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Arithmetic Bird: a game for training mathematical operations

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Abstract

We present a game for training main mathematical operations for elementary school students, mainly for the third and fourth-grade. The learning mechanisms used in the game were included in the game mechanics. The target audience evaluated the game and the results were positive, both in the gameplay and in the learning. Three groups were used to evaluate the learning: one control group that did not play the game, another group that played it in the school and the third group that played at home. The last two groups were used to compare the use of the game in scholar and in the home contexts. The first group was used to compare to the groups that played the game. The results showed that the use of the game has a positive effect on the improvement of the mental calculus rapidness of the players. The statistical analysis of the data showed a significant reduction of the time from pre- to post-test and Cohen's d value was used to evaluate the magnitude of the effect for each group analysed. Besides, we also observed that playing the game at school or at home has similar results. Therefore, the game can be an effective educational tool for students and teachers.

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1. Introduction

With the growth of new technologies, the use of digital games has been increasing mainly for recreational purposes though. However, not all games have a single purpose entertainment and fun, some have other purposes such as teaching or coaching the players for real concrete situations (i.e., serious games). In this category, we can find the games for learning, which have as main goal to teach some contents to players in a fun way. Boyle et al. [1] present a literature review about the empirical evidence of the impacts and outcomes of computer games and serious games, where the learning games are half of the games identified in the study. Likewise, Wu and Wang [2] reviewed the scientific literature on the topics of a game development-based learning and their results suggest that it have many potential benefits as an aid to teach computer science, software engineering, art design, and other fields. Several approaches and studies can be found related to gamification in education (see [3] for details). For example, Laamarti, Eid, and Saddik [4] also presented a literature review from serious games in different applications areas, including the education area, while Ricciardi and Paolis [5] presented a review of serious games developed for health professions and related fields.

Several authors already shown the benefits of games in the learning process and All et al. [6] summarized the best practices to evaluate the effectiveness of digital game-based learning. They refer to the use of groups of control and a similar test pre- and post-intervention to evaluate the pre-existing differences and take pre-test scores, post-test scores, and a comparison of progress across groups into account. Also, Petri and Wangenheim [7] present the state of the art on how educational games are evaluated and the results are similar.

There is not a unique way to develop games for learning because they depend on several factors, as for example, the target audience, the game genre and the contents to teach. However, Barbosa et al. [8]

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presented a methodology to design and develop serious games, which is based on the concept of learning mechanisms that must be included in the game, either in storytelling, gameplay or mechanics, as also referred by Ke [9] when he identified the need to situate learning activities within the game story. Likewise, Offenholley [10] provided examples of both computer and non-computer games in mathematics, where she makes the distinction between intrinsic games, in which the concept being taught is an integral part of the game, and extrinsic games, which can be used for a variety of topics.

Shi and Shih [11] presented a game-based learning design model, where they identify eleven game factors to be into account in the creation of a game for learning. However, not all the factors identified can be present in a game, and this model not considers the learning contents.

The studies show that game-based learning has been used to teach a variety of subjects to children and young people in primary school with mathematics, science, language and social studies being the most popular [12, 13]. But there are other studies, for example to higher education to strengthen programming skills [14] or to supporting language learning [15], etc. Furthermore, Drummond and Sauer [16] analysed data from over 192,000 students in 22 countries involved in the 2009 Programme for International Student Assessment (PISA) to estimate the true effect size of the frequency of video game use on adolescent academic achievement in science, mathematics, and in reading. The results showed that video-gaming use had little impact on adolescent academic achievement, i.e., the differences in academic performance were negligible across the relative frequencies of video game use. Thus, in this paper, we will present a new game, called Arithmetic Bird, designed to helps kids to train the four main mathematical operations.

2. Related Work

In this section, we present a brief review of the games for learning mathematics since they have a positive effect on learning and students' memory, attention, and cognitive skills, as claimed by Digras and Pappas [17] in their paper about game-based learning for mathematics. Similarly, Abdullah et al. [18] evaluated the impact of video games on children's learning of mathematics. The results revealed that video games as a supplementary activity to classroom learning bring significant and positive effect on students retention as compared to students who rely only upon formal classroom instructions. However, Su-Ting et al. [19] developed a study to explore the potential use of digital games in learning mathematics at the secondary school level in Malaysia. Their results suggested that students like the use of computer games in learning mathematics, but the parents preferred conventional teaching approach, while the teachers did not go on to oppose the idea of using computer games for teaching mathematics. Thus, they suggest that the combination of classroom teaching and computer games might the best mathematics pedagogy.

Ke [9] presented a case study of computer gaming for math that targets 4th and 5th-grade students, within a series of web-based games developed by the Centre for Advanced Technologies for the Pennsylvania System of School Assessment. The results indicated there was no significant effect of computer gaming on students cognitive test performance, but the students developed more positive attitudes towards math learning after playing the game for five weeks.

Shin et al. [20] presented a study to evaluate the effects of game technology on elementary student learning in mathematics. They used a game called Skills Arena developed for GameBoyTM, which is more like a digital exercise book than a game. But the results revealed that using game technology in the classroom was beneficial to students of all levels in learning arithmetic skills. Besides, they identify some design principles to guide the development of game environments to support student learning, where one of those principles is repetition. Repetition allows learners to evaluate their performance based on trial-and-error strategies and encourages them to persist to complete the tasks.

Castellar et al. [21] presented a study comparing the effects of a math game and paper exercises and the children reported that playing the game was more enjoyable when compared with doing paper exercises. Additionally, most children who played the game reported that they would like to play it again in the future compared to the ones who did the exercises.

Ke [22] examined the potential of math game making activities in facilitating design-based math learning for school children. In their study, sixty-four middle school children participated in Scratch-based, math game making activities. The results indicated that participants developed more positive dispositions towards mathematics after computer game making. But also helped to activate children's reflection on everyday mathematical experiences. However, the tasks associated with the game design would suspend the student's interaction with the math content.

Kim and Chang [23] realised a study that examined the effects of playing computer games on the math achievement of 4th graders, with a special focus on gender and language minority groups in the USA. Their results showed that English-speaking students who played computer math games in school every day displayed significantly lower math achievement than those who never played. But positive effects of daily

computer use were noted amongst male students whose first language was other than English.

Recently, Derboven et al. [24] presented a study about playing educational math games at home. Children are increasingly encouraged to engage with learning content at home through educational games and most of the studies are done only in controlled school settings. They discovered that in the home context the respondents used various tactics to avoid educational content. However, this result may have been influenced by the game used, i.e. the Monkey Tales. In this game, the learning contents were put in a separate layer, which breaks the flow of the game (e.g., in the Bridge of Death, the player goes to another layer to solve a math exercise and then returns to the 3D game environment).

Shelton and Parlin [25] presented a study about teaching math to deaf/hard-of-hearing children using mobile games. In this study, they created six games based on the student and teacher perspectives taking into account the special needs of the target audience. They explain how teachers were utilised to help inform design and development decisions, contributing to the design and development of educational applications. A similar study was presented by Neves et al. [26]. This study is part of a project, called Educacaoacessivel.pt, that aims to contribute to improving the pedagogical resources with the production and distribution of free educational games for teaching mathematics to deaf students.

Also recently, Hieftje et al. [27] presented an evaluation of an educational game on mathematics for the first-grade students. In the study participated 134 students and the application/game used was "Knowledge Battle". Overall, the game did improve math skills in participants who played the game. Note that this application includes games in eight subject areas: math, science, geography, creativity, health, programming, sustainability, and language.

Taking into consideration the results of the studies mentioned above, we propose a new math game that includes the learning contents in the story and gameplay. Additionally, we evaluate its effectiveness in school and home contexts according to the best practices referenced in literature.

3. The Game – Arithmetic Bird

The design of this game took into account the type of games that the target audience usually plays (e.g., adventure and runner games), as well as being inspired by the popular Flappy Bird game (see Figure 1). Its visual was inspired by the short film of animation from Pixar- For the Birds [1].

[1] Pixar 2000 For The Birds, https://www.youtube.com/watch?v=AkFuvTHaMUE

Figure 1. Screenshot of the first level of the game.

The game developed is a runner where the player controls a bird and has to avoid enemies that can be other birds or land enemies. The player has to pick up items to progress in the game, which can be operations, operands, results or coins. In addition, the player has to keep the bird flying without letting it touch the ground or leave by the top, and for this, the player has to click on the screen to make the bird fly up, otherwise, it begins to descend. This mechanic of continuous action, although simple, as it is defended that should be the mechanics of educational games, causes that the player has to stay focused on the game to not lose. Note that this mechanic does not require too much time to the player because it involves only the coordination of hand-eye. Thus, in the remaining time, the player focuses on the logical reasoning for the mental calculation of the mathematical operations. Besides, the action of picking up items is the same for coins and for math operations, which means that the learning contents are inside the game and not posted in another layer. This way there isn't the break of game flow by the learning contents.

The main goal of the game is keeping the bird alive and pick up items to progress in levels. The progress is obtained every time that the player completes an operation successfully, which means that he must pick the operation, the operands and the correct result of the operation to advance in the level. If he does not pick the correct result he loses one life and he has only three lives available, as you can see in the bottom left corner of Figure 1. In case he loses the three lives, he loses and has to start the level again. Besides, the player can also pick up coins during the game (as you can see in the bottom right corner of Figure 1), which they can be used later to personalize the bird.

As shows Figure 2 the player already picked up the operation (sum) and the operands (six and three) and

Figure 2. Finishing an operation in the first level of the game.

Figure 3. The medals and levels of the game.

has now to pick up the correct result, which normally appears in a sequence with three options. Additionally, he must keep the bird inside the scenario and keep it alive by avoiding the enemies as shown in Figure 2.

The game is divided into four medals and each one into three levels, as shown in Figure 3. In the levels of the first and second medal, the operations that appear to the player are only the addition and subtraction, and the difference between the two medals is only the magnitude of the numbers that appear. The difference between the levels in each medal is the number of operations that the player needs to complete successfully. In the third medal appear the operations of division and multiplication and in the fourth and last medal appear all the operations (i.e. the addition, subtraction, division, and multiplication). When the player completes the level three of a medal he wins it.

Each medal is associated with a different scenario, in the first medal the scenario of the levels is the desert, in the second it is the mountains, in the third medal

Figure 4. The four scenarios of the game. (a) Scenario of the first medal. (b) Scenario of the second medal. (c) Scenario of the third medal. (d) Scenario of fourth medal.

Figure 5. Screenshots of feedback to the player. (a) When the player win. (b) When the player loses.

Figure 6. Menus of the game. (a) Main menu. (b) Score menu.

it?s the forest and in the last medal, the scenario is the beach, as shown in Figure 4.

When the player completes one level, he receives feedback about the number of correct and incorrect operations, as well as the number of coins earned and has the possibility to advance to the next level (see Figure 5-top). But if he loses the game he receives a similar feedback but has only the possibility to restart the level or return to the main menu (see Figure 5-bottom). Note that he loses if he does not give the correct answer to an operation, but also if he does not avoid the enemies or does not keep the bird flying in the scenario.

The main menu of the game has three options, apart from play and exit, that are the personalize, score and help menus (see Figure 6-top). The help menu presents to the player a detailed video tutorial about how to play the game. This tutorial is illustrated with screenshots of the game where a narrator explains the options available and the rules. In the score menu is presented detailed information about the results of the player. For example, it presents the number of playing sections, the number of times that the player won and lost, the number of operations that he did correctly and incorrectly, the number of coins earned, and the medals obtained (see Figure 6-bottom). This information gives us an overview of how the player/children use the game, which is important also to perceive the learning process with the game.

As referred above, the player can also pick up coins in the game, which they can be used to personalize the bird as shown in Figure 7. The main goal of this strategy is motivating the children to play more because usually, they like personalising their characters. Thus, if they play more, they will also learn more because one of the learning mechanisms is repetition.

4. Game Evaluation

In Portugal school curricula, the mathematical operations sum and subtraction are introduced in the second-grade, and the multiplication and division in the third-grade. Thus, was selected the third and fourth-grade students as the target audience of our game because

Figure 7. Personalize menu of the game.

they already learned the four math operations. Therefore, the evaluation study was conducted in a primary school with third and fourth-grade students. Thirty children participated in the study, where sixteen were male and fourteen were female, fifteen from the third grade and fifteen from the fourth grade. They were randomly divided into three groups, one group that played the game only at school (G1 - PGS), another group that played the game only at home (G2 - PGH) and the third group of control that did not play the game (G3 - NPG). Each one of these groups is composed of ten students, five from the third-grade and five from the fourth-grade.

The method used to evaluate the usefulness of the game in the learning process of mathematical operations was based on a pre-test and a post-test after the students played the game during a period of three weeks.

The pre-test and post-test consisted of a paper test with several math operations that the students had to do, where was annotated the number of correct answers and the time expended in the test. These tests were divided into three parts, the first part with summing operations only (fifteen operations), the second part with only subtracting operations (fifteen operations) and the third part with multiplication and division operations (twenty operations). This subdivision into parts follows the same strategy used in the game developed, i.e., the type of operations is different for each medal in the game.

The intervention with the game was divided into two groups, one that played only at the school, in sections of twenty-five minutes per day, and another that played the game only at home. For the group that played the game at home, it was asked to the parents that their children played also twenty-five minutes per day. But in this case, it was impossible to guarantee that they played also twenty-five minutes only.

To motivate the children, it was developed a leaderboard where it was annotated the results obtained by each student in the game. This strategy was a way to promote the competition between children and to motivate them to obtain better results in the game.

After three weeks of playing the game, based on the leaderboard, the top three received a certificate. Besides, all of those that participated in the study received also a certificate of participation. This simple procedure was very appreciated by the children.

4.1. Statistical Analysis

In this study, the intervention with the game was defined as the independent variable. The number of correct answers and the time to do the tests, pre-test, and post-test, were defined as dependent variables. The thirty participants (G1 to G3: $n = 30; 14f, 8.56 \pm 0.61$ years) were divided into three groups [G1: $n = 10; 5f, 8.6 \pm 0.4$ years. G2: $n = 10; 6f, 8.5 \pm 0.5$ years. G3: $n = 10; 3f, 8.6 \pm 0.4$ years.].

In our analysis, the paired samples t-test was used to compare each group, between pre- and post-test, at the dependent variables, after validating normality and homogeneity assumptions [28]. Note that a paired-samples t-test will tell us whether there is a statistically significant difference in the mean scores for time 1 (i.e. pre-test) and time 2 (post-test).

A preliminary analysis was made to ensure no violation of normality with Shapiro-Wilk [29] and Levene's test for equality of variances [28]. If a non-verification of normality occurs, the Equation 1 was used to analyse the symmetry [29].

$$| Skewness/StderrorSkewness | \leq 1.96 \qquad (1)$$

To evaluate the effect size, it was used the Cohen's d, which is defined as the difference between two means divided by the standard deviation for the data [30]. For the case of paired samples t-test, Cohen's d was executed as ES measure using the follow criteria: very small effect ($d < 0.01$), small effect ($0.01 \leq d < 0.20$), moderate effect ($0.20 \leq d < 0.50$), large effect ($0.50 \leq d < 0.80$), very large effect ($0.80 \leq d < 1.20$), and huge effect ($1.20 \leq d < 2.0$).

Data analysis was conducted using the IBM SPSS©(version 24.0) software for Microsoft Windows©, and a statistical significance of 5%($p < 0.05$) was defined.

5. Results and Discussion

Table 1 presents the descriptive analysis [mean (M) and standard deviation (SD) values in pre-test and post-test]

Table 1. Paired Samples Statistics - G1-PGS.

	Mean	Std. Dev.	Error Mean
Pair 1 pre_test	47.8500	1.52843	0.48333
Pair 1 pos_test	48.1000	1.59513	0.50442
Pair 2 pre_test	487.3880	198.63619	62.81428
Pair 2 pos_test	224.2040	37.70879	11.92457

Table 2. Paired Samples Statistics - G2-PGH.

	Mean	Std. Dev.	Error Mean
Pair 1 pre_test	43.0000	4.42217	1.39841
Pair 1 pos_test	46.2000	3.25918	1.03064
Pair 2 pre_test	375.3860	129.80676	41.04850
Pair 2 pos_test	234.3560	65.06565	20.57556

Table 3. Paired Samples Statistics - G3-NPG.

	Mean	Std. Dev.	Error Mean
Pair 1 pre_test	44.0000	4.10961	1.29957
Pair 1 pos_test	44.1000	3.63471	1.14940
Pair 2 pre_test	397.7080	152.93052	48.36088
Pair 2 pos_test	289.7050	135.00153	42.69123

for the group that played the game only at school (G1-PGS). Apart from these data, and also for this group, mean difference (MD) and p value are presented to verify, respectively, whether there is a loss or an increase of values, considering the dependent variables, and significant statistical differences as a result of the game use in the school for each dependent variable.

Considering the time variable there are significant statistical differences between pre- and post-test in the G1-PGS group, as confirmed by the p-value, which is equal to 0.001. Note that if the p-value is equal or less than .05 (e.g. .03, .01, .001), then there is a significant difference in the mean scores on the dependent variable for the pre-test and post-test. But if the value is above .05 (e.g. .06, .10), there is no significant difference between the dependent variable for the pre-test and post-test (for details see [28]). However, for the variable the number of correct answers, there is no significant difference between pre-test and post-test.

Table 2 presents the descriptive analysis [mean (M) and standard deviation (SD) values in pre-test and post-test] for the group that played the game only at home (G2-PGH). In this case, there are significant statistical differences between pre- and post-test for both dependent variables.

Table 3 presents the descriptive analysis [mean (M) and standard deviation (SD) values in pre-test and post-test] for the group that did not play the game (G3-NPG).

For the three groups, there are significant statistical differences between pre- and post-test related to the time variable [G1: $t(9) = 4.604; p = 0.001; d = 1.84$; huge effect. G2: $t(9) = 4.695; p = 0.001; d = 1.37$; very large effect. G3: $t(9) = 5.816; p0.001; d = 0.74$; large effect.]. But, as expected, in last group (i.e., G3-NPG), the effect is much inferior because the students did not play the game. However, the simple fact that they continued to learn in the classes contributed to their times reducing.

Table 4. Mean of the data recorded for 3rd and 4th-grade.

	3rd-grade	4th-grade
Number of times played	523.6	430.8
Number of times won	13.6	15.6
Number of times lost	510	415.6
Number of correct answers	266.6	298.7
Number of wrong answers	73.1	58.8
White Medal	1.3	1.2
Green Medal	0.9	1.2
Silver Medal	0.9	0.9
Gold Medal	0.1	0.3

Table 5. Mean of the data recorded for groups G1 and G2.

	3rd-grade	4th-grade
Number of times played	434.3	520.1
Number of times won	13	16.2
Number of times lost	421.3	504.3
Number of correct answers	282.4	282.9
Number of wrong answers	61.2	70.7
White Medal	1.3	1.2
Green Medal	1.1	1.0
Silver Medal	0.7	1.1
Gold Medal	0.2	0.2

Table4 presents the mean of the data recorded for the 3rd-grade and for the 4th-grade separately. As expected the 3rd-grade has more difficulties in mental calculus than the 4th-grade, and these difficulties can be viewed on the number of correct answers that is inferior to the 4th-grade, even playing more times.

Table 5 presents the mean of the data recorded for the two groups that played the game. The group G1-PGS played more times the game that the group G2-PGH, however, the number of correct answers is similar. This means that the performance of the G2-PGH was better than the group G1-PGS.

Figure 8 shows the percentages of correct answers divided by groups and grades, where is possible to observe that the students that played at home have an inferior percentage of correct answers. This fact may be explained taking into consideration that at home the students play more in a fun way. In school, the teacher supervised the playing sections.

As shows the Figure 9, the number of correct answers is almost constant during all the fifteen sections. In fact, the use of the game improved the mental calculus

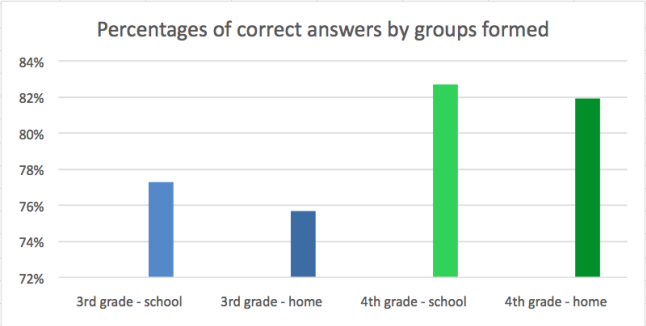

Figure 8. Evolution of the number of correct answers during the fifteen sections.

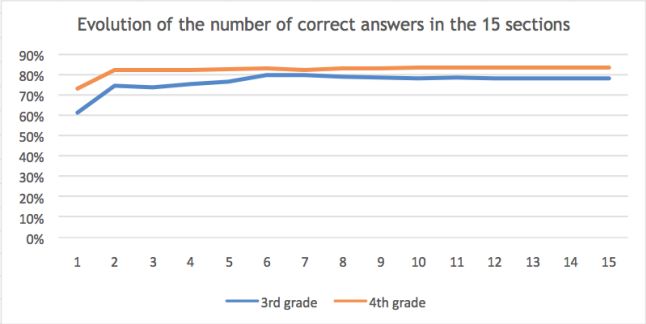

Figure 9. The graph with the percentages of correct answers divided by groups and grades.

efficiency, which was observed in the reduction of times from pre-test to post-test (as referred above).

6. Conclusions and Future Work

The design and development of games for learning must include the learning contents in the second plane because the game must be in the first plane. Thus, the learning contents must be included in the elements of the game, as mechanics, story or others. Taking into consideration these aspects, it was developed the game, arithmetic bird, to help students with mathematical operations and improve their mental calculus. Note that our game uses a continuous mechanics (i.e., the constant clicks to keep the bird flying), which makes the player to be focused on the game. In addition, the learning contents (i.e., the math operations) are included in the gameplay, i.e. they are not in the first place.

Our analysis of the game was very positive in terms of the reduction of the time needed to make mental calculus. Besides, we can conclude that playing the game at school or at home have similar results, which means that the game can be used as a learning tool at school but also as a learning game at home.

In short, it is possible to create games for learning if the learning contents do not take the first plane, otherwise, the students do not see it as a game, but as a learning tool that they do not want use again. But, if they see it as a game they will want to play several times, and in this case, they will learn, at least, by repetition process.

In the future, we hope to develop a new version of the game in the client/server architecture to allow the creation of the leader board to be automatic and also to share the ranking of the best players, for example, in social networks as a way to promote the competition between players.

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References

[1] Boyle E.A. and Hainey T. Connolly T.M. and Gray G. and Earp J. and Ott M. and Lim T. and Ninaus M. and Ribeiro C. and Pereira J. (2016) *An update to the systematic literature review of empirical evidence of the impacts and outcomes of computer games and serious games* (Computers & Education), vol. 94, pp. 178-192.

[2] Wu B. and Wang A.I.(2012) *A Guideline for Game Development-Based Learning: A Literature Review*, (International Journal of Computer Games Technology), Volume 2012, Article ID 103710, 20 pages.

[3] Information M.R.A. (2018) *Gamification in Education: Breakthroughs in Research and Practice* (Hershey, PA: IGI Global), pp. 1-677.

[4] Laamarti F. and Eid M. and Saddik A.E. (2014) *An Overview of Serious Games*, (International Journal of Computer Games Technology), Volume 2014, Article ID 358152, 15 pages.

[5] Ricciardi R. and Paolis L.T.D. and Saddik A.E. (2014) *A Comprehensive Review of Serious Games in Health Professions*, (International Journal of Computer Games Technology), Volume 2014, Article ID 787968, 11 pages.

[6] All A. and Castellar E.P.N. and Looy J.V. (2016) *Assessing the effectiveness of digital game-based learning: Best practices*, (Computers & Education), vol. 92-93, pp. 90-103.

[7] Petri G. and Wangenheim C.V.G. (2017) *How games for computing education are evaluated? A systematic literature review*, (Computers & Education), vol. 107, pp. 68-90.

[8] Barbosa A.F.S. and Pereira P.N.M. and Dias J.A.F.F. and Silva F.G.M.(2014) *A New Methodology of Design and Development of Serious Games*, (International Journal of Computer Games Technology), Volume 2014, Article ID 817167, 8 pages.

[9] Ke F. (2008) *A case study of computer gaming for math: Engaged learning from gameplay?*, (Computers & Education), vol. 51, pp. 1609?1620.
[10] Offenholley K.h:. (2012) *Gaming Your Mathematics Course: The Theory and Practice of Games for Learning*, (Journal of Humanistic Mathematics), vol. 2, No. 2, pp. 79-92.
[11] Shi Y.R. and Shih J.L. (2015) *Game Factors and Game-Based Learning Design Model*, (International Journal of Computer Games Technology), Volume 2015, Article ID 549684, 11 pages.
[12] Hainey T. and Connolly T.M. and Boyle E.A. and Wilson A. and Razak A. (2016) *A systematic literature review of games-based learning empirical evidence in primary education*, (Computers & Education), vol. 102, pp. 202-223.
[13] Alzahrani F. (2013) *Evaluation of videogames for mathematics education with young children*, (Proceeding of International Conference on Computer Applications Technology), pp. 1-4.
[14] Muratet M. and Torguet P.and Jessel J.P.and Viallet F. (2009) *Towards a Serious Game toHelp Students Learn Computer Programming*, (International Journal of Computer Games Technology), Volume 2009, Article ID 470590, 12 pages.
[15] Marciano J.N. and Miranda L.C.and Miranda E.E.C. (2014) *Evaluating Multiple Aspects of Educational Computer Games: Literature Review and Case Study*, (International Journal of Computer Games Technology), Volume 2014, Article ID 139205, 12 pages.
[16] Drummond A. and Sauer J. (2014) *Video-Games Do Not Negatively Impact Adolescent Academic Performance in Science, Mathematics or Reading*, (PLoS ONE), vol. 9, No. 4: e87943.
[17] Drigas A and Pappas M. (2015) *On line and other Game-Based Learning for Mathematics*, (International Journal of Online Engineering),Vol 11, No 4, pp. 62-67.
[18] Abdullah M.R.T.L. and Bakar Z.A.and Ali R.M. and Faye I. and Hasan H. (2012) *The Impact of Video Games in Children?s Learning of Mathematics*, (International Journal of Educational and Pedagogical Sciences), vol. 6, No. 4, pp. 607-613.
[19] Yong S.T. and Gates P.and Harrison I. (2016) *Digital games and learning mathematics: Student, teacher and parent perspectives*, (International Journal of Serious Games), vol. 3, No. 4, pp. 55-68.
[20] Shin N. and Sutherland L.M.and Norris C.A.and Soloway E. (2012) *Effects of game technology on elementary student learning in mathematics*, (British Journal of Educational Technology), vol. 43, No. 4, pp. 540-560.
[21] Castellar E.N. and All A.and Marez L. and Looy J.V. (2015) *Cognitive abilities, digital games and arithmetic performance enhancement: A study comparing the effects of a math game and paper exercises*, (Computers & Education), vol. 85, pp.123-133.
[22] Ke F. (2014) *An implementation of design-based learning through creating educational computer games: A case study on mathematics learning during design and computing*, (Computers & Education), vol. 73, pp. 26?39.
[23] Kim S. and Chang M.(2010) *Computer Games for the Math Achievement of Diverse Students*, (Educational Technology & Society), vol. 13, No. 3, pp. 224?232.
[24] Derboven J. and Zaman B.and Geerts D. and Grooff D.D. (2016) *Playing educational math games at home: The Monkey Tales case*, (Entertainment Computing), vol.16, pp. 1?14.
[25] Shelton B.E. and Parlin M.A. (2016) *Teaching Math to Deaf/Hard-of-Hearing (DHH) Children Using Mobile Games: Outcomes with Student and Teacher Perspectives*, (International Journal of Mobile and Blended Learning), vol. 8, No. 1, pp. 1-17.
[26] Neves J.C. and Nunes L. and Sousa C. (2016) *Educacaoacessivel.pt: A Case Study of Production and Application of Videogames for Teaching Mathematics to Deaf People*, (Proceedings of Play2Learn), pp. 136-156.
[27] Hieftje K. and Pendergrass T.and Kyriakides T.C. and Gilliam W. and Fiellin L. (2017) *An Evaluation of an Educational Video Game on Mathematics Achievement in First Grade Students*, (Technologies), vol. 5, No. 2, 30.
[28] Pallant J. (2011) *SPSS Survival Manual. A step by step guide to data analysis using SPSS*, (Open University Press), 4th ed.
[29] Ghasemi A. and Zahediasl S. (2012) *Normality tests for statistical analysis: a guide for non-statisticians*, (International Journal of Endocrinology and Metabolism), vol.10, No. 2, pp. 486.
[30] Coheni J. (1988) *Statistical Power Analysis for the Behavioral Sciences*, (Academic Press), 2nd ed.