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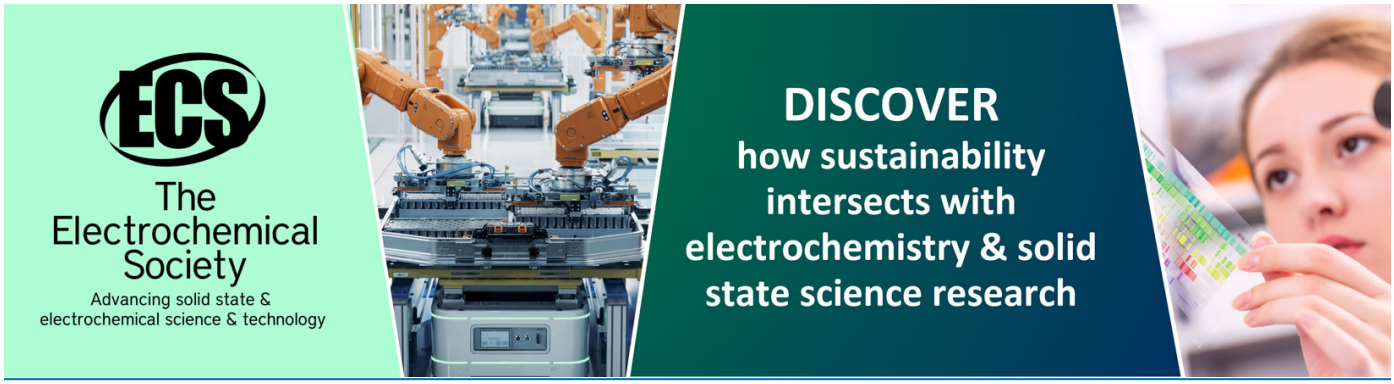

Exploring constructivism learning theory using mobile game

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Abstract. Experience as our way of constructing our understanding of the world we live in is what constructivism theory advocates. In this study, the Decimal FunPro, a mobile game application which is designed to learn number systems was used to explore the occurrence of constructivist learning theory by employing clustering algorithm on the dataset by means of RapidMiner instrument. The performance of the students in using the mobile game shows that during the first tries from the different game categories, students spent more time finishing the activity as compared to the other trials. This means that the students learned from the first trials. A t-test was also conducted to define the significant transformation between the post-test and pre-test. The result showed that there is a significant difference between the posttest as well as the pre-test signifying that students acquired knowledge in number systems when they used the mobile game application. With the evidence stated, it can be concluded that using the Decimal FunPro mobile game application reveals that students can build new knowledge based on prior experience.

1. Introduction

Academic interest evolved and is being adopted today in different approaches. With the escalating demand for high quality education and the emergence of smart mobile phones technologies, educational institutions are taking other forms of learning. Laptops, personal digital assistants, and mobile devices are becoming learning instruments posting great help inside the classes [1].

On the other hand, a clear learning theory improves significance to lesson study, as the different theories of learning serve as foundation in managing values for the teachers when employing academic plans, lesson studies, and assessments [2]. Playing with a yo-yo in the years before the digital age is like observing a youngster with a smartphone in their hand nowadays [3]. Behaviorist, constructivist, positioned, combined, relaxed and enduring learning, and learning and teaching sustenance have momentarily recognized six main theories and ranges of knowledge related to learning with portable technologies [4][5]. Students are stimulated to be dynamic builders of information when students with difficulties are encouraged to be answered to some extent than bringing them straight information. Empowering the learners to be rooted in the good framework over mobile devices and offer them with quick assistant [6] can improve learning.

As mobile technologies are becoming more persistent, the greatest challenge is to determine how to use mobile technologies to transform learning into a continuous component of daily life to the point where it is not recognized as learning at all[7]. One good example of this is the use of a mobile learning application called Decimal Binary Fun Pro. This mobile application is very engaging and challenging

for learners learning binary to decimal conversion and vice versa. The said mobile application activates the logical thinking of the learner and trains the brain in converting binary to decimal numbers. The application is used to learn binary coding and decoding. It will help computer science students to do faster binary conversions.

In learning, constructivist paradigm says that an individual construct his own understanding and knowledge of the world, through experiencing things and reflecting on those experiences [8]. The constructivism emphasizes on the situation and content in need in mobile learning such as queries for investigation and tricky answered and decision-making applications, as well as teamwork and active collaboration in mobile learning like communication via mobile phones or contact among learners. The Decimal Binary Fun Pro gamified mobile application was used in the classrooms and this study investigates that learners aggressively concept their knowledge and figure out problems related to binary and decimal number systems interactively. It sought to substantiate that learners build or construct new knowledge created in their prior learning. Specifically, it required explanations on the learner's accomplishments by clustering the learners and by comparing their pre-test and post-tests.

2. METHODOLOGY

The study is experimental. The approach employ in this study is defined in this section.

2.1. The Decimal Fun Pro Mobile Game

Decimal Binary Fun Pro gamified mobile application used in this study for one of the main beliefs of the constructivist is that student develops and builds understanding from their own personal experiences. Students bring their own past experiences in the binary system into their Intro to Computer Subject with binary system topic, use it to enhance their learning in a binary system by gaining more knowledge and build upon their previous knowledge. Constructivist learning theory enables the Decimal Binary Fun Pro gamified mobile application to prove on the student's ability in a binary system to be self-directed and draw their decisions [9]. Likewise, students finally learn more when they have to explore the binary system in Decimal Binary Fun Pro gamified mobile application rather than being told how to solve. When students can use what they are learning in real world situations, it sinks in and stays with them for a longer period of time

Decimal Binary fun pro game is an interesting game wherever players require placing one of the zeros in the grid to arrive a correct illustration of the decimal number assumed at the end of row and column. The game has three categories, the 4x4, 6x6 and the 8x8. The accomplishment is measured in seconds. It indicates how fast a player finishes the game. Figure 1 shows the screenshots of the game.

Figure 1. The Decimal Fun Pro Mobile Game

2.2. Data Gathering

The target group was students of Quirino State University and Cagayan State University who were enrolled in Computer 101 – Computer Fundamentals class because the course contains the topic

regarding decimal and binary number systems. A 30 item pre-test was intended and given to the learners. The pre-test includes items which ask students to convert binary numbers to decimal numbers and vice versa. After checking, the result of the pre-test was recorded. After the pre-test, a series of lectures about number systems were given to the students. At the same time, the mobile game Fun-pro mobile game was downloaded and installed to the mobile devices of the students. Board works and exercises were given to the students after the lecture. This time, there are fewer board works and practices given compared to the classes in the previous years. A quiz was given after the lectures to gauge the knowledge acquired from the lectures. After that, students were taught about using the mobile game and the rules to follow. They were also instructed to record game information. Each of the students was given 3 hours as laboratory time in using the mobile game. During the laboratory time, the students played the different categories of the mobile game, the 4 x 4, the 6 x 6 and the 8 x 8 categories. Each of the categories was played five times. The researchers observed the students and recorded notable acts that can be used in the analysis of the experiences of the students. A post-test was given to each of the learners after the given laboratory exercises. The result was recorded.

2.3. Data Set

The dataset gathered 52 examples with 19 features. The succeeding is the features included:

- Pre-test (1) – scores from the first test given to the students before introducing the topic.
- Pre-test (2) – scores this is the quiz given to the students used the mobile application.
- 4 x 4 (1) – time spent during the first try in the 4 x 4 category.
- 4 x 4 (2) – time spent during the second try in the 4 x 4 category.
- 4 x 4 (3) – time spent during the third try in the 4 x 4 category.
- 4 x 4 (4) – time spent during the fourth try in the 4 x 4 category.
- 4 x 4 (5) – time spent during the fifth try in the 4 x 4 category.
- 6 x 6 (1) – time spent during the first try in the 6 x 6 category.
- 6 x 6 (2) – time spent during the second try in the 6 x 6 category.
- 6 x 6 (3) – time spent during the third try in the 6 x 6 category.
- 6 x 6 (4) – time spent during the fourth try in the 6 x 6 category.
- 6 x 6 (5) – time spent during the fifth try in the 6 x 6 category.
- 8 x 8 (1) – time spent during the first try in the 8 x 8 category.
- 8 x 8 (2) – time spent during the second try in the 8 x 8 category.
- 8 x 8 (3) – time spent during the third try in the 8 x 8 category.
- 8 x 8 (4) – time spent during the fourth try in the 8 x 8 category.
- 8 x 8 (5) – time spent during the fifth try in the 8 x 8 category.
- Post-test – score on the test given after using the mobile game.

Table 1. Sample Dataset

Student	Pre-test(1)	Pre-test(2)	4 x 4 (1)	4 x 4 (2)	4 x 4 (3)	4 x 4 (4)	4 x 4 (5)	6 x 6 (1)	6 x 6 (2)	6 x 6 (3)	6 x 6 (4)	6 x 6 (5)	8 x 8 (1)	8 x 8 (2)	8 x 8 (3)	8 x 8 (4)	8 x 8 (5)	Post test
1	53	70	130.2	94.2	103.5	88.9	60.1	153.7	128.9	122.5	134.2	142.5	183.8	196.7	143.2	127.3	123.2	82
2	55	67	115.4	110.3	90.4	85.3	69.5	110.4	116.9	100.3	98.7	104.3	105.8	99.6	93.2	95.7	99.2	92
3	50	80	96.3	91.1	88.3	64.5	67.6	99.8	95.6	102.3	100.6	99.4	93.2	90.5	100.2	92.0	88.3	93
. . .																		
52	52	75	91.9	112.2	122.5	134.2	142.5	183.8	94.2	103.5	88.9	142.5	183.8	177.5	100.3	97.3	92.1	80
Ave.	**53.75**	**77.85**	**96.25**	**100.94**	**99.19**	**96.36**	**98.54**	**108.26**	**105.36**	**101.61**	**99.48**	**104.41**	**105.61**	**109.41**	**105.87**	**104.38**	**102.79**	**87.72**

Actual values ranging from 1 to 100 are recorded the times recorded are floating values measured in seconds as shown in table 1.

2.4. Data Analysis

To prove that students can build new knowledge based on previous knowledge, the following data analyses were conducted:

2.4.1. Clustering Techniques

One of the primary methods frequently used in studying datasets is clustering where individual cluster formed is a group of data objects that are similar to another place within the same cluster but different objects in another cluster [10]. This study used a clustering analysis to segment students into groups based on their scores and fun-pro time achievement. There are numerous present clustering algorithms which possibly produce the entire dissimilar segments on the similar set of data. Various groups of data set based on the standard of getting the most out of the intra-class similarity and reducing the inter-class similarity where clustering algorithm partitioned employed. In this study, the clustering algorithms are assessed using internal validity measures to select which of the algorithms is utmost suitable for the fun-pro dataset. Three clustering algorithms were emphasized to the internal evaluation which comprises k-means, k-medoids, and expectation maximization (EM) clustering.

The procedure for clustering and assessing the clustering algorithms with RapidMiner is given in figure 2.

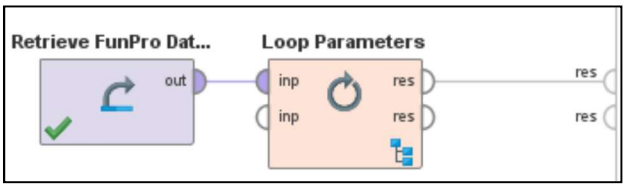

Figure 2. RapidMiner process for clustering and evaluating the clustering algorithm

The operator 'Retrieve FunPro Data Set' is an operator used to get the repository where the FunPro dataset was saved. This allowed the RapidMiner to access the data and automatically converted it into complete metadata which helped as the output of the operator. Also, the 'Loop Parameters' operator was defined to execute a loop process of evaluation of the different algorithm used. The 'Loop Parameters' operator comprises a 'Clustering (Subprocess)' and 'Silhouette Index' as inner operators as shown in figure 3.

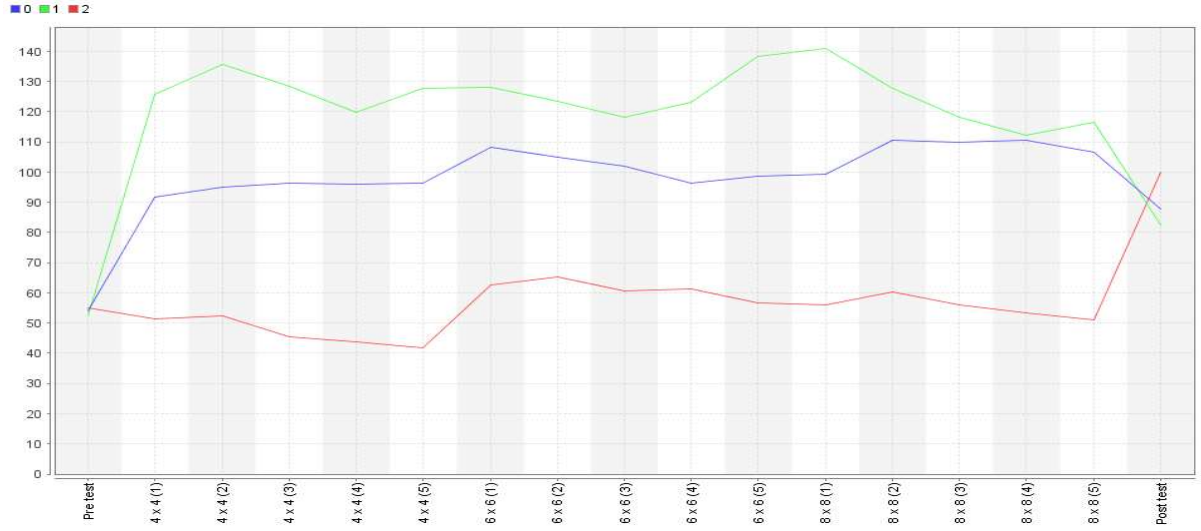

Figure 3. K-means Clustering Centroid Plot

Result shows that K-means provided the best model as related to the other clustering algorithms tested. Cluster 0, cluster 1 and cluster 2 formed by the k-means algorithm were composed of 32, 14

and 6 students correspondingly as the larger value of the silhouette index specifies a better clustering model. Likewise, the centroid plot formed through the k-means algorithm, where k = 3 is shown in figure 5. Centroid plot is used to review the clustering outputs. It can be concluded from the figure that the students who belong to Cluster 0 (blue line) with 32(62%) for number of instances are the AVERAGE LEARNERS, as performance compared to the other two clusters for they ranked second on both Pre-test(2) and Post-test, spent longer time finishing the activities using the mobile application compared to cluster 2.

Besides, cluster 1 (green line) are students as the TOP LEARNERS with 14(27%) number of instances compared to with other clusters. They spent lesser time finishing each category in the mobile app, and they scored best in their post-test. In contrast, Cluster 2 (red line) characterizes the students as POOR LEARNERS with 6(11%) number of instances. They spent more time finishing the activities given using the FunPro game with these students, and they scored lowest during the post-test. It can also be inferred from the figure that during the first tries from the different categories, students spent more time finishing the activity as compared to the other trials. Table 3 shows the output of the t-test.

Table 2. Type of Learners Based on the Clustering Result

Cluster Number	Number of Instances	Type of Learners	Behaviour
0	32(62%)	Average Learners	- They ranked second on both Pre-test(2) and Post-test - Spent longer time finishing the activities using the mobile application compared to cluster 2
1	14(27%)	Top Learners	- Highest score in the Pre-test(2) as compared to the other clusters - Highest score in the Post-test as compared to the other clusters - Lowest time spent in completing all the mobile application activities as compared to the other clusters
2	6(11%)	Poorest Learners.	- They spent more time finishing the activities given using the FunPro game with these students, and they scored lowest during the post-test. It can also be inferred from the figure that during the first tries from the different categories, students spent more time finishing the activity as compared to the other trials

Table 3. t-test result

Samples of Paired Statistics			
	Mean	**N**	**Standard Deviation**
Pair Pre-test (2)	77.852564	52	9.8149354
Post test	87.724359	52	8.3952834
Paired Samples Test			
Pair 1	**Mean**	**t**	**Sig. (2-tailed)**
Pre test (2) – Post test	-9.8717949	-13.130	0.000

Based on the result, the mean of the post-test is greater than the mean of the pre-test. A t-test was conducted to check for the significant difference between the post-test and the pre-test. Table 4 shows

the result of the t-test where the *p*-value computed is .000 which is lesser than 0.05, and the computed t=13.13 is greater than t critical = 2.008. This means that there is a significant difference between the post-test and pre-test.

3. CONCLUSION

This study focuses on the exploration of the constructivist learning theory in the Decimal FunPro mobile game application by applying clustering algorithm on the dataset using RapidMiner tool to derive with the clusters of students. By using an internal validation measure which is the silhouette index measure, the output presented that the K-means algorithm, using k = 3, as long as the best clustering model to cluster students requiring a value of 0.253. Three groups were made having 32 students in the cluster 0, 14 students in cluster 1 and six students in cluster 2. The performance of the students in using the game shows that during the first tries from the different game categories, students spent more time finishing the activity as compared to the other trials. This means that the students learned from the first trials. A significant difference between the post-test and pre-test as the t-test result shows. The post-test is higher than the pre-test indicating that the students acquired knowledge in number systems when they used the mobile game application. Having the said evidence, it can be concluded that using the Decimal FunPro mobile game application reveals that students can build new knowledge based on previous knowledge.

Acknowledgment

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