Design of educational games oriented to chemical literacy on petroleum material

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Abstract. This study uses the stages of the Research Based Design method to produce an educational game oriented to chemical literacy on petroleum material. This research is driven by the importance of a visual learning media in order to improve the ability of chemical literacy in petroleum material so that students can connect between knowledge of concepts and phenomena that occur. The aim of the study is to describe the appearance of educational games oriented to chemical literacy on petroleum material. Based on the results of the study, it is obtained that the chemical literacy-oriented educational game products in the form of chemical monopolies and chemical energy ladders which have characteristics such as game rules that modify the monopoly and snake ladders games equipped with questions oriented to chemical literacy, obstacles in the games show the levels of difficulty and levels of thinking as well as different visualizations that illustrate the context and application of petroleum.

1. Introduction
Chemistry is one of the studies of science that can connect the existence of natural phenomena with the reason why this can happen [1]. Learning chemistry must pay attention to the characteristics of chemistry as processes, products, and instill scientific attitudes to students because the characteristics of chemistry are the same as science [2]. Chemical learning aims to find and compile theories that can provide an explanation of things that occur in everyday life [3]. One of the materials in chemistry subjects that are very close to everyday life is petroleum.

The ability of chemical literacy is very suitable to be developed in petroleum material [4]. Chemical literacy is an ability that involves several components including: (1) Understanding chemical properties, norms and methods, (2) Understanding theories, concepts, and chemical models, (3) Understanding how chemistry and chemical-based technology relate to each other others, and (4) Appreciating the impact of chemistry and chemical technology related to society [5]. With the development of chemical literacy skills, students can cultivate high curiosity and can also appreciate the impact of petroleum in nature [6].

The ability of chemical literacy on petroleum material will be achieved if supported by the use of various media [7]. Media is made in a valid, practical, and effective manner that aims to enable students to foster student learning interest and overcome learning difficulties [8]. Media can be an intermediary channeling messages from senders to recipients that can stimulate thoughts, feelings, attention, and interests in the learning process [9].

Educational games are one example of media in the learning process that can improve student learning outcomes [10]. This can be used as a support for learning that can increase students' learning
motivation to obtain better learning outcomes [11]. In the process, educational games can make students feel happy and comfortable in participating in learning because of activities that make it easier for students to understand and increase knowledge about petroleum material [12].

Educational game consists of electronic games and traditional games. According to psychologists, traditional games are more profitable than electronic media games [13]. Traditional games are able to develop character because they have noble values and certain moral messages such as values of togetherness, honesty, responsibility, and an airy attitude (if defeated), encouragement of achievement and obedience to rules [14]. Meanwhile, the game of electronic media prioritizes individual games and makes children will concentrate and interact fully with the electronic media [13].

The results of the study of the application of traditional educational games that have been widely known domestically and abroad is the game of monopoly and snake ladders, the adaptation of this game into educational games is done by modifying the appearance and rules of the game by linking the material learned [15]. Based on research by Rosyana and Mulyani [16], monopoly and snake ladders learning media in colloidal material have a good influence on student learning achievement in cognitive and affective aspects. The game of monopoly and snake ladders can be one of the supporting factors in the success of learning activities so that it can foster a high curiosity and also be able to appreciate the impact of phenomena that exist in nature [17]. Unlike the case with the research that has been done. The results of this study will describe the appearance of educational games oriented to chemical literacy on petroleum material.

2. Method
This research uses Design Based Research methods. The stages of the research are used to develop and produce a learning product are conducted through two stages, namely introduction study that includes the analysis of aspects of chemical literacy, analytical indicators of chemical literacy on the material of petroleum, and the analysis of the use of educational games in the learning and product designs which includes the creation and design and manufacture of educational games oriented to chemical literacy on petroleum material.

3. Results and discussion

3.1. Educational game making stage
To produce oriented chemical literacy educational game on the petroleum material begins by analyzing the concepts and petroleum material concept map-making based on Based Competency, this analysis aims to match the existing material on the game education with material learned by students. Then analysis of concepts and representations in general, researchers create flow charts and story boards to become a reference for the course of the game flow. Flow charts can be seen in Figure 1 below:
After making flow charts and story boards researchers made connections between material and in-game question indicators. Indicators were made in accordance with the dimensions of cognitive processes C2, C3, C4, C5, and C6 which indicate the level of difficulty of the item. Then, after making the item, the researcher made a development of the display design of the chemical educational game of monopoly and chemical energy ladder with visualization of a more tangible form by using the help of an image processing application. In the chemical monopoly educational game presented in the form of a game that has several properties including 4-5 pieces used as player symbols, 1 pair of dice used to run pieces, game boards with several plots inside, chemistry cards, and library cards and a guidebook on the game of chemical monopoly which is a reference for the course of the game. While in the chemical energy ladder education game presented in the form of a game that has several properties including, the board game containing 100 plots with 9 pairs of ascending plots is represented by pictures of stairs and 9 plots of descending symbolized by spilled oil images, chemistry cards, 1 pair of dice and 4-5 pawns.

### 3.2. Plots of chemical monopoly educational game

Chemical monopoly is one of the chemical literacy-oriented educational games on petroleum material. Chemical monopoly has a game regulation that is almost the same as a monopoly in general. The following is a form of visualization of the chemical monopoly educational game board. Monopoly plots can be seen in figure 2 below:
3.3. Chemical energy ladder educational game plots
Chemical energy ladder is a game that is in the educational game oriented to chemical literacy on petroleum material. This chemical energy ladder board has 100 plots. Inside plot there is a picture of a ladders that direct the player to go up to the next plot if he can answer the questions in the chemistry quiz and there is an oil image that directs him to descend if the player cannot answer the question on the chemistry quiz. The form of visualization of chemical energy ladder education board game can be seen in the following figure 3:

4. Conclusion
The stages of making a chemical literacy-oriented educational game on petroleum material include the stages of design to produce educational games that have characteristics: game rules modify games of monopoly and snake ladders equipped with questions oriented to chemical literacy, obstacles in the game show the different level of difficulty and level of thinking and visualization illustrates the context and application of petroleum. The display of chemical literacy-oriented educational games on petroleum
material includes several properties design that are used in games including the plots of the educational game of chemical monopoly and the plots of the chemical snake ladders education game, chemistry quiz and library quiz, as well as the game guide book.

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