Using Gamification to Teach Programming Concepts for Distance Learning Students (SUST) (Master Java Treasure Hunt Game as a model)

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ABSTRACT:
This study aimed at designing a gamification tool to help in learning programming concepts for Distance Learning Students at (SUST). The researchers used the descriptive-analytical method. The research sample was deliberately chosen, they were drawn exclusively from Distance Learning students of 1st year. The sample comprised of 50 students (40 males, 10 females) who learned Java programming for the first time. The research tool was Master Java Treasure Hunt Game(designed by researchers) and a questionnaire was designed to assess to what extent the gamification tool can motivate students to practice Java exercises and learn programming concepts. The results showed that students gain enjoyment and interest in playing games, playing activities can be used to teach programming concepts. Integrating gamification in the learning process increases students' motivation, excitement, and interest. On the light of the results, the researchers presented a number of recommendations most importantly are: the study should make use of technologically enhanced learning (TEL) in the game.
Keywords: Teaching programming language, distance learning students, motivation

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استخدام التلعيب في تدريس مفاهيم البرمجة لطلاب التعليم عن بعد (سست)
(ماستر جافا البحث عن الكنز كنموذج)

المستخلص:

هدفت هذه الدراسة إلى تصميم أداة تلعيب للمساعدة في تعلم مفاهيم البرمجة لطلاب التعلم عن بعد في جامعة السودان للعلوم والتكنولوجيا استخدم الباحثون المنهج الوصفي التحليلي. تم اختيار عينة البحث بالطريقة القصدية ، حيث تم اختيارهم بشكل حصري من طلاب التعليم عن بعد للعام الأول. تكونت العينة من 50 طالباً (40 ذكور ، 10 إناث) ممن تعلموا برمجة جافا لأول مرة ، وكانت أدوات البحث هي لعبة ماستر جافا للبحث عن الكنز (صممها الباحثون) ، وتم تصميم استبيان لتقييم مدى تحفيزاللعبة للطلاب على ممارسة تمارين جافا وتعلم مفاهيم البرمجة. أظهرت النتائج أن الطلاب يكتسبون المتعة والاهتمام بلعب الألعاب ، ويمكن استخدام أنشطة اللعب في عملية لتعليم مفاهيم البرمجة. إدخال التلعيب في عملية التعلم يزيد من الدافعية والإثارة والاهتمام. على ضوء النتائج قدم الباحثون عدد من التوصيات، كان من أهم التوصيات أن الدراسة يجب أن تستفيد من التعلم المعزز بالتكنولوجيا (TEL)في اللعبة.

الكلمات المفتاحية: تعليم لغات البرمجة,طلاب التعليم عن بعد, التحفيز

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Statement of the Study Problem
Introduction
Using gamification in education provides more fun and facilitates information keeping. There is a strong relationship between gamification and learning. Both of them are passive activity that require participants' motivation from the beginning to the end (Glover, 2013) . There is no difference between kids and adults. They both want to learn through fun. This study describes using gamification in teaching programming concepts to adults.

People have a strong desire for satisfying their needs; ranging from fundamental needs to the need for self-actualization as determined by the Maslow's hierarchy of needs. The goal of this theory is the attainment of individuals' needs for self-actualization, which means the desire for accomplishing everything that one can, to become the most that one can be (to be successful) (Tröndle, 2017). The term "gamification" is used for many years. But in the sense provided in this paper, it appeared in 2010.

Statement of the Study Problem
 The difficulties encountered in learning programming language are not a new phenomenon; they were discovered by researchers in (1980). According to (Sajaniemi, 2008) learning programming is not as easy as many students find, but it is a difficult task; so new methods and techniques are needed. This refers to many factors including crowded classes or a shortage of assistant lecturers in labs (Sajaniemi, 2005). Many skillful lecturers have migrated while remaining ones lack good skills in teaching or organizing course materials. Some students are not mature enough, that is, they tend to miss their lectures, labs and do not do home assignments and exercises, getting feedback from the lecturers. Some students may find learning programming language very difficult because they do not have the minimum required level of proficiency in the English language.

Moreover, some students find it difficult to understand programming concepts as they fail in the programming course for several times and some of them remain at the university for many years because they are unable to pass the programming course. The main problem can be attributed to understanding programming logic which is viewed by students as difficult and practicing exercises are boring. However, Guided practice problem solving is beneficial for Computer Science students; beginners need to see how experts solve problems and have a chance to try on their own. So we must find an attractive method to engage students in learning and understanding programming language.

Objectives of the Study
This study aims at:
1. Designing a gamification tool to help students in learning programming concepts.
2. Using game mechanics in a story to teach, encourage, and engage students in learning programming concepts.
3. Implementing the gamification tool to enable students to use it and conduct a survey benefit, interest student have got.

Hypotheses of the Study
The study hypotheses are:
H1: Students can gain enjoyment and interest in playing games.

H2: Playing activities can be integrated into a learning process so as to teach programming concepts.

H3: Involving a game in the learning process increases students' motivation, excitement and interest.

Limits of the Study

a-TimeLimits: December 2018

b- Spatial Limits: Sudan University of Science and Technology, Deanship of Distance Education, Department of Management Information Systems

c- Objectivity Limits: Define gamification positive effects on motivating adult learners/ students.

d- Humaneness Limits:

    1st-year students of Management Information System (MIS)

Terms used in the Study

In this section, the following basic terminologies of gamification are reviewed.

• Playing: it refers to do something in an informal way. The behavior is improvisational.

• Game: is to play formally where there are rules and objectives and goals. Moreover, there are challenges in interactivity and feedback.

• Gamification: is a mechanism that encourages people to do something. It is used to improve the quality of education. (Lee & College, 2014)

Theoretical Frame and Previous Studies

Theoretical Frame

Gamification in Education: Gamification means the use of game thinking, game elements, game technique, game methodology, and game framework in a non-game context in order to motivate users, solve problems, increase user experience, and encourage good desired behaviors (Duggal, 2014). Gamification is used in many fields such as marketing to encourage customers, and in employment to motivate employees (Domínguez, Saenz-de-navarrete, Fernández-sanz, & Pagés, 2013).

Before implementing gamification, educators used the educational game to teach and add knowledge by reaching game goal and objectives which are divided into levels. Players gain rewards that act as external motivator.

There are many games types used in learning such as Game-Based Learning (GBL) GBL is a type of game play that supports learning outcomes. And there is a different between gamification and GBL. Gamification is turning the learning process as a whole into a game, while GBL is using a game as part of the learning process. Gamification is used in all part of our life to increase fun and engagement but GBL is used just for education(Al-azawi, Al-faliti, & Al-blushi, 2016)

There is a strong relation between gamifcation and game so it is vitally important to discuss some of the game concepts; Game Mechanics: describes the rules of game and components of creating game dynamic. Examples of mechanics watch this video and get 8 points. Game Dynamics: describes the run-time behavior of the mechanics acting of the player over time such as appointment, status, progression, and reward.

Game Elements: These are components taken from games such as Missions, points, badges and leader boards. Aesthetics: describes the desirable emotional responses moved in the player when they interact. Some Aesthetics like narrative, challenge, fellowship, and challenge. Components: describes the elements or characteristics of the game to

create mechanics or to give feedback to the player. Some components like badges, points, achievements, leaderboard, levels and countdown.

Game mechanics or game techniques are used to build blocks of gamification application. Badges are one of gamification elements; it can be used for each assignment given to students. Each student accomplishes the assignment gets a badge. This idea came from the concepts of games. Some games have many badges awarded to the player after achieving a certain level or after finishing the certain task in the game. The player is happy by gaining this badge and he/she works hard to get it. Students will be strongly motivated to do their assignments to win the badges. Leaderboard, using this gamification mechanism in teaching students will stir up a competition between students in the class. Students work hard because everyone wants to see his/her name on the leaderboard. This method can be applied to encourage students to do their assignments quickly. Using points instead of grade has a better meaning. Points enable students to a positive flaw of marks. A teacher can give a student points for any task accomplished by him/ her. A gamifing point is more attractive than giving the student a grade.

Students Motivation

As gamification is used to motivate students to study, defining motivation and its types are very important. Researchers define that human behavior is determined by both types of motivation, extrinsic and intrinsic motivations. Intrinsic motivation is to engage in doing something by your own desire and for internal rewards. So, the enjoyment one gains comes from doing a task. In Extrinsic motivation, a person is motivated to do something because he/she will get an external reward or avoid punishment. Intrinsic motivation is better than extrinsic motivation. People of the first type work hard and are happier and more motivated. Motivation theorists say that extrinsic rewards reduce intrinsic motivation. This constitutes a serious problem because extrinsic incentives for performing a behavior or engaging in an activity are ineffective or they produce the opposite of the desired effect(Tröndle, 2017).

Related Previous Studies

Study of Fotaris and others (2016) titled: Climbing up the Leaderboard: An Empirical Study of Applying Gamification. The study aims at keeping students motivating and engaging during studying. Authors found that in traditional learning, it is difficult to motivate students and keep their focus more than ten minutes. But by using video games, the motivation will increase and learners spend many hours doing tasks and their information retention is increased. In this study, a classroom response system which is called "kahoot" is designed. Also, a version of the TV game show called "who wants to be a millionaire" is designed. Kahoot is applied to a group of traditional students who are learning the basic of python programming. A sample included a controlled class that consisted of 54 students (43 males, 11 females) who attended the Fundamental Software Development (FSD) course in the first year of the study, and experimental class 52 students (44 males, 8 females) who attended FSD in the second year. The participants' age ranged from 19 to 25 years. The researcher used an online survey and semi-structured interview to see the effect of gamification. The result showed that those students became more motivated and engaged in attending, downloading of course material, and had a good final result. The study recommended to add gamification to other subjects(Fotaris, Mastoras, Leinfellner, & Rosunally, 2016).

Study of Wilson and Others (2015) titled: Gamification challenges and a case study of online learning. In this case study of online learning, the authors mention that the gamification system provides extrinsic motivation for the students to accomplish the designated task. Their main goal is to reduce students' fairness when they are working in online team and to produce excellent projects which were developed by a group of 3-4 members. Using gamifiction offers the promise of better online experiences. The result was that those students participate, collaborate and develop effective online team skills. Future successes in this area will come from careful planning and design (Wilson, Calongne, Henderson, & Henderson, 2015)

Study of Li and others (2013) titled: Engaging Computer Science Students through Gamification in an Online Social Network Based Collaborative Learning Environment. The study aimed at improving students motivation in learning through the building of supportive peer networks.

The study was conducted using the mixed-method sequential explanatory protocol. A gamification framework was prepared to enable students to ask questions and learn subjects related to C programming language using basic elements of game mechanics. The result showed that most students continued working even after earning the maximum amount of grade points to collect all the badges and to keep learning. The author mentioned that gamification was successful and engagement was a valuable indicator of students' academic achievements(Li, Dong, Untch, & Chasteen, 2013).

Study procedure

Study Method: The researchers used the descriptive method.

Sample: The research sample was selected purposively. They were selected from distance learning students in their first year (40 males, 10 females) that learned programming Java for the first time. Students, in order to use the tool, must have smart phones connected with an internet. Moreover, they use what Sapp to facilitate the process of the interaction with an instructor and colleagues.

 Data Collection Tool: This study tackled the problems encountered by students when learning programming by developing a Master Java game which is a web-based application using gamification to teach students programming concepts. A model of gamification was designed with the intent to motivate students. A presentation was done at the College of Computer Science at Sudan University of Science and Technology to assess Master Java as a gamification tool.

Figure1: the main screen in master Java shown to the students, the diamond he/she can win to get the treasure and all important information like points, his/her level in the game, assignment to be solved.

After that, a questionnaire was designed to assess the effect of the tool. The questionnaire was presented to a number of experts to make sure whether it is valid or not. After finishing the game, students answered a questionnaire and their log data. The distributed questionnaire in Arabic was translated into English for the benefit of non-English users.

Gamification Elements Used

Points

Points are important elements of gamification. About 57% of empirical researches of gamifcation use points. Using points motivates students, especially when combined with other elements of gamification. Points have many uses, such as awarding points to complete a task, answering quizzes and assignments, attending lectures, solving puzzles and taking part in-class exercises. Awarding points will increase students' intrinsic motivation, although not all researches report a positive relationship between points, students' motivation and, performance (Barata, Gama, Jorge, & Gonçalves, 2013). In Master Java, points are used in case of answering any question as correct.

Levels

To make gamification successful, appropriate progress and sequence should be observed to content and activities in a manner that makes a learner not frustrated and have an appropriate level of challenge. So the game was divided into small accessible pieces, moving up to the next level provides feedback and encouragement to the learner. That it is a motivator of continued efforts (Mullai & Jebanesan, 2007). In master Java used levels to rank the students according to their points, also the game was leveled from the first topic to the sixth topic according to the syllabus.

Badges / Achievements

They are symbolic rewards given to students who have accomplishing a certain task. Some researchers found out that there were no impact or negative effects of using badges and achievements among students at post-secondary level(Abramovich, Schunn, & Higashi, 2013). In master Java, diamond are used as badges to encourage students to win the treasure.

Statistics Used

The study used the descriptive statistical method including frequency and percentage. A number of phrases related to the subject of the study were also reviewed; all these words are descriptive questions. To find out the weighted arithmetic means, weight was assigned to each answer as follows:

The respondents' answers (yes) were given the number "2"

The respondents' answers (no) were given the number "1"

Results and Discussion

The researchers come up with the results based on hypotheses of the study:

Hypothesis (1): Students can gain enjoyment and interest in playing games.

After tabulating and analyzing the data of the first hypothesis the result is shown as in Table No (1)

Table (1) shows the sample's responses to the above-mentioned hypothesis as expressed by the frequency and percentages of the participants' responses to the table items.

Form the above table, we find out that the percentage of those who agree to the statement "Do you always like to play games using your mobile" is 90% and who disagree is 10%.

And the percentage of those who agree to the statement "Do you like treasure hunt game and always play it" is 70% and disagree is 30%.

Table (1): answers to the study sample for the statements of hypothesis one.

No	Statements	Yes		NO	
		frequency	Percentage%	frequency	Percentage%
1	Do you always like to play games by using your mobile?	45	%90.0	5	%10.0
2	Do you like treasure hunt game and always play it?	35	%70.0	15	%30.0
	Hypothesis Percentage	-	%80.0	-	%20.0

The total of those who agree with all statements of the hypothesis is 80% and those who disagree are 20%. Accordingly, we can say that this hypothesis has been accepted: Students can gain enjoyment and interest in playing games.

The researcher confirms that this result is reasonable that people like to play games because it make they feel relax, reduces stress and games are source of entertainment for all of us. Also winning the game gives us a feeling of achievement.

Hypothesis (2): playing activities can be integrated in a learning process to teach students.

After tabulating and analyzing the data of the second hypothesis, the result shown as in Table (2)

Table (2): shows the responses of the sample to the above-mentioned hypothesis as expressed by the frequency and percentages of the participants' responses to the table items.

No	Statements	Yes		No	
		frequency	Percentage%	frequency	Percentage%
1	I think play is a good method for studying	50	%100.0	0	%0.0
2	Gmaification motivates the student to participate	45	%90.0	5	%10.0
3	Every player did his best to be a boardleader	45	%90.0	5	%10.0
4	I did my best to win a diamond and then treasure	35	%70.0	15	%30.0
5	I felt that time passed quickly during the game	50	%100.0	0	%0.0
6	I have finished master java treasure hunt	50	%100.0	0	%0.0
	Hypothesis Percentage		%91.7		%8.3

From the above table the result shows that half of the statements gained a full approval as shown in statement No (1, 5, 6). The percentage of those who agree to the statement No (2, 3) is 90% and those who disagree is 10%. And the percentage of those who agree to the statement No (4) is 70% and those who disagree is 30%. The total of those who agree with all statements of the hypothesis is 91.7% and who disagree is 8.3%. Accordingly, we can say that this hypothesis has been accepted: playing activities can be integrated in a learning process to teach students.

This result agrees to the study of (Fotaris et al., 2016) a class room response to a system which is called "Kahoot" was designed to teach students. Also study of (Wilson et al., 2015) agrees using gamification in education. Authors mentioned that students participate, collaborate, and develop effective online team skills.

The researchers justify this result is reasonable that: playing and learning are similar, both of them are passive activity that required participants' motivation from the beginning up to the end.

Hypothesis (3): Integrating a play in the learning process increases students' motivation, excitation, and interest.

After tabulating and analyzing the data of the third hypothesis the result shown as in Table (3)

Table (3): shows the responses of the study sample to the above-mentioned hypothesis as expressed by the frequency and percentages of responses to the table items.

No	Statements	Yes		No	
		frequency	Percentage%	frequency	percentage%
1	The time passed quickly during the game	40	%80.0	10	%20.0
2	I was worried during the game	35	%70.0	15	%30.0
3	I felt excited during the game	40	%90.0	10	%10.0
4	I believed that gaming is a valuable use of instructional time	50	%100.0	0	%0.0
	Hypothesis Percentage	-	%75.0	-	%25.0

Form the above table, we find that the percentage of those who agree to the statement " The time passed quickly during the game" is 80% and who disagree is 20%,the percentage of those who agree to the statement " I was worried during the game " is 70% and who disagree is 30%. And the percentage of those who agree to the statement "I felt excited during the game" is 90% and who disagree is 10%. Finally all students agreed to the statement "I believed that gaming is a valuable use of instructional time". The total of those who agree with all statements of the hypothesis is 75% and who disagree is 25%. Accordingly, we can say that this hypothesis has been accepted: Integrating a play in a learning process increases students' motivation, excitation, and interest.

This result confirms the study of (Delgado-kloos & Member, 2014) in this paper gamification is used to engage Computer Science students.

The researchers justify that this result is reasonable that: instructors should try to think outside the box and devise a plan or a method that is fit to the purpose.

Conclusions and Recommendations

Conclusions

- Students can gain enjoyment and interest in playing games.
- Playing activities can be integrated in a learning process to teach students.
- Integrating a play in a learning process increases students' motivation, excitation and interest.

Recommendations

- Further studies should make use of Technology Enhanced Learning (TEL). The environment of TEL has various tools, such as automated assessment and visualization.
- This will make Master-Java more attractive and has a sense of the game, allowing students to play the game and get feedback immediately without waiting for a teacher to inform that getting the diamond or reaching the next level. All those are done automatically.

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