

Session 8: ICT Education

Title: Learning Catalyst: A Play-based Strategy for Teaching Applied Computing Concepts
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Title: Integration of Maker Movement into Education
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Learning Catalyst: A Play-based Strategy for Teaching Applied Computing Concepts

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Abstract

The research work in this paper investigates a new teaching strategy that uses active learning through play to increase students' uptake of learning computing concepts. The strategy promotes student engagement through playing a customized Jenga game. The game consists of a set of blocks, one side of each block is covered with a piece of dry-erase tape to allow erasing and writing on the blocks. This allows instructors to reuse this editable Jenga for developing their own game-based learning activities. Three sample activities have been developed and conducted to test the strategy experimentally. The test results showed that the strategy improves the class average and promotes the student engagement. A survey has been conducted to get students' feedback on the strategy. The survey results demonstrated that students like the play-based strategy. The contribution of this paper is the development of a teaching strategy that improves students' engagement which in turn helps students to learn important computing concepts.

1. Introduction

Games can improve students' uptake of learning in ways that regular lectures cannot [1, 2, and 3]. Play is voluntary and enjoyable [3] which in turn facilitates and promotes student engagement [4]. Game-based learning enables students to practice on working in process-based environments because games are process-oriented and rule-governed. However, the positive effects of using games on learning cannot be generalized to all areas or games [5]. Over the last few years, research showed that using games in classrooms improves student engagement for specific subjects such as Math and English [6, 7, and 8].

The most important game's feature is that play promotes student's creativity. Each student should construct his own method that enables him to win. This method could be refined and mapped to a particular learning outcome space by group discussion. These gaming features inspired me to

propose a play-based teaching strategy for teaching computing concepts at the School of Applied Computing, Sheridan.

Jenga is a simple game that promotes the development of physical and mental skills. The game requires players to take turns removing one block at a time from a tower constructed of fifty four blocks. Each block that is removed is then balanced on top of the tower. The game was selected for this project because it teaches students a lot about solving multi-objective problems that can be mapped to various design problems in applied computing through analogy. The game was created by Leslie Scott, and currently is marketed by Hasbro.

This work aims to investigate a play-based teaching strategy that promotes learning through play at the School of Applied Computing. The strategy is to use editable Jenga blocks and other necessary tools that enable constructing customized versions of Jenga game for learning computing concepts and acquiring relevant skills. The deliverables of the project include this paper and a Jenga toolbox that contains editable Jenga game sets, dry-erase markers and examples of slightly modified versions of Jenga games for promoting learning through play. The toolbox enables professors to design various activities that help students to learn different concepts through play.

The remaining sections of the paper present the strategy and its tactics then discuss the results of testing the strategy.

2. The Strategy

The strategy is to involve students in a customized Jenga game competition that constructs an active learning environment. This environment promotes student engagement and enables collaborative learning. Instructor prepares several Jenga game sets for the competition. He writes various sentences on a particular topic to the Jenga block sets. This allows students to read the sentences one by one randomly. The sentences written on each game set should cover a specific concept relevant to the topic. The sentences will be written to sticky labels too. A blank concept map should be prepared. Students use the labels to fill out the concept map.

2.1. The Strategy Guidelines

The class is split into groups so that each group uses a different Jenga game set that focuses on a particular concept. Each group removes one block a time from their tower, searches for a label that contains the sentence seen on the block, and sticks the label on the appropriate position on the blank concept map then stacks the block at the top of the tower to create a new layer. Each group uses the sentences to construct a concept map/model on the concepts targeted by their game set. Each group changes their game set every seven minutes by exchanging their place with the closest group located on their left. This rotation enables each group to explore each game set and learn from the concept maps created by the other groups. Students are not allowed to stack the removed block before adding the label to the map. The winner group should stick the maximum number of labels and reach the highest height in all games. We can allow students to write the sentences to the concept map directly instead of sticking labels. All students should join a gallery walk to explore the concept maps of the other groups and prepare for a group discussion.

3. The Strategy Tactics

The strategy tactics are to (1) identify an editing technique that enable instructors to write text on the blocks; (2) design sample activities including abstract maps that could be used for teaching various topics. These activities could be used as examples that inspire applied computing instructors to develop their own activities and (3) Test the strategy.

3.1. Identifying an editing technique

My initial idea for creating editable Jenga was to paint the Jenga blocks using the dry-eraser paint. However upon further investigation I ran into two issues. Firstly, there are left over smudges of ink on the blocks after erasing the text. Secondly there is not a lot of writing space on the regular wooden Jenga blocks. The large wooden Jenga cannot be manipulated for safety and mobility reasons. The weight of the large wooden Jenga could reach 20 lb which is not safe when the tower falls.

To address these problems I have used dry-erase tape and found it easier than using the paint as shown in Figure 1. This tape could adhere to wood, metal and cardboard. This inspired me to use Xlarge Jenga which is made from cardboard. The Xlarge Jenga provided enough writing space for complex sentences. Moreover it has a light weight (1.5 kg) which improves the mobility of the game and keeps it safe when the tower falls.



Figure 1. Preparing an editable Jenga

3.2. Sample activities

Three sample activities have been designed to help students to learn through playing Jenga. The activities are designed to support learning abstract topics such as identifying relationships among objects and comparing several objects. This abstraction facilitates customizing the activities for various subjects and disciplines in future. The three activities were conducted in forty five minutes on July 21, 2016. The session plan and the three activity guidelines are shown in Figures 2, 3, 4 and 5 respectively.

A Learning Through Play Session that facilitates learning two UML diagrams: statechart and sequence diagrams

The purpose of the session

This session aims to help students achieve the following learning objectives:

- (1) To describe a state chart
- (2) To identify the difference between a sequence diagram and a state chart
- (3) To identify the relationships among requirement models and design models

Through the play of Jenga.

Expected Time: 45 minutes

Activity Description

1. Three Jenga game sets J1, J2, and J3 will be used during this session. The blocks of each game set read sentences that are relevant to one of the target learning objectives listed above
2. The class will be split into 3 groups G1, G2, and G3
3. Each group will play a game for 7 minutes and then rotate to play the other games. For example: G1 plays J1, G2 plays G2, and G3 plays J3. After 7 minutes G 1 plays J2, G2 plays J3, and G3 plays J1. After another 7 minutes G1 plays J3, G2 plays J1, and G1 plays J2. (21 Minutes in total)
4. Each group will develop a concept map using the sentences written on the blocks of J1, develop a comparison table using the sentences from blocks of J2, and insert the diagram names written on the blocks of J3 into the appropriate position on the chart associated with J3.

How to play the Game while write the information found on each block to the sheet

1. Each time a student pulls the block they need to read a sentence
2. Write the sentence to the appropriate place on the sheet
3. Add the block at the top of the tower
4. Repeat steps from 1 to 3 till the 7 minutes end.
5. Each group posts their sheet
6. Groups will rotate to exchange games

Gallery Walk and Discussion

All students participate in a Gallery Walk in which they will read other groups' work and identify the following: (9 min)

- A common idea
- A unique idea
- An interesting idea
- A new piece of information

Discussion:

All students are welcome to share information they gathered from the activity (15 min)

Figure 2. Session plan for conducting the three learning-through-play activities

3.3. Testing the strategy

The three activities (see Figures 3, 4, and 5) were conducted by the students of the course titled: Object

Oriented Methodologies (SYST39409) in summer 2016 at Davis campus of Sheridan. Quiz 3 was designed to test students on statecharts diagram including relevant diagrams which is the topic targeted by the activities. To evaluate the strategy impact on student learning' uptake, the quiz 3 marks of the summer 2016 group are compared to the marks of a control group of the same course held in fall 2015. The two groups used exactly the same quiz and have been taught by myself at the same campus. The only difference between the two groups is that the Jenga learning activity was conducted by the summer 2016 group while no game-based activities were used in fall 2015. Additionally, a survey has been conducted to investigate the student feedback on the strategy.

Activity 1: Identify Relationship among Objects - J1

The purpose of playing J1 is to construct a concept map that describe the UML Statechart properly. The blocks of this Jenga game set reading many sentences related to statechart concepts. Each student in your group is required to do the following in his turn:

1. Pull a block
2. Read the text located on the block
3. Insert this text into an oval on the provided sheet
4. Connect the new oval to the previous ovals (if it is not the first).
5. The arrows that connect the ovals must be labelled using one of the following verbs/phrases: models, form, are represented by, are, are when an object, lasts for, change by, could include, must have, change
6. Add the block to the top of the tower

Note:
The tower must not fall and if a student touch a block he/she must play it
The game ends when the tower falls or after the 7 minutes from the beginning of the game
A score will be assigned to each concept map to determine the winner team (5 points per correct item).

Sample for the expected concept map that should be developed at the end of the game

Figure 3. An activity that helps students to identify relationships among objects

Activity 2: Identify Differences among Objects - J2

The purpose of playing J2 is to construct a table that compares the UML statechart and the UML sequence diagram. The blocks of this Jenga game set reading many features related to the two diagrams. Each student in your group is required to do the following in his turn:

1. Pull a block
2. Read the text located on the block
3. Write this text to the appropriate side on the table (statechart or sequence)
4. Add the block at the top of the tower

Note:
The tower should not fall and if a student touch a block he must play it
The game ends when the tower falls or after 7 minutes from the beginning of the game
A score will be assigned to each concept map to determine the winner team (5pts per correct item).

Figure 4. An activity that helps students identify differences between two objects

Activity 3: Identifying Missing Objects of A given Concept Map- J3

The purpose of playing J3 is to identify the relationships among requirement models and design models. A diagram with empty rectangles is provided and each group is required to fill out the empty rectangles by the appropriate models. The blocks of this Jenga game set reading all requirement and design model names. Each student in your group is required to do the following in his turn:

1. Pull a block
2. Read the model name on the block
3. write model name to the appropriate rectangle
4. add the block at the top of the tower

Note:
The tower should not fall and if a student touch a block he must play it
The game ends when the tower fall or after 7 minutes
A score will be assigned to each concept map to determine the winner team (5pts per correct item).

Figure 5. An activity that helps students identify missing objects of a given concept map

4. Results and Analysis

This section shows and analyzes the results of the following: (1) a quiz on the topics taught using the strategy compared to the results of the same quiz without using the strategy; (2) a survey that determines how much students like the strategy, and (3) the observations of the author during conducting the activity. The results are discussed in the following sections.

4.1. The Strategy improves the class average

The average marks of the summer 2016 group are greater than the corresponding average marks of the fall 2015 group, see figure 6. This improvement could be attributed to the student engagement with the Jenga game activity (the strategy). Students read the statechart-related sentences from the Jenga blocks then insert them into the appropriate places on the concept map prepared for the statechart.

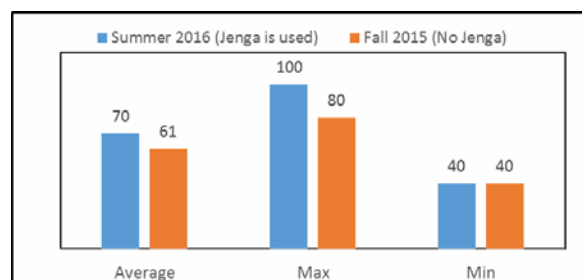


Figure 6. Marks of Quiz3 of two SYST39409 groups: summer 2016 and fall 2015

In this activity, we ask questions that allow students' sense of purpose to evolve from their collaborative play. The open-ended discussion conducted after the game seems to inspire students to

seek out and create answers for themselves based on their experience. This game allows students to build living models using their own experiences (languages) for the discussed concepts. These models are assets for students' uptake of learning. The value of these models increases when the student continue to care about updating these models to represent his recent knowledge.

4.2. The strategy promotes student engagement

The student engagement to the activity was observed. Students were seriously focus on playing the game and building the concept maps. The engagement was shown by many student actions such as: a student picks up a block while the other two students have prepared to catch the tower if it happens to fall. Another example noticed is that smiley student who are amused by the unstable tower

4.3. Students like the activity because they can learn from it more than traditional lecture.

The ultimate goal is to promote diversity in learning activities to accommodate different learning styles of students. A survey was designed to investigate student feedback on the Jenga activity and the adopted teaching approach generally. Figure 7 shows the survey questions.

Note: This activity is part of an education research project and your work may be used anonymously.

Question 1
How well does the activity offered today help you to learn the proposed concepts?
 Extremely well Quite well Fairly well Mildly well Not well at all

Question 2
How well does the activity match your learning style?
 Extremely well Quite well Fairly well Mildly well Not well at all

Question 3
In the second part of this course (from week 8 till now), how well does the overall approach to learning work for you?
 Extremely well Quite well Fairly well Mildly well Not well at all

Question 4
How comfortable are you in asking for help from the instructor?
 Extremely comfortable Quite comfortable Fairly comfortable Mildly comfortable Not well at all

Question 5
How well this activity does helped you to develop critical thinking skills?
 Extremely well Quite well Fairly well Mildly well Not well at all

Question 6
Which Jenga game set gives more fun and help in learning?
 Cardboard Jenga with extra-large blocks Wooden blocks Jenga with small size

Figure 7. the survey used to collect student feedback

The survey results showed that students like the Jenga activity which helped them to learn more than the regular lecture. This result has been demonstrated by the analysis of students' answers for the first five

questions of the survey. Fourteen students out of twenty one stated that the Jenga activity fits their learning style extremely well, see Figure 8.

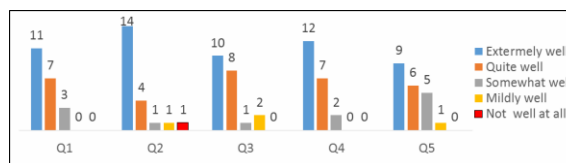


Figure 8. The students' answers for the first five questions of the survey

The total number of students who selected extremely well and quite well reflects how well the activity alleviates different students to learn. Figure 9 shows the survey results after merging these two student groups (extremely well and quite well). For the first three questions, the total number is eighteen students out of twenty-one students. For questions four and five, the total numbers are nineteen and fifteen respectively. This confirms that the majority of the students liked the activity and learned from it

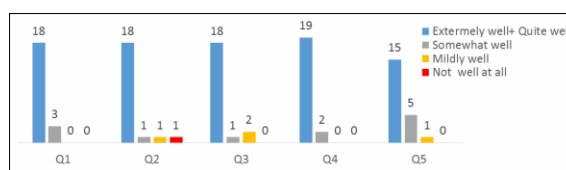


Figure 9. The student answers for the first five questions -combining the extremely well and quite well options

4.4. No significant difference between regular size and the XL size of Jenga in terms of engagement

The answers of question 6 shows that students enjoyed the two Jenga sizes. Eleven students preferred XL size and ten students preferred the regular size.

5. Deliverables

The deliverables of this project include: (1) this report; (2) two editable cardboard XL Jenga; (3) one editable wooden regular size Jenga; (4) dry-erase markers; (5) board eraser; (6) white-board spray cleaner; (7) instructions of three sample activities and (8) a box for keeping all components. Figure 10 shows these components where each component is referenced by its order in this list except the seventh component which is shown in figures 2, 3, 4 and 5.