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Development of Integrated Digital Pop-Up Book Media Using PBL Model for HOTS Science Literacy

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Abstract: *Low Science Literacy and limited PBL-based learning media encourage the need for media development that can improve students' HOTS. This study aims to develop a Pop-Up Book Digital learning media integrated with the Problem-Based Learning model and test the validity and practicality of the media on stoichiometry material. This study uses the Research and Development (R&D) method with the ADDIE development model. The sample was 3 lecturers who are media and material experts from the chemistry department, 1 chemistry teacher, and students of Class X-C at SMAS Imelda Medan. The data collection instrument used a questionnaire adopted from BSNP based on the Likert Scale. The results of the study showed that the developed media was declared valid based on the average percentage of material experts of 85.15%, media experts of 98.33% and educator assessments of 88.54% with very high validity criteria. In addition, the developed learning media is included in the very good criteria reviewed from the response of students, with an average percentage of 87.89%. Thus, it can be concluded that the Pop-Up Book Digital media integrated with the Problem-Based Learning model can be used in chemistry learning of stoichiometry material at SMA Swasta Imelda Medan.*

Keywords: *HOTS; digital pop-up book media; PBL model; science literacy; stoichiometry*

INTRODUCTION

The Independent Learning Curriculum is an educational innovation that aims to provide freedom to students in choosing, accessing, and developing learning according to their interests, talents, and potential. This concept is carried out with the aim that students can develop themselves holistically, creatively, and independently in accordance with the development of the times (Septiani et al., 2023). This curriculum can be applied to every subject, including chemistry. Chemistry is a science that plays a fairly important role because, through chemistry, various life phenomena can be explained logically (Saptono Nugrohadi & Iswatun Chasanah, 2022).

One of the chemistry materials studied in high school is stoichiometry. Stoichiometry is a field of chemistry that discusses the basic concepts of chemistry, so that the learning difficulties experienced by students in studying stoichiometry will certainly have an impact on the learning process in the next material (Evangelista et al., 2022).

The problem that is often found in the world of education is the limited learning media that can facilitate students in building conceptual understanding of learning materials (Nasution et al., 2024). The use of

learning media can help achieve learning success (Puspitarini & Hanif, 2019). Media has a clear function, namely to clarify, facilitate, and make interesting the material that will be delivered by the teacher to students (Hasanah et al., 2023).

Technology-based learning media is currently an interesting topic to discuss (Julita&Purnasari, 2022). 21st-century learning also requires the use of appropriate technology and learning media (Nasution & Uqba, 2024). One of the media that is increasingly attracting attention in this context is pop-up books. The presence of pop-up books offers new opportunities in science education by allowing students to learn in a more fun and interactive way (Edarto & Martadi, 2022).

The results of observations and interviews by researchers with chemistry teachers at Imelda Medan Private High School found that student learning outcomes in chemistry learning, which was 70, indicated that student learning outcomes had not reached the Learning Objective Achievement Criteria (KKTP) of 75. This was also conveyed by the chemistry teacher during the interview that the learning process used was less varied and conventional by only using Power-Point media which tended to be informative which only contained descriptions of the material and examples of questions that did not trigger students to be more active and develop their thinking skills in finding their material concepts.

The results of a survey from the Program for International Student Assessment (PISA), which has the goal of measuring the mathematics, reading, and science skills of Indonesian students periodically in 2022, showed a decline in international learning outcomes due to the pandemic. The reading literacy score in Indonesia decreased by 12 points from the previous PISA results. The results also explain the lag of Indonesian students by 117 points from the average global literacy score. Sadly, only 25.46% of Indonesian students achieved the minimum reading competency standard from PISA (Amelia et al., 2023).

High-level thinking skills are one of the factors that influence scientific literacy skills (Thahir et al., 2021). People who have chemical literacy understand basic chemical concepts, can explain phenomena and solve problems in life using their understanding of chemistry, understand chemical innovations in social life, and have an interest in chemistry (Pulungan & Simamora, 2024). About problem solving, pop-up books also offer students the opportunity to hone their problem-solving and critical thinking skills (Rosyadi et al., 2024).

Students' scientific literacy skills and understanding can be developed and improved with appropriate learning models and supporting technology (Fitriyana et al.,2020). One of the learning models that can optimize the role of students during the learning process is PBL (Problem-Based Learning). The application of PBL supports the formation of three scientific competencies in scientific literacy, namely the ability to identify scientific issues, the ability to explain phenomena scientifically, and the ability to use scientific evidence (Nevrita et al., 2019).

About the PBL model used, the results of Utami & Endang Setyaningsih's (2022) study stated that the PBL learning model can have an effect on improving students' scientific literacy. Evalina et al.'s (2024) research also showed that the implementation of the Problem-Based Learning (PBL) learning model assisted by innovative media can improve students' scientific literacy.

The purpose of this study was to develop a Pop-Up Book Digital learning media integrated with the Problem-Based Learning model to support the improvement of HOTS Science Literacy of students in stoichiometry material. In addition, this study also aims to measure the level of media validity based on 3 media expert lecturers and material experts from the chemistry department, 1 chemistry teacher, and measure the level of media practicality according to Class X-C students at SMA Swasta Imelda Medan.

LITERATURE REVIEW

Learning Media

Media comes from the Latin medius, which means middle, intermediary, and messenger. Therefore, media can be interpreted as a messenger or conveying messages from the sender to the recipient of the message (Daniyati et al., 2023). In the learning process, media is an intermediary between the source of the message and the recipient of the message, stimulating thoughts, feelings, attention, and will so that they are motivated and involved in learning (Ramadani et al., 2023).

Strategic selection of appropriate instructional media is identified as a key approach for educators to achieve their learning objectives (Daeli & Silitonga, 2023). The use of learning media can help achieve learning success (Sugiharti et al., 2022). It can be concluded that learning media is an educational tool that can be interpreted as a tool in the form of hardware or software used in delivering material by teachers to students in the learning process.

Digital Pop-Up Book Learning Media

Pop-Up Book media is a three-dimensional teaching aid that can stimulate children's imagination and increase knowledge, and improve children's understanding. When opened, it can present a 3-dimensional or raised construction and provide a more attractive visualization or display to improve students' understanding of the material (Setiyanigrum, 2020).

According to Bluemel & Taylor (2012:1) Spring up book is a book that offers the potential for movement and collaboration using paper mechanisms like folds, scrolls, slides, tabs, or wheels, meaning a PopUp book is a book that creates a display of movement and interaction with various paper usage techniques. In line with that, according to Yanto et al (2023) Pop-up or movable book is a three-dimensional book containing pieces of paper that appear or move when the book is opened and fold completely when the book is closed.

Problem-Based Learning Model

The Problem-Based Learning model is a learning model that is centered on problems, and learners are centered on a dynamic process where students are actively involved in action and solving problems related to the content and context being investigated (Sugiharti & Zen, 2020). According to Koeswanti (2018:7), the Problem-Based Learning (PBL) learning model helps students develop problem-solving skills,

The steps of the Problem Based Learning model consist of five steps, namely: (1) Orienting students to problems (2) organizing learning activities (3) guiding individual and group investigations (4) developing and presenting work results (5) analyzing and evaluating the problem-solving process (Novelni & Sukma, 2021). PBL helps students develop thinking and problem-solving skills, learn authentic adult roles, and become independent learners (Arends, 2012).

Higher Order Thinking Skills

Higher order thinking skills (HOTS) are the ability to connect, manipulate, and change existing knowledge and experience critically and creatively in determining decisions to solve problems in new situations (Tasrif, 2022). Halpern (in Huda, et al., 2021) defines critical thinking as “cognitive skills and strategies that increase the likelihood of desired outcomes.

According to Bloom, skills are divided into two parts. The first is low-level skills that are important in the learning process, namely remembering, understanding, and applying, and the second is classified into high-level thinking skills in the form of analyzing, evaluating, and creating skills (Ariyana et al., 2018). Thus, it can be concluded that the indicators in HOTS questions include three indicators, namely analyzing (C4), evaluating (C5), and creating (C6).

Scientific Literacy

Science literacy comes from the Latin word literatus, which means letters, literate or educated, and scientia, which means having knowledge (Pratiwi et al., 2019). Literacy is a set of a person's abilities and skills to read, write, speak, count, and solve problems at a certain level of competence needed in everyday life (Jahro et al., 2024).

In general, scientific literacy focuses on four interrelated aspects, namely knowledge, context, competence, and attitude (Fuadi et al., 2020). In its development, PISA in 2015 determined that scientific literacy consists of four large dimensions (aspects) which are interrelated, namely competence (science process), knowledge of science content, science context, and attitude (Rini, et al., 2021).

METHODS

The research method used is the development method (Research and Development). The development model used refers to the ADDIE development model, whose stages include: Analysis, Design, Development, Implementation, and Evaluation.

The data collection instruments used were validation questionnaire sheets adapted from BSNP and student response sheets. The sample in this study was 3 lecturers who were media and material experts in the chemistry department, 1 chemistry teacher, and class X-C students at SMA Swasta Imelda Medan.

Data for analyzing the validity and practicality of the media were obtained from the results of assessments by material experts, media experts, teacher responses, and student responses, then analyzed using the following equation:

$$P = \frac{\Sigma x}{\Sigma xi} \text{ x } 100\%$$

(Wijayanti, et all, 2022)

The percentage results obtained are grouped into the following validity and practicality criteria:

Table 1. Percentage of Product Validity Criteria

No	Validity Criteria	Level of Validity
1	85,01% - 100,00%	Very High Validity
2	70,01% - 85,00%	High Validity
3	50,01% - 70,00%	Moderate Validity
4	01,00 – 50,00%	Low Validity

Table 2. Percentage of Product Practicality Criteria

Value Criteria	Percentage (%)	Attractiveness Criteria
4	76 – 100	Very Good
3	51 – 75	Good
2	26 – 50	Not Good
1	0 – 25	Very Not Good

RESULT AND DISCUSSION

This research was conducted at SMA Swasta Imelda Medan with the product developed being Integrated Digital Pop-Up Book Learning Media with Problem Based Learning Model. Product development uses steps in accordance with the stages of the ADDIE development model (Analysis, Design, Development, Implementation and Evaluation). The media development process involves assessments from various parties, including material expert validators, media expert validators, teachers, and students. Assessment of the quality of teaching materials is carried out by distributing questionnaires to all related parties in order to obtain relevant input and feedback.

I. Development of Integrated Digital Pop-Up Book Media With Problem Based Learning Model on Stoichiometry Material

At the analysis stage, based on the results of observations conducted at SMA Swasta Imelda Medan, it is known that there are

limitations in learning media that can facilitate students to build conceptual understanding of learning materials so that results are obtained to enrich student learning resources at SMA Swasta Imelda Medan, the solution offered is the development of integrated Digital Pop-Up Book media with a problem-based learning model as a learning medium with stoichiometry material based on student needs in chemistry subjects.

At the design stage, the researcher first prepares a media design to be developed and obtains design results with the following components: Media cover; First page (foreword, author's identity and table of contents); Introduction (CP and ATP, media usage instructions, learning objectives, and concept maps); Activities (learning materials, learning activities, and evaluation); Final page (glossary).

At the development stage, (Development), the researcher creates a product to be developed and the results obtained are Integrated Digital Pop-Up Book Media with Problem Based Learning model. The cover results on the media contain the title, class, author's name and the name of the supervising lecturer which are presented in Figure 1.

Figure 1. Examples of Cover Media

Next, in the introduction section of the media, clear instructions for using the media and CP-ATP , as well as a concept map presented in Figure 2.

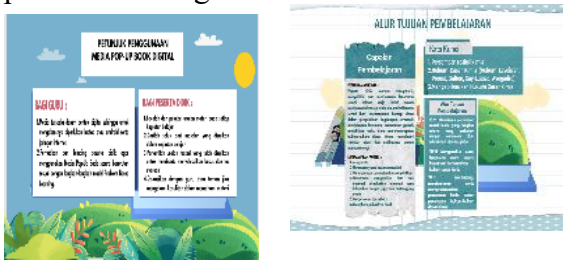

Figure 2. Examples of Media Introduction

Then in each sub-chapter there is material to be studied, learning activities use the PBL model which contains group problems and at the end there are evaluation questions based on scientific literacy which can be seen in Figure 3.

Figure 3. Examples of Display Material based on PBL syntax

After the media development is complete, the next step is to conduct a validation test by experts. Validation was carried out by three chemistry education lecturers, each as a material expert and a media expert, using a feasibility assessment instrument that has been modified from the BSNP standard. Input and comments from the validator experts in the validation test process were used as a basis for revising the initial product. Thus, the final product can be declared feasible for use in learning activities.

II. Quality of Development Results

a. Feasibility of integrated digital pop-up book media using the problem-based learning model on stoichiometry material

In the material experts, the digital pop-up book media developed was validated by referring to the National Education Standards Agency (BSNP) eligibility standards that have been adjusted to the assessment aspects including the eligibility of content, evaluation, language and PBL components. The results of the percentage of the expert material validator assessment are shown in diagram 4 below.

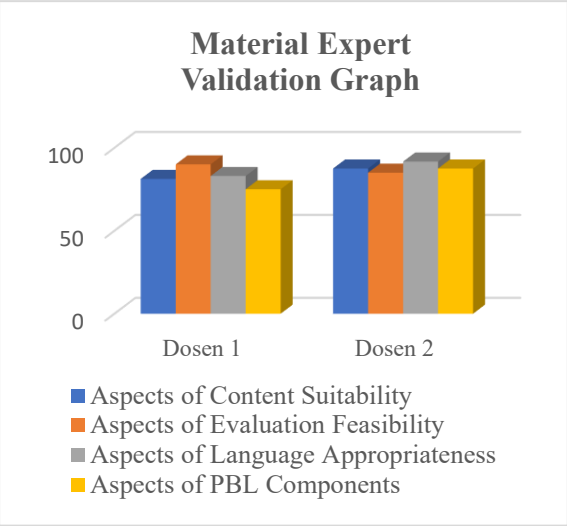

Figure 4. Material Expert Validation Graph

In the diagram above, based on the average aspect of content feasibility of 81.25% in lecturer 1 and 87.5% in lecturer 2. The evaluation feasibility aspect is 90% in lecturer 1 and 85% in lecturer 2. The next aspect is language feasibility of 83% in lecturer 1 and 91.66% in lecturer 2. And the PBL component aspect is 75% in lecturer 1 and 87.5% in lecturer 2. So that from the 4 assessment aspects, an average of 85.15% was obtained with very high validity result criteria.

The results of the percentage of expert media validator assessments are shown in Figure 5 below:

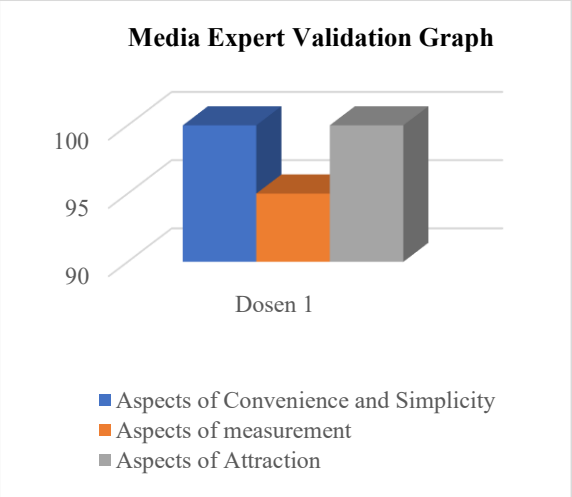

Figure 5. Media Expert Validation Graph

In the diagram above, the percentage results of the 3 assessment aspects obtained an average of 98.33% with very high validity criteria. With an average description of the ease and simplicity aspects of 100%. The size aspect is 95% and the attractiveness aspect is 100%.

Overall, the results of media development are considered very valid. This statement is in line with the results of research showing that Pop-Up Book media is very suitable for use in the learning process (Ananda et al., 2024). In line with this, research conducted by Hasanah, et al., (2023) shows that the average percentage of the summary of the validation results of Pop-Up media with practical basic chemical law material for learning will improve student learning achievement.

b. Teacher responses and student responses to digital pop-up book media integrated with the problem-based learning model on stoichiometry material.

At the teacher response stage, the developed media is assessed using the learning device feasibility assessment instrument by the teacher. The results of the percentage of teacher response assessments of the developed learning media are shown in Figure 6.

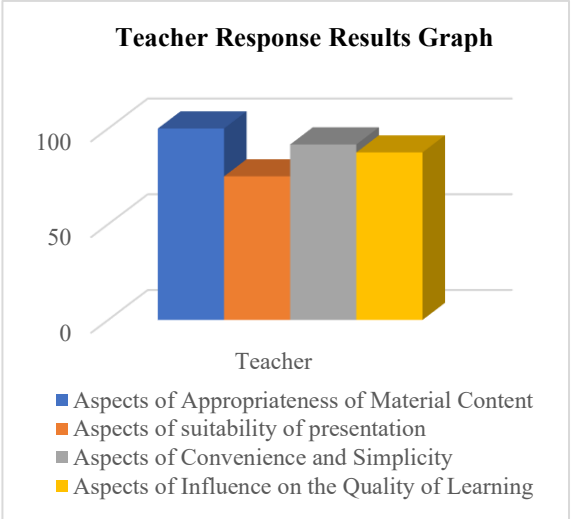

Figure 6. Teacher Response Results Graph

In the diagram above, the percentage results of the 4 assessment aspects obtained an average of 88.54% with very high validity criteria. With an average description of the aspect of the feasibility of the material content of 100%. The aspect of the feasibility of the presentation is 75%. The aspect of ease and simplicity is 91.66%. And the aspect of influence on the quality of learning is 87.5%.

Next, in the implementation stage, the media that has been developed and validated and improved, then implemented to class X-C at SMA Swasta Imelda Medan. At the implementation stage, this media aims to test the practicality of the product. The results of the percentage of student response assessments to the media are shown in Figure 7.

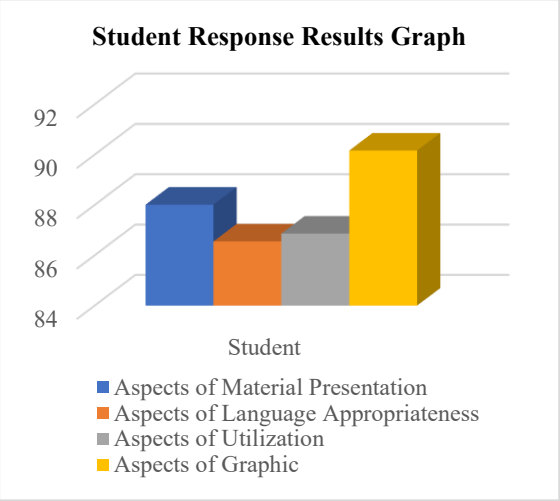

Figure 7. Student Response Results Graph

In the diagram above, the percentage results of the material presentation aspect are 88.01%. The language feasibility aspect is 86.55%. The utilization aspect is 86.86% and the graphic aspect is 90.16%. so that it shows a total percentage of 87.89% with very good criteria. This finding is in line with research by Hasanah et al. (2024), which shows that Pop-Up Book Digital learning media based on graphic organizers is very practical to use as a science learning media. Research by Sugiharti & Anugrah (2023) also shows that the use of PBL and Macromedia Flash models on chemical bonding material is very good as an additional learning outcome for students and online lecture activities. This is in line with research by Rosyadi et al. (2024), which shows that the development of Pop-Up books based on scientific literacy is important to ensure good integration with the curriculum and improve students' understanding of scientific concepts. Research by Sugiharti et al. (2024) also shows that learning using HOTS-based modules allows students to obtain a greater cognitive load and shows how important HOTS-based teaching modules are for improving students' critical thinking.

CONCLUSION

Based on the results of the research findings that have been conducted, it can be concluded that the Development of Digital Pop-Up Book media integrated with the Problem Based Learning (PBL) model on stoichiometry material to improve HOTS Science Literacy of Students by utilizing the ADDIE type (Analysis, Design, Development, Implementation, Evaluation) is declared "Valid" with a very high validity category by material experts, media experts and teacher responses. Based on the results of the average percentage of material experts of 85.15%, media experts of 98.33% and educator assessments of 88.54%. The practicality of Digital Pop-Up Book Media integrated with the Problem-Based Learning Model is included in the very good criteria reviewed from student responses, with an average percentage of 87.89%.

Thus, it can be concluded that the Pop-Up Book Digital media integrated with the Problem-Based Learning model on stoichiometry material to improve HOTS Science Literacy of students can be used in chemistry learning at Imelda Private High School, Medan.

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