The making of chemistry chess media for colloid material

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Abstract. The main objective of this study is to provide a summary of the steps in making the Chemistry Chess media on the concept of colloids. Descriptive research method is used to analyse the steps in making Chem-Chess media on the concept of colloids through flowcharts and storyboards. Flowcharts and storyboards are described based on the steps of making Chem-Chess media on the colloid concept. This research produces a learning media that needs to be applied to the concept of colloids by providing an instruction book as well as 3 types of knowledge cards, question cards, and challenge cards, which correspond to them at different cognitive levels. The colloid concept used contains learning indicators that are determined in general. With some equipment from chemistry chess media, it can be said that this research produced media that has the potential and suitable to be applied during the learning process on the colloid concept.

1. Introduction
In colloid material, there are concepts which emphasize students’ memorization and sufficient comprehension [1]. However, in its learning process, there are students who underestimate the material because it is abstract in nature and requires memorization [2]. The students’ attitude towards the material has caused the learning process to be passive. Students may become bored and unmotivated when their learning is oriented towards their teacher [3].

A passive learning process can be improved by the usage of learning media [1]. According to Hamalik, the usage of media in learning can boost and stimulate students’ motivation, interest and will during the process [4]. The usage of media can also enhance students’ mastery towards a material being studied. One learning media which is popular among students is games. Games can make students fully involved in their learning process [5]. A game based learning media may bring additional knowledge to students on a colloid material [6]. According to Smith and Munro, games can be used as assets in class and stimulus in learning which can develop students’ skills [7]. There are various forms of games used in education. One of them is board game. Brydges and Dembinski argue that board games can shift learning orientation towards students and make the learning atmosphere more active [8].

Chess is an example of board games used in an educational setting. According to Purwanto et al., chess involves understanding, strategy, attention and creativity: all things which are required in learning [9]. Previous studies, Agustina [10] and Kurniawan [11], have used chess in the Accounting subject but none has been attempted in Chemistry subject. Therefore, there is a need for testing the effectiveness of Chess media in Chemistry, especially on the colloid concepts.

The main objective of this research then is to describe the steps for making Chemistry Chess (Chem-Chess) media on the colloid concepts. The descriptive method was used, in which each data acquired...
was processed by describing it in words. The research produced a conventional learning media on the colloid material (in form of chess) with an instruction book and three types of cards (knowledge, question and challenge) which have different cognitive levels.

2. Methods
The method used in this research regarding the making of Chemistry Chess media was descriptive. The method allows us to explain the steps for making Chemistry Chess so that the product could be created and then used in a learning process. The research is divided into two phases: planning and development of media. In the planning phase, literature review on learning media and Chemistry material to be integrated into research product were performed. In the development of media phase, storyboard and flowchart were created and used in developing the research product. The flowchart and storyboard will also be described in explaining the steps for making Chemistry Chess media.

3. Results and discussion
As mentioned previously, the descriptive method was used in this research in order to explain the steps for making Chemistry Chess media. The research itself has two phases: planning and development of media. They are explained as follows:

3.1. The planning phase
During this phase, literature review on relevant learning media which has not been used in chemical concepts was performed. It resulted in the selection of board game as the model for our research product. Rachma describes that board games can be used to convey information and motivate students during a learning process [12]. One example of board games which can be used for such purposes is chess. Chess has been previously used as learning media for the Accounting subject in Agustina [10]. It resulted in students’ increased learning involvement and skills. According to Kurniawan, the usage of chess as learning media could enhance students’ comprehension towards materials being studied and train them to be more independent in learning [11]. The media itself is interactive and interesting. Therefore, chess was selected as the model for our research product.

The colloid concepts were selected as the material to be integrated in the research product based on literature review and problems found in the learning processes on the material. According Hayati at al., learning processes on the colloid concepts tends to be passive due to the nature of the material which requires memorisation [2]. Taqwima also identifies that students can be bored towards the colloid concepts learning which often is too teacher-oriented, reducing their engagement and motivation into the learning process [3]. Such problem has created the need for innovation which can improve the colloid concepts learning.

3.2. The development of media phase
The first step of the development of media was to create Flowchart and Storyboard. Flowchart is a diagram which illustrates the order, flow, and relationship between processes in the learning media to be developed. Storyboard is a series of detailed images regarding the learning media to be developed, which includes the design, components and instruction of the media. In the storyboard, the designs of the chessboard and pieces of Chemistry Chess (the name of our research product) were created. They are displayed below.
Figure 1. The design of the chessboard.

Figure 2. Several designs of the pieces.

The designs were created in Sketchup software. Unlike the normal chessboards, our chessboard is equipped with a drawer slot. The drawer slot is divided into three sections to keep the pieces, the cards, the instruction book and the answer key book. The pieces used in Chemistry Chess have the same designs as the conventional ones. They come in black and brown (Figure 2). The pieces were created using a wood carving tool. Chemistry Chess includes two sets of cards, blue and red. The designs of both sets are displayed as follows:

Figure 3. The knowledge card.

The blue cards consist of knowledge and question cards. They were designed using Corel Draw software. A player receives a blue card after he moves a piece on the Chemistry Chess board. Question cards consist of questions categorized into two cognitive levels namely C1 (to memorize) and C2 (to comprehend). In a Chemistry Chess game, the knowledge and question cards are combined and then shuffled. A player has a chance to pick one of them after moving a piece. The cards contain the colloid concepts which have been adjusted to the existing base competence and learning indicators. For example, knowledge cards may provide information about: 1) the term “colloid” which was coined by Thomas Graham (1805-1869) from Britain in 1861. While studying the diffusion processes of several substances in liquid medium, Graham observed that substances such as starch, gelatin, gum, and albumin diffuse very slowly and are unable to penetrate certain membranes. Thus, such substances were called colloids, resembling glue (in Greek, *kolla* means glue while *oidos* means resemble); and 2) the Tyndall effect which was coined by John Tyndall (1820-1893), an English physicist. The Tyndall effect is a phenomenon of light scattering by colloids particles. Colloid particles could scatter light to all directions so that the colloid particles can be seen in form of bright particles. Several examples of questions presented in the question cards are: 1) How many ways (at least three) the colloid concepts can be applied in daily life?; 2) What is lyophilic colloid?; 3) What is lyophobic colloid?; 4) How can colloid particles carry a charge?
Besides the blue cards, the Chemistry Chess is also equipped with red cards. The red cards are divided into two: challenge and special challenge. The designs of the red cards are depicted as follows:

Figure 5. The challenge cards.

Figure 6. The special challenge cards.

The challenge cards can be received when a player is about to take his opponent’s piece. The cards have several levels based on the piece being targeted. For example, every pawn which has been taken gives 2 points. Then, the player who has taken the pawn piece will receive a red challenge card with number 2 on its back. This rule applies to other types of pieces as well. The bishop and knight give 6 points each, the rook 8 points and the queen 10 points. The red challenge cards have two cognitive levels, i.e. C3 (to apply) and C4 (to analyses). The points from taking certain pieces determine the difficulty levels. The red cards with number 2 on their backs belong to the easy level, number 6 the medium level, number 8 the hard level and number 10 the expert level. Examples of level based questions are provided as follows:

Table 1. Question types level media chem chess.

| Level   | Question Types                                                                 |
|---------|--------------------------------------------------------------------------------|
| Easy    | Mention the characteristics of colloidal mixture!                              |
|         | Analyses any differences between lyophobic and lyophilic colloids!            |
| Medium  | Explain an application of colloid concepts for purifying water to your opponents! |
| Hard    | In factories, many chimneys are equipped with smoke filtering systems. Analyse any colloid concept which could be applied in such circumstances! |
| Expert  | Colloid creations involve several ways. One of them is a condensation process. Develop an experimental procedure in form of flowchart which shows the final result of the colloid mixture process in the form of Fe(OH)$_3$ from the initial solution FeCl$_3$. Also, predict any reaction equation which will occur in the process! |

The special challenge cards are given to a player who is going to promote his pawn. These cards have a crown logo in their back. For example: 1) Create an experimental procedure for purifying water! (2) Analyse the concept of protective colloids with your group. Present it in front of the class in order to continue the game!

Another component of the Chemistry Chess is the instruction book. The book contains the general instruction and game rules such as: 1) the number of players allowable and the distribution of their tasks, 2) how the blue and red cards are distributed, 3) the distribution of points in the challenge cards, 4) the rules of the game time and how challenges or questions are answered, 5) the rules regarding players who cannot answer question and challenge cards, 6) the rules regarding the checkmate mechanism and how the game is ended. The Chemistry Chess also includes the answer key book which contains answers to the challenge and question cards. The designs of the instruction and answer key books are displayed as follows:
The designs were created using Corel Draw software and printed in A6 papers. After all components were finally created, starting from the chessboard, the chess pieces, the blue and red cards to the instruction and answer key books, the Chemistry Chess learning media is ready to be used in learning class on the colloid concepts. The Chemistry Chess can be played according to the rules written in the instruction book. There are two teams. Each team has six members. One member acts as a chess player, three members to answer questions and challenges and two members to take notes regarding any card received by their team as well as answers they provide. The game is guided by a teacher and a referee. The referee directs the game flow, determines the game time and gives cards to the players. Once a game is considered finished, the guide teacher orders the players to submit all cards they have received and all answers they have given in form of a game result report. After that, the class can be dismissed.

Hopefully, the Chemistry Chess game set, including 63 blue cards, 36 red cards, the instruction and answer key books can be used to help students and solve problems in chemistry classes in which the colloid concepts are being taught.

4. Conclusion
A learning media for aiding students in learning the colloid concepts was made. The media is called Chemistry Chess and equipped with two sets of cards. The blue cards have two types: knowledge and question. The players can receive a blue card after moving a piece. The red cards also have two types: challenge and special challenge. The challenge cards have different levels based on the types of pieces to be taken. The special challenge cards are given to the player who is going to promote his pawn. The Chemistry Chess is also equipped with the instruction and answer key books. The media can be used as a learning aid for students in learning the colloid concepts since the materials are complex and detailed. After finishing a Chemistry Chess game session, the students are asked to create a report regarding their game result to summarize what they have learned during the game.

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