Chemical domino card game integrated with "Jamu Madura" natural materials in improving students' science literacy

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Abstract. The Domino card game media for chemical elements is integrated with natural Madurese herbal ingredients as an alternative media for learning elemental chemistry. Science literacy skills are needed in the learning process, as well as activities in society along with the development of access to information and communication in science content. This research aims to analyze the effect of implementing a chemical Domino card game with integrated elements of Madurese herbal medicine on increasing students’ science literacy. This research is a quasi-experimental research with Non-equivalent Pretest-Posttest Control Group Design. This research was conducted in class XII SMA with a sample size of 60 students. Sample selection was carried out randomly. Science literacy skills were measured using an 8-item essay test. The science literacy indicators used are explain scientific phenomena, evaluate and design scientific investigations, and interpret data scientifically. Data were analyzed using a single ANCOVA with pretest as a covariate. The results of the research show that there is a significant influence of the application of web-based elemental chemistry Domino cards on students' science literacy skills in elemental chemistry material. These results indicate that web-based elemental chemistry Domino cards can improve students' science literacy skills in chemistry learning.

1 Introduction

Games in general are a recreational activity with the aim of having fun, filling free time, or doing light exercise [1,2]. Each game has different rules and ways of playing, making games more varied. Games are a medium of entertainment that is used to relieve boredom [3-4]. Playing games is a fun activity to do and everyone must like it.

In addition to having a positive impact, some games also have a negative impact on their users such as making them forget time and obligations. Playing games can also cause sleep deprivation, depression, self-isolation, and stress [5]. Games have an addictive charm that can make users experience addiction. So we must be careful in choosing games. The most important thing about games is that they contain educational elements.

Educational games are games used in education to support the learning process [6]. Educational games have a very positive impact on their users. Educational games are a new breakthrough in the world of education because they can invite users to learn while playing. Users can gain knowledge and skills by playing educational games [7]. Education is very effective for learning games while playing happily and not boring. Learning by using games will be better remembered than memorizing because learners will try to solve problems or questions by thinking for themselves. There are many types of educational games, one example is an educational game using the Domino card concept [8].

The concept of Domino cards collaborated with the concept of the main group in I A to VII A. This will give students a new experience in the process of learning elemental chemistry through the Elemental Chemistry Card game. Domino Card Game as a learning media that packs chemical education in an entertaining media is effective in increasing student interest in the chemistry learning process so that it can improve student learning outcomes in elemental chemistry material. These results are supported by research which states that Domino card games can train students' skills in thinking and have a positive effect on chemistry learning outcomes. Based on the increase in learning outcomes obtained by all students, the Domino Card Chemistry game media is said to be feasible / very feasible to be used in the chemistry learning process, especially in elemental chemistry material [10].

The periodic system is one way to classify elements that have similar properties. The periodic system table provides information about similar elements [11]. The grouping of elements categorized by nature is divided into 2 groups, namely metal and non-metal properties. The periodicity of an element is the relationship between the nature of an element and the place where the element is placed [12]. These properties change and repeat periodically. Changes according to the atomic number and electron configuration of the element. The following
elemental properties are atomic radius, ionization energy, electron affinity, electronegativity, and cocency. Elemental chemistry is closely related to everyday life [13]. One concept that is closely related to elemental chemistry is drinks such as Madura herbal medicine culture [14].

Jamu is the name for traditional medicine from Indonesia. Later it became popular as herb or herbal [15-16]. Jamu is made from natural ingredients, the result of concoctions of native plants from Indonesia's nature be it from roots, leaves, fruits, flowers, or bark. Jamu does not use chemicals as additives [17-18]. The traditional connotation is always attached to Jamu because Jamu has been known since the time of our ancestors before modern pharmacology entered Indonesia [19-20]. Therefore, many Jamu recipes are hundreds of years old and are used for generations to this day.

Dissecting the Secrets of Madurese Herbs, drinking herbal medicine has become a habit for Madurese families and communities, especially those who are still descendants of blue blood [descendants and relatives of kings]. The habit of drinking herbal medicine has been introduced since early childhood [21-22]. And this habit is more emphasized to women than men. Jamu is mostly utilized by the Madurese community as a health maintainer although there are other types of jamu that are known as medicines to cure diseases. Jamu is also the first aid if there are health complaints. Jamu that is generally used to maintain health is Jamu Sehat Wanita and Sehat Lelaki [23-24]. Learning elemental chemistry will be more meaningful if it is directly related to applied chemistry concepts such as Madurese herbal medicine [25]. This will train students' science literacy skills in elemental chemistry.

Science literacy skills must be possessed by someone in carrying out all activities [26-27]. The 21st century is known as the knowledge age. Science plays an important and dominating role in social life. Science will have a major impact on the quality of personal life, the environment, and the world economy, so it is expected that learners have high science literacy [28-29]. Through science literacy, learners are able to keep up with the pace of development of Science and Technology. There are three main indicators in science literacy skills, namely explaining scientific phenomena, evaluating and designing scientific investigations, and interpreting scientific data and evidence.

Science literacy can be defined as the scientific knowledge and skills to be able to identify questions, acquire new knowledge, explain scientific phenomena, and draw conclusions based on facts, understanding the characteristics of science, awareness of how science and technology shape the natural, intellectual and cultural environment, and willingness to engage and care about science-related issues [30-31]. The range of scientific competencies required for science literacy reflects the view that science is an ensemble of social and epistemic practices common to all sciences, framing all competencies as actions. Science literacy is part of science, is practical, deals with issues about science and scientific ideas [32-33].

The importance of students' science literacy skills, especially in chemistry learning, is a challenge for a teacher. Many things need to be developed to achieve this ability optimally. One of the solutions needed is a development of learning media in the form of games [11]. This game will be expected to train students in the process of science literacy while playing, especially in elemental chemistry learning. Based on the description above, a research was conducted on "Chemical Domino Card Game Integrated with "Jamu Madura" Natural Materials in Improving Students' Science Literacy".

2 Methods

The method used is an experimental method by using a quasi-experimental design. The type of experiment used is the Non-equivalent Pretest-Posttest Control Group Design. The research design in this study is shown in Table 1.

Table 1. Research design.

<table>
<thead>
<tr>
<th>Pretest</th>
<th>Treatment</th>
<th>Posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td>O1</td>
<td>Elemental Chemistry Domino Card</td>
<td>O2</td>
</tr>
<tr>
<td>O3</td>
<td>Conventional</td>
<td>O4</td>
</tr>
</tbody>
</table>

The independent variable in this study is using elemental chemistry Domino cards integrated with natural ingredients of Madurese herbs, and the dependent variable is students' science literacy skills. The population of this study were XII grade students of SMA Negeri 2 Pamekasan. The technique of determining the sample using Non Probability Sampling Technique by selecting two classes that have the same ability of learning outcomes based on the value of chemistry subjects. In this study using two classes with a total sample size of 60 students. The number of classes with the implementation of Web-Based Elemental Chemistry Domino Cards was 30 students, and the conventional class was 30 students.

This study used a test instrument to measure the improvement of students' science literacy on elemental chemistry material with the help of the use of elemental chemistry Domino cards [10]. The test instrument consisted of 10 items that were prepared based on science literacy indicators, namely explaining scientific phenomena, evaluating and designing scientific investigations, and interpreting scientific data and evidence [34-35]. This test was given to the control and experimental classes before and after treatment. This research uses learning tools consisting of syllabus, lesson plans, and worksheets that use web-based elemental chemistry Domino cards. All instruments and research tools have passed the media and material expert validation process. ANCOVA was used to analyze data on the results of students' science literacy skills by involving pretest as a covariate [36]. Data normality prerequisite test was conducted with Kolmogorov-Smirnov test and data homogeneity test with Levene test. Data were analyzed
with the help of IBM SPSS Statistics 23 for Windows Software.

3 Result and discussion

3.1 Results

The summary of the ANCOVA test results of the effect of elemental chemistry Domino card game on students’ science literacy skills in elemental chemistry learning class XII is presented in Table 2.

Table 2. Summary of anova test of science literacy ability of students in experimental and control classes.

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrected Model</td>
<td>2195.557*</td>
<td>2</td>
<td>1247.776</td>
<td>30.154</td>
<td>.000</td>
</tr>
<tr>
<td>Intercept</td>
<td>9328.069</td>
<td>1</td>
<td>9734.063</td>
<td>269.182</td>
<td>.000</td>
</tr>
<tr>
<td>Class</td>
<td>1335.494</td>
<td>1</td>
<td>1239.354</td>
<td>36.432</td>
<td>.000</td>
</tr>
<tr>
<td>Error</td>
<td>3156.832</td>
<td>7</td>
<td>35.249</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>624625.000</td>
<td>80</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected Total</td>
<td>5651.389</td>
<td>79</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Based on the ANCOVA test results in Table 2, it is known that the significance p-value < 0.05 so that H₀ is rejected and the research hypothesis stating that the web-based elemental chemistry Domino card game has an effect on students’ science literacy skills in class XII elemental chemistry learning is accepted. The results of the category of improvement in the science literacy skills of experimental class students in terms of the n-gain score category SHOWN IN Table 3.

Based on the results of the n-gain score in Table 3, it was obtained that the increase in science literacy skills in the experimental class was 100% in the high category, while the control class was 27% in the high category and 66% in the medium category, and 7% in the low category.

Table 3. Results of n-gain score of Students' Saisms: Literacy Skills in Experimental and Control Classes.

<table>
<thead>
<tr>
<th>Category</th>
<th>n-gain</th>
<th>Experiment</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>30</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Medium</td>
<td>-</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>-</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

3.2 Discussion

The results showed that there was a significant effect on the results of students' science literacy skills by using a web-based elemental chemistry Domino card game integrated with Madurese herbal chemistry. Educational games are one of the effective media in improving students' literacy in learning. The elemental chemistry Domino card will provide a stimulus in performing the stages on the science literacy indicator. This game is an alternative media in training students’ literacy, especially in the content part of the natural ingredients of Madurese herbal medicine which is connected to the concept of elemental chemistry [10]. The results show that the elemental chemistry Domino card applied in the experimental class can perfectly improve the value of students' science literacy skills in chemistry learning and in the high category.

Science literacy has three main indicators, namely explaining scientific phenomena, evaluating and designing scientific investigations, and interpreting scientific data and evidence [35,37]. These three indicators will be mandatory in training students' science literacy skills in the learning process. Each indicator requires knowledge, such as the indicator that explains the phenomenon of science and technology requires scientific knowledge content called knowledge content [38]. The second and third indicators require not only content knowledge but also procedural knowledge that underlies various methods and practices in building scientific knowledge and requires cognitive knowledge, namely an understanding of the reasons for conducting scientific research practices in general, the status of the results to be achieved [39].

The first indicator of science literacy is explaining scientific phenomena. Science has successfully developed a set of explanatory theories that have transformed our understanding of the natural world, particularly of the natural ingredients of Madurese herbal medicine [40]. Such knowledge has enabled the development of technologies that support human life, such as treatments for various diseases and rapid communication around the world. Competence to explain scientific and technological phenomena thus depends on knowledge of these key explanatory ideas of science [37,41]. However, explaining some scientific phenomena requires more than just the ability to recall and use theories, explanatory ideas, information and facts [content knowledge] [32].

The elemental chemistry Domino Cards are integrated with the natural ingredients of Madurese herbs, so as to emphasize the science phenomena around us. The concept of elemental chemistry on the natural ingredients of Madurese herbal medicine is closely related [14,42]. Students can understand and analyze how the phenomenon of Madurese herbal medicine concept in elemental chemistry [25,43]. The elemental chemistry Domino card provides a new experience in improving students' literacy skills, especially in the indicator of scientific phenomena in elemental chemistry in the natural ingredients of Madurese herbs. The second indicator on science literacy is evaluating and designing scientific inquiry. Science literacy requires learners to have some understanding of the purpose of scientific inquiry, which is to produce reliable knowledge about natural knowledge [28,30]. In this study, the emphasis is on the concept of elemental chemistry integrated with natural ingredients of Madurese herbal medicine. The concept of ethnomedicine is needed in learning elemental chemistry to better understand the relationship between
material and community culture [44]. Data obtained by observation and experimentation, either in the laboratory or in the field, leads to the development of explanatory models and hypotheses that allow predictions that can then be tested experimentally [38].

The elemental chemistry Domino card uses the main element (Group A) to illustrate the content of natural ingredients in Madurese herbal medicine [10]. Each card is integrated with a web that contains natural ingredients commonly used in Madurese herbal medicine. This will train students in evaluating and designing the concept of elemental chemistry in the natural ingredients of Madurese herbal medicine [7]. The elemental chemistry Domino card game media is an alternative in improving students’ literacy skills, especially in the indicator of evaluating and designing scientific investigations on elemental chemistry in the natural ingredients of Madurese herbal medicine.

The third indicator of science literacy is interpreting scientific data and evidence. Interpreting data is a core activity for all scientists. It usually starts with looking for patterns, perhaps through creating simple tables or graphical visualizations [27,32]. Any relationships or patterns in the data should be read using knowledge of standard patterns of measurement. The content of Madura herbal medicine natural ingredients on the elemental chemistry Domino card web can provide an overview of data about the use of a natural compound in the utilization of Madura herbal medicine [10].

In the elemental chemistry Domino card game, students can analyze elemental chemical data on Madurese herbal ingredients. An educational game is not just playing, but provides new experiences for students to find scientific evidence in a subject matter [4,5]. Scientifically literate individuals must be able to assess whether this procedure is appropriate and whether subsequent claims are justified. This competency also includes accessing scientific information, generating and evaluating arguments and conclusions based on scientific evidence [26,35]. The elemental chemistry Domino card game media becomes an educational game in improving students’ literacy skills, especially in the indicator of interpreting data and scientific evidence on elemental chemistry in natural ingredients of Madurese herbal medicine.

4 Conclusion

The effect of elemental chemistry Domino card game integrated with Madura herbal medicine natural ingredients on students’ science literacy skills. The results showed a significant effect in the application of elemental chemistry Domino card game on students’ science literacy skills in elemental chemistry subjects. The application of elemental chemistry Domino card perfectly provides an increase in the high category of students’ science literacy ability. The elemental chemistry Domino card game successfully trained three indicators of science literacy skills consisting of explaining scientific phenomena, evaluating and designing scientific investigations, and interpreting scientific data and evidence. The combination of play and integration of local wisdom (Jamu Madura) in learning can train and stimulate the process of students’ science literacy skills.

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