In a similar experimental design, Chen and Chung (2007) reports students' motivation and achievement are improved when they are engaged in an M-Learning environment on their own pace.

To facilitate out-of-class access to the M-Learning environment, task completion requirements are manageable but incessant. Based on the rubric prepared with the course instructor and provided to the students at the end of the implementation, summatively students are evaluated 10% out of their course grade. Each task is starred by the students upon completion; students also post comments and reviews, such a need emphasized by Moreno-Ger, Burgos and Torrente (2009). Furthermore, frequent teacher feedback increases value attached and improves the active learning process. The system will be left open for any updates and improvements for further uses.

Augmented Reality and Artificial Intelligence oriented mechanisms employed in the application are for improving effectiveness and efficiency of the learning process. By using intelligent mechanism in the background, it will be possible to run a more accurate learning flow in the context of changing nature of learning affected by many factors. On the other hand, use of Augmented Reality will enable students to interact with the real world in order to complete activities run over a mixed reality.

DESIGN PRINCIPLES OF THE APPLICATION

Designing mobile learning environments (MLEs) for smart phones is a meticulous process. Elias (2011) suggests four universal instructional design (UID) principles for MLEs: equitable use, flexible use, tolerance for error, and instructional climate. These UID principles are followed to develop the mobile learning environment in this study. The first step of the design and development process of the MLE is to formulate the content tree in the light of the curriculum and learning objectives. The next step is to develop the story board based on the content tree. Whole process is supervised by a team of field experts and educational technologists whose comments are taken into consideration to edit and update the story board.

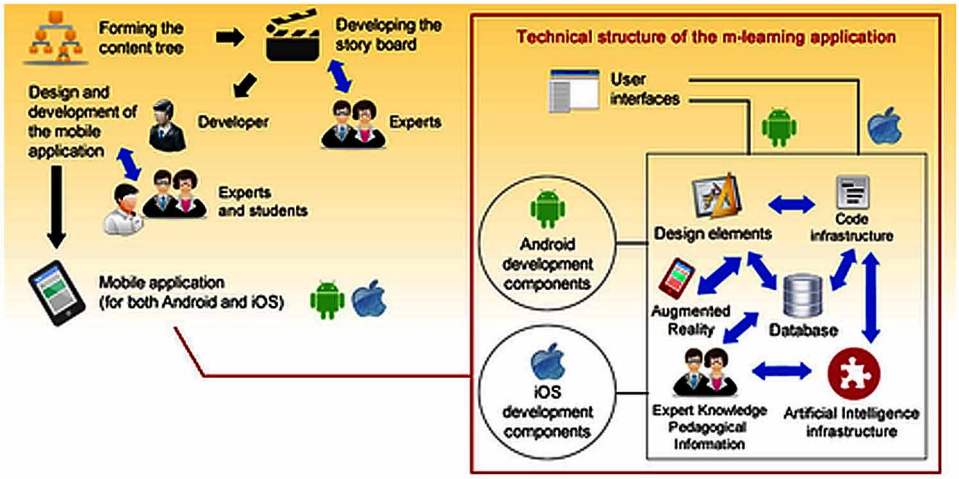
Upon forming the story board, coding process is initiated for two different operational systems: Android and iOS. The application is developed via platforms like Android Studio and Eclipse for Android, and XCode and Swift for iOS. Similarly, platforms like Adobe Fireworks, Illustrator and Flash are utilized to design interfaces and visuals (e.g. graphics, animations). It is of vital importance to develop two identical versions of the mobile application for both Android and iOS in terms of design, features and functions. SQLite, which runs with both operational systems, is used for database support. Data for schematic and functional structures, including the story board are stored in the data base. On the other hand, codes and data for artificial intelligent- expert systems approaches are included for pedagogical operation mechanisms. At this point, necessary framework for the Augmented Reality is included by keeping touch with other elements of the mobile application.

The feedback for the prototype is obtained from field experts and educational technologists. Any required changes are included according to the constructive feedback. The resulting prototype is submitted to random student feedback and is edited accordingly. In order to achieve the optimum format, each version of the prototype is tested, updated, and edited accordingly before it is put to use.

The proposed system design processes are shown briefly in Figure 3:

Technical structure of the application focuses on the following aspects:

Figure 3. System design processes



- Key using features and functions of the application are adapted to the different environments of Android and iOS operating systems. Android and iOS development components are employed within two separate development processes to obtain accurate versions of the mobile application.
- Database of both different versions is designed in the same structure. It is aimed to make development processes of user interfaces and code infrastructures easier and faster. In addition, design elements (i.e., icons, images, style files) are used directly in both Android and iOS versions.
- Interrelations among Design Elements, Code Infrastructure, Database, Expert Knowledge, Pedagogical Information, and Artificial Intelligence Infrastructure of the mobile application can be seen in Figure 3. This is because of running Expert Knowledge, Pedagogical Information and also Artificial Intelligence approaches under user-oriented sides of the application. AI has an important role on making the application adaptive to the learning process without the need for face-to-face teacher interaction. In detail, some well-known AI techniques like Artificial Neural Networks and also some optimization oriented techniques under Swarm Intelligence are used in order to form an intelligent working mechanism affecting the whole application in terms of experiencing an adaptive learning process (Cochocki, & Unbehauen, 1993; Hassoun, 1995; Kose, 2015; Miller, Sutton, & Werbos 1995).
- Augmented Reality infrastructure of the application has been formed to ensure a flexible approach, which is connected with the whole elements included like design elements, code infrastructure and of course, Artificial Intelligence infrastructure.

Potential Risks and Challenges

Before, during and after the implementation, some problems are likely to emerge; first predicable problem is related to interface: interfaces are partially monitored or run because different smart phones do not support the platform. In such cases, source codes are updated to support all the smart phones. Another relates to user interface freezes: after checking the compatibility, source codes are edited according to user smart phones. Moreover, visuals may appear partially or differently on different smart phones; in such a case, source codes of those schematic images are resized and relocated. To avoid such interface grounded pitfalls, design and coding process need to consider possible difficulties with instant and appropriate actions to be taken.

As an important component of the application designed, Augmented Reality may be also another challenging factor for students. In this sense, it may be a little difficult to interact with the real-world under the control of Augmented Reality. But this will transform itself in a short time to a great advantage of interaction and an enjoyable learning experience, after students learn how to benefit from Augmented Reality.

Another possible problem is regarding the mobile learning skills of students; they might have weak mobile learning skills. With exposure to supplementary training and support, they will be merged into the world of M-Learning in a comprehensive and contextualized way. Finally, students' perception of M-Learning might cause problems; they may perceive educational use of smart phones pointless. To overcome such a barrier, they will be encouraged to use small-scale educational applications and to reflect on their experiences. Positive experiences are believed to motivate them to change their perspectives.

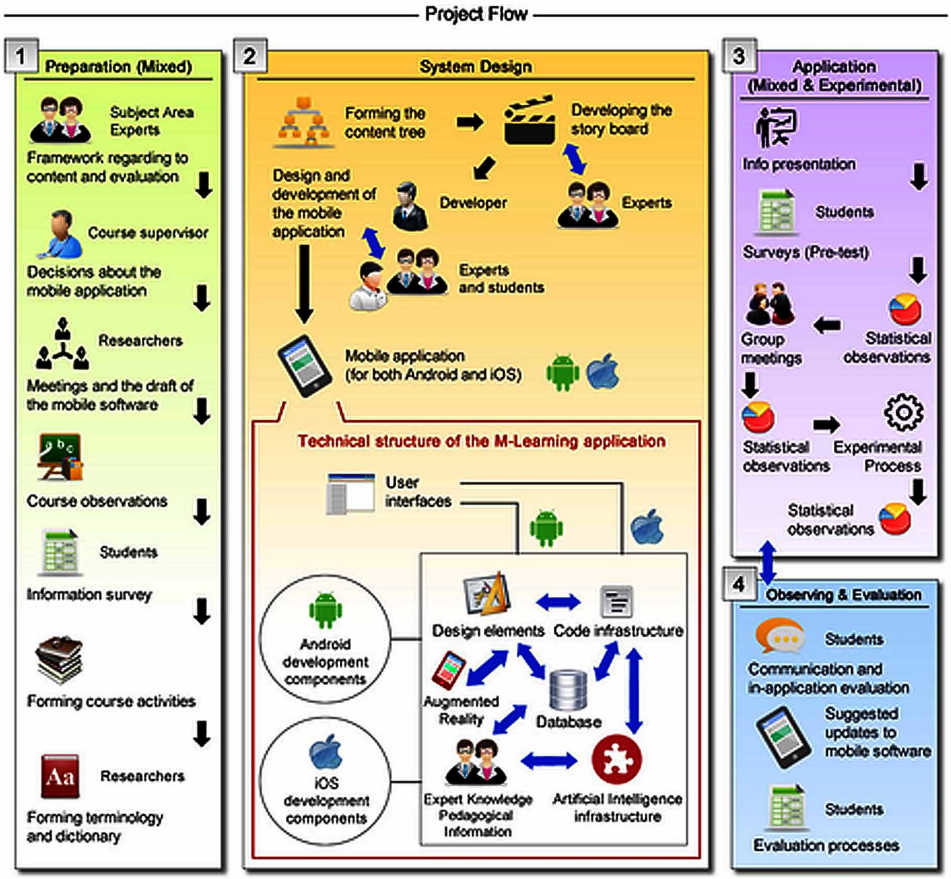
FUTURE RESEARCH DIRECTIONS

As it can be understood, future research directions regarding to the application considered in this chapter includes running of some project phases. In this context, the project will include four phases at total, called as Preparation, System Design, Application, and Observing and Evaluation respectively. Principles considered in this chapter will take place as the second phase of the whole project flow. Before it, there is a preparation phase in which all pedagogical infrastructure needed for the project will be formed. After the system design phase, the application will be run by employing lots of statistical observations in order to have idea about the process. Finally, the application phase will be followed by an observing and evaluation phase in which students will have the responsibility to evaluate the application.

By including the proposed system design processes mentioned under Figure 3 as the second phase, a bigger picture of the project (project flow) is shown in Figure 4:

In addition to the mentioned project flow, the application will also include further steps including development of newer versions of the mobile application with more advanced Augmented Reality functions and also use of alternative Artificial Intelligence based approaches to achieve more educational outputs to be evaluated. Of course, future research will always include the related phases of statistical observations, group meetings, and evaluation works done by students.

Figure 4. Project flow



CONCLUSION

This chapter has provided a brief view on preparation of an improved educational approach for improving engineering students' English language skills. Because of the detailed background regarding to the infrastructure, more focus was given to the design of the application. Briefly, the study aims to analyze the content instruction context following the English as a Medium of Instruction (EMI) policy and to align higher education language instruction with the 21th century learning skills and requirements. Though numerous reforms have been initiated in Turkish higher education, undergraduate students in Turkey were ranked among the last ten countries in Europe for language competence (British Council, 2015). Students' proficiency level and lack of interest, and faculty's inefficiency and reluctance to deliver EMI classes pose challenges. Moreover, monotonous and difficult to access instructional materials and the scarcity of international students – relations add to these issues that can be handled with a needs analysis for identification purposes, and a curriculum and material revision (Cheon, & Reeve, 2015). Hence, a transition from EMI to CLIL with dual focus on language and content improvement seem to meet such a demand and challenge (Arkin, 2013; British Council, 2015). As the technological infrastructure, the application is supported with the most remarkable and effective approaches like Augmented Reality, M-Learning, and Artificial Intelligence.

The proposed study merging ICT skills through Augmented Reality, Artificial Intelligence supported M-Learning and language learning competences of the engineering students is believed to contribute to the pedagogical processes, student and teacher attitudes to M-Learning and practicing English through mobile phones. The program curriculum might benefit in diversifying and individualizing the content education with an application piloted and developed considering the students' needs in terms of language and content.

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KEY TERMS AND DEFINITIONS

Artificial Intelligence: (1) A term that is used to describe the feature, function or characteristic of computer systems or machines that try to simulate human-thinking behavior or human intelligence. (2) A field of Computer Science, which is based on research studies or developments on providing intelligent systems simulating the human-thinking behavior or human intelligence.

Augmented Reality: Some kind of reality in which virtual world based elements – objects are added to the real world based environment.

E-Learning: Learning activities, which are supported and performed via electronic media – sources, by enabling individuals to experience educational processes on anytime and anywhere.

Intelligent M-Learning: M-Learning supported with Artificial Intelligence based approaches, methods, or techniques.

Mixed Reality: The reality including elements – objects from both real world and virtual world based approaches.

Mobile Assisted Language Learning: An approach of language learning supported with mobile technologies.

M-Learning: A type of E-Learning done via mobile technologies including both software and hardware oriented factors.

Mobile Learning Environments: Software oriented platforms (especially over Web) that is used for M-Learning purposes.