Integration of gamification technology in education

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Abstract

Educational system plays crucial role on the development of nations, and the impact of early education empower knowledge acquisition. In this research, technology assisted second language learning (English) with peace context is used to reveal impact of information and communication technologies (ICT) in learning. The study is carried on 5 years old pre-schoolers, representing 4 classes with the average of 17 students in each, and the total of 60 sample students. Knowledge acquisition and tests are conducted with in class gamification training. Tests are first carried out by written assessment, then conducted with technology assisted gamification activity. Results revealed that teaching language with ICT together with gamification context significantly improved language acquisition and awareness of peace concept. Furthermore, observations show that technology assisted learning also minimizes distraction of children and boosts learning curve.

Keywords: gamification; technology in education; information and communication technologies (ICT) in learning; statistical performance investigation

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1. Introduction

Nowadays, technology and social networks form big part of human life from early childhood to very elder ages. Children with all ages are directly or indirectly benefitting from the emerging technology. With the invention of Web 2.0 technology, massive number of new websites, services, blogs and social networking platforms are developed and still continuing to emerge.

In the early 2000s, the main forms of ICT learning was formed by rich media environment such as CD-ROMs, DVDs, Tape Medias and vs. Then, learning with computer games started to get prominence by the use of personal computers (Second Language Learning at Primary Levels using Adaptive Computer Games). In these days, mobile phone and tablet usage overwhelms personal computer usage, and even very young child can use these highly portable devices easily because of their user friendly and easy to use nature.

Playing games to acquire basic skills especially in preschools has been one of the most effective way of learning from decades and so today. Pre-schoolers acquire learning and variety of motor skills through educational games. Game Based Learning is recently emerged and highly popular medium due to its seductive and exciting nature. Games uses its playful nature to attract and motivate players, but the success of the game highly depends on relationship between challenge, fantasy, curiosity and control.

CALL (Computer Assisted Language Learning) is a language learning system that uses multimedia, together with text, visuals, audio and video files in order to teach a language through the use of computer technology. It should be noted that rather than a method for teaching, CALL is considered to be a tool for the teachers to communicate information to the students. Use of computers in language instruction is a growing tool in everyday teaching in parallel with the ever increasing advancements in technology. While the teachers are increasingly relying more and more on the CALL technologies, studies are also being held in conjunction with this interest.

A research on the effectiveness of CALL on preschool students in Tanzania was conducted by Ongoro and Mwangoka. Their driving point was not having a specific way of pronouncing alphabet letters of the English language in Tanzania.

As the brains of children before the age of 7 are in the preoperational stage, they are only capable of making sense of comprehensible objects. So, CALL also needed to be supported with tangible objects in order to make the ‘digital visual-audio’ format easier to comprehend for them. This would allow the kids to not lose interest in the game easily. The use of letters, pictures and audio instructions were merged with a point based scoring system, different levels, badges and competitions. The audio stimulation was kept to the minimum due to the loud environment in a kindergarten classroom. For students’ interaction, speech recognition and a screen that can be controlled through the use of touch were implemented.

The game was tested in 12 preschools – 10 of these institutions, using English as the main teaching language. Students’ reactions were noted to be positive. As for the teachers of the preschools, they stated that as the CALL was using the senses of hearing, sight and touch all together, the experience of this technology would boost the learning process. It was also noted by them that the use of this game all around the country would benefit the students in learning the correct way of pronouncing the words. Finally when the results of game based learning was compared with the traditional methods, it was noted that the average results of the CALL approach was higher.

Through this research, a benefit of the CALL technology could be observed. When a foreign language is thought by individuals who themselves are not native to that language, naturally pronunciation differences may occur. With the spreading of such game throughout a country, it can be deducted that one definite method of teaching pronunciation can certainly increase consistency among the students.

Looking at such study is certainly beneficial in seeing what kind of researches are undertaken by the researchers in the field of computing technology. However, psychologists Chen-Lin Kulik and James Kulik rightfully stated that findings of a single research would be insufficient to determine the effectiveness of computer based instruction (CBI) as a teaching method. For that reason, they created an analysis of 254 different studies conducted on kids of nursery age to adulthood on CBI.

Out of the 248 researches that presented results, 81% of these studies concluded that students who used CBI had higher average. When looked at overall results, Kulik and Kulik concludes that overall the students who used the CBI method had an average mark of 62%, while the students from the conventional classes had an average of 50%. In addition to these findings, it was noted that using CBI as a means reduced the time of the learning process substantially. This extensive research goes to show the effectiveness of the computer assisted learning systems over traditional methods.
Studies done on computer assisted learning in different subject areas by researchers such as Escalada and Zollman, Klassen and Milton, Vrtacnik also all concluded that the students had a more positive approach to computer assisted learning compared to the traditional methods which in turn increases the effectiveness of the learning process\(^6\). Similar findings were also observed by a TEFL (Teaching English as Foreign Language) specialist and lecturer, Robert Ayres, in the use of CALL. He stated that the use of computers in language learning had improved the subjects’ attitude towards learning significantly\(^6\).

CALL is an interactive and individualised tool of teaching. An ideal CALL system should allow the student to be able to interact with readily structured or unstructured lessons while learning by themselves\(^5\). Although the lessons may be unstructured, it is still crucial that the lessons are carefully planned just like the traditional teaching methods and tied to classroom teachings\(^9\). However, unlike a classroom environment, CALL allows the students to be able to access their lessons at any time and to be able to focus on the bits as the users please; thus allowing some independence during the learning process\(^9\).

Another benefit is that, students who need additional assistance can find the chance to work on more focused programs with additional time as well as students who want to progress quicker can simply choose to do additional lessons. This sort of experience allows language learning to be individualised with personal control. Abuseileek claims that interactive nature of CALL increases students’ involvement to the lessons which in turn make the learning process more effective. When CALL is initiated by teachers, different mediums could be linked with each other, such as videos, pictures and sounds in order to spark more interest from the students\(^9\).

2. System Architecture

System is designed on web-based environment which uses model-view-controller (MVC) architectural pattern. This architectural pattern separates input control layer, display layer and business layer from each other for better orchestration, manoeuvrability, control and security\(^10\) with the use of this architectural pattern, user layer is kept separate from input control layer, where all the intelligent system communication and database operations are done with the help of this layer, with the help of business model.

For the development of each test, Phaser\(^11\) desktop and mobile gaming framework is used. The main focus is held on personal computer usage and the tests are well designed to fit for this purpose. Nevertheless, the system also supports mobile usage for ease of use and Omni-directional experience. JQuery and pure JavaScript is used to code tests and real-time statistical delivery.

2.1. Database model

Microsoft SQL Server Database is used as an RDBMS system. Database is formed by seven main tables. The authentication mechanism checks the Users table for validating credentials whenever the user wants to login. When user access to the system and initialize the assessment set, the system gives user a unique session id and store it in Assessment Session table. We employ session handling to keep track of the users, and in case they leave from the game without completing it they can come back and continue from where they left the assessment.

In Fig.1 (a), Games table stores each individual game formation, and Assessment Sets table stores assessment sets. Assessment Set_ Games is a bridge table which stores relationship between games and assessment Sets. With this architectural design, multiple games can be created as assessment and each assessment can be assigned to one or more assessment set. Question Items table stores all the game related audio, images, and figures. All Assessment related statistics are stored in Statistics table. User Id, Game Id, Assessment Set Id, Session Id and trial Number guarantees uniqueness of the statistical data. Number of correct answers, number of incorrect answers and total elapsed time for each game is stored for statistical purposes.

2.2. Security model

The authorization system is built with ASP.NET Web API 2.2\(^12\) technology and works with bearer token authentication\(^13\). As it is seen on Fig 1 (b), user first enters username and password on the client, then the client sends these information to the authorization server, and the authorization server authenticates the credentials and turn back with a unique access token. Client uses verified access token and adds it to the HTTP Request header before any
request is sent to the server. This authorization mechanism is developed to add increased security together with extensibility and mobility. The assessment software can be easily extended to work on any device including development of the hybrid mobile applications by the potential of the Web API 2 Technology. In this project, we used local login mechanism, however our security mechanism also supports social login which enables direct authentication and authorization using external services such as Facebook, Twitter, Microsoft, Google and etc. The assessment software employs role based authorization which includes admin, teacher and student role for separation of duties. Student role is default role and is assigned to the user on the time of registration. Only admin user has right to change roles. Teachers have ability to create and modify games and assessment sets, and change order of the questions.

![Database and Authorization System](image1.png)

(a) Relational Database Model

(b) Credential Flow

Fig.1 Database and Authorization System.

2.3. GUI model

Bootstrap front-end development framework\(^{14}\) is used for designing responsive and mobile friendly web application. System automatically adopt itself (games) according to the screen resolution of the client devices and is well suited for mobile usage.
3. Intelligent System

Intelligent statistical system is designed to store and manage real-time statistical data which is continuously collected by the computer-user experience. To be able to collect complete and accurate real-time user statistics for every question, the use of intelligent data collection system is crucial. For this purpose, the unique session and game identifier is generated and given to the user to monitor every user, test and game experience separately. The user can only play one game at a time and questions cannot be bypassed by the user, instead rules are predetermined by the system and students need to obey them. The unfinished games are also statistically collected but can be distinguished.

4. Game Types

For the current version of the platform, 5 different types of games have been developed, and the Instructor can generate multiple questions (games) from each game type with the help of dynamic nature of the platform. The generated questions can then be bounded to one or more assessment set with a predefined order. The Instructor has ability to assign each assessment set to a class/classes or even to specific group of user where this helps instructor to create games with different difficulty levels and assign assessment sets to children based on their pedagogic level and behaviour. Puzzle Game can be given as an example where number of pieces needed to be aligned can be pre-defined by the instructor based on the difficulty level. All the games has positive reinforcement for the children according to the peace concept of the research. The wrong answers does not punish and only scores of the correct answers are shown to the children.

4.1. Matching game

In this game, at most sixteen different figures (8 pairs) can be placed. The Child need to couple each figure with the other related figure. The left side of the figures are needed to be dropped on to the related figure, which is placed at the right side of the game, for matching. If the matching fails, then the figure turns back to its original location and the child can try again. Otherwise, if the figure overlaps with the correct figure, then the matching happens and the child gets point. The matching game has 2 versions with or without sound. In sound assisted version of the game, random sound is first pronounced for the child and the correct object, which is related with sound, is needed to be dragged and dropped on the related object.

4.2. Ordering game

In this game, the original and complete image figure is first displayed to the child and system wait for the start game button to be pressed. When the child starts playing game, timer starts to count, the figure divided into 4, 16, 36 or 64 different pieces with same aspect ratio according to the difficulty level of the game and the pieces are shuffled on the canvas. The shuffled items are needed to be rearranged by dragging and dropping, where drag and drop action switches dragged piece with the dropped one. The game automatically finishes and the timer stops when all the pieces are placed on the correct places, and the balloons shows up with the congratulations sound as reward for the child.

4.3. Classification Game

This game is concentrating on classifying items according to their types. Instructor can generate large amount of items for classification purposes. The Child needs to select correct type for each item in order to get points. Each item is needed to be dragged and dropped to the correct classifier. If the child drop item to the correct type, the child rewarded with star, otherwise he cannot get star. At the end of the game, total number of correct answers are collected for the statistical purposes.
4.4. Selection Game

This game is sound assisted. Game starts when the child presses “Start Game” button, then timer starts counting. Random item is selected and pronounced by the system, and system waits for the child to click on the related picture. The sound is repeated every five seconds if no action is provided by the child. Game automatically finishes and the timer stops counting when all the expressions are pronounced and selected. Child gets positive score whenever correct expression is selected.

4.5. Slideshow

This game has sliding pictures. Instructor can add multiple pictures for the sliding window and the child needs to categorize each picture according to its characteristics. Each picture may reflect positive or negative behaviour, and one of them is needed to be selected according to the characteristics of the picture. Game finishes when all the pictures are categorized by the child, and statistical information collected from the pictures is sent to the server. At the end of the test, the child’s behaviour is analysed according to the collected answers.

Peace with environment game is recycling game and is developed on Classification Game. Total of 9 garbage items used where they categorized uniformly in recycling papers, recycling plastics, and recycling aluminium and/or steel. Students are expected to classify each item by looking type of the respected item. Peace with others game is Smile Game and is formed on Selection game. Human faces are used, and children are expected to select correct facial expression after listening related sound.

5. Statistical Performance Investigation

Fig. 2 (a) and (b) show the percentage of students versus the total number of correct answers they give for Assessment1: Peace with the Environment. Fig. 2 (a) represents the results from classroom based teaching only and Fig. 2 (b) represents the results from classroom and gamification based teaching. Let the students’ performance with three or less total number of correct answers be considered as “low performance”; from four to six total number of correct answers be considered as “medium performance”; and seven or more total number of correct answers be considered as “high performance”. It is shown from the figures that, there is considerable percentage of students with low performance when only classroom based teaching is employed (see Fig. 2 (a), there is 23% of students with low performance). On the other hand, when gamification technology is used to enforce classroom based teaching, there is no students with low performance (see Fig. 2 (b)). And the percentage of high performance students increased significantly; the percentage of high performance students in Fig. 2 (b) is 75%, but in Fig. 2 (a) is 42%. Therefore, it is shown from the figures that employing gamification technology to enforce the classroom based technology provides significant improvement to students’ learning.
Table 1 shows the mean and variance of total number of correct answers given by the students to Assessment 1: Peace with the Environment when only classroom based teaching is employed and classroom and gamification based teaching are employed. It is shown by the table that employing gamification technology improved the mean for total number of correct answers from 5.6 to 7.45. This is, on average the students give 33% more correct answers. Further, the variance for total number of correct answers reduces from 6 to 1.9, which is 68% improvement. That is, on average difference between the best and worst performing student is about 1.9 correct answers. Therefore by employing gamification technology a more uniform standard of learning is provided to the student.

Table 1 The Mean and Variance of total number of correct answers for Assessment 1: Peace with Environment

<table>
<thead>
<tr>
<th>Performance</th>
<th>Classroom based teaching only</th>
<th>Classroom and gamification based teaching</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>5.6</td>
<td>7.45</td>
</tr>
<tr>
<td>Variance</td>
<td>6</td>
<td>1.9</td>
</tr>
</tbody>
</table>

Fig. 3 (a) and (b) show the percentage of students versus the total number of correct answers they give for Assessment2: Peace with the others. Fig. 3 (a) represents the results from classroom based teaching only and Fig. 3 (b) represents the results from classroom and gamification based teaching. Let the students’ performance with one and zero total number of correct answers be considered as “low performance”; two and three total number of correct answers be considered as “medium performance”; and four and five total number of correct answers be considered as “high performance”. It is shown from the figures that, there is considerable percentage of students with low performance when only classroom based teaching is employed (see Fig. 3 (a), there is 43% of students with low performance). On the other hand, when gamification technology is used to enforce classroom based teaching, there is no students with low performance (see Fig. 3 (b)). And the percentage of high performance students increased significantly; the percentage of high performance students in Fig. 3 (b) is 81%, but in Fig. 3 (a) is 34%. It is important to note that these performance improvements agree with the results from Fig. 3. Therefore, it is shown once again from Fig. 3 (a) and (b) that employing gamification technology to enforce the classroom based technology provides significant improvement to students’ learning.
Fig. 3. Percentage of students versus total number of correct answers they give for assessment 2: Peace with the others.

Table 2 shows the mean and variance of total number of correct answers given by the students to assessment 2: Peace with the others when only classroom based teaching is employed and classroom and gamification based teaching are employed. It is shown by the table that employing gamification technology improved the mean for total number of correct answers from 2.45 to 4.4. This is, on average the students give 80% more correct answers. Further, the variance for total number of correct answers reduces from 4 to 0.76, which is 81% improvement. That is, on average difference between the best and worst performing student is about 0.76 correct answers. Therefore assessment 2 also shows that by employing gamification technology a more uniform standard of learning is provided to the student.

Table 2 the mean and variance of total number of correct answers for assessment 2: Peace with others

<table>
<thead>
<tr>
<th>Performance</th>
<th>Classroom based teaching only</th>
<th>Classroom and gamification based teaching</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>2.45</td>
<td>4.4</td>
</tr>
<tr>
<td>Variance</td>
<td>4</td>
<td>0.76</td>
</tr>
</tbody>
</table>

6. Conclusion

Computer assisted learning is available and used on every aspect of education for a long time, and the benefit of CALL is experimented and approved within decades. In the last few years, the aspect of CALL is begun to transform on mobile device assisted language learning with the Development of HTML 5, Web API and advanced front-end CSS capabilities. From this point of view, the assessment module is developed with mobile device capabilities, and gamification concept is applied to accelerate learning and to keep focus of students from destruction. The peace concept is chosen as mediator to give children basic positive behavioural skills. The tests are applied on 4 classes and results shows significant performance improvement on the acquisition of knowledge. Assessment results shows that there is %33 to %90 performance improvement on the acquisition of knowledge according to the gathered results, and the variance of the knowledge acquisition is improved %68 to %81.

References