Chapter 3

Learning Linear Algebra through Storytelling Gamification Strategy

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ABSTRACT

Initiatives have been taken to utilize gamification for Mathematic subject in teaching and learning purposes using a storytelling gamification strategy. The focus was on students at Polytechnics who studied Algebra Linear, in Electrical Engineering and in Mechanical Engineering. Algebra Linear involves two topics; Matrix and Numerical Method. The development of this gamification application prototype focuses on the counting of ‘Inverse’, ‘Cramer's Rule’, ‘Gauss Elimination’, ‘Lower Upper Doolittle’ and ‘Lower Upper Crout’. This application is designed to improve the teaching and learning process to be more interesting and effective by expanding the use of Linear Algebra Simultaneous Equations in daily life. It is also to change students perceptions on Mathematics subject that are often felt to be difficult, unattractive and less motivated to learn. In addition, students often experience carelessness and lack of confidence in learning Mathematics subject especially for topics involving long calculations. The development process of this gamification application involves three main phases, namely; ‘Pedagogy’, ‘Design’ and ‘Achievement’. Each of these phases can be solved in several processes for the development of gamification development. ‘Pedagogy’ phase can be divided into; identifying the curriculum, gamification goals, students’ existing skills and the enhancement of student knowledge. ‘Design' phase
can be divided into the process of gamification design, assignment and interface. ‘Evaluation’ phase can be divided into five gamification elements which is student experience, system mechanics, rewards, goals and social. With the development of the Linear Algebra Gamification Application prototype, it is hoped that the use of learning based can be extended to a variety of subjects as well as topics to make the learning process more interesting and fun as well as helping to motivate students to learn.

**Key Words:** Mathematics, Polytechnics, students, interesting, motivate.

1. INTRODUCTION

The topic of Algebra is considered difficult by students even though it has been learned since secondary school. Algebra is a Mathematical expression that combines one or more numbers as well as Mathematical symbols (Yew, 2009). The basics of using Algebra are taught to students in Form One such as Introduction to Variables, Algebraic Expressions and Use of Arithmetic. While in Form Five, students were exposed to Algebra more thoroughly by learning pronunciation with two Variables, Concepts and Calculations, Multiplication and Distribution Operations. Linear Algebra is one of the subdivisions of Algebra, where students have learned its use in Form Five for Matrix and Vector topics. According to Taleb et al. (2015), learning Mathematics (Maths) using the smartphone method can positively impact students and enhance students’ motivation. In addition, the gamification learning method is very synonymous with students. Students love gamification because it is fun and motivating for learning (Alsawaier, 2018). At the same time, students have a weak mastery of basic Algebra and students also have difficulty solving questions related to Expansion and Factorization (Shankar, 2015). Therefore, it is very appropriate to develop Mathematical gamification for Algebra topics to stimulate students’ interest in learning Algebra topics by providing gameplay with various levels of difficulty and variety of tasks as it is compatible with the students’ ability and understanding.

2. IMPORTANCE OF RESEARCH

Interesting and fun learning using a gamification strategy enables student engagement to stay focused on the learning delivered by educators. This in turn helps improve student achievement and skills when the learning objectives set by the educator are achieved successfully. Learning to use gamification strategies will indirectly promote thinking skills among students (Yue and Ying, 2017). In addition, students will master the skills of counting, communication and problem solving. Student-centered learning enables educators to act as facilitators for students. Educators are responsible for organizing activities that will be creatively designed to ensure that the learning objectives that have been set are achieved at the end of the Teaching and Learning session. Learning to use
gamification strategies is one of the approaches for student-centered learning. Gamification strategies can encourage students to be active, increase their self-confidence and increase their motivation for learning to complete the activities provided by educators (Johanna and Güll, 2015).

Referring to the statement by Oliver (2017), learning using gamification strategies can attract students to learn and love Math subjects. Learning gamification can have a positive impact and enhance student achievement. As students’ interests, motivations, confidence and achievement increase, this will further enhance their Maths as well as other subjects. HEIs can also play a role by encouraging educators to be more creative in the classroom and to give exposure to 21st century learning methods. This study aims to benefit students, faculty and HEIs. It also improves students’ thinking skills, enhances student academic achievement and at the same time helps prepares students for future work challenges. HEIs, educators and students need to work together to achieve their goals for the benefit of all.

3. STORYTELLING STRATEGY

Storytelling is a traditional method that is unfamiliar to our everyday lives as humans use storytelling approaches to tell stories before humans are good at reading and writing. Storytelling is meant to tell something or to tell a story or example from one generation to the next. Storytelling can be defined as a technique for communicating stories using a variety of media, to convey similarities and differences in terms of ethnicity, values, and cultural norms more effectively (Walter et al., 2017). Storytelling can also be used to convey events in the form of words, sounds or images used as entertainment, education, cultural preservation and tools for instilling moral values (Giankalaras, 2016).

Today, the method of storytelling has evolved with the digital storytelling approach. There are several media that can be used for the transmission of digital storytelling such as using video, animation, audio only in the form of electronic files, disks or tape (Giankalaras, 2016). In addition, digital storytelling has also been adapted in various applications including gamification. According to Miller (2014), there are several special features for digital storytelling use:

i. Narrative type: it involves a series of related dramatic events that serve to tell the story.
ii. Character: a character controlled by a user or by a computer, or with the help of artificial intelligence
iii. Interactive: the user determines the aspect of the illusion and the effect.
iv. Non-linear: events or scenes do not occur in a fixed sequence, characters are not found at fixed points.
v. Very deep: they draw users into the story.
vi. Participation: users participate in storytelling.
vii. Note: users can create their own storyline through a story or through a virtual environment.
Storytelling is one of the approaches outlined for the success of gamification in education by Stott and Neustaedter (2013), because gamification provides the freedom to fail, fast feedback and progress in learning. Giankalaras (2016), said that storytelling will help to make one unique gamification than others as it has its own goals and storyline. For example by breaking down the learning goals into smaller goals by rewarding gamification as an incentive to complete a given task.

4. METHODOLOGY

The methodological study used in this study is an adaptation of Safitri et al., (2016). The models used are the Three-Stage Thinking Model, in which the model links 'Pedagogical Phase', 'Design Phase' and 'Test Phase'. In the 'Phase Pedagogy' a few things will be considered such as 'Curriculum Goals' to achieve, 'Gamification Goals' to be achieved, 'Existing Skills' students and 'Knowledge Improvement' students. Once all the processes in the 'Pedagogical Phase' have been completed and completed, the 'Design Phase' should be implemented. In the 'Design phases' the emphasis is on 'Gamification Style Design', 'Gamification Task Design' and 'Gamification Interface Design'. After completing all the processes for the 'Design Phase', the next 'Test Phase' can be implemented by which this phase is divided into two stages namely 'Pilot Study' and 'Final Test'. The process of evaluating the performance and effectiveness of the prototype has been developed in terms of 'Experience Factors', 'Mechanical Systems', 'Rewards', 'Goals' and 'Social'. Methodological studies are as shown in Figure 1.
5. DEVELOPMENT OF LINEAR ALGEBRA APPLICATION SIMULATION PROTOTYPE

In order for the development of Linear Algebra Gamification Applications to be developed using storytelling strategies, preliminary planning is required to use storyboards using Power Point software. Storyboarding is the first step taken before the interface development process. The storyboard view of the prototype Linear Algebra Application is like Figure 2.

Figure 2 shows how the story presented in the prototype application of Linear Algebra Application is to create a situation where there is a search process for the King and Consort of the Linear Algebra Kingdom. Prototype allows students to choose the character they want to be the King or Queen. Gamification requires students to study and solve questions for Linear Algebra using Inverse calculation method, Cramer’s Rule, Gauss Elimination, LU Doolittle and LU Crout. Each calculation method is given different situations such as controlling traffic in the roundabout, combining content for generating fire, transmission and receiving computer data, power supply flow for three-light circuits (blue, red and green) and airflow processes in in a vehicle engine. When students complete all the tasks, they will be categorized as Kings or Queens eligible for the Linear Algebra Kingdom or vice versa.
Figure 3 shows a storyboard for the prototype Linear Algebra Application. There are five methods of computing Linear Algebraic equations using Inverse, Cramer’s Rule, Gaussian Elimination, LU Crout and LU Doolitte. In addition, five scenarios for the use of Linear Algebraic equations in everyday life are used to manage traffic in the circle, combining content for generating fire, transmitting and receiving data for networks, electric distribution for a circuit with three different bulbs and air distribution to enable a working engine.

Using different scenarios for each method of calculation can give students exposure to how they can apply Numerical Methods in their daily lives. This also helps students to be more creative in solving their problems by applying Linear Algebra they have learned.

6. CONCLUSION

The problem that led to the study was that Maths subjects were not considered interesting. By developing the application of Linear Algebra gamification applications using storytelling strategies using a concept or theory framework, by implementing Pedagogical Phase, Design Phase and Testing phase to develop prototype Linear Algebra Application. The use of this prototype not only helps to increase student engagement in learning Linear Algebra topics, but it also enhances students' understanding, motivation and enjoyment of learning Linear Algebra topics. In addition, this prototype can also be used as a teaching aid by applying gamification in the classroom or as a review material for students before or after class to boost student understanding and efficiency. For further research, there are several things that can be done to improve in terms of content, development, testing and analysis.
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