

Healthy Kidney: An Educational Game for Health Awareness

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Abstract: The emergence of computer educational games in learning has a great impact mainly for adolescents. Educational games can be used to teach sensitive issue such as health well-being. In particular, many works point out the success of games in improving someone's knowledge in the medical field. This paper describes an educational game "Healthy Kidney" which aims to raise people's awareness about the prevention against chronic kidney disease. The developed educational game is validated by a classroom experiment in which 41 students from different educational levels were involved. Students were divided into two experiment groups who played two different versions of the game and one control group which underwent a traditional method of learning. Results show that students are more satisfied with the game and enjoy using it than learning by traditional methods.

Keywords: Educational game, kidney disease, awareness, prevention, adolescent

1. Introduction

Educational games are designed to simplify the learning of certain subjects. Hence, adopting educational games can be considered as a more attractive tool to combine the pleasant and the usefulness in order to facilitate the understanding of medical issues and to raise awareness toward diseases. The use of educational games helps in identifying diseases and its contributing factors and therefore deploys the prevention to follow in order to reduce the growing threat of diseases. This can also lead to improve health knowledge aiming at reducing and even avoiding the incidence of most illnesses. In particular, implementing game based learning in the medical field has been a subject of study in many works that they proved the success of games in raising the level of knowledge of the player (Goodman et al., 2006; Lieberman, 2001; Yoon & Godwin, 2007). Since most of the existing studies aim to convey information about the cure of a specific disease rather than its prevention, the lack of interest with conveying knowledge about prevention is noted. As stated by Webb and Litton (2017) that prevention is better than cure and that it is crucial to prevent one's self against a disease before being infected.

The World Health Organization (WHO) shed the light on the importance of prevention and considers that the prevention against chronic diseases is a vital investment which helps in saving the life of 36 millions of people over the next ten years. That's why it is crucial to establish a healthy society where essential general knowledge about health is widespread. For that reason, an educational 3D game called Healthy Kidney is developed with Unity. It is a single player game and has two main sides: learning and playing. This game is dedicated mainly for teenagers but it is helpful for people in all ages since having good health is the common interest of everyone regardless the age. The game is validated in a secondary school in order to check its effectiveness in improving one's knowledge.

The paper is structured as follow: Section 2 talks about the review of relevant literature and Section 3 explains the implementation of the game "Healthy Kidney". Section 4 presents the experiment and the validation of the game. Finally, Section 5 concludes the paper.

2. Literature Review

Health field is of paramount importance and games can represent an efficient option that can resort to it in this process especially for adolescences since they spend a lot of time playing. Adolescences can acquire useful information while playing. The spread of computer games among children and adolescents should be exploited by educational software to make learning more attractive and motivating (Virvou et al., 2005). Playing games is a crucial factor that contributes on the social and mental development (Amory et al., 1999). In the same way, Rieber (1996) confirms the need to play during childhood as well as the importance of using games as a powerful tool to build an interactive learning environment.

Many researchers have demonstrated the efficiency of educational games in the medical field. *Bronkie the bronchiasaurus* is an educational medical game which aims to teach asthma self-management (Lieberman, 2001). It consists of two asthmatic dinosaurs that the player has to control them in taking their medication and avoiding triggers. The player also has to answer questions about the respiratory system and basic asthma self-management and how to handle common social situations in asthma emergencies cases. *Sickle Cell Slime-O-Rama Game* is also one for cure purpose (Yoon & Godwin, 2007). It aims to improve children's knowledge and ability in self-management for the Sickle Cell disease. This game has been tested and the results show its great utility in fostering better self-management behaviors in children.

Re-mission is designed for people who have cancer and aims to provide them cancer-related knowledge (Tale et al., 2009). Through the body of patients affected by cancer, the players can discover symptoms, destroy cancer cell, stop the spread of the disease and manage treatment's negative effects. The game has also been evaluated and the results show its efficiency in the acquisition of cancer knowledge and the improvement of medication adherence. *Dance-Dance Revolution* also aims to teach about fitness and the way to burn calories for overweight people (Hoysniemi, 2006). This game promotes health by offering alternative modes of fitness and diet mode training since it instructs the player via onscreen movements that he or she has to follow and check how many calories are burnt while playing. On the other hand, *Squire's Quest!* is used for users to learn the basics of prevention against numerous illnesses (Baranowski et al., 2003). It aims to increase children's awareness about the importance of consuming fruits, vegetables and juice to prevent them from many illnesses such as cancer.

Most of the existing educational games evolve around cure rather than prevention although Webb and Litton (2017) state that prevention is better than cure and that it's crucial to prevent one's self against a disease before being infected. According to the World Health Organization¹, non-communicable diseases present a serious health issue that increasingly threatens the life of an appalling number of people. Among existent diseases, Chronic Kidney Disease (CKD) is chosen by the research team to implement a game to help people be aware of it and its prevention.

The proposed game should show the player what he or she has to do in order to protect himself or herself from becoming a victim of CKD. People have to be aware of the importance of their health and it's crucial to develop a self-care behavior. Although the game can be played by everyone, its major target is the adolescents since the prevention against chronic diseases should start from the early childhood in order to avoid them in adulthood (Curtis et al., 2011). Curtis and colleagues also discussed the limited ability of many adolescents to access preventive health programs.

3. Game Implementation

The implemented game, *Healthy Kidney*, aims to raise the awareness of its player on how to do in order to maintain healthy kidney. It makes players acquire more knowledge in an easier and faster way while playing. *Healthy Kidney* is a 3D game developed with Unity. When playing the game, the player has to control his or her avatar and follows the designated path in order to reach the destination. In the route, all objects on the way can be picked up. At the same time, he or she can see the changes of the avatar's health bar to know whether a pick-up object contributes in boosting the avatar's physical ability or

¹<http://www.who.int/mediacentre/factsheets/fs355/en/>

being harmful for the health. The knowledge displayed in the game are inspired from the research of Dirks and colleagues (2005) and from the French health care administration report² (i.e., HAS).

Adding a particular feature to a game can be considered as an efficient way aiming to facilitate knowledge transmission. For instance, Bouzid and colleagues (2016) develop an educational game for deaf and people who have difficulty in hearing to enhance their vocabulary acquisition of any written language. The game is specifically based on adding a new feature (i.e., a 3D virtual signer) to the memory match game. The 3D avatar is integrated in order to facilitate learning the sign language by rendering card's content in visual-gestural modality. The 3D avatar aims to simplify the understanding of sign language by all players. Adding animated avatars to educational contexts has great advantages. Many researches have proved the success of integrating a 3D avatar in motivating the player and increasing his or her attention as well as facilitating the displaying and the understanding of knowledge in sign language (Kipp et al., 2011; Jaballah & Jemni, 2013). Many features can be added to games either for promoting knowledge understanding or for testing its usefulness in educational contexts.

The research team agreed on testing the usefulness of adding the new feature (i.e., the prompt message mechanism) to the game in order to examine its effect in enhancing knowledge acquisition. Two versions of the game are developed. The first version doesn't prompt the health influence message about the objects on screen when the player picks them up and the second version does. The research team expects the message prompted could help players get clear idea of what they picked up and be aware of the positive or negative influence to their avatar's health. Figure 1 shows the two versions of the game.



Figure 1. Screenshot of the two versions of the game which doesn't prompt messages

Both versions of the game are designated to evaluate the hypothesis that the player may not pay attention to the objects that he or she is picking up. The player actually can pick them up unintentionally. Thus, the prompted messages is reminding what objects that he or she is just picking up. As shown in Figure 1(a), the health bar increases when the avatar picks up something beneficial to the kidney and the bar decreases when the avatar picks up something harmful; for instance, there is a bottle of water that the avatar can pick up and increase its health bar. Figure 1(b) shows the second version of the game which prompts the health influence messages. As we can see, there are some fruits in front of the avatar as well as a message that appeared when it has already picked a bottle of water. It is important to note that once an object is picked up by the avatar, it will immediately be disappeared.

4. Game Experimentation

The research team conducted a pilot experiment at a secondary school in Kairouan city, Tunisia. Two classes with 41 students from different educational levels were recruited in the experiment. Students were randomly divided into 3 groups: two experiment groups and one control group. Each one of the two experiment groups has 13 students and the control group has 15 students. Two different learning modes were adopted in this experiment: learning through playing game and learning through traditional method. Each of the experiment groups played one of the two versions of the game to assess the

² https://www.has-sante.fr/portail/upload/docs/application/pdf/2012-04/guide_parours_de_soins_mrc_web.pdf

effectiveness of the game and the proposed prompt message mechanism. The control group students were learning in traditional way.

This experiment included pre-test and post-test aiming to evaluate student's level of knowledge before and after using different methods of learning. The assessment questions cover the preventive measures against CKD (i.e., the necessity of drinking a lot of water). It aims to make player differentiate between the wrong and the right lifestyle in order to protect him/her health. These questions are formed based on the given recommendations for prevention against CKD in the research that Dirks and colleagues (2005) done and also from the French health care administration report² (i.e., HAS). The given pre-test was composed of 20 questions to test their knowledge about CKD.

After the public health issue was introduced and a quick explanation about it was made, all students were first asked to answer some assessment questions (i.e., pre-test) to check their prior knowledge about the prevention of CKD and to know their lifestyle. The research team then gave the control group students a text containing information about CKD and explaining the preventive measures to follow; asked students in the experiment group 1 to play the first version of the game which doesn't prompt messages; and, asked the students in the experiment group 2 to play the second version of the game which prompts messages. A post-test at the end of experiment took place to evaluate student's knowledge learned and the results were compared to evaluate the effectiveness of different learning methods. In order to verify whether or not a hypothesis is sustained, the research team analyzes students' performances of the pre-test and post-test as well as the difference between their pre- and post-test performances (i.e., learning gain).

The results of the post-test will make the research team know whether or not the game as well as the prompting message mechanism is useful. Our research team has the following two hypotheses:

- H1: The prompting message mechanism makes students learn better.
- H2: The games make students learn better

Table 1 summarizes the pre- and post-test results that the three groups have. From the pre-test average performances, we can tell that students in different groups have similar understanding level for the prior knowledge about the prevention of CKD. Therefore, their learning gains could help us verify the two hypotheses this research has.

Table 1: Pre- and post-test results.

	Pre-test	Post-test	Average difference
Experiment group 1	0.48	0.92	0.44
Experiment group 2	0.48	0.94	0.46
Control group	0.48	0.55	0.07

Results for the three groups are recapitulated. Different average learning gains between the three groups is noted. To verify whether or not this difference is significant, one-way ANOVA test is used. In Table 2, results of ANOVA test are listed.

Table 2: One-way ANOVA test outputs.

Source of Variation	SS	df	MS	F	<i>p</i> -value
Between groups	1.378	2	0.689	35.113	0.000*
Within groups	0.746	38	0.020		
Total	2.124	40			

*: $p < 0.001$

As the results listed in Table 2, the *p*-value is smaller than 0.001. In this case, it's proven that there are statistically significant results. Further independent t-tests are conducted to analyze data by comparing groups with each other in order to exactly find out which groups have significant differences in terms of students' average learning gains between each other and which ones have similar results. Students' average learning gains between the two experiment groups shows no significant difference. As the results listed in Table 3, the *p*-value is larger than 0.001. In this case the results did not show any significant difference in the average learning gain between the experiment groups 1 and 2. This proves

that the proposed prompting message mechanism is not so helpful as the research team thought since students in the experiment group 2 doesn't have significant difference in their average learning gain. Therefore, hypothesis H1 is rejected.

Table 3: t-test results of the comparison between between experiment groups 1 and 2.

		Descriptive statistics			t-test		
		N	Mean	SD	t	df	p
Learning gain	Experiment group 1	13	0.43	0.174	-0.361	24	0.722
	Experiment group 2	13	0.45	0.15			

The research team also used t-test to evaluate whether or not there is a significant difference in the average learning gain between the two experiment groups and the control group. As the results listed in Table 4, p value is smaller than 0.001. The result shows that there is a significant difference in the average learning gains between experiment group 1 and the control group students. Similarly the results listed in Table 5 show that there is a significant difference ($p < 0.001$) in the average learning gains between experiment group 2 and the control group students; therefore, H2 is supported and the game's effectiveness is proved.

Table 4: t-test results of the comparison between experiment group 1 and the control group.

		Descriptive statistics			t-test		
		N	Mean	SD	t	df	P
Learning gain	Experiment group 1	13	0.43	0.174	7.213	26	0.000*
	Control group	15	0.06	0.087			

*: $p < 0.001$

Table 5: t-test results of the comparison between experiment group 2 and the control group.

		Descriptive statistics			t-test		
		N	Mean	SD	t	df	P
Learning gain	Experiment group 2	13	0.45	0.15	8.557	26	0.000*
	Control group	15	0.06	0.087			

*: $p < 0.001$

Based on the experiment results, the major remarks to state are:

- The students in the two experiment groups had done a remarkable progress at the level of gaining knowledge compared to the control group students although they had all an approximate average understanding of the prior knowledge.
- Educational game is a more efficient and useful way than traditional methods while learning the knowledge of the prevention of CKD.
- The proposed prompting message mechanism is not so helpful in the game in this study.

5. Conclusion

The research team develops a Healthy Kidney game for adolescents to help them enhance their awareness toward the needed preventive measures against chronic kidney disease. This educational game is validated in a classroom with 41 students of different level of prior knowledge. A study is conducted and the collected data has been analyzed. Results show the effectiveness of adopting games as a learning tool compared to conventional methods of learning. It is also proved that the Healthy Kidney game succeeded in improving students' knowledge about the convenient preventive measures despite of the uselessness of the proposed prompting message mechanism. Since the impact of Healthy Kidney game on gaining knowledge has been verified, the follow-up research will focus on examining student's perception and level of satisfaction toward the game.

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