JPPIPA (Jurnal Penelitian Pendidikan IPA)

Vol.10 No.1 2025

http://journal.unesa.ac.id/index.php/jppipa

DEVELOPMENT OF DIFFERENTIATED TEACHING MATERIALS BASED ON THE INDEPENDENT CURRICULUM TO ENHANCE STUDENTS' KNOWLEDGE OF SUBSTANCE AND ITS CHANGES

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Abstract

It is widely acknowledged that it is imperative to accommodate the diverse characteristics of learners. However, empirical evidence suggests that the learning process has yet to fully consider the individual needs of students. This development research aims to determine the viability of differentiated teaching materials based on the independent curriculum to enhance students' knowledge learning outcomes on substance and its changes in terms of validity, practicality, and effectiveness in an effort to accommodate the learning needs of diverse learners. The research method employed is Research and Development (R&D), utilizing the 4D development model (Define, Design, Development, & Disseminate). The data analysis techniques used include Aiken's validity analysis, practicality analysis using percentages, and analysis of the effectiveness of knowledge learning outcomes using N-gain. The results showed that the developed teaching materials received a validity score of 0.83 (very valid), a practicality score of 90% (very practical), and an effectiveness score of 0.4 (medium/effective). It is evident, based on the analysis of these scores, that the teaching materials developed are of a high validity, practical nature and efficacy in facilitating the learning process of scientific concepts, substances and its changes.

Keywords: Teaching Materials, Knowledge Learning Outcomes, Independent Curriculum, Differentiated Learning Approach, Substances and Its Changes

Article History: Received: March 27th, 2025. Revised: May 28th, 2025. Published: June 30th, 2025

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p-ISSN: 2527-7537
e-ISSN: 2549-2209

INTRODUCTION

The diversity of learner characteristics in the classroom has been recognized pedagogically for a long time, but in reality, in the learning process in accordance with teaching achievements so far, attention to this condition has not been maximized. The classical learning system with one teacher facing around 30 learners is not able to accommodate such diversity. Similarly, the previous curriculum system, which was material-intensive, made teachers' attention more focused on strategies for delivering subject matter to students (Purnawanto, 2023). Nurani et al. (2022) explained that an independent curriculum is predicated on the notion of learning diversity. It prioritizes essential content, ensuring that learners have adequate opportunities to understand concepts and develop their abilities.

Through the science learning process, students are expected to gain direct experience, so as to increase the power to accept, store, and apply a concept that has been learned. This makes students experienced to independently discover for themselves the various concepts they learn thoroughly, meaningfully, and authentically (Nita et al., 2020). Based on the results of interviews with teachers who teach science subjects in class VII G SMP Negeri 2 Banjarmasin, it is known that teachers have never implemented differentiated learning so that the learning needs of students have not been optimally accommodated. Therefore, teachers should make accommodations by applying differentiation in the learning process, especially through a differentiated learning approach. Wahyudi et al. (2023) explained that differentiated learning can be defined as an educational approach that caters to the distinct learning requirements of each individual learner. This pedagogical method entails a learning process in which learners are enabled to explore the subject matter in accordance with their personal abilities and learning needs.

Another problem that is also often found in education is the limited teaching materials that can facilitate students to build conceptual understanding of learning materials (Mardeni et al., 2021). The prevailing tendency in the field of education is for teaching materials to be developed with insufficient consideration for the multifarious learning styles of students, so that students get low learning outcomes in the learning process. Cahya et al. (2022) explained that teaching materials are very important and play a major role in achieving learning objectives, because the utilization of teaching materials has been demonstrated to facilitate the delivery of educational content by educators, thereby enhancing the comprehension of students and promoting enhanced learning outcomes. In line with the exposure of Cahya et al. (2022), the author assumes that it is necessary to create teaching materials that in content and activities can accommodate the diverse learning needs of students. The creation of such teaching materials is crucial for ensuring the efficacy of the learning process and the enhancement of student learning outcomes. Printed teaching materials are a vital resource for educators seeking to address students' diverse learning requirements and enhance learning outcomes.

The material of substances and its changes is one of the interesting materials to learn. Nevertheless, students frequently encounter challenges in comprehending the concepts inherent in the subject matter of substances and its changes. Sugo et al. (2021) explained that the primary issue encountered by students in the material of substance and its changes pertains to the preponderance of listening activities within their learning activities. This pedagogical approach, characterized by an emphasis on auditory input, has been observed to hinder students' engagement in active cognitive processing. Consequently, students encounter challenges in comprehending the concept of substances and the process of change. The challenges encountered by students in comprehending the substance and its changes have a consequential bearing on the learning outcomes they achieve, as seen in the documentation of the learning outcomes of students at SMP Negeri 2 Banjarmasin, it is known that most of the students in class VII G obtained the final test scores for chapter 2, namely on the material of substance and its changes in the odd semester of 2023/2024 below the MCC (minimum completeness criteria). The way that teachers usually overcome the low learning outcomes obtained by students is by conducting remedials until the students concerned reach the specified MCC.

The extent to which students achieve learning outcomes is indicative of the quality of education provided. The achievement of learning outcomes is said to occur when students demonstrate the anticipated development in the formulation of learning objectives, as evidenced by the value of the evaluation results carried out by the teacher against students through repetitions or exams taken (Yandi et al., 2023). Dakhi (2020) explained that an effective learning process is a support for enhancing student learning outcomes. The successful realization of the teaching and learning process in accordance with the learning objectives affects the success of the learning process (Annur et al., 2020). Wahyuni (2022) and Setiyo (2022) explained that the utilization of a differentiated learning approach has been demonstrated to be an effective methodology for enhancing student learning outcomes. This approach is widely

applicable across diverse learning contexts, with its capacity to adapt to the individual learning requirements of students. Students tend to be more motivated and engaged in the learning process that suits their learning style. Through a differentiated learning approach, each student's diverse learning styles can be accommodated. The differentiated teaching materials developed will be able to provide learning experiences that suit their needs and learning styles.

The differentiated learning approach incorporated into the teaching materials will help to create an inclusive learning environment, to make every student feel welcome and actively involved in learning, so that students are able to understand the information better. By using a differentiated learning approach, the teaching materials developed will be able to facilitate deeper understanding and better retention for students. This is in line with the explanation of Asnawi et al. (2023) who stated that applying a differentiated learning approach in the learning process will allow each student to learn in the most effective way for them, thus improving their overall understanding and learning outcomes. In addition, a differentiated learning approach will also help improve the overall quality of teaching to better achieve learning objectives. Especially ensuring every student gets equal opportunities to grow and develop.

Based on the description above, research and development were carried out entitled 'Development of Differentiated Teaching Materials Based on The Independent Curriculum to Enhance Students' Knowledge of Substance and Its Changes'. The author conducts research by developing teaching materials using Microsoft Word 2016 and Canva applications which are designed with an attractive appearance according to the material of substances and its changes. After completing the making of teaching materials, then the teaching materials are printed using B5 size HVS paper with a cover of HVS paper and plastic mica. The objective of this development research is to ascertain the validity, practicality and efficacy of differentiated teaching materials based on an independent curriculum.

METHODS

The present research employs the Research and Development (R&D) method, also referred to as development research. Zafri & Hastuti (2021) explained that the R&D research method is research that produces a product in education and learning by going through research and development procedures and testing the validity, practicality, and effectiveness of the resulting product. The research model employed in this development study is the 4D model. Zafri & Hastuti (2021) explained that the development model is a guide in developing products, in the form of cycles or steps that must be carried out to produce valid products. Thiagarajan, Semmel & Semmel (1974) introduced the 4D model, which was one of the development research models consisting of four steps. Figure 1 provides a visual representation of the 4D model's constituent steps.

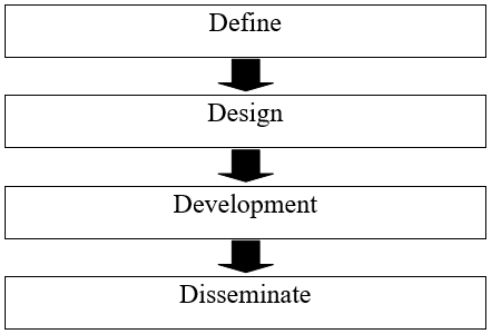

Figure 1. Steps of the 4D development model (Al-Tabany, 2014)

The define stage was initiated with preliminary studies, which included interviews and documentation. The results of the present stage of the analysis indicate that the school in question has implemented an independent curriculum. Furthermore, it is evident that teaching materials are required for the purpose of accommodating a diverse range of learning styles among students. The design stage was carried out by making research instruments, teaching modules, and initial designs of teaching materials developed. The development stage is characterized by the execution of trials of the initial design of teaching materials on a small group of test subjects. This is followed by a process of revision and validation. The disseminate stage is the stage of disseminating the final results of teaching materials developed by printing limited to be distributed to students and made in the form of flipbooks that can be accessed by students anytime and anywhere.

Research Design

The present development research employed a one group pre-test post-test design. This particular design was selected on account of the fact that only a single class was utilized in the present development research, thus rendering it impossible to employ a class for the purpose of comparison. Sugiyono (2013) explained that the research design incorporates a pre-test prior to the administration of treatment. This enables a more precise evaluation of the treatment's efficacy by facilitating a comparison with the initial status. This research design is depicted as in Figure 2.

O_1 X O_2	**Description:** O_1 = Pre-test score O_2 = Post-test score X = Treatment

Figure 2. One group pre-test post-test research design

(Sugiyono, 2013)

Research Objectives

In this development research study, a large group of 33 students from SMP Negeri 2 Banjarmasin class of VII G were selected as test subjects. Other subjects were 10 students of SMP Negeri 2 Banjarmasin consisting of VII C, VII E, VII F, and VII classes as small group test subjects who provided responses and comments on the initial design of teaching materials. The object of this development research is differentiated teaching materials based on the independent curriculum in terms of validity, practicality, and effectiveness. Research and testing of differentiated teaching materials based on an independent curriculum were carried out at SMP Negeri 2 Banjarmasin in November 2024 odd semester with 3 meetings.

Data Collection Technique

The data collection instruments employed in this developmental research comprise validation sheets, student learning style questionnaires, student response questionnaires and student knowledge learning outcomes test sheets. Concomitantly, the data collection techniques employed included interviews, documentation, questionnaires and tests. Interviews are a data collection technique carried out by asking directly to respondents (Kusumastuti et al., 2020). This data collection technique aims to find out the problems that occur in science learning at SMP Negeri 2 Banjarmasin through interviews with teachers who teach science subjects in class VII G SMP Negeri 2 Banjarmasin. Then documentation is used as a complement to the interview data that has been obtained. The present study documented the learning outcomes of students from SMP Negeri 2 Banjarmasin in class VII G, for the 2023/2024 academic year. The documentation was conducted by photographing the score lists for the science subject, which focused on substances and its changes.

The distribution of questionnaires is a data collection technique that can reach a large number of respondents in a relatively short time (Kusumastuti et al., 2020). The questionnaire used in this study uses closed questions to direct validators and students to answer. The scale used in the questionnaire is divided into two, namely a nominal scale and an interval scale. The interval scale employed in this study is a Likert scale. By using a 5-point Likert scale (1-5), the validator will give a score on each question item, where a score of 1 indicates an irrelevant opinion/answer, while a score of 5 indicates a very relevant opinion/answer. Meanwhile, using a 4-point Likert scale (1-4), respondents (students) will give a score on each question item, where a score of 1 indicates an opinion/answer that disagrees, while a score of 4 indicates an opinion/answer that strongly agrees.

A test involves items or tasks that respondents must complete honestly to evaluate a specific aspect of the individual (Kusumastuti et al., 2020). The test's objective is to ascertain alterations in student learning outcomes following the use of teaching materials developed through a pre- and post-test. This enables a comparison to be made of the learning process before and after the utilization of different teaching materials based on the independent curriculum. The evaluation instrument administered to students is of the multiple-choice variety.

Data Analysis Technique

The data analysis technique used is validity analysis using Aiken's validity index, practicality analysis using percentage, and analysis of the effectiveness of knowledge learning outcomes using N-gain. The viability of assessing teaching materials based on an independent curriculum is determined by the results of validity, practicality, and effectiveness tests. Testing the validity of differentiated teaching materials based on an independent curriculum was carried out by 3 lecturers of the Science Education Study Program FKIP ULM and 2 science teachers of SMP Negeri 2 Banjarmasin.

Data analysis of the validity of differentiated teaching materials based on the independent curriculum was obtained using the Aiken validity index formula which can be seen in Formula 1.

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

Description:
V = Validator agreement index regarding validity (Aiken validity index)
s = The score assigned to each validator minus the lowest score in the category used (s = r- l_0)
n = Number of validators
r = Validator's preferred category score
l_0 = The lowest score in the scoring category (l_0 = 1)
c = The number of categories a validator can choose (c = 5)

(Retnawati, 2016)

The results of the calculation of Aiken's validity index are then converted into the Aiken

validity index category from Retnawati (2016). Differentiated teaching materials based on the independent curriculum are declared valid if the calculation results using the Aiken validity index formula are categorized as medium, reaching a value of $0.4 < V \leq 0.8$ or very valid, reaching a value of $V > 0.8$.

Concurrently, the practicality of differentiated teaching materials based on the independent curriculum is determined through calculation using Formula 2.

$$P = \frac{Q}{R} \times 100\% \quad (2)$$

Description:
P = Percentage of practicality score
Q = Score obtained
R = Maximum score
(Tridiwanto & Trishandra, 2020)

The percentage score for each statement item was then calculated, and the mean percentage score for each aspect was determined. The results of the calculation of the average percentage of practicality scores for each aspect are then converted into the practicality level category from Tridiwanto & Trishandra (2020). Differentiated teaching materials based on the independent curriculum are considered practical if the average percentage score of the practicality of all aspects is categorized as practical, namely reaching a value of $51\% < x \leq 75$ or very practical, namely reaching a value of $76\% < x \leq 100\%$.

With regard to the calculation of the increase in students' knowledge learning outcomes before and after using differentiated teaching materials based on the independent curriculum, this is achieved by utilizing Formula 3.

$$g = \frac{((S_f) - (S_i))}{(100 - (S_i))} \quad (3)$$

Description:
g = Average N-gain/Average normalized gain
S_f = Average post-test score
S_i = Average pre-test score
(Hake, 1999)

The results of the calculation of the average N-gain value are then converted into the average N-gain value category from Hake (1999). Differentiated teaching materials based on the independent curriculum to enhance student's knowledge learning outcomes are considered effective in enhancing students' knowledge learning outcomes if the average N-gain value is categorized as medium, reaching a value of $0.3 \leq g < 0.7$ or high, reaching a value of $g \geq 0.7$.

RESULTS AND DISCUSSION

The outcomes of the developmental research have yielded the creation of teaching materials that are based on the independent curriculum. These teaching materials are characterized by using a differentiated approach and can be observed in Figure 3. This teaching material is made in the form of printed teaching materials designed with an attractive appearance so that students are interested in learning to use this teaching material. This teaching material is equipped with pictures, tables, diagrams, and additional knowledge (Did You Know?) to support students' understanding of the material as can be seen in Figure 4. The teaching material has been meticulously designed to facilitate independent experimentation by students, with the incorporation of learning video barcodes that can be scanned to assist in the clarification and comprehension of the material. Figure 5 shows students employ differentiated teaching materials, which are based on the independent curriculum, throughout the learning process.

Figure 3. The exterior of the printed differentiated teaching materials

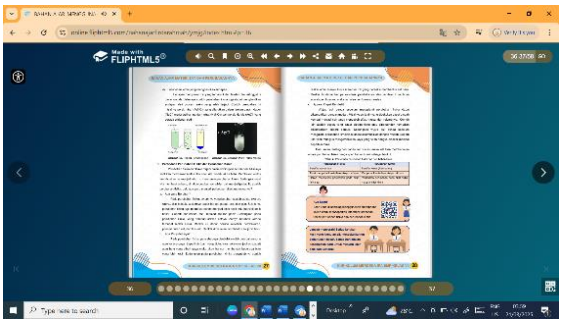

Figure 4. Flipbook display of the contents of the differentiated teaching materials

Figure 5. Use of differentiated teaching materials by learners

This teaching material uses a differentiated learning approach by considering the diversity of learners' learning styles. The objective is to provide an educational environment that caters to the diverse learning styles of students, thereby ensuring that each learner is able to optimize their learning experience and feel supported throughout the learning process. Learners with visual learning styles can understand the material through looking at the pictures, tables and diagrams provided. For learners with auditory learning styles, understanding can be obtained through teacher explanations or through videos accessed using barcodes. Meanwhile, learners with kinesthetic learning styles can try out the various examples of experiments available.

Furthermore, a plethora of activities are provided, which have been customized to align with the diverse learning styles of the learners. This ensures that the learners can assimilate the concepts in a manner that is optimally congruent with their individual learning styles. This teaching material is based on the independent curriculum. It is evident that the preparation of this teaching material involved the utilization of the achievement standards and learning objectives stipulated within the independent curriculum as a point of reference. This approach caters for different learning needs and styles, in line with the independent curriculum's emphasis on learning diversity.

The differentiated teaching materials based on the independent curriculum developed have been reviewed by five validators. The validity of the teaching material has been calculated on the basis of the assessment of five validators. The results of this calculation are presented in Table 1.

Table 1. The results of the validity test of teaching materials

Number	Aspect Assessment	Validator					V	Category
		I	II	III	IV	V		
1	Content viability	110	116	104	100	108	0.83	Very Valid
2	Presentation	53	58	47	48	53	0.83	Very Valid
3	Language	63	59	58	50	54	0.84	Very Valid
4	Media	37	39	31	32	35	0.84	Very Valid
Average							**0.83**	**Very Valid**

Description: V = The result of the calculation of Aiken's validity index

The validity of a teaching material is determined by the extent to which its development is grounded in robust theoretical frameworks and exhibits internal coherence. That is to say, there must be a discernible relationship between the constituent components of the teaching material (Yuliastuti & Soebagyo, 2021). Based on the results of the teaching material validity test which can be seen in Table 1, the average value of the Aiken validity index is 0.83 (very valid). This means that the differentiated teaching materials based on the independent curriculum are considered very valid in terms of content to be used in the learning process. There are four aspects that are assessed, namely aspects of content viability, presentation, language, and media.

The aspect of content viability in this teaching material obtained an Aiken validity index value of 0.83 (very valid). This means that the teaching materials developed contain complete, in-depth, accurate, and up-to-date material in accordance with the applicable curriculum and the learning objectives to be achieved. In addition, the differentiated learning approach presented in the developed teaching materials is also in accordance with the learning needs of students with diverse learning styles, so as to increase the motivation and involvement of students. This finding aligns with Kosasih (2021) assertion that effective teaching materials must adhere to the curriculum and acknowledge the diverse backgrounds of students. Moreover, the material must capture students' interest and motivation to learn, be readily comprehensible, and foster active learning.

The second aspect assessed from differentiated teaching materials based on the independent curriculum is the presentation aspect. The presentation aspect of this teaching material obtained an Aiken validity index value of 0.83 (very valid). This means that the teaching materials

developed are presented in a complete, sequential, and consistent manner. This finding aligns with the assertions put forth by Kosasih (2021), who contends that effective teaching materials must exhibit a clear and varied systematic arrangement of subject matter, encompassing a progression from simplicity to complexity, from the concrete to the abstract, and from the proximate to the remote.

The third aspect assessed from differentiated teaching materials based on the independent curriculum is the language aspect. The language aspect of this teaching material obtained an Aiken validity index value of 0.84 (very valid). This means that the language used in the teaching materials developed is straightforward, communicative, dialogical and interactive, and in accordance with the developmental level of students. This is consistent with the assertion of Kosasih (2021) that the utilization of language in efficacious teaching materials must align with the developmental level of students, ensuring comprehension is facilitated. Consequently, the language employed in teaching materials must be effective, uncomplicated, courteous, and engaging.

The last aspect assessed from differentiated teaching materials based on the independent curriculum is the media aspect. The media aspect of this teaching material obtained an Aiken validity index value of 0.84 (very valid). This means that the teaching materials developed have an attractive appearance (color composition, illustrations, images, fonts, and layout), there are videos and instruction for use, and the use of media is varied and according to the needs of students. This is in line with the presentation of Kosasih (2021) which explains that good teaching materials must be accompanied by attractive illustrations, involve various sources, according to the needs of students, and vary.

The validated independent curriculum-based differentiated teaching materials were then enhanced according to the comments and suggestions given by the five validators. The revised teaching materials were then carried out a limited trial in a small group of 10 seventh grade students. The trial in small groups has two objectives. Firstly, to ascertain the practicality of the teaching materials developed. And secondly, to determine whether any enhancements still need to be made to these materials. The average score for practicality is shown in Table 2.

Table 2. Small group practicality trial results

Number	Aspect	Average Percentage Score of Practicality of Each Aspect	Category
1	Teaching materials	89%	Very Practical
2	Learning	85%	Very Practical
Average		**87%**	**Very Practical**

As demonstrated in Table 2, the results of the small group practicality trial revealed an average score of 87% in the very practical category. This finding indicates that the developed teaching materials are highly practical for students to utilize in small group trials. Not only obtained an average practicality score, the teaching materials developed also obtained positive comments from students on the small group trial. Following a thorough evaluation of the comments provided by the students, it was determined that the teaching materials developed were highly effective in facilitating the learning process. No modifications or enhancements were deemed necessary.

The practicality of the teaching materials was also assessed in large groups. The objective of the practicality trial in large groups is to ascertain the practicality of the teaching materials developed and the practicality of the learning process using the teaching materials developed. The results of the practicality test, based on the calculation of the average percentage score of all aspects of practicality, can be viewed in Table 3.

Table 3. Results of the large group practicality trial

Number	Aspect	Average Percentage Score of Practicality of Each Aspect	Category
1	Teaching materials	86%	Very Practical
2	Learning	94%	Very Practical
Average		**90%**	**Very Practical**

As demonstrated in Table 3, the outcomes of the large group practicality trial indicate that the teaching materials, encompassing aspects such as ease-of-use instructions, the suitability of images and language, the clarity of material descriptions, the learning activities presented, and the accuracy

in choosing background and text, have achieved an average score of 86%, categorized as 'very practical'. This finding signifies that the differentiated teaching materials, developed based on the independent curriculum, are highly practical for students in large group trials within the learning process. This is in line with Kosasih's (2021) explanation that teaching materials must provide knowledge and information systematically and programmatically. Teaching materials must also be able to develop various competencies of students in accordance with their lessons in addition to providing motivation in mastering learning materials, either with certain methods or media. In addition, teaching materials must also contain exercises that aim to provide reinforcement and evaluation to students for their mastery of a subject.

When conducting trials of differentiated teaching materials based on the independent curriculum on large group trial subjects, students were enthusiastic in using teaching materials and understanding the instructions for using the developed teaching materials. Learners also scan the learning videos available in the teaching materials to increase their understanding of the material. This finding is consistent with the positive comments from students regarding the efficacy and appeal of the differentiated teaching materials, which are based on an independent curriculum and are tailored to align with students' learning styles. This observation aligns with the assertion by Misrawati & Suryana (2022) that the design of teaching materials according to students' learning needs and characteristics is instrumental in facilitating effective learning.

The results of the average score obtained for learning aspects related to ease of helping to understand the material, supporting independent learning, increasing interest and motivation, supporting active involvement, and creating a sense of pleasure for students can be seen in Table 3, which is 94% (very practical). This shows that learning using the developed teaching materials is fun and able to enhance students' understanding in the large group trial. In addition, learners are also more active and motivated when learning using this developed teaching material. This activeness and increased motivation of learners is due to the learning activities presented in accordance with the learning style of learners. This finding aligns with the numerous positive comments from students, who reported that the learning activities presented at each meeting were both engaging and enjoyable. The activities were tailored to align with students' learning styles, thereby fostering a greater sense of engagement and enthusiasm for the subject matter. This is in line with Kosasih (2021) explanation that teaching materials can increase students' motivation in learning.

Differentiated teaching materials based on the independent curriculum as a whole obtained an average score of 90% (very practical) in the large group trial which can be seen in Table 3. This shows that the differentiated teaching materials based on the independent curriculum are very easy to use by students in terms of teaching materials and their use in the learning process. This finding aligns with Hamdani's (2011) assertion that the practicality of a teaching material is contingent upon its ease of implementation in learning contexts.

The effectiveness of differentiated teaching materials based on an independent curriculum in the knowledge domain is seen based on the results of the calculation of the average N-gain value of the average data of students' pre-test and post-test results. The results of the effectiveness test of differentiated teaching materials based on the independent curriculum in the knowledge domain can be seen in Table 4.

Table 4. Effectiveness test results

Average Score Pre-Test (S_i)	Average Score Post-Test (S_f)	N-Gain Average (g)	Category
44.2	66.1	0.4	Medium

As demonstrated in Table 4, the mean N-gain test results indicate an increase in student scores of 0.4, categorized as medium. Consequently, the outcomes of the effectiveness test in the knowledge domain are deemed effective. This finding indicates that the teaching materials developed are effective in enhancing students' knowledge learning outcomes. According to Piaget, learning will be more successful if it is adjusted to the stage of cognitive development of students (Jaenudin & Sahroni, 2021). The results of the effectiveness test in the knowledge domain reflect the principle of cognitivism, as expressed by Piaget, because the differentiated teaching materials based on the independent curriculum developed are able to facilitate students in processing information through cognitive stages from knowing to analyzing in a structured and relevant way.

The average N-gain test results which can be seen in Table 4, show the acquisition of an average

N-gain value in the medium category, meaning that the learning process using the developed teaching materials is able to enhance students' knowledge learning outcomes, but has not yet reached a high category. This may be related to the relatively short trial implementation time, so that students have not had sufficient opportunity to understand the concept in depth. In addition, the limited time allocation for each meeting, coupled with the busy learning activities can cause the process of delivering and reinforcing the material to be less than optimal. According to the theory of cognitivism, the learning process is understood as an effort to compile, process and store information in the minds of students (Jaenudin & Sahroni, 2021). Providing adequate time to understand and reflect on the material is essential for deep information processing to occur. Therefore, it is recommended that this differentiated teaching material be applied in several meetings in a more planned and directed manner, so the learning process will be more structured and unhurried, enhancing conceptual understanding and knowledge learning outcomes.

The test of the effectiveness of differentiated teaching materials based on the independent curriculum in the knowledge domain was also carried out by calculating the average N-gain value for each learning style of students. The results of the calculation of the average N-gain value for each learning style of students can be seen in Table 5.

Table 5. Effectiveness test results for each learning style

Learner Group	Average Score Pre-Test (S_i)	Average Score Post-Test (S_f)	N-Gain Average (g)	Category
Auditory	46.7	77.2	0.6	Medium
Kinesthetic	43.5	63.0	0.3	Medium
Visual	42.5	56.3	0.2	Low

Based on the results of the average N-gain test for each learning style which can be seen in Table 5, it is known that the group of learners who have an auditory learning style obtained the highest average N-gain value of 0.6 (medium), followed by the kinesthetic group of learners of 0.3 (medium), and the visual group of learners of 0.2 (low). The low average N-gain value in the visual group suggests that the teaching materials developed have not adequately supported the enhancement of knowledge learning outcomes among students with visual learning styles. This is likely due to an absence of appropriate learning activities for visual learners, which results in students experiencing difficulties in comprehending the material. According to behaviorism theory, students' responses to certain stimuli (such as learning activities) can be optimized by providing relevant reinforcement (Suralaga, 2021). Therefore, it is necessary to redesign learning activities to provide visual stimuli that are more relevant and support concept understanding.

CONCLUSIONS AND SUGGESTIONS

Conclusions

Based on the results of research on the development of differentiated teaching materials based on the independent curriculum to enhance students' knowledge of substance and its changes, it is known that the validity test results obtained a value of 0.83 (very valid). Then the practicality test results obtained a score of 90% (very practical). Differentiated teaching materials based on the independent curriculum are also known to be able to enhance students' knowledge learning outcomes, seen from the results of the effectiveness test which obtained a value of 0.4 (medium/effective). Based on these results, differentiated teaching materials based on an independent curriculum are declared feasible for use in learning.

Suggestions

In light of the research findings that have been disclosed, the following recommendations have been proposed by the researcher.

1. The trial phase of teaching materials should be designed with a longer duration, so that students have adequate time to understand, explore, and apply the concepts taught.
2. The material presented in the teaching materials should also include other materials in science lessons, so that the research results can provide a broader picture of the effectiveness of differentiated teaching materials based on the independent curriculum in supporting the learning process.
3. The learning styles of students considered in further development research should be more varied and not limited to the main learning styles, namely visual, auditory, and kinesthetic.
4. The utilization of differentiated teaching materials within every learning process is imperative to accommodate the diverse learning needs of students, thereby facilitating enhanced knowledge learning outcomes.

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