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Enhancing Numeracy Literacy through CBL-STEM: Developing Differentiated Learning Materials with Augmented Reality and Articulate Storyline Integration

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ABSTRACT

Numeracy literacy is a critical skill for solving real-world problems, yet it remains low among students in Indonesia. This study aims to address this issue by developing Challenge-Based Learning (CBL)-STEM learning materials tailored to differentiated learning styles and integrated with Articulate Storyline and Augmented Reality (AR). This Research and Development (R&D) study utilized cluster random sampling and employed tests, questionnaires, and interviews for data collection. Data analysis was conducted using descriptive quantitative and qualitative techniques. The feasibility, readability, and student response tests scored averages of 93.38%, 88.13%, and 87.27%, respectively, demonstrating the effectiveness of the developed materials. The CBL model presented real-life challenges, while the STEM approach integrated science, technology, engineering, and mathematics to create meaningful learning experiences. These materials significantly enhanced numeracy literacy among students. The integration of CBL-STEM with technologies such as Articulate Storyline and AR proved highly feasible and effective. Students found the materials easy to understand and engaging, indicating a positive reception. This approach highlights the potential of innovative, tech-integrated learning solutions in addressing Indonesia's numeracy literacy challenges. CBL-STEM learning materials incorporating Articulate Storyline and AR are highly effective and practical for improving numeracy literacy. This innovation demonstrates promise for broader applications, with the potential to address low numeracy literacy in Indonesia on a larger scale by integrating additional technologies.

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1. INTRODUCTION

The rapid advancements of the Industrial Revolution 4.0 have made the mastery of 21st-century skills essential for preparing human resources to navigate ongoing changes and innovations (Jannah & Oktaviani, 2022). Among these critical skills, numeracy literacy holds a prominent position (Agenda, 2016). Numeracy literacy not only fosters critical and systematic thinking but also enhances individuals' ability to make effective and informed decisions (Rezky et al., 2022). As such, numeracy literacy plays a vital role in equipping individuals with the competencies needed to address complex problems, adapt to technological advancements, and contribute meaningfully to personal, professional, and societal development.

Facts in the field show that the condition of numeracy literacy in Indonesia is still lagging behind other countries. This fact is supported by data from the Program for International Student Assessment (PISA) in 2022, showing that Indonesia ranked 69th out of 81 countries, with a score dropping from 379 in 2018 to 366 in 2022 in mathematics (OECD, 2023). One of the causes of low numeracy literacy is the approach to learning mathematics that still focuses on memorization and formulas, and the lack of application in real contexts (Puspitasari et al., 2021). Therefore, innovations in learning that aim to improve numeracy literacy are needed.

Innovative approaches such as Challenge Based Learning (CBL) and STEM (Science, Technology, Engineering, and Mathematics) have great potential to improve numeracy literacy. CBL provides real challenges that encourage students to develop solutions, while STEM emphasizes the application of science in everyday situations (Yoosomboon & Wannapiroon, 2015; Pangesti et al., 2017). The integration of CBL and STEM creates a learning environment centered on challenge and practice, which is relevant to numeracy literacy objectives.

The effectiveness of CBL-STEM can be maximized through the implementation of differentiated learning that suits students' various learning styles (auditory, visual and kinesthetic). This strategy helps teachers customize learning content and processes to make them more relevant and engaging (Maulidia & Prafitasari, 2023). In addition, technologies such as Articulate Storyline and Augmented Reality (AR) can enhance the learning experience by providing interactive and contextualized materials (Gultom & Siagian, 2023; Pujiastuti & Haryadi, 2023)

An interview with two mathematics teachers at SMP Negeri 2 Semarang revealed that the CBL model within a STEM context had not been utilized before. CBL-STEM is a contextual learning process that emphasizes Problem Based Learning focused on the application of STEM in real life (Ash-Showy et al., 2022). The teacher also stated that in learning activities, teachers must create additional learning resources beyond the learning resources provided by the school. Under the current independent curriculum, teachers are also required to implement differentiated learning that is adapted to meet students' needs. The CBL-STEM approach with differentiated learning styles and ICT such as Articulate Storyline and Augmented Reality to improve numeracy literacy is an innovation.

The selection of learning media in the form of learning materials is an important point because of its standardization, and can be integrated with learning models and technology. Therefore, this research aims to develop CBL-STEM-based learning materials integrated with differentiated learning and technology in the form of Articulate Storyline and Augmented Reality. The focus of this research is to assess the feasibility, ease of understand, effectiveness of learning materials in improving students' numeracy literacy, and get positive responses from students. With this approach, it is expected that students will not only understand mathematical concepts but also be able to apply literacy numeracy in everyday life.

2. METHODS

2.1 Research Design

The method employed in this research is the Research and Development (R&D), which is used to create a product and assess its effectiveness (Sugiyono, 2015). This research utilizes the 4D development

model, which encompasses the stages of define, design, develop, and disseminate (Thiagarajan et al., 1974). At the stage define, activities are carried out such as conducting initial and final analysis, conducting student analysis, task analysis, and material analysis, also formulating learning objectives. At the define stage, will designing learning materials by choosing the format and media to produce an initial draft. At the develop stage, the initial draft will be tested for product effectiveness until the final draft is produced. At the disseminate stage, the final draft will be evaluated and disseminated. The product developed is CBL-STEM on differentiated learning materials integrated with Augmented Reality and Articulate Storyline. The flow chart for the study is shown in **Figure 1** below.

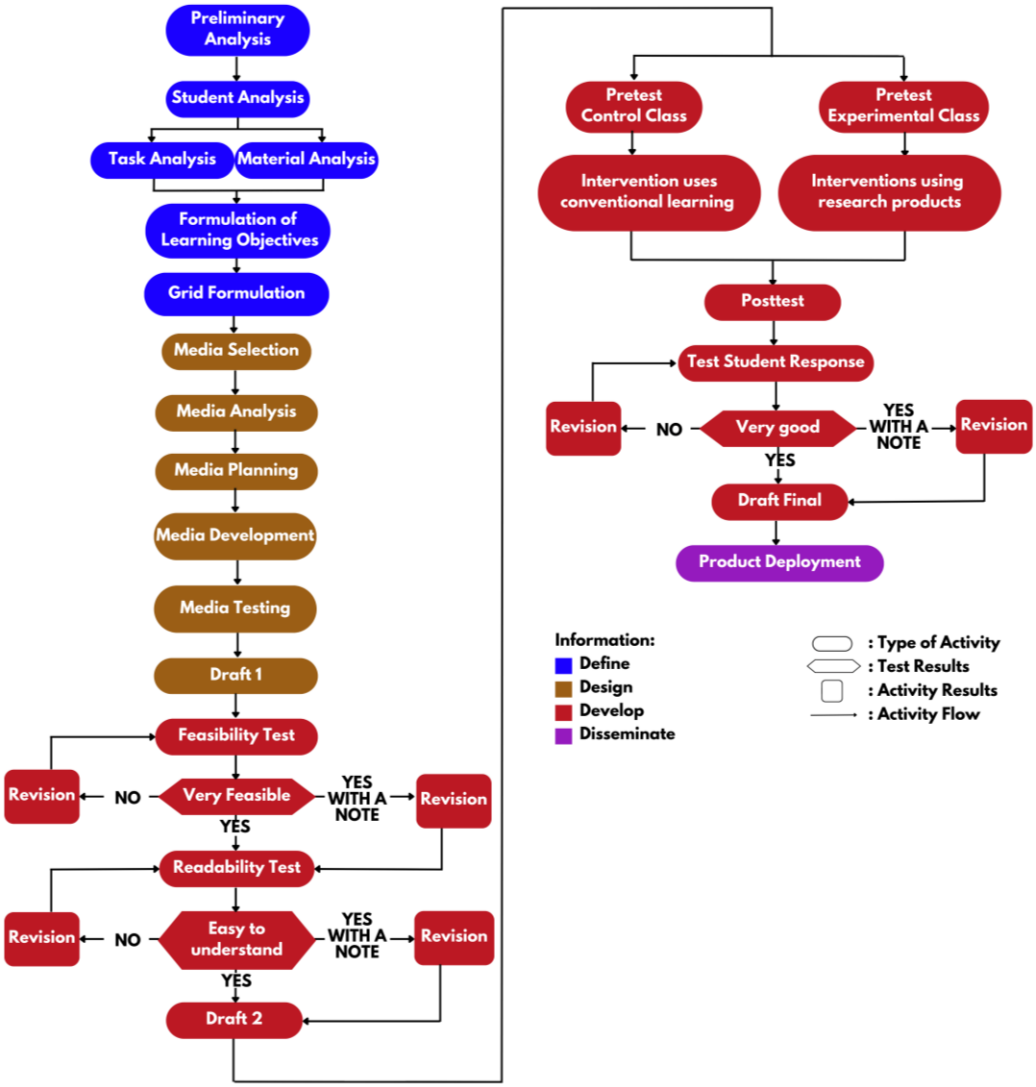


Figure 1. Research flowchart

2.2 *Participants and Sampling*

This research is conducted at SMP Negeri 2 Semarang, situated in East Semarang, Central Java. The research focuses on the eighth-grade students of SMP Negeri 2 Semarang, using a cluster random sampling technique this is because out of a total of 9 classes will be selected to select the control and experimental groups. The chosen samples include class VIII F as the control group and class VIII G as the experimental group which each class has 33 students. The experimental class will be treated using learning materials where as the control class will use a problem-based learning model and then will see the difference between students' numeracy literacy skills.

2.3 Data Collection

The data collection methods used in this study included interviews, questionnaires, and tests. Interviews were carried out during the define stage with students and teachers to gather detailed insights into their views, experiences, and perceptions as an initial step. The questions in the interview guideline were prepared based on the learning model, learning methods, technology used at school, and student conditions. During the development stage, data collection tools included feasibility test questionnaires, readability test questionnaires, and student response questionnaires related to the developed learning materials. The questionnaire items are arranged based on indicators of feasibility, readability and student response. The tests instrument were pretests and posttests to evaluate students' numeracy literacy. Pretests and posttest will be made based on numeracy literacy indicators so that it can be measured. The research instruments will be validated by experts and practitioners before being used. Data analysis involved both quantitative and qualitative descriptive techniques. Quantitative descriptive analysis was derived from the levels of feasibility, readability, and responses, as well as pretest and posttest results from both control and experimental groups to assess the effectiveness of the learning materials. Qualitative descriptive analysis was based on feedback and suggestions provided on the questionnaire sheets.

2.4 Data Analysis

There are several criteria for the feasibility test, readability test, effectiveness test, and student response test. The feasibility test, readability test, and student response test criteria are shown in **Table 2**. Learning materials are considered 'very feasible', 'easy to understand', and receive 'very good' student response if they percentage score is $> 85\%$. Learning materials must be revised and revalidated if they percentage score is $\leq 85\%$. Learning materials are declared to meet the effectiveness test if students meet six effectiveness tests. The Effectiveness test is shown in **table 1**.

Table 1. learning materials effectiveness indicators

No	Indicator	Statistics analysis
1	the average posttest score of the experimental group reached completeness according to the KKTP, which is more than 75	t-test
2	the proportion of learning completeness of the experimental group is more than 70%	z-test
3	the average posttest score of the experimental group is more than the average posttest score of the control group	Independent t-test
4	the results showed a significant increase in students' numeracy literacy skills as evidenced by the average posttest score which is more than the average pretest score in the experimental group	Paired sample t-test
5	the proportion of experimental group learning completeness is more than the proportion of control group learning completeness	Independent sample t-test
6	the increase in students' numeracy literacy skills in the experimental group is more than the increase in students' numeracy literacy skills in the control	Independent sample t-test

The researchers initially performed the N-Gain test to assess the improvement in both the control and experimental groups. N-Gain test is needed to obtain data on the increase in each group and the average N-Gain score in each group will be categorized according to the criteria. Subsequently, researchers conducted a two-sample mean comparison test, which revealed that the average improvement in numeracy literacy for students in the experimental group was more than that of the control group. The N-Gain test criteria is shown in Table 3.

2.5 Evaluation Criteria

Table 2. Feasibility test, readability test, student response test level criteria

Level	Criteria
$1\% < S \leq 50\%$	Not feasible/Difficult to understand/Bad
$50\% < S \leq 70\%$	Fairly feasible/ Less understand/Enough
$70\% < S \leq 85\%$	Feasible/ Pretty easy to understand/Good
$85\% < S \leq 100\%$	Very feasible/ Easy to understand/Very good

(Table Source: (Ardiansyah & Pratama, 2021))

Table 3. N-Gain score criteria

N-Gain Interval	Criteria
$g < 0.3$	Low
$0.3 \leq g < 0.7$	Medium
$g \geq 0.7$	High

Table Source: (Hake, 1999)

3. FINDINGS AND DISCUSSION

In this research, CBL-STEM learning materials on differentiated learning styles integrated with Articulate Storyline and Augmented Reality to improve numeracy literacy was developed. The development of this learning material follows the stages of the 4D model, and the findings and discussion are presented as follows.

3.1. Define

3.1.1 Conducting Initial and Final Analysis

In carrying out the initial and final analysis, interview with two mathematics teachers at SMP Negeri 2 Semarang findings show that learning already uses technology, requires the use of additional learning materials, Challenge Based Learning and STEM nuanced learning have never been carried out in learning, and learning according to learning styles has been implemented. Apart from that, increasing students' numeracy literacy is carried out in the middle of learning by inserting material or questions based on numeracy literacy.

3.1.2 Conducting Student Analysis

Student analysis was carried out by interviewing three class VIII students at SMP Negeri 2 Semarang. Interview findings show that students prefer technology-based learning media that are not too complicated, and challenge-based Learning and STEM integration attract students' interest. In addition, students are more likely to use learning materials in learning

3.1.3 Conducting Task Analysis

Task analysis is carried out to identify assessments that will be used in the learning process. The assessments given to students are located in the CBL stages with a STEM nuance, in challenges, guiding questions, guiding activities, and also reflection. In addition, the analysis in the task of reviewing differentiated learning strategies is suitable because it is flexible for students to use to overcome problems and present solutions in a way that is in harmony with their respective learning styles.

3.1.4 Conducting Material Analysis

In material analysis, learning material is determined, namely focusing on straight line equations and their subtopics. Figure 2 depicts a concept map of material in learning resources that was developed to provide an overview of the material that students will study. The concept map contains prerequisite material as well as core material for straight line equations, namely graphs of equations, slopes and linear equations.

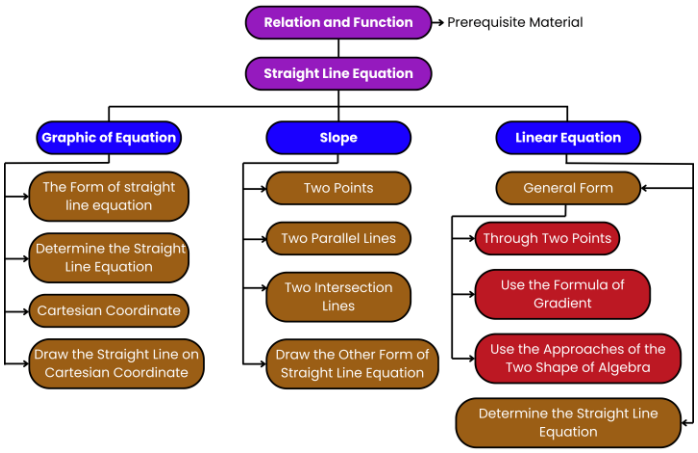


Figure 2. Concept map

3.1.5 Formulating of learning objectives

The analysis of learning objectives is based on the Merdeka curriculum. Table 4 outlines the learning objectives that the developed learning materials aim to achieve.

Table 4. The learning objectives

The Learning Objectives
Through CBL-STEM learning materials on differentiated learning styles integrated with Articulate Storylines and Augmented Reality, students are able: 1. differentiate between explicit and implicit forms of straight-line equations correctly. 2. draw straight line equations on Cartesian coordinates correctly. 3. identify the slope of the line correctly appropriately. 4. apply the formula for the slope of a line correctly. 5. analyze contextual problems about straight line equations with STEM nuances appropriately. 6. apply various alternatives to solve contextual problems on straight line equations with STEM nuances appropriately.

Based on conducting initial and final analysis, conducting student analysis and formulating of learning objectives, students' numeracy literacy problems are obtained which can be helped by developing innovations in the form of technology that is integrated with several elements to improve this. The innovation can be CBL-STEM learning materials on differentiated learning styles integrated with Articulate Storyline and Augmented Reality in straight-line equation material. Based on the results of the interview, the teacher mentioned that the use of technology in the learning materials used is minimal. The teacher also said both Augmented Reality and Articulate Storyline, has never been implemented at the school and has the potential to improve students' numeracy literacy. Therefore, information from the define stage will be used in designing learning materials. This aligns with research by Ash-Showy et al. (2022), which indicated that CBL learning materials are feasible and suitable for use in educational settings. CBL-STEM learning materials are effective for improving student' skills and can be used to improve numeracy literacy (Simarmata & Ardiansyah, 2024; Sari et al., 2021).

3.2. Design

During the design stage, the focus was on creating the CBL-STEM on differentiated learning based learning materials integrated with Augmented Reality and Articulate Storyline to improve students' numeracy literacy. At this stage, several activities were undertaken, including (1) media selection and (2) format selection for the developed learning materials. The media selection is conducted to determine the form of learning material. The learning material is provided as a hard copy, making it more user-friendly for students. The media that integrated are in the form of Augmented Reality and Articulate Storyline in the form of QR-codes embedded in learning materials. The design of learning material adapted from CBL stages namely, (1) big idea, (2) essential questions, (3) challenge, (4) guiding resources, (5) guiding questions, (6) guiding activities, (7) publishing, and also (8) reflection. All the stages of CBL are nuances

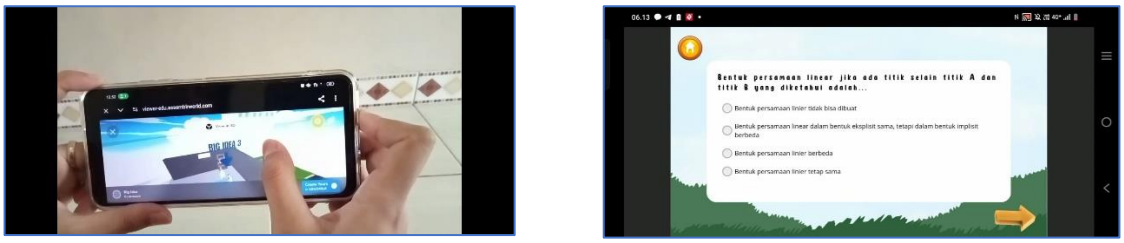
by STEM and then integrated with Augmented Reality and also Articulate Storyline. Augmented Reality is integrated in the big idea stages to help students come up with the idea of the material. Furthermore, in the guiding question stage students are given a quiz using Articulate Storyline.

The format selection is conducted to choose the format that is suitable to use for students. The paper of the learning materials is B5 size. The font type is Poppins with size is 10 for sentences and Cambria Math with size 10 is used for equations. The margins for the learning materials are set to 3 cm on the top, left, bottom, and right. The space line for the paragraph is 1,15. For the cover book used navy colour and for the book contents use the white colour for background and also navy, orange, green, red, and yellow colour for the elements. Then, learning materials are designed and produced draft 1. **Figure 6** is the first draft of CBL-STEM learning materials on differentiated learning styles integrated with Articulate Storyline and Augmented Reality.

(a) (b) (c)

(d) (e) (f)

(g) (h) (i)



(j) **(k)**

Figure 3. (a) First draft of cover; (b) First draft of concept map; (c) First draft of big idea; (d) First draft of essential question and the challenge; (e) First draft of guiding resource; (f) First draft of guiding question and guiding activities; (g) First draft of solution-action and publishing; (h) First draft of reflection; (i) First draft of uji kompetensi; (j) First draft of Augmented Reality; (k) First draft of Articulate Storyline

In previous research, the development of CBL-STEM learning materials assisted by learning videos to improve creative thinking skills. In that study, the application of learning materials was used to examine the effectiveness of learning materials on creative thinking skills while in this study the effectiveness of numeracy literacy was studied (Simarmata & Ardiansyah, 2024). In the development of CBL-STEM learning materials previously using technology, namely learning videos, but in this development will use augmented reality and articulate storyline as visualization and quiz. The novelty in this research is also applying differentiation strategies in the CBL-STEM model.

The learning method that is used in the learning materials is CBL-STEM. This method is chosen based on research by Sari et al. (2021) and Ash-Showy et al. (2022)which states that CBL-STEM is suitable for learning activities. This means that the real problems in learning that will be raised are related to STEM nuances. Numeracy literacy demands students' ability to solve fundamental problems. CBL-STEM model trains students in solving real problem challenges in STEM disciplines. Differentiating learning styles in this learning approach provides students with a more meaningful learning experience. In the CBL-STEM model, there is a challenge stage that provides challenges related to STEM problems. At this stage, product differentiation will be carried out based on learning styles to explore student creativity.

Augmented reality in this research help improve students' numeracy literacy because they play a role in students' understanding in processing information. This is in line with the of AR in the other studies. Based on the research Maulidia & Prafitasari (2023) state that differentiation learning can improve students' motivation, engagement, and also learning outcomes. Augmented Reality (AR) is integrated into the learning materials to aid students' understanding. In these learning materials, AR is used during the big idea stage to help students grasp the main concepts they will learn. Pujiastuti & Haryadi (2023) suggest that Augmented Reality (AR) can improve the comprehension of mathematical concepts, making AR use in education a valuable option.

Additionally, Articulate Storyline is incorporated into the learning materials as a medium for presenting guiding questions to help students processing information then can help to improve student's numeracy literacy. In this research Articulate Storyline used as a digital quiz increases students' motivation to learn because it is something new in their learning process. Aligning with the findings of Gultom & Siagian (2023) that Articulate Storyline can also improve understanding of mathematical concepts. So, the innovation CBL-STEM learning materials on differentiated learning styles integrated with Articulate Storyline and Augmented Reality developed to provide the learning materials that improve numeracy literacy students.

3.3. Develop

During the develop stage, the learning steps in the learning materials to be developed with the CBL-STEM model integrated with differentiated learning integrated with Augmented Reality and Articulate Storyline are shown in Figure 4.

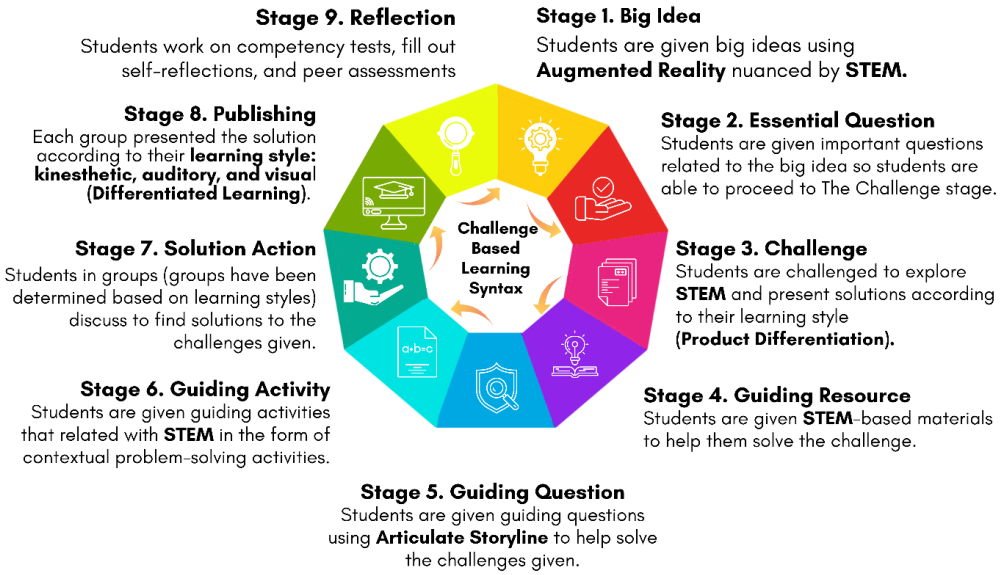


Figure 4. The learning steps in CBL-STEM on differentiated learning based learning materials integrated with Augmented Reality and Articulate Storyline

3.3.1 Feasibility Test

The feasibility test for CBL-STEM learning materials on differentiated learning styles integrated with Articulate Storyline and Augmented Reality, was conducted by five mathematics lecturers from Universitas Negeri Semarang as experts, along with three junior high school mathematics teachers and two senior high school mathematics teachers as practitioners. This feasibility test aims to evaluate the feasibility of content, presentation feasibility, linguistic aspects, learning innovation, and ability achievement. Learning materials developed by researchers are deemed feasible, if learning materials fulfill the criteria of being very feasible for students.

The results of the validity test from five experts and five practitioners were compiled to obtain the average validity test results. A summary of the evaluations conducted by the experts and practitioners on the learning materials is presented in **Table 5.**

Table 5. Recapitulation of feasible test

Evaluator	Validity (%)					Final Score	Criteria
	Content	Presentation	Language	Learning Innovation	Ability Achievement		
A01	87.5	93.18	92.86	100	93.75	93.46	Very Feasible
A02	95	97.73	92.86	93.75	100	95.87	Very Feasible
A03	91.25	95.45	91.07	93.75	100	94.31	Very Feasible
A04	90	93.18	83.93	93.75	93.75	90.92	Very Feasible
A05	83.75	93.18	94.64	93.75	93.75	91.81	Very Feasible
P01	83.75	86.36	80.36	87.50	87.50	85.09	Very Feasible
P02	96.25	97.73	96.43	100	100	98.08	Very Feasible
P03	96.25	97.73	96.43	100	100	98.08	Very Feasible

P04	96.25	95.45	92.86	87.5	87.5	91.91	Very Feasible
P05	93.75	95.45	82.14	100	100	94.27	Very Feasible
Average	**91.38**	**94.55**	**90.36**	**95**	**95.63**	**93.38**	**Very Feasible**

The developed learning materials received a final average score of 93.38%. The average of feasibility test that the learning material criteria have achieved the research objective of producing learning materials that very feasible. Learning materials did not require retesting but were revised based on suggestions from the validators.

The results of the feasibility test indicate that the developed learning materials satisfy the content feasibility criteria, including (1) alignment of material with learning outcomes and objectives, (2) accuracy of content, and (3) supporting materials, obtained a final score of 91,38% with very feasible criteria. In terms of presentation, the materials have met the indicators for (1) presentation techniques, (2) presentation support, (3) learning presentation, and (4) presentation completeness, obtained a final score of 94,55% with very feasible criteria .The language aspect received a final score of 90.36%, indicating that the materials meet criteria such as (1) clarity, (2) communicativeness, (3) dialogue and communicative nature, (4) appropriateness for student development levels, (5) coherence and logical flow, and (6) use of terminology, symbols, or icons. The learning innovation aspect achieved a final score of 95%, showing that the materials fulfill indicators like (1) novelty and (2) integration of innovation. Lastly, the learning materials met the criteria for ability achievement, including (1) development of numeracy literacy and (2) attainment of numeracy literacy indicators, obtained a final score of 95,63% with very feasible criteria.

Based on the overall feasibility test results, the learning materials received a final percentage of 93.38%, indicating that they are very feasible. These results are in line with previous research, such as the research of Puspitasari et al. (2021) who developed STEM-based physics learning materials at the high school level and received a feasibility score of 86.2%. Research into the development of ethnomathematics learning materials that integrate the CBL model with GeoGebra is considered very feasible, with a final score of 90.21%, and is effective in enhancing students' problem solving skills (Ardiansyah et al., 2022). Research on using AR to improve students' numeracy literacy received validation from experts, with average rating of 92%, indicating that it meets the criteria for being very feasible (Ilman, 2024). Another study that created learning media using Articulate Storyline to investigate mathematical problem solving skills and self-regulated learning among boarding school students achieved a score of 84%, placing it in the very feasible category (Yusuf et al., 2023). In addition, research by Pangesti et al. (2017) on STEM-based learning materials aimed at improving high school students' concept mastery, with a feasibility score of 83.57%. Consistent with previous research which shows that the results of the feasibility test of learning media are very feasible, meaning that they can help in improving the abilities being studied. In this case, the learning materials that have been developed meet the criteria of being very feasible so that they can improve student's numeracy literacy.

3.3.2 Readibility Test

Thirty-six students in grade IX completed the readability test by filling out the questionnaire given by the researcher are shown in **Figure 5**. The readability test is performed to assess whether the content of the learning materials is easy to understand or not. The aspects of readability evaluated include language, writing, presentation, and density of ideas. The readability test also provided valuable comments and suggestions for further improvement. Some comments and suggestions from students include: (1) the learning materials are good and interesting because students have complete information, besides that the writing of words and pictures is also very good so that it makes students not lazy to read; (2) the learning materials provided are good and easy to understand; (3) the learning materials are good but for the formulas maybe students can be given colours to make them more interesting; (4) the learning

materials designed are very good, so students attract readers; and (5) everything is good, according to the readability aspects, very easy to understand.

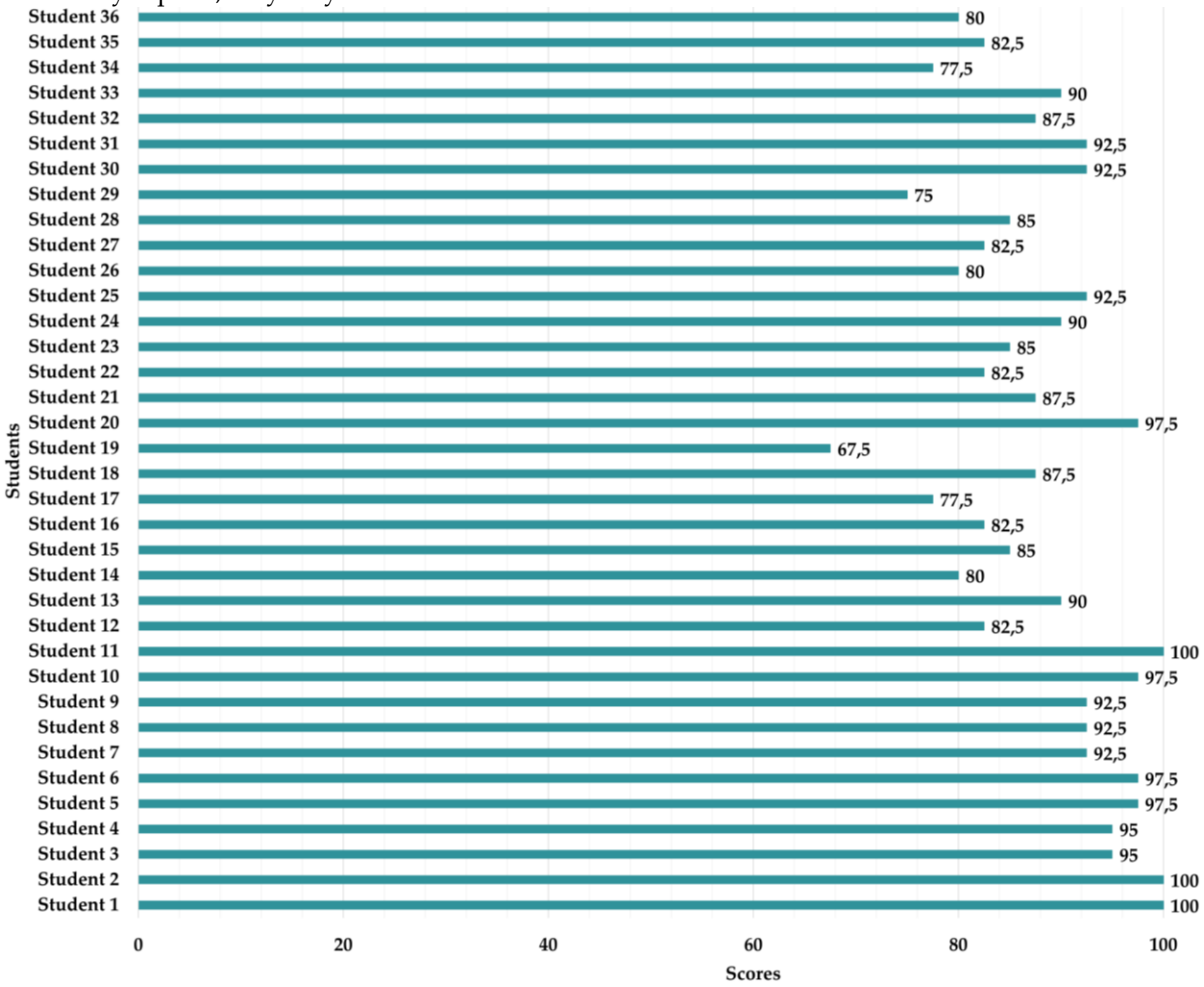


Figure 5. Learning materials readability results

The findings from the readability test of the developed learning materials are shown in Figure 7, yielded a final score of **88.13**%. The average readability test that the learning material criteria have achieved the research objective of producing learning materials that easy to understand.

The readability shows that the learning materials use sentences, vocabulary, and paragraphs that are easy for readers to understand. The use of appropriate spacing between lines, the choice of appropriate font type and size, and the use of attractive graphics and images make students interested in this learning material. In addition, the selection of Indonesian style and grammar that is formal and in accordance with the age of the reader, namely grade VIII students, makes this learning material easier to understand.

The readability test results in this study are consistent with previous research. One study on the development of ethnomathematics learning materials integrated with CBL and GeoGebra to enhance problem solving skills achieved a readability score of 94% (Ardiansyah et al., 2022). Similarly, research on STEM based digital learning materials for population data sources and analysis received a readability score of 82%, indicating ease of understanding for students (Putri et al., 2022). Another study focusing on Islam-Science-based biology learning materials using AR media attained a readability score of 87.64%, also categorized as easy to understand (Destiara, 2020). This shows that learning materials with easy to understand criteria can help improve numeracy literacy.

3.3.3 Effectiveness Testing

Before conducting the tests, the data was initially examined for normality and homogeneity. The results indicated that the data followed a normal distribution and had homogeneous variance. The

research conducted has fulfilled six hypotheses, namely (1) The average posttest score of the experimental group surpassed the KKTP standard, achieving was more than 75; (2) the proportion of learning completeness of the experimental group was more than 70%; (3) the average posttest score of the experimental group was more than the average posttest score of the control group; (4) the average posttest score of numeracy literacy of experimental group was more than the average pretest score of numeracy literacy of experimental group; (5) The proportion of experimental group learning completeness was less than or equal to the proportion of control group learning completeness; (6) the improvement of students' numeracy literacy skills in the experimental group was more than the improvement of students' numeracy literacy skills in the control group. The improvement in the experimental group is 0.783 fell into the high category and improvement in the control group is 0.69 fell into the medium category. The effectiveness results were presented in **Table 6**.

Table 6. Effectiveness test result

Result	Conclusion
$t_{count} = 21.19$ and $t_{table} = 1.69$ so $t_{count} > t_{table}$	The average posttest score of numeracy literacy of the experimental group more than the KKTP, which was more than 75.
$z_{count} = 1.86$ and $z_{table} = 1.64$ so $z_{count} > z_{table}$	The percentage of experimental group who completed numeracy literacy has reached more than 70%.
$t_{count} = 2.39$ and $t_{table} = 1.99$ so $t_{count} > t_{table}$	The average posttest score of the experimental group is more than the average posttest score of numeracy literacy of the control group.
$t_{count} = 26.53$ and $t_{table} = 1.66$ so $t_{count} > t_{table}$	The average posttest score of students' numeracy literacy of the experimental group is more than the average pretest score of students' numeracy literacy of the experimental group.
$z_{count} = 0.16$ and $z_{table} = 1.64$ so $z_{count} \leq z_{table}$	The proportion of experimental group learning completeness was less than or equal to the proportion of control group learning completeness
$t_{count} = 2.23$ and $t_{table} = 1.99$ so $t_{count} > t_{table}$	The average improvement of students' numeracy literacy skills in the experimental group was more than the improvement of students' numeracy literacy skills in the control group.

The learning materials have been implemented and can improve students' numeracy literacy according to the research objectives. Based on the data analysis related to the effectiveness of the hypothesis formulated by the researchers, the experimental group achieved an average completeness score of over 75 and a learning completeness proportion exceeding 70%. The average numeracy literacy of the experimental group was more than that of the control group. Additionally, the improvement in the experimental group surpassed that of the control group. However, this study also found that the proportion of students meeting the KKTP requirements was equal between the experimental and control groups. This indicates that while the number of students who completed the KKTP was comparable in both groups, the average numeracy literacy score of the experimental group remained more than that of the control group.

Based on the effectiveness test conducted in class VIII G at SMP Negeri 2 Semarang, it can be concluded that the developed learning materials effectively improve students' numeracy literacy. This effectiveness is closely associated with the application of the CBL model on differentiated learning in the experimental group. In this learning material, the CBL on differentiated learning plays an important role in improving students' numeracy literacy. Differentiated learning with product strategy provides opportunities for students to present solutions of challenge with students' unique abilities. The challenge stage in the CBL model is very important because the challenges provided are designed based on learning styles to train students' numeracy literacy. In addition, the implementation of STEM at each stage of the CBL model makes the problem more contextualized in improving students' numeracy literacy. Incorporating AR and Articulate Storyline into the big idea and guiding questions also enhances the learning materials' ability to accommodate various learning styles and boost students' numeracy literacy.

The results of the effectiveness test are consistent with previous research. The first relevant study investigated the use of learning resources with AR and found that it positively impacted the numeracy

literacy of fifth-grade students at MI AT-Taufiq (Jannah & Oktaviani, 2022). This study demonstrated that AR media significantly enhanced students' understanding and was more efficient in enhanching students' numeracy literacy. These findings collectively support the notion that integrating advanced technologies and innovative methods in learning materials can significantly enhance students' numeracy literacy. Differentiated learning, which adapts to students' various learning styles to meet their unique needs, strengths and interests, can effectively improve primary school students' numeracy literacy skills (Indrawatiningsih et al., 2024). Furthermore, research on creating learning media in the form of STEM-based e-comics with the Project Based Learning (PjBL) model has proven effective in enhancing numeracy literacy (Aprilia et al., 2023). The findings indicated that STEM encourages students to engage with problems in a contextual manner and emphasizes applying STEM knowledge to address real-world issues. That way it can help in improving numeracy literacy.

Numeracy literacy completeness occurred in the experimental group because the CBL-STEM model had a positive effect on training students' numeracy literacy skills. the CBL-STEM model familiarizes students in analysing information, solving systematically, and making decisions. This is what distinguishes the control group that does not use CBL-STEM learning materials on differentiated learning styles integrated with Articulate Storyline and Augmented Reality.

3.3.4 Student Response Testing

The student response test was carried out with thirty-three students from class VIII G at SMP Negeri 2 Semarang to evaluate students' responses on the learning materials developed by the researcher. The findings from this student response questionnaire are illustrated in **Table 7**.

Table 7. Student response test result

Respons	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
Results	90	80	90	80	70	90	100	70	70	80	90
Criteria	Very Good	Good	Very Good	Good	Not Enough	Very Good	Very Good	Not Enough	Not Enough	Good	Very Good
Respon	S12	S13	S14	S15	S16	S17	S18	S19	S20	S21	S22
Results	100	80	100	100	80	80	100	80	90	70	100
Criteria	Very Good	Good	Very Good	Very Good	Good	Good	Very Good	Good	Very Good	Not Enough	Very Good
Respons	S23	S24	S25	S26	S27	S28	S29	S30	S31	S32	S33
Results	80	100	80	90	80	100	70	90	100	100	100
Criteria	Good	Very Good	Good	Very Good	Good	Very Good	Not Enough	Very Good	Very Good	Very Good	Very Good
Average	87.27%										
Criteria	Very Good										

The results indicated that students had a positive response, with an average approval rate of 87.27%. The average student response shows that the learning material criteria have achieved the research objective of producing learning materials that get very good responses from students.

The development of CBL-STEM learning materials on differentiated learning styles integrated with Articulate Storyline and Augmented Reality is supported by several relevant studies. The first study, focusing on STEM-based physics learning materials for the topics of temperature and heat at the high school level, achieved a score of 90.98% (Puspitasari et al., 2021). The findings indicated that STEM-approach learning materials received very positive responses from students. Another study on applying the STEM learning model to improve numeracy literacy achieved a student response score of 97% following the learning process (Sari et al., 2021). Additionally, research on CBL-STEM based learning materials that incorporated learning videos for creative thinking skills received a favourable response from eighth-grade students, achieving a final score of 95.5% (Simarmata & Ardiansyah, 2024). Furthermore, the creation of STEM-based physics learning materials for junior high school, which included character education on topics such as work and simple machines, received a student response

score of 91.69%, indicating a very positive category (Mahfudin & Wahyuni, 2021). The final draft of the CBL-STEM on differentiated strategy based learning materials integrated with Augmented Reality and Articulate Storyline, is illustrated in **Figure 6.**

Figure 6. (a) Final draft of cover; (b) Final draft of concept map; (c) Final draft of big idea; (d) Final draft of essential question and the challenge; (e) Final draft of guiding resource; (f) Final draft of guiding question and guiding activities; (g) Final draft of solution action and publishing; (h) Final draft of reflection; (i) Final draft of competency test; (j) Final draft of Augmented Reality; (k) Final draft of Articulate Storyline

3.4. Disseminate

After the CBL-STEM learning materials on differentiated learning styles integrated with Articulate Storyline and Augmented Reality were considered very feasible for use, easy to understand, effective to improve numeracy literacy, and received very good responses from students, learning materials were submitted as *Hak Kekayaan Intelektual* (HKI). The physical version of these learning materials was distributed in print to schools and teachers at SMP Negeri 2 Semarang as many as 40 pieces and introduced to mathematics teachers to be used as a student resource for learning about straight line equations. Meanwhile, the digital version of the materials can be accessed through a link in the description of the Instagram account, YouTube, and e-book platforms as a student learning resource. This corresponds with the definition of learning materials, which are a set of content or lesson components organized in a structured and systematic way. Based on the results of this study, it opens up the same innovation and can be implemented in other mathematics materials. Not only that, other subjects can also implement CBL-STEM or integration of Augmented Reality and Articulate Storyline in learning. Learning materials provide a comprehensive overview of the competencies students need to master, allowing students to study and understand the material thoroughly during learning activities (Listiana et al., 2022).

4. CONCLUSION

The CBL-STEM learning materials, designed with differentiated learning styles and integrated with Articulate Storyline and Augmented Reality, have proven highly effective and feasible for enhancing numeracy literacy. Evaluation results show an average feasibility score of 93.38%, indicating robust quality. The materials are also accessible and easy to understand, achieving an average score of 88.13%. Furthermore, they effectively enhance numeracy literacy and received very positive feedback from students, with an average satisfaction score of 87.27%. Future research should explore integrating additional information and communication technologies (ICTs) and investigating their impact on other mathematical competencies. Contextual approaches such as ethnomathematics could also enrich the learning experience by connecting mathematical concepts to cultural contexts. Practical recommendations for educators and policymakers include incorporating CBL-STEM strategies into curricula to foster more engaging, differentiated, and technologically enriched learning environments. This study's unique integration of CBL, STEM, and digital tools offers a valuable blueprint for advancing numeracy literacy and 21st century skills development in education.

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