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Ushering in the Age of Endemic

**THE 11TH INTERNATIONAL INNOVATION,
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INDES 2022**

EXTENDED ABSTRACTS BOOK



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PIXMATH

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ABSTRACT

Gamification is becoming more popular in academic contexts. Gamification theory in education states that students learn more effectively when they are having fun at the same time. Moreover, they learn best when they have goals, targets, and achievements to strive for. PixMath is a physical educational board game that aims to encourage children 8 to 12 years old to practice and improve their arithmetic skills in a fun and interactive way. Its creation is motivated by a mathematical counting game known as Picture Cross. In PixMath, the players are required to fill up empty numbered grids to complete a chosen picture and win the game by solving arithmetic questions. The arithmetic questions are classified into three levels: easy, intermediate, and difficult questions. A survey that was conducted on a group of students who played PixMath has received positive feedback. Some students claimed that the game is interesting, and exciting and has helped them improve their arithmetic skills. Hence, it has a high potential to be commercialized as a physical-mathematical board game in the market.

Keyword: Gamification in education, mathematical board games, picture cross, arithmetic

1. INTRODUCTION

For a variety of reasons, gamification is becoming increasingly popular in educational contexts (Oliveira et al, 2022; Rivera et al., 2022; Smiderle et al., 2020). In simple terms, it makes the 'tough work more fun', thereby motivating students and increasing their engagement with the subject matter. According to the gamification theory in education, students learn more effectively when they are having fun at the same time. Furthermore, they learn best when they have goals, targets, and achievements to strive for. Gamification in learning is the utilization of game-based elements such as point scoring, peer competition, teamwork, and score tables to increase participation, and assist students in the integration of new information while testing their understanding. It can be applied to school-based subjects such as Mathematics and can also be widely used in self-teaching applications and courses.

PixMath is a physical-mathematical educational board game that aims to encourage children 8 to 12 years old to practice and improve their arithmetic skills in a fun and interactive way. Its creation is motivated by a mathematical mobile counting game called Picture Cross, which is also known as 'Picross,' 'Nonograms,' or 'Griddlers'. To date, it has received a high rating of 4.5/5 in the Apple App Store and 4.4/5 in the Android Play Store. It involves solving classical logic puzzles in which empty cells are filled up to create a picture by using the number clues provided. This key idea of filling up empty cells to create a picture is adapted in PixMath. In PixMath, instead of filling up empty cells, players are required to fill up empty numbered grids

to complete a chosen picture and win the game. In addition, some of the pixel pictures in PixMath feature symmetrical patterns, which will introduce young children to symmetrical and geometrical shapes in the hope of inspiring future mathematicians.

2. METHODOLOGY

There are 4 major components of PixMath: a playing board, 20 picture cards, 98 arithmetic cards, and 7 action cards. The playing board is the main component of the game. It consists of a 7 x 7 square-grided table on its left with each grid numbered 1 to 49 and on its right, there is a picture deck, supply deck, and discarded deck arranged in a column.

At the start of every game, there are 20 picture cards to choose from. The chosen picture is used as a reference to win the game. An arithmetic card has one side covered in black and the opposite side consists of an arithmetic question which is placed facing up and down respectively on the supply deck. The side of the card with an arithmetic question also consists of a placement number in its top right corner which tells the players the position of the card on the grid of the playing board. The arithmetic questions are classified into three levels of difficulties: Easy, Intermediate, and Difficult questions. The easy questions consist of basic arithmetic addition and subtraction; for instance, $77 + 9$ and $283 - 47$. The intermediate questions involve arithmetic multiplication and division such as 28×3 and $35 \div 7$. The difficult questions consist of any two combined of the four arithmetic operations; for example, $3 + 15 - 5$, $(8 \times 3) \div 4$, $8 - (3 \times 2)$ and $(6 + 4) \times 2$. There are 98 arithmetic cards in total. Next, action cards are cards that are shuffled together randomly in the arithmetic cards. These action cards provide the option to discard an unwanted arithmetic card on the board. There are 7 action cards in total.

The players start the game by choosing a picture card from the picture deck on the playing board. Each player will take turns picking up an arithmetic card and attempting to answer the question on the card. If the question is answered correctly then they are allowed to place the arithmetic card on its assigned numbered grid on the board. However, if the question is answered incorrectly then the player must place the arithmetic card on the discarded deck. If the player receives a card that is not required by the picture, they should place it into the discarded deck without answering it. If the player answers an arithmetic card that is not required by the picture, then they must place the card onto its numbered grid and try their luck in getting an action card to remove it. Hence, using an action card, the players are free to discard any unwanted card placed on the board. The unwanted card will then be placed onto the discarded deck. However, if the player receives an action card before any unwanted arithmetic card is placed on the grid, then they must discard the action card into the discarded deck. If the players run out of arithmetic cards, then the cards on the discarded deck will be shuffled and then placed back onto the supply deck. The player who completes the picture wins the game.

3. FINDINGS

A survey has been conducted on a group of students to test the PixMath mathematical board game. All the feedback received was positive. Some students have stated that the board game was interesting to play and has helped them to improve their mathematical skills. Others even commented that the game was very exciting and made them want to continue solving more arithmetic questions.

4. CONCLUSION

In conclusion, PixMath is a mathematical board game that aims to encourage children of 8 to 12 years old to practice and improve their arithmetic skills through an engaging and enjoyable way. Hence, finding the best way to encourage young children to enjoy mathematics is our top priority. From the positive feedback received from the students, it has a high potential to be commercialized as a physical-mathematical board game in the market. We hope that PixMath will be practiced in the future to study arithmetic in Mathematical subjects. As for future work, PixMath can be developed digitally as a mobile game so that it can be advertised and exposed to international players.

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