

## BOARD GAME DEVELOPMENT ON CELL MEMBRANE TRANSPORT MATERIAL

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### ABSTRACT

Board games are one of the supporting tools for understanding complex material and abstract scientific concepts. This study aims to develop a board game with cell membrane transport material and to test the board game response by experts. This study is research and development. This board game was developed for class XI science students using learning progression. The research design used was adopted by Arnel A. Gutierrez's research. The steps used in this study include the preparation stage, game development and response testing by experts. Test responses are carried out by distributing questionnaires to validators /experts using Google Form. The questionnaire assesses the content, instructions, and appearance and design of the media. Analysis of the validity of the instrument with five options using a Likert scale, given four choices between ranges of disagree, disagree, agree, and strongly agree. The results of data analysis using a ranking scale Rasch model may indicate that the validity of the score of the selected respondents indicated that the average value of observations shows significant difference starting from logit -0.32 for selection score of 1 (disagree), and 0.96 for the selection quite agree, 2.58 for the agreeable choice and 5.69 for the strongly agree choice. Between these options there is an increase in logit, which indicates that the scale on the questionnaire used is good. The Andrich Threshold average value starts from the value of none, negative -3.54 to positive 4.17 indicating that the answer option from the respondent is valid, which means the board game can be used.

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## 1. INTRODUCTION

The report on the results of the National Examination according to Balitbang Kemendikbud in 2018 shows that the percentage of students who answered correctly on biomolecular and biotechnology materials was 39.70%. This percentage is the lowest compared to other materials. The material for biomolecular and biotechnology tested 11 indicators, two of which were explaining the processes that occur in cell organelles with the percentage of students answering correctly at 30.56% and interpreting the molecular transfer process based on experiments of 36.67%.

The two indicators with the lowest percentage of students answering correctly were taught in class XI, namely Basic Competence 3.2 which reads "analyse various bioprocesses in cells which include membrane transport mechanisms, reproduction and protein synthesis", and Basic Competence 4.2 which reads "make a model of the bioprocess that occurs in cells based on literature studies and experiments". KD 3.2 and KD 4.2 have the scope of cell learning which includes transport on the membrane, diffusion, osmosis, active transport, endocytosis and exocytosis as the basis for understanding bioprocesses in living systems.

As a supporting tool to help students understand complex material and abstract scientific concepts, board games are created. Based on field facts, the author uses board game media to assist learning on cell membrane transport materials. Similar studies have been conducted previously by Cesar et al. (2018) which uses the board game 'Synthesizing Protein', to understand protein synthesis material. The board game created by Cesar et al., helps students to simulate the mechanism and process of protein synthesis. The results of his research show that

this board game is able to improve conceptual understanding and improve (or form) protein synthesis models for students.

The board game that the author made has a gameplay and structure that is almost the same or can be said to adapt the board game made by previous researchers. Previous research was conducted by Cesar et al., who made a board game with protein synthesis materials. The way of playing and the design of the board game that the author made refers to the board game made by Cesar.

## 2. RESEARCH METHOD

Research in the form of board game development was conducted at Sebelas Maret University. Data collection was done online using the Zoom application and questionnaires were taken using Google Form. The game is developed following the stages of game development, namely literature study, design making, testing and production. Aspects and principles applied in the preparation of the game pay attention to the design of the game form and the concept or content of the material. The concepts presented in the game are concepts that follow the sequence or sequencing:

1. Water enters the cell through the cell membrane
2. Water enters the cell through a specific channel
3. Water particles move from different concentrations
4. Only the particles needed by the cell can enter
5. Environmental conditions and the number of particles lead to various processes (Examples: diffusion, osmosis, active transport, endocytosis, exocytosis, concentration and tonicity)

Games that are made must contain aspects of creative thinking and contain elements of competition. This cell membrane transport board game is designed to be played in groups. This board game material is made of paper with different thicknesses. Cards, boards, and game manuals are part of a cell membrane transport board game. After the board game prototype has been made, it takes experts and class XI high school students to provide an assessment using Google Forms to find out whether the board game is worth playing or not.

## 3. RESULT AND DISCUSSION

The results of the board game design are as shown in the following image;



Figure 1. Cards



Figure 3. Molecules

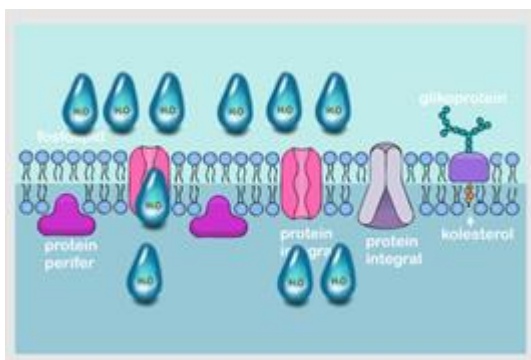


Figure 2. Game Board



Figure 4. Guide Book

Table 1. Validity of the board game from experts and users

| Indicator   | the validity of the expert | User Validity |
|-------------|----------------------------|---------------|
| Concept     | x                          | v             |
| Content     | v                          | v             |
| How to play | v                          | v             |
| Design      | v                          | v             |

The cards are composed of 6 sets of cards, each of which has a different material such as diffusion, osmosis, active transport, etc. as well as 3 additional cards, namely toxic cards, expert cards and bonus cards. Toxic cards serve to inhibit opposing players. The expert card is a sign that the player has finished collecting cards of the same material, and the bonus card is. In addition, a board with pictures of cell membranes and molecules is provided which is useful for demonstrating conditions on the membrane such as diffusion or osmosis or active transport.

The task of students or players after the cards are shuffled and distributed according to the number is to collect cards from similar materials. Students who get cards of the same kind and in the correct order have the right to proceed to the next round, which is to demonstrate the material, for example, the card that students get is about the concept of diffusion, then students demonstrate the conditions of diffusion with the molecular tokens and boards that have been provided. The sequence of the game rounds and explanations of the cards have all been summarized in a small pocket book entitled Components & Rules of the Cell Membrane Transport Board Game.

The validity of the board game after being assessed by experts and users is summarized in the following table below. Experts are biology subject teachers and users are students of class XI IPA SMA.

Based on validation from experts and users obtained:

1. Items that are less valid include the membrane transport concept presented in the game, the sequence of the membrane transport concept, the suitability for high school students, the clarity of the competency target, after following the content proof task correctly, the card can give students the correct understanding, and the inner colour picture. This item is not valid because it only meets two criteria, namely Z-standard Outfit and Point Measure Correlation Value
2. The indicator in the form of game content has 10 items, 6 are less valid and 4 are valid.
3. The next indicators, namely instructions and game steps, are all valid because they have met 3 criteria.
4. The third indicator, namely the display and design of the media, has 10 items, 9 valid and 1 less valid, namely the colour match of the image.

#### 4. CONCLUSION

This board game was developed for class XI science students using learning development. Using Outfit Z-standard and Point Measure Correlation, given that the membrane transport concept presented in the game, the sequence of membrane transport concepts, suitability for high school students, clarity of competency targets, has followed the content-evidence-task correctly, the card can provide a better understanding, correct to students, and the colours in the pictures are appropriate. The indicator in the form of game content has 10 items, 6 are less valid and 4 are valid. The next indicators, namely instructions and game steps, are all valid because they have met 3 criteria. The third indicator, namely media display and design, has 10 items, 9 valid and 1 less valid, namely the colour match of the image. Hopefully this board game will be useful for future study.

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