

Development of Flipped Classroom Based Guided Inquiry Learning System with Digital Literacy Using Discord Application on Thermochemistry

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Abstract: The era of the industrial revolution 4.0, teachers will deal with children who are very intense with gadgets or other technology. This is a challenge in the learning process. This article aims to produce a learning system with digital literacy based guided inquiry integrated flipped classroom using Discord application on thermochemistry and determining the validity and the practicality level. The study took six months to complete utilizing the Plomp Model and educational design research (EDR). The research steps carried out preliminary research and development of prototyping, this paper is limited to testing the validity and practicality of the developed learning system. The Subject of this research is lectures and teachers as expert review, and 9 students. Data on content and construct validity and practicality were analyzed using Aiken's V formula and practicality percent, respectively. Based on the study's findings, it was determined that the values of 0.84 for both construct and content validity fell into the category of being valid. Results that are practical, scoring 92% in the extremely practical category. Therefore, it was determined that the learning system created was genuine and usable so that its efficacy could be tested for future research.

Keywords: Digital literacy; Discord application; Flipped classroom; Guided inquiry

Introduction

Currently, the development of the industrial revolution 4.0 era cannot be avoided by anyone. The application of artificial intelligence (artificial intelligence) is one of the characteristics of the industrial revolution 4.0 era. The main pillar of the 4.0 industrial revolution era is education. In this case, learning can optimize the use of technology as an educational tool to support the learning process (Rahman & Nuryana, 2019). In the field of education, educators are required to adapt themselves and be creative in order to successfully take advantage of all the benefits brought by the 4.0 industrial revolution era (Aryanti & Utamajaya, 2022). Learning through the internet has become a challenge for educators and students to finding the right learning in this kind of situation (Ismail & Mawardi, 2021).

The adaptation that teachers and students must make is to change their thinking about the role of the teacher and the learning process as well as students'

digital literacy abilities in pursuing modern education today. Digital literacy is the ability to process and understand information and be able to communicate with others in various ways effectively in achieving educational goals (Nasrullah et al., 2017). Utilization of learning materials available on digital platforms depends on the level of literacy and competence of individual students (Rasheed et al., 2020). In the era of the industrial revolution 4.0, teachers will be dealing with children who are very intense with gadgets. This is a challenge in itself to anticipate these conditions in the learning process. Teachers need to adjust the content that will prepare students with 21st century skills, as well as implement blended learning and utilise social media in learning (Afrianto, 2018).

Blended learning is an online education with several components (Herpika & Mawardi, 2021). Based on a lesson plan that has been determined remotely (Clayton et al., 2013). Blended learning has four types of models, one of which is the rotation model. One type of

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rotation model is the flipped classroom. Flipped classrooms provide opportunities for structured and active learning and encourage students to discuss with teachers or peers (Divjak et al., 2022). Flipped Classroom encourages students to think and adjust students' learning styles and speeds (Herpika & Mawardi, 2021; Winata & Mawardi, 2021). There are two learning conditions, namely asynchronous learning and synchronous learning. Asynchronous learning is between teachers and students in different times and places, while synchronous learning is the opposite (Chaeruman & Mudiarti, 2018). This explains that all processes in the flipped classroom implement a learning process with a scientific approach (Al-Samarraie et al., 2020).

One of the causes of the lack of response of students in teaching is because there is no preparation related to the material or the initial concept. Therefore, a learning model is needed that can guide students in finding concepts (Mawardi et al., 2021). One model that can apply a scientific approach is the Guided Inquiry model. Guided inquiry is a learning model that helps students understand and discover concepts based on their own understanding with prior knowledge (Hanson, 2013). Guided inquiry can improve learner activity, motivation and learning outcomes (Asra et al., 2016; Fani & Mawardi, 2022; Piawi et al., 2018). The Discord application can combine that of all and provides features that can help students to practice digital literacy competencies in the learning process (Uong et al., 2022).

Based on the theory and problems that have been described, the researchers designed research aims to produce a learning system with digital literacy based guided inquiry integrated flipped classroom using Discord application on thermochemistry and determining the validity and the practicality level. This is hoped to support learning in the era of industrial revolution 4.0 with students' digital literacy skills towards technology and information development, independent curriculum, and student-centred learning.

Method

The type of research used is development research or commonly known as Educational Design Research (EDR) or educational research design. This research is an educational research that will produce a product in the form of a learning system with digital literacy based on guided inquiry integrated flipped classroom using Discord application on thermochemistry. The development model used in this research is the Plomp development model developed by Tjeerd Plomp. This Plomp development model consists of three stages, namely: (1) preliminary research (initial investigation phase), (2) development or prototyping phase, (3) assessment phase (trial and assessment phase) (Plomp

& Nieveen, 2007). This research is limited to the development and prototyping phase.

The Preliminary Research stage, also known as the initial investigation stage, begins with a needs analysis and context analysis, then a literature study, and the development of a conceptual framework. Needs analysis is the first step in this research. The needs analysis aims to analyze the basic problems that occur in Senior High Schools. The method used in the needs analysis was interviews with three chemistry teachers in three different high schools. Then, study the literature by analysing articles in several journals, analysing the methods used and finding solutions to the problems faced by teachers and students in the learning process.

The next stage is the development of a conceptual framework by analysing the results of the needs and context analysis. Then, the results of the analysis are supported by the results of the literature study so that an overview or summary is produced regarding the reasons for conducting this learning system development research.

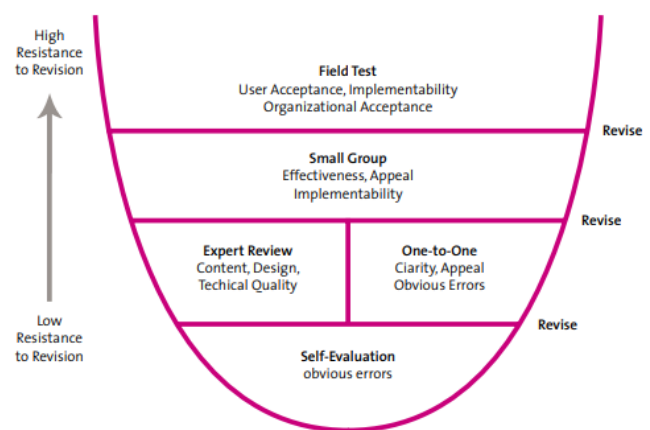


Figure 1. Layers of Formative Evaluation from Tessmer (Plomp Tjeerd & Nieveen Nienke, 2007)

The second stage is the development or prototyping stage. Prototyping phase that will produce prototype I, prototype II, prototype III and prototype IV. These four prototypes are the result of the formative evaluation. This evaluation consists of four stages based on Figure 1, namely self-evaluation using a checklist of design characteristics or specifications; Expert review, the experts in question are content experts, media experts, and technical experts, namely by providing suggestions for improvement and assessment of the products developed. The expert assessment was conducted by three chemistry lecturers of FMIPA UNP and two chemistry teachers of SMAN 8 Padang.

One-to-one evaluation, which is observing and monitoring how students use the developed product. Then ask questions to three students through direct interviews. This stage is carried out after the expert

review is carried out then continued with revision. The expert review and one-to-one evaluation stages are the validity process of the product developed. Small Group (small group trial) to measure the practicality of the developed product (Plomp Tjeerd & Nieveen Nienke, 2007).

The interview data is explained in the discussion. Then Equation (1) is used to check the validity of the product produced after the data obtained from the expert validator is processed using the Aiken's V formula.

Aiken's V Formula:

$$V = \frac{\epsilon s}{n(c-1)} \quad (1)$$

$$S = r - I_0 \quad (2)$$

Information:

S : The validator's assigned score minus the lowest score of the category

r : as the score of the category of choice

I₀ : as the lowest score in the scoring category.

n : many validators

c : many categories chosen by the validator (highest validity score)

Practicality processing is obtained from the administration of a learner response questionnaire which is analyzed using a formula:

$$NP = \frac{R}{SM} \times 100 \quad (3)$$

Information:

NP : percent value sought or expected

R : raw score obtained by students

SM : ideal maximum score of the test concerned

100 : fixed number

Result and Discussion

Preliminary Research

Research has been completed and resulted in several stages in implementing the Plomp development model. The first stage is preliminary research namely need and context analysis. The needs analysis looks at the fundamental issues that senior high schools face. Three chemistry teachers from three separate high schools were questioned for the needs analysis. The three high schools are SMAN 1 Padang, SMAN 8 Padang and SMA Pembangunan UNP.

Based on the new curriculum, the independent curriculum, a scientifically based, learner-centered learning system is required. The scientific approach aims to improve the ability to think critically, creatively and

develop students' skills in utilizing technology, especially social media. One of the appropriate learning models with a scientific approach in an independent curriculum is the guided inquiry model combined with a flipped classroom to overcome existing problems at school.

Based on the results of the interview, it was found that there were no teaching materials specifically for thermochemical material in accordance with the independent curriculum. Not only that, social media has not been utilized that can facilitate the entire guided inquiry syntax in one application. Based on the results of the interview, it is also known that there is no application that can monitor student activities and learning progress and there is no social media that can automatically organize the stages of learning.

Context analysis is carried out curriculum analysis, namely analysis of learning outcomes. Learning outcomes aim to identify, systematically arrange thermochemical material, learning objectives, flow of learning objectives, material development by applying chemical multirepresentations and learning strategies and improve students' digital literacy skills in utilizing technology. This analysis is in the form of content standard analysis on thermochemical material, learning outcomes on thermochemical material are students able to observe, investigate and explain everyday phenomena according to the rules of scientific work in explaining chemical concepts in daily life, applying mathematical operations in chemical calculations, understanding, explaining energy aspects and using chemical energy transformations.

The next stage is a literature study, namely the analysis of articles also aims to find out and analysing the problems faced by teachers and students in the teaching and learning process on thermochemical material. Then, the development of a conceptual framework by analysing the results of the needs and context analysis. Several literature studies have shown that flipped classroom-oriented guided inquiry learning can improve the interaction between teachers and learners and can also improve learners' thinking skills. This method facilitates time for teachers to implement higher levels of learning activities based on Bloom's taxonomy levels that hone learners' higher order thinking skills (DeMatteo, 2019).

Research from Syafe'i et al. (2022) the validity and practicality of the FGIL (Flipped Classroom Based on Guided Inquiry Learning) learning model designed for studying chemical bonds were examined. With valid categories, validation was done on both content and media, yielding validity results of 0.84 and 0.89. Then, practicality displays an 89% score in the category of extreme practicability. This describes how the guided inquiry-based flipped classroom system is a

combination of very helpful learning techniques for blended learning.

Other research from Mawardi et al. (2020), the use of guided inquiry-based student worksheets improves students' ability to learn in 21st century learning. The research from Siregar et al. (2022), the learning model of Guided Inquiry will certainly also get the students used to being able to think more critically, to be able to make assumptions and to be responsible in order to gain understanding independently in order to solve a problem.

Then, the results of the analysis are supported by the results of the literature study so that it is known that these problems exist, so a product is designed, namely a learning system with digital literacy based on guided inquiry integrated with a flipped classroom using the Discord application on thermochemical material. The design of the learning system with digital literacy based on guided inquiry integrated flipped classroom using Discord application on thermochemistry material can be seen in Figure 2.

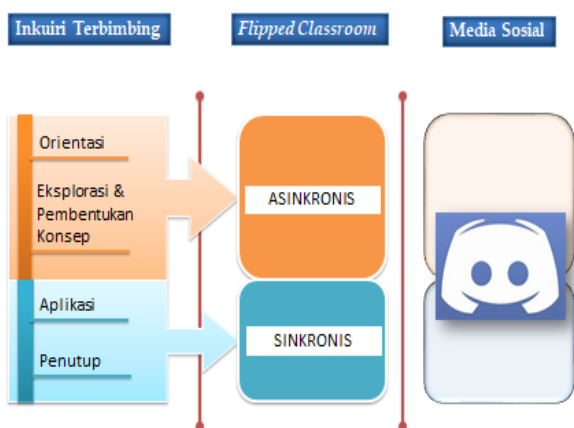


Figure 2. Learning cycle with digital literacy based on guided inquiry integrated with flipped classroom using discord application

Development or Prototyping Phase

Product development, which creates prototype 1, is the initial stage of the development or prototyping phase. The end result is a learning strategy for digital literacy built on guided inquiry and integrated with a flipped classroom utilizing the Discord software, which is made for online learning or blended learning. Figure 3 shows this concept in action. This learning system combines in-class and out-of-class learning. Guided inquiry-based learning using Discord application starts with the stages: preparation (asynchronous), orientation (asynchronous); exploration and concept formation (asynchronous); application (synchronous); and closing (offline and online synchronous).

During the orientation phase, students are shown a movie that includes learning objectives, apperception, motivation, and introduction content in addition to

learning instructions. Figure 4 is an illustration of a Discord orientation video post.

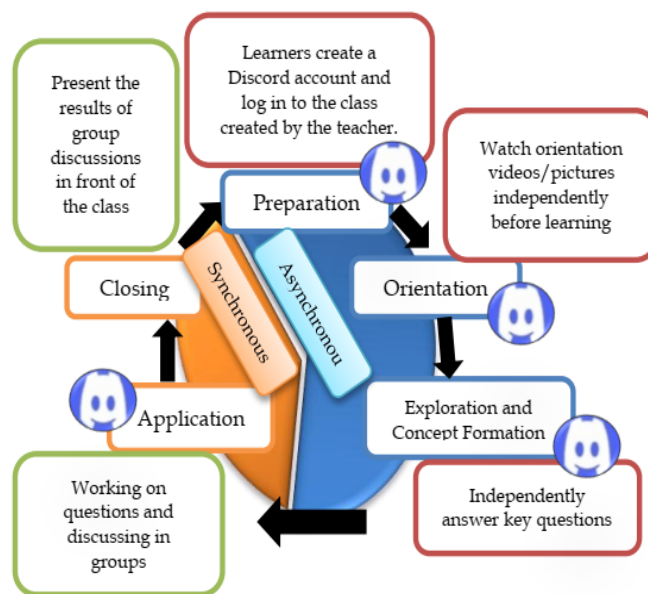


Figure 3. Learning stages of an integrated guided inquiry model flipped classroom using discord application



Figure 4. Orientation video on discord

Students will evaluate the model (image, table, or chart) throughout inquiry and concept formation. then respond to a few crucial model-related queries. Figure 5 shows an illustration of how Discord displays information.

The synchronous activity is then resumed during class instructional time with the application step and continued with the closing stage. Group talks are used to carry out the application stage. In their individual groups, each student will discuss the solutions to the questions that have been presented. Figure 6 displays a sample of a Discord presentation.

In the application stage, students will conduct discussions in groups. Group learning will engage students to play an active role in learning that emphasises data analysis and critical thinking. When

students analyse the model in the key question and understand the concepts found in the exploration stage and concept formation stage, they will be successful in answering the questions in the application stage (Khairunnisak et al., 2023; Mawardi et al., 2020).

make conclusions from the material can be seen in Figure 7.

After product development that resulted in prototype I. The second stage is self-evaluation. At this stage, produced a personal assessment of the researcher based on the assessment aspects: (1) Guided inquiry-based flipped classroom learning steps. (2) Orientation video/image uploaded to Discord. (3) Model and key questions on Discord with a maximum of 1 day to complete. (4) Instructions to take attendance as proof of attendance. (5) Small group division on Discord. (6) Discord usage guide. (7) The application stage on Discord. (8) Practice questions on the small group feature that are worked on. (9) Instructions for answering questions on Discord. (10) Problems on the assignment feature that were collected 1 day after class time. (11) Instructions for the closing stage on Discord. (12) Link to enter the Video Conference feature on Discord. (13) Schedule for video conference meetings. Valid self-evaluation measures were used to conduct the assessment. reliable self-evaluation tools. All elements that were thought to have been properly satisfied were revised, along with some undesirable elements like language improvement.

Expert review is the third stage. The product is evaluated and reviewed by content and construct experts, either with or without the involvement of researchers. Three lecturers and two chemistry teachers did the content and construct validation. Validation is performed in accordance with a valid validation sheet's instructions. The validators provided various ideas to this method, which were subsequently updated based on the feedback (in the appendix). Each validator provided feedback when the revision had been completed.

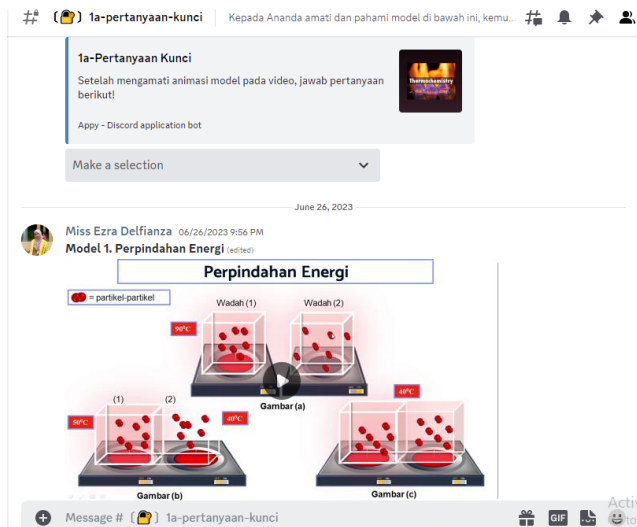


Figure 5. Exploration and concept formation on discord



Figure 6. Application stage on discord

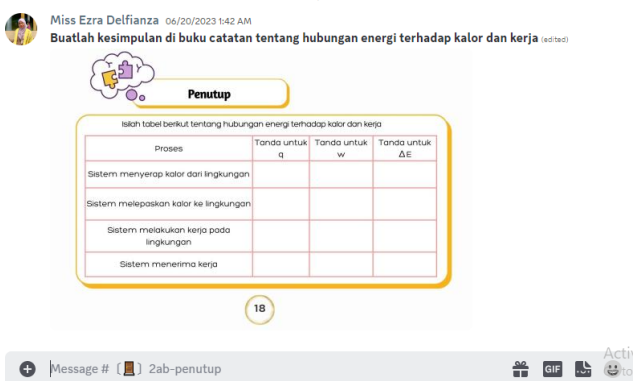


Figure 7. Closing stage on discord

Then the closing stage is carried out synchronously in the classroom, the closing contains instructions to

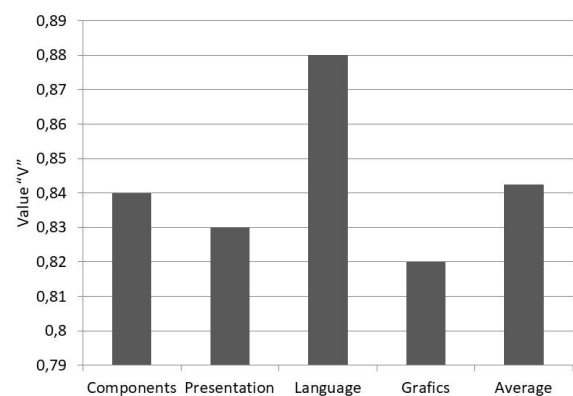


Figure 8. Analysis of content validation results

The Aiken's V formula was used to calculate the validity features of the validity aspects (Aiken, 1985). With the valid category being 0.84 for five validators. Figure 8 shows the findings of the content validation investigation, whereas Figure 9 shows the findings of the construct validation analysis.

Based on Figures 8, it can be seen that the value of validity for each item is above 0.84, which means that the developed product is valid in terms of content, appearance, language, and graphics. The average content validity value is 0.84.

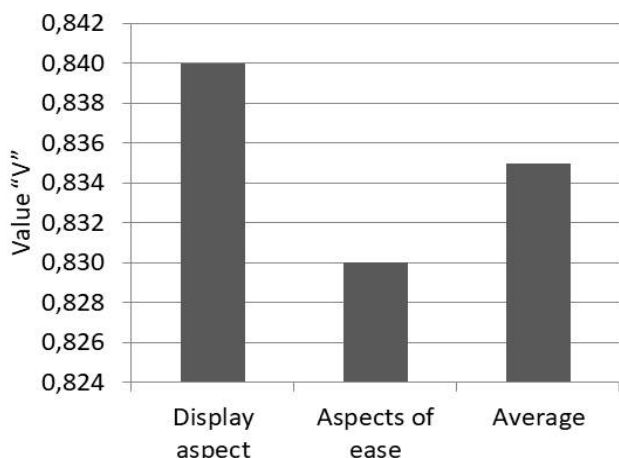


Figure 9. Analysis of construct validation results

Based on Figure 9, it can be seen that the value of construct validity for each item above is 0.84 and above, which means that the developed product is valid from the display aspect and aspect of ease.

The fourth stage is one-to-one evaluation. At this stage, interviews were conducted with three eleventh grade students who had different abilities, namely students who had high, middle and low abilities. This aims to find out how students respond to the learning system being developed. After the expert review and one-to-one evaluation, it was continued with revisions based on the suggestions given to prototype II. This aims to improve the quality of the prototype so as to produce a valid prototype III.

The fifth stage is small group, namely the formation of prototype IV by testing prototype III to small groups by selecting nine students with different ability levels, namely high, middle, and low based on recommendations from high school chemistry teachers. Researchers divided students into several study groups, then simulated the use of Discord and learning procedures that had been designed with digital literacy based on the flipped classroom integrated guided inquiry learning model. Learners conducted a flipped classroom learning process based on guided inquiry on Discord for one cycle on thermochemical sub-materials. The researcher gave a questionnaire to students and gave directions on how to fill out the questionnaire. Learners are asked to fill out a questionnaire and provide suggestions and criticism.

After the above stages are carried out, evaluation results will be obtained. In addition to students, a practicality questionnaire was also given to the chemistry teacher of SMAN 8 Padang, then the

evaluation results from teachers and students were analyzed. If revisions are needed in prototype III, revisions will be made based on suggestions from teachers and students. This aims to improve product quality in prototype III so that prototype IV is produced with a valid and practical product so that it can be used in the learning process. The results of the formation of prototype IV can be seen in Figure 10.

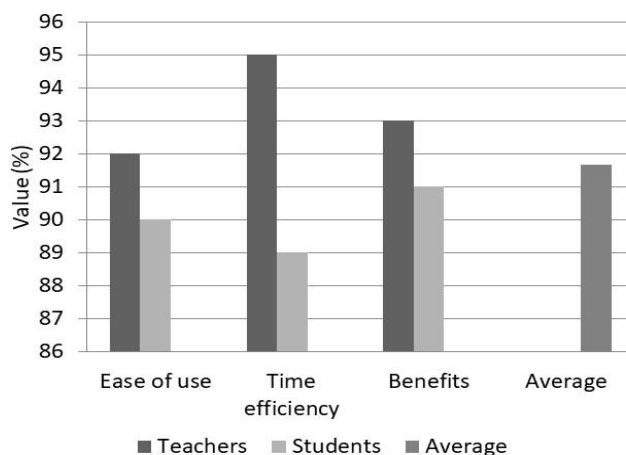


Figure 10. Analysis of practicality results

Based on Figure 10, it can be seen that the practicality value for each item above with an average is 92%, which means that the developed product is practical in terms of ease of use, time efficiency, and benefits. These results were then revised to produce a valid and practical prototype IV.

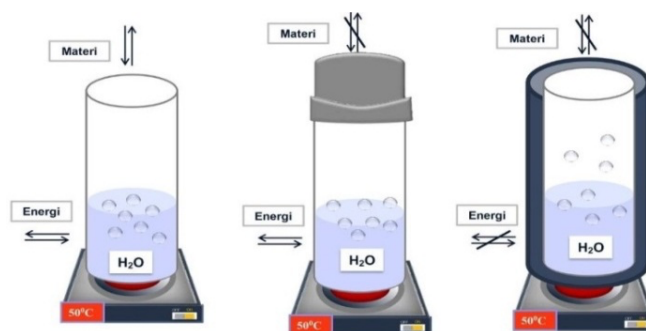


Figure 11. One of the models in exploration and concept formation

One of the key question models that students must answer can be seen in Figure 11, where students are relied upon to understand the types of systems. From interviews conducted with students, it is known that an open system is a transfer of energy and matter from the system to the environment or vice versa. This reaction occurs due to the transfer of heat from the stove to the container which causes energy and matter to move. In a closed system, only energy can move from the system to the environment or vice versa. While an isolated system is that there is no transfer of energy and matter from the

system to the environment or vice versa. In short, these are the types of systems.

At this stage, students are expected to be able to answer the key questions correctly and be able to find concepts after analyzing the models or images contained in the key questions with the help of microscopic level images and animated models. This explanation can be seen in Figure 11 which shows how the state of energy and matter in a system. This helps students' understanding when given a model in the form of multirepresentations consisting of macroscopic, sub-microscopic, and symbols. When given an image presented in macroscopic form only, students cannot clearly understand how matter and energy can move from the system to the environment or vice versa. If given images in macroscopic form, students cannot see the changes that occur at the sub-microscopic level.

Based on research conducted by Ismail et al. (2021), the results show that it is the combination of these three parts of substance depiction that helps students track ideas in the natural, sub-microscopic, and symbolic worlds without which students would be misled, and with the help of synthetic depiction, learning will become more significant.

Conclusion

The development of learning systems produced through validity and practicality tests resulted in valid and very practical categories. This explains that the product developed can proceed to the effectiveness test so that it can be implemented in the learning process. The content validity value is 0.84 and construct validity is 0.84 and the practicality value is 92%.

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Author Contributions

All author contribute the research article with their respective responsibilities namely Mawardi Mawardi, conceptualization, methodology, validation supervision, review and editing; Mawardi Mawardi; formal analysis, validation; Okta Suryani, formal analysis, validation; Ezra Delfianza, investigation, data curation, writing—original draft preparation, editing and project administration.

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Conflicts of Interest

The authors declare no conflict of interest.

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