Knowledge Management & E-Learning
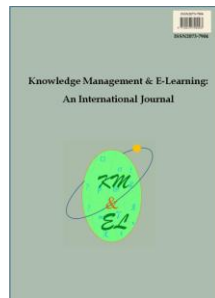
The use of serious gaming for open learning environments

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Abstract: The extensive growth of Open Learning has been facilitated through technological innovation and continuous examination of the global Open Education development. With the introduction of compulsory computing subjects being incorporated into the UK school system in September 2014, the challenge of harnessing and integrating technological advances to aid children's learning is becoming increasingly important, referring to £1.1 million being invested to offer training programs for teachers to become knowledgeable and

experienced in computing. From the age of 5, children will be taught detailed computing knowledge and skills such as; algorithms, how to store digital content, to write and test simple programs. Simultaneously, as the Internet and technology are improving, parents and teachers are looking at the incorporation of game based learning to aid children's learning processes in more exciting and engaging ways. The purpose of game-based learning is to provide a better engagement, and in turn, an anticipated improvement in learning ability. This paper presents a research based on the investigation of properly combining the advantages of serious games and Open Learning to enhance the learning abilities of primary school children. The case study and the adequate evaluation address a learning environment in support of a history subject matter.

Keywords: Open learning; Serious gaming; Children education; Edutainment

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1.   Introduction

Information Communication Technology (ICT) was first introduced into schools over 25 years ago. The general view was that it would increase educational attainment through changing the learning and teaching processes and strategies (Rodriquez, Nussbaum, Lopez, & Sepulveda, 2010). Within the last 10 years the level of ICT within schools has

risen dramatically. The number of computers, projectors and interactive whiteboards has increased and mobile devices and specialist equipment such as speech recognition software has been introduced. There has also been a significant increase in the ubiquitous use of laptops and wireless connections. Teachers are using ICT to help gather resources and plan lessons, but more importantly, within the classroom as a teaching tool. Technology plays a vital role in modern society as parents, teachers and children are constantly engaged with using their phones, tablets, laptops or desktop computers daily for many different purposes. Schools including more of a range of technology within the classrooms from desktop computers to laptops and IPads are offering the children a more enhanced way of learning. By incorporating technology, it can create greater motivation and can inspire more learning, rather than the traditional means of using pen and paper which may appear dull and uninteresting (Bonk & Cunningham, 1998).

Since the introduction of home computers and gaming consoles in the mid-1980s, school-aged children have spent more time with electronic media than ever before (Young et al., 2012). Furthermore, as the Internet and technology are vastly improving, parents and teachers are increasingly trying to incorporate game based learning, in aid to help the children learn in a more exciting and engaging way. The gaming industry is a large sector within the computing market. There is a steady growth in a wide range of users' interests and games being produced to cater for differing entertainment preferences. As school aged children are progressively investing more time in playing computer games, it would be a sensible idea for educational games to be readily available to support children learning. Serious games market is worth more than $20 million (Susi, Johannersson, & Backlund, 2007), there is a substantial amount of money to be made in the growing serious games industry. Furthermore, gaming industry giants such as UBISOFT predict that 'serious gaming' will be the fastest-growing segment of the industry over the next decade (Chee, 2010). Serious games are tools that are designed for education and learning purposes. They can be used to teach topics ranging from medicine and healthcare, to training for military and engineering jobs (Kolb, 1984).

Before serious gaming there was Edutainment. This was popular in the 1990s due to the growing use of personal computers. Edutainment refers to any sort of education that also entertains, although it is usually associated with computer games, with educational aims. However, edutainment software did not have the expected impact as children reported them to be unstimulating. As a result, this lead to the decline in the serious games industry (Sorathiaa & Servidio, 2012). In the early 2000s interest in serious gaming increased. This was a result of a team of International Scholars in Washington, D.C. proposing the Serious Games Initiative and consequently; the term "serious games" was established. Serious games have the same aims as edutainment, however, more substantial educational features were added to support teaching and training.

Concluding, there are a variety of resources that parents and teachers can use in order to help children learn not only in terms of writing and reading (traditional ways of learning methods using pen and paper), but also in an entertaining manner. There is a wealth of age appropriate games and courses aimed at children's learning, via websites on the Internet, application stores such as Apple, Kindle fire, Google Play for Android, and more. Children can read books online on computers, rather than in the more traditional manner and style of learning; they can also play educational games on their own or their parent's phones and tablets which brings more excitement and more of a desire to learn. Often children are learning without realising it, especially in the earlier years of school. By engaging with the games, the children are enticed to want to play more, and therefore, are subconsciously gaining more knowledge in the process. Serious

games can be viewed as significant tools for children in regard to Open Learning, namely open to everyone everywhere. This learning technology can provide an effective and powerful approach to skills development and learning support in a long term.

In following this line, this paper addresses the design and development of an Open Learning application based on serious games that children can use within their school or at home, in a formal or informal education setting, as a learning tool by utilising the most appropriate functionality of modern technology. In a more general way, this research supports school systems by providing positive change within the curriculum, and the society by offering engaging opportunities and enhanced motivation for Open Education. The steps that will be taken in order to help achieve this aim are; appropriate research into the different theories and learning styles and how children learn which can be implemented when designing and developing the targeted application, accompanied by appropriate research of the user group approached, namely school children, in light of the serious games approach, as described in Section 2. Section 3 refers to the serious games in the context of Open Learning. Research methodology is illustrated in Section 4 whereas evaluation and discussion of the results obtained is presented in Section 5.

2.   Serious gaming

Serious games can be applied to a broad spectrum of areas, as many games have educational objectives to support subjects such as physics, maths or history, all of which the player can learn from. Many of these have the potential to be fun and interesting. Children can learn with serious games also in an informal setting, outside of school hours on their own pace, without the need of the input or support of the teacher. In this case, computer systems (including serious games) can support teachers and children to enhance the learning process (Bertacchini, Bilotta, Pantano, & Tavernise, 2012). Games can be created using the knowledge of various experts on a specific subject for example teachers and professionals.

Table 1
Differences between entertainment games and serious games (Kolb, 1984)

	SERIOUS GAMES	ENTERTAINMENT GAMES
Task vs. Rich Experience	Problem solving in focus	Rich experiences preferred
Focus	Important elements of learning	Have fun
Simulations	Assumptions necessary for workable simulations	Simplified simulation processes
Communication	Should reflect natural (i.e. non-perfect) communication	Communication is often perfect

Serious games offer a different experience than entertainment games as their primary purpose is learning. In reality people often prefer entertainment games as they are more engaging. Table 1 shows the inherent differences between serious gaming and entertainment gaming.

Information in serious games needs to be extremely accurate as they are aimed to be a valuable learning experience. For example serious games such as flight simulations are designed to imitate real life flying experiences, enabling pilots to have good flying practice lessons before they fly a real plane. Serious games are much harder teaching methods to develop than other teaching approaches (Ott et al., 2011). This means that serious games need more time and effort to be spent on them than a text book or video, it has to convey the educational message whilst still being enjoyable for the user to play and want to replay again. Another factor is that game developers have different experience than educators, due to the fact that digital game designers and educational experts do not usually share a common vocabulary (Yusoff, Crowder, Gilbert, & Wills, 2009). It may be difficult for them to gauge what a young child can and cannot understand. Young learners have different expectations than older learners and learn better through different methods, children tend to prefer images, animations and sound as opposed to reading plain text (Dunlosky, Rawson, Marsh, Nathan, & Willingham, 2013).

A problem for serious gaming is the notion that they may be perceived as tedious when they are designed for learning; the designers try to make them realistic as they want the players to learn. The entertainment purpose becomes a secondary concern although the anticipation of fun is what brings players to play those games in the first instance. While teaching using text books is efficient and can help pupils learn, it often does not lead to a deep understanding. Deep understanding takes time, reflection, and active engagements, which are strengths of video games (Bertacchini, Bilotta, Pantano, & Tavernise, 2012). An advantage of games is that they can have different skill levels so children can learn at their own pace, this is useful as it enables less able children to play at a lower level. Through playing at a lower level they can still learn without finding the work too difficult and once they are ready they can progress to a more challenging level.

Many serious games have assimilated game features into the constraints of the school day, becoming 20-minute activities with associated work sheets (Ott et al., 2011). Currently many games have the capability of short activity to get the children's brains working so that they are ready to start paper based work. However, for games to have better educational benefits, they should have more detailed information about the subject under consideration so that they can be the main teaching tool in the classroom instead of textbooks and worksheets. These games would require a larger budget and more development time, which will make them more beneficial for children's learning. Rather than an "all comprehensive" teaching tool, serious games look particularly suited as an instrument for motivating beginners to new topics and as a practicing tool to apply and test knowledge acquisition (Ott et al., 2011). This again shows that current serious games do not have the capability to replace a teacher in the classroom and they are additional tools, which introduce children to a new topic or to test them on current topics they have been studying.

Children are getting used to learning with computer technology earlier in their life, compared to 10 years age (Shields & Behrman, 2000). Targeting serious games at a younger age would be more suitable. Children are growing up with technology developing around them, so getting them involved with it at an early age will help them later in life. It is apparent that the delivery and organization of teaching material need to be changed to accommodate young learners and meet their expectations, the utilisation of games using Open Learning environments can provide the required solution (Yusoff, Crowder, Gilbert, & Wills, 2009), especially also by addressing the above-mentioned children's demand for having an additional tool for learning and testing at own pace, which can be accessed at any place and in any setting.

3.   Games in the context of open learning environment

In order to clarify the correlation between Open Learning and serious games, Open Learning has been prevalent in the realm of distance learning, particularly on platforms such as Open University and Coursera. However, unlike some of the pre-existing platforms, Open Education, which constitutes various forms of Open Learning, by its definition, should be open to all and free of charge to use. The key focuses of Open Learning are laid out by Lewis (1986). The author highlights the importance of the removal of barriers (geographical, financial, time requirements, disabilities). (Fasihuddin, Skinner, & Athauda, 2014) further reiterates the importance of providing the learning materials to anybody who is interested, without any learning prerequisites.

By addressing various learners and stakeholders in an Open Education context, the need for adaptive learning systems that have two key components, namely the identification agent, which is responsible for identifying the learners' learning styles, and the recommender agent, which is responsible of providing an adaptable navigational support based on the identified learning styles and references, increases. Against this background, the combination of serious gaming with Open Learning appears advantageous to improve the children's learning ability by facilitating adaptation to learning styles, on the one hand, and persistent and free educational support, on the other hand. In addition to that, the main point for serious gaming in this scenario is to offer an excellent environment with excitement and entertainment. The relevance that games can have to Open Learning are that an additional layer of interaction can be achieved between the children and the learning environment being able to add a scoring, or achievement based system (commonly found in games), to gauge learning progress and learning style.

In order to build an Open Learning environment with serious games, there are a number of researchers who have demonstrated a new hypothesis to see the effects of games on human brain. Research into the effects of computer games on human memory indicates that games are perceived by the brain to be an experience (Gee, 2008). Additionally, experiential memory has been found to be close to unlimited, meaning that content delivered through a gaming platform can be easily retained (if properly presented) and generalised. One of the key components for tapping into the experiential memory is creating a social scenario, where the user can face a problem in a collaborative environment, where differential approaches to solutions are encouraged and eventually filter into a definitive solution (Gee, 2008). A computer game would allow such a scenario to exist as well as providing a solid interface for analysing and reverse-engineering the mind of the learner and adapting the presentation of materials accordingly (Marfisi-Schottman, Labat, & Carron, 2013).

Further advantages of combining serious games with Open Learning concern building on the proper formation of hypotheses and problem solving abilities linked to experiential memory, which is, strongly developed in a gaming setting. Additionally, in a gaming setting, immediate feedback is given to the user so that they can recognise and asses their errors and re-evaluate their expectations. The learners are then able to apply their previous experiences to similar situations, so that they are able to properly "debug" their knowledge to form a more generalised approach, rather than applying them to specific scenarios.

Considering the above-explained advantages of serious gaming, the research goal is to provide an effective learning environment for children where they are involved with serious gaming (1) to learn from the interpreted experience in the purpose of building simulations in their minds, which permit them to prepare for immediate action to solve the problem faced in the real world; (2) to reflect on their learning strategy and (3) to

have a loop of decision-making evaluation by providing instant feedback (Alaswad & Nadolny, 2015). The implementation of a gaming based Open Learning environment would be crucial to the proper development of the desired skills expected from a system. With regard to developing the ability for the learners to learn from "interpreted experiences", they would be able to apply their knowledge in a social context, such as that of a multiplayer online game, with both their peers and experts in the field. The main objective behind this view on serious games for educational purposes is to share knowledge and experience with their peers and collaborators, and to benefit from the self-assessment in the Open Learning environment that evolves to a genuine platform for user generated experience, namely interpreted and shared experience.

The latter confirms the main characteristic of Open Learning systems that are built upon the premise that the learning resources are crowd-sourced and refined by many users. Courses can be designed from beginning to end by the users of the Open Learning system and refined by their user-base to offer accurate material as well as varying delivery methods (such as audio, imagery and text) (Fasihuddin, Skinner, & Athauda, 2014; Oblinger, 2001; Raykar et al., 2010). Eventually, the main goal of involving serious gaming for Open Learning is to offer direct experience to learners in association with increasing their learning ability, immediate feedback, excitement and entertainment.

4. Research methodology

Primary research and qualitative data were the chosen research methods in this case study for enhancing Open Learning based on serious gaming. This research aimed to investigate the theories of children's learning and the strategies that are used in order to maintain the attention of the children when learning their particular subjects. The theories into the way children learn have a huge importance as it is a necessity for educators to understand different strategies as not all children learn the same. By understanding this, the children can enjoy and can benefit from how the subject is being presented to them which can be in unique ways, so that they can remain focused, instead of becoming restless. In particular, this case study observed and evaluated what games and applications are already available online today that help children learn and the ways in which they are presented. The literature review shows the current contributions are still limited in providing effective learning techniques based on serious gaming. Currently, there are no studies that have been applied for a history subject aimed at a particular age range, between 7-8 years old.

4.1. Requirements analysis

In this research study, an Open Learning environment based on serious gaming was developed to provide children in primary schools with a new learning opportunity about Ancient Egyptians. The application was aimed at children aged 7 - 8 years in year 3 of a primary school in the United Kingdom. The driving force behind this study was to create an effective way to motivate and engage the children in the acquisition of learning subjects.

To set up the system requirements, it was important to put into consideration the theories of how children learn into account, and the teachers and the children's preferences in order to be able to create an all-round successful Open Learning environment that the children would find enjoyable but also educational and beneficial to their learning goals. In addition, interviews with the head teacher of the subject were

conducted to gain an understanding into what she would be looking for in the application to use in the formal lessons for the children, and also to provide the whole subject syllabus so that the correct and vital information for the subject could be included, in parallel with sections that were not taught. Finally, the knowledge level of the children about Ancient Egyptians was discussed. The teaching syllabus was used as a guide for the level of child's ability and what they should be taught corresponding to their age.

As a result of the pre-design development phase, there are four levels included within the application. When the children open the application, it displays a setting about the Ancient Egyptians including; each kingdom, information on the pharaohs, jobs in ancient Egyptian times, the geographical region and facts about Egypt. The application contains informative learning material that the children can study and subsequently be included in a quiz. In order to test the children about what they should have learnt, the application offers effective assessment techniques in each section. To provide appropriate steps, and thus, enable the children move from where they are to where they need to be, two types of test were incorporated so that the children were not only reading the information, but also were engaged and excited to move onto the quizzes, having read each section. By including quizzes, this encouraged the children to self-test their capabilities of studying and recalling in order to answer the questions correctly. The application also included a jigsaw puzzle that the children could construct a map of Egypt, which was not only fun and different from the quizzes that they played, but also focused on their cross curricula geography skills at the same time.

In order to design the application so that it is age appropriate and suits the needs of the children, observation techniques were used in the pre-design development phase to gain an understanding into the games and applications that the children used on a regular basis and the complexity of those applications. By observing the children, it was found that bright colours, easy and readable text features were used in similar educational games. The majority of games contained simple navigation that the children could use without any difficulty, a large range of images, graphics and animations were included to grasp the attention of the children.

Therefore, within the design of the application, these particular aspects were taken into account, so that the content was designed age appropriately, easy to understand and pleasant to read using clear fonts, suitable bright and vibrant colours as well as a range of images to allow the application to look interesting and child friendly. In regards to the navigational elements, the application was structured in a way so that the children can easily become familiar with navigational buttons and how to move around without any problems arising. Moreover, a very simple and consistent structure was created so that there were no problems for the children exploring the application. A range of different scenes were used throughout to give the application interest and appeal.

4.2. Iterative system development

To ensure an iterative system development, reinforcement learning and collecting feedback from the school were the techniques applied to enable the authors to interact with the school environment as well as gain valuable comments and suggestions from the teachers and pupils. In an interview with the teachers, they provided feedback into what sections looked suitable and what improvements could be incorporated to create a well-designed and effective system to be used for Open Education. When the children tested the final application, the feedback was obtained by a variety of methods: handing out questionnaires, conducting interviews and focus groups, in order to gain an understanding into what aspects they liked and what they would like to see improved in the future. This

combination of various assessment techniques helped realize which system features to play a role in recognising past experiences, interpreting and sharing experiences and gaining from instant feedback.

The questionnaires were included in order to gather first hand important information about the use of the application. Each child completed a questionnaire; the questionnaires focused on the children's impression. They were very similar to the layout of the quiz that the children were faced with in the application. Also, the teachers was given a questionnaire to elicit own opinions of how testing phase and application worked with the children.

In addition, a focus group was setup for the children user group, once they had completed their questionnaires. This approach was chosen to give the children a chance to talk face to face with the researchers, so that they could ask more in depth questions that were easier for the children to voice their answers, rather than write them down on a piece of paper. Moreover, a focus group approach did not appear as formal as an interview with each child would appear. By gathering all of the children together, they may discover reasons and further answers that they may not have concluded by themselves. When the children discussed their opinions, they enlarged the understanding and appreciation into what they liked, or what changes they would make, which gave more reasoning to their answers. The children and teachers were asked similar questions but in an age appropriate wording that would suit better with the children and also with the teacher. If there were chances to gain more of an understanding into an answer than had been given, the children or teachers were asked to elaborate and explain in more depth. This helped collect more knowledge into their feedback of the system.

This mix of focus group, interviews and questionnaires allowed for gathering an all-compassing range of answers and opinions from the children and teachers into what they liked and missed when using the application toward an Open Learning setting.

5.   Evaluation and discussion

The Ancient Egyptians application was designed and tested in the primary school with the children before making it available for an Open Learning environment. By attempting to be similar and yet striving to be unique to existing teaching history applications, the serious game aimed to grasp the attention of the children and engage them so that they enjoyed using it and that the children and the teachers as well as further stakeholders, such as parents and educators, would wish to continue to use it in the future in an Open Learning environment. Fig. 1 shows the welcome page of the serious game, while Fig. 2 demonstrates the complete information on the Ancient Egyptians subject that can be accessed by the users and explored for the full contents within the application.

The children were allowed to learn with the serious game through the various scenes referring to text to read and animations to understand more about Ancient Egyptians, which significantly enforced the curriculum study requirements. To test the learning outcomes and to check that the children have learned what is required, a scored quiz was performed as shown in Fig. 3.

The purpose of the Three Kingdoms' quiz was to allow the children to test their knowledge on the material offered in the game by learning in an enjoyable and engaging manner. Two different sets of quizzes could be completed. The quizzes aimed at keeping track of the scores clearly displayed in the particular passage so that the children would be able to learn what questions they answered correctly and what questions they did not,

and go back in the application and look for adequate information to answer the questions correctly in the future. The interactive jigsaw puzzle was to broaden the variety of games included within the application and capture the children's attention throughout. When testing the application in the primary school with the children, the class was divided into half. Half of the class used and tested the application for an Open Learning environment, whilst the remaining half worked in the classroom and were taught the content in a traditional manner. By doing so, this would enable the authors to still be able to use the results and gain an understanding into the knowledge of the children using the application and the children who learnt in the classroom. This was also to test whether the two groups of children learnt more or less than the other due to one group using an Open Learning approach, whilst the other group were learning with worksheets by a common approach. As described in the previous Section, the pupils using the application were given a questionnaire afterwards to complete, in order for the authors to understand their opinions of the learning environment, and they were also asked to take part in a focus group discussion.

Fig. 1. The learning application of ancient Egyptians

Fig. 2. Information range of the application

Fig. 3. The three Kingdoms' quiz page

To evaluate the system, two sets of questionnaires were utilised. The first set of questions was passed to the pupils, while the second set of questionnaires was given to teachers. The application was tested on the target audience in order to gain feedback and an understanding into whether the application was a success due to how well the children could use the application, whether it was enjoyable to use, educational and also age appropriate.
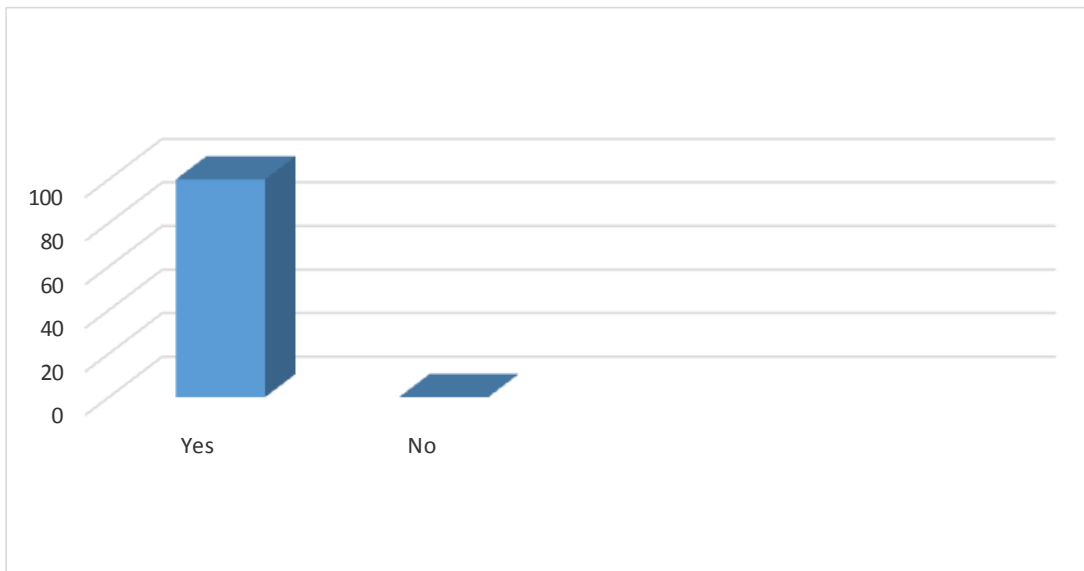

Fig. 4. Feedback from pupils regarding the enjoyment factor of playing the Ancient Egyptians game (%)

In an age appropriate manner, the pupils were asked four questions. Fig. 4 displays the positive results of the first question concerning how many pupils enjoyed learning using the Ancient Egyptians gaming application. As 100% of the pupils enjoyed

the game, this is the total confirmation of the main aim of a game following the original design proposal that demonstrates the key game's enjoyment factor.
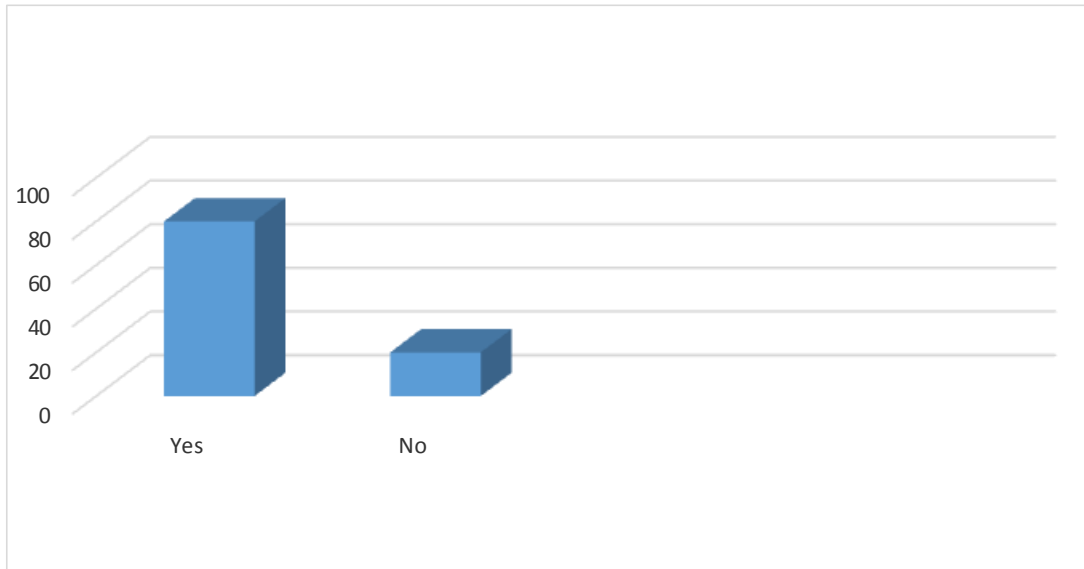

Fig. 5. Pupils' feedback regarding playing similar game (%)

Fig. 5 shows the results from the second question of the questionnaire given to the children related to the number of children having used before a game similar to the application they were testing. Over 80% of the responses were positive, which illustrates that the majority of the children have used educational games in the past, and consider the Ancient Egyptians application to be similar to the games available for this age today. With just under 20% of the children stating that they had never used a game similar to the application, in the focus group it came out that the children have not played any educational games in the past, or any ancient Egyptians games, or that they are not able to compare the games that they have played in the past to the Ancient Egyptians application.

The answer of this question is relevant to the application of games in an Open Learning environment that ensures a broad access to education, for every age. From researching what games the children used in their lessons, it was obvious that the Internet connection was quite poor in the school. Due to the fact that an Open Learning environment can be accessed from anywhere anytime, also mobile, the Internet connection in schools, which can become a problem in the children's school lessons can be reduced as a disturbing factor. By applying an Open Learning approach, stakeholders, teachers and children will be able to use their time more effectively gaining more understanding and knowledge in subjects when concentrating on the content instead on load time. This finding is demonstrated in Fig. 6 that summarizes the responses from the children who stated that they had used a similar game to the application, asked to indicate where they have used the game. Whereas 30% of the children stated that they have used a similar game at home, 50% of the children chose the option of 'somewhere else', which opens up the path for Open Learning and Open Education for this age. The interpretation of the results was refined in the focus group pointing out that the children have used serious games, for example an online or mobile application, in their friends or relatives houses, libraries or museums, or on the move. With 20% of the children replying that they had used a similar game in their school, shows that the school is willing to add

technology to the curriculum in order to aid the children's learning process. By understanding that over 80% of children had used a similar gaming application in various learning scenarios, such as home, mobile, school, etc., backs up the thesis that Open Learning is an approach to widening the learning and education opportunities for young children, and this is extensively supported by many stakeholders in this process, namely, parents, teachers, education managers, government, etc.
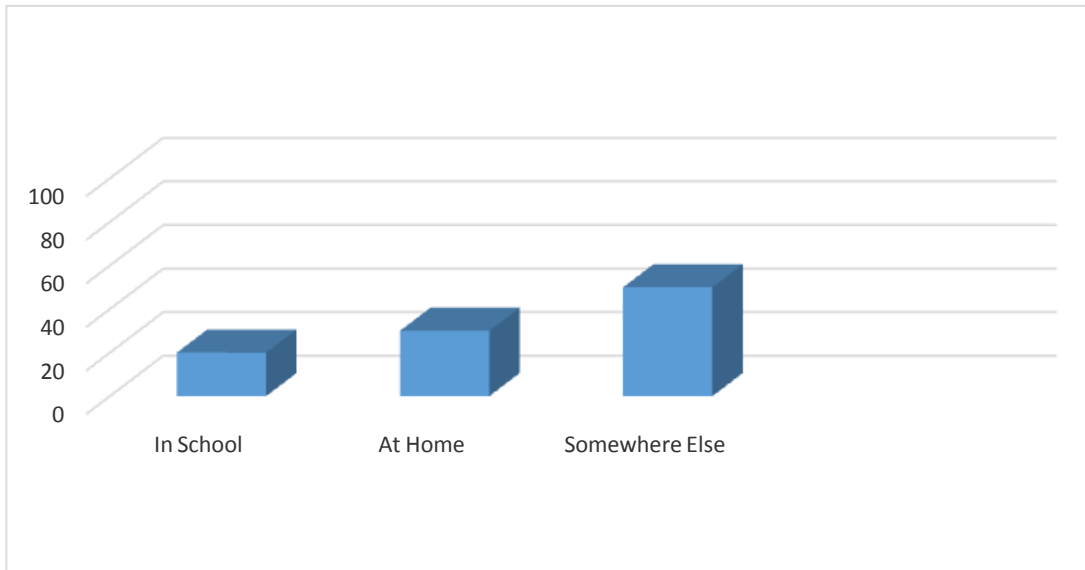
Fig. 6. Feedback from pupils regarding where did they learn with a similar game (%)

The case study results undoubtedly demonstrate that that children are enjoying using educational learning systems, especially serious games, in various learning settings. This development expands the education potential not only of the schools – the children are playing the games at home and in other environments preparing the ground for an all-encompassing Open Learning implementation. It lays out the basis for enhancing children's education in a contemporary manner facing the positive results of gaming implementation in education scenarios as presented in Section 3.

The third question of the questionnaire investigated the children's attitude whether those children who used the application would learn with the game again. Just over 80% of the children stated that they would like to use the game again, whilst just fewer than 20% of the children stated that they would not. With such a huge number of children expressing that they would use the application again, shows that they not only did enjoy using the application, but they would like to use it in the future. Summarizing, the application was a success with a large number of the target audience. The children who stated that they would not like to use the application again referred in the focus group to reasons that need further investigation with regard to psychology, iterative design, and learning theories, for example there is no need in repeating the quizzes and jigsaw puzzle games that they have only recently completed, or no need to further explore this subject matter.

The final question on the questionnaire asked the children to give the application a score consisting of choices including; very good, good, ok, bad and really bad. Just over 40% of the children chose the option of 'very good', whilst 25% of the children chose

'good' and just over 30% of the children chose 'ok'. This result illustrates that all of the children did value the application as no one child scored the system with the 'bad' or 'really bad' option. With the children who chose the 'very good' option, this indicates that they enjoyed the game and were pleased with what their task was for the session. The focus group revealed that this opinion was based on the opportunity to be allowed to work online or mobile instead of having to work in the classroom, and in addition the satisfying quality and the choice of the games that they were able to learn with to date. The children who chose the 'good' option expressed the opinion to having moved through the application quickly and found that the material was too easy, the whole application quite quick and simple to complete. Those children also have not enjoyed using quizzes as they preferred more action or interaction such as the jigsaw, yet there was one jigsaw and two quizzes implemented at this stage of research. The children who chose the 'ok' option have found that the application could be improved with advanced features, for example a scoring system tracking their score throughout the quizzes and providing more opportunities for shared experience.

From the feedback gained from the primary school teachers, it was found that the gameplay suited the targeted age range and children as young as 7 would also be able to play, enjoy and learn with the game. The focus group carried out with the children who used the application provided further insight into their views and opinions that they have not been able to express when filling out the questionnaire. For example, the authors asked to the group if the game helped them learn about the ancient Egyptians and if so, to name one thing that they learnt. The children were able to name particular facts that they learnt from the application. This fact confirms that they were paying attention and remembered some important parts of the passages included within the various game sections. It also demonstrates that the application was not only fun and engaging for them to use, but had also an educational outcome. Attention was drawn also to the question what the children enjoyed about using the application. The children were able to exactly explain what they enjoyed and why, which finally pointed out that they enjoyed different sections of the application.

By the children offering their feedback into what they disliked about the quiz, for example, their views can be taken into account for subsequent improvements within the application to better suit their needs and to make the application more of a success.

Evaluation results were also gathered by observation techniques, especially assisting in the lessons of the class. This particular research was conducted in order to gain an understanding into what games the children used in general, what games they enjoyed and how they interacted with the games. By observing the children in their lessons it confirmed whether computer games acted as a hindrance to their lesson time and education, or improved them substantially.

When looking at the results from the quizzes completed by the children who were using the application and the children who were using the traditional class methods, they all completed the questions and answered each question correctly. This finding is essential as it fosters the understanding that the children using the online and/or mobile Open Learning environments, engaged more into the tasks as they were able to navigate through the application and learn about the topic in an exciting and interactive way; the computer as a medium did not act as an hindrance to their work results. They also could study the passages and were able to easily return back to each section as well as investigate the correct answers to their questions. The children who were using the traditional class methods worked well and also completed the work, but were very keen in asking could they learn with the application next as they preferred this method of

engagement. In the beginning of the evaluation, when they were told that they would use only the common worksheets they were very disappointed. This is the evidence that the children are far more interested and excited in a subject when they have access to digital learning environments as they offer more interaction and entertainment to their lessons, as available in Open Learning scenarios.

6. Conclusion

This research sets up the basis for implementing educational games in Open Learning and Open Education settings increasing the effectiveness as well as learning values for children in a primary school. The case study described was evaluated in a school in the northwest area in the United Kingdom. Through a large pre-design and iterative design development phases in terms of user requirements, learning theories implications, and user feedback the authors were able to evaluate the serious game developed, and moreover, to determine the success factors with regard to future developments when using serious games for this age in Open Learning environments.

The main findings of the literature review referring to the advantages of serious games for early education presented in Section 3 were mapped on the current expectations about the effectiveness of the Open Learning approach. The evaluation results in this case study indicated that designing serious games for Open Learning can be such an effective way to motivate and engage children to achieve learning ability and goals. In this research, we implemented and tested a serious game for a specific age range of children, which were between 7-8 years old, to be offered in a generalized Open Learning setting for early education, combining the aspects of informal and formal learning in an engaging manner toward achieving maximum learning outcome in a particular subject. The research presented illustrated that this learning setting can assist children in their learning process by providing them with immediate feedback, learning motivation, excitement and entertainment.

Also, with over 80% of the children stating that they would use the application again in the future shows that they enjoyed using an interactive way of learning with no restrictions on time and connectivity options when learning about their history subject.

Therefore, further research studies are needed to expand the combination of serious games and Open Learning into multiple dimensions, such as for not only specific subject and age, for informal education, for enhanced reinforced learning and skills development in various ages, for sharing experiences and creating multifaceted feedback. Our future plans refer to creating an Open Learning environment in an adaptive way suitable for formal school education and allowing for different uses of this environment, such as revision, repetition, start a new area of interest or conclude an existing topic, so that the Open Learning environment becomes more broadly applicable for various user groups and goals.

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