DEVELOPMENT OF VAK BASED TEACHING MATERIALS INTEGRATED WITH MIND MAPPING AS AN INNOVATION IN MATHEMATICS AND STATISTICS INSTRUCTION IN JUNIOR HIGH SCHOOL

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Abstract

Students' mathematical problem solving skills in statistics remain low, necessitating the use of instructional tools such as innovative teaching materials to support the learning process. Meanwhile, existing teaching materials still have limitations,including monotonous visual presentations and a lack of variety in the learning experience. This study aims to develop valid and practical visual, auditori, kinestetik (VAK) based mathematics teaching materials integrated with mind mapping, specifcally for statistics. The model used wa Sugiyono' Research and Development (RnD) model, modified through product revision stages based on feedback from limited pilot test. The study was conducted at SMPN 9 Tegal, with eight grade students from Class VIII G serving as the pilot test participants. Research instruments included an expert validation sheet and a student practically questionnaire. Based on the research results, the expert validation conducted by one mathematics teachers yielded an average score of 92,593% (highly valid), while student responses regarding the practically of the instructional materials yielded an average score of 84,607% (highly practical). The research results indicate that the integrated mind mapping based teaching materials as an innovation in junior high school statistics mathematics instruction are valid and practical.

Keywords: Teaching materials, VAK, mind mapping, innovation

1 INTRODUCTION

Mathematics education plays crucial role in developing logical, crical, systematic,and analytical thinking skills for problem solving, especially in that 21st century (Setiawati et al., 2024). This aligns with NCTM's statement that mathematics education is intended to develop students' ability to solve problems, articulate ideas, connect concepts, think sequentially, and apply mathematical ideas (Hafriani, 2021), despite the importance of problem solving skills that students must master, student achievement in this area remains relatively low compared to other countries. This is evident from the 2022 PISA results released by the OECD on its official website, where Indonesia's mathematics score was only 366 significantly lower than that of other OECD countries worldwide (OECD, 2023). This means that students are only able to interpret a problem mathematically and are not yet able to select the appropriate problem solving strategy to resolve it. Poor problem solving skills are also evidenced by students' low mathematics achievement scores according to the Ministry of Education and Culture's website, students' TKA mathematics score were low at 36,10 (Kemendikdasmen, 2025). This is because declining problem solving skills lead to suboptimal learning outcomes (Agustina et al., 2025). Abdul Mu'ti recommended conducting an evaluation covering everything from teaching materials to the learning process (kumparanNEWS, 2025).

Statistics is a subject that requires conceptual understanding and the ability to interpret information mathematically. Through this subject, sudents are expected to be able to present and analyze data characteristics, which directly sharpens their logical thinking skills in solving complex mathematical problems. Therefor, the learning process requires instructional materials that only align with learning outcomes but also accommodate students' individual characteristics to make learning more meaningful.

Based on interviews with mathematics teachers at SMPN 9 Tegal, it was found that the teaching materials used are still dominated by text based content presented in a monotonous and boring manner, which affects students' motivation to learn. Observations of the teaching materials also revealed that the number of examples and practice problems provide is still limited the failing to offer students sufficient opportunities to develop their conceptual understanding gradually. The teaching materials used also do not accommodate the diversity of students' learning styles, whether visual, auditory, or kinethetic. These conditions make leraning less engaging, and student engagement during the learning process is not yet optimal, resulting in a theacher centered learning movement.

This problem can be addressed through one alternative that is developing valid and practical instructional materials that integrate visual, auditory, kinesthetic learning with minf mapping, the instructional materials are structured by combining various learning tools and resources to achieve optimal understanding (Magdalena et al., 2023). The instructional materials are designed with learning outcomes and learning objectives in mind. In this study, the development of instructional materials is intended to address these issues by supporting conceptual understanding, problem solving skills, and motivation while taking into account the leraning characteristics of each student.

The objectives of this study are (1) to describe the results of developing integrated subject based mind mapping instructional materials statistical mathematics; (2) to determine the level of validity of integrated subject based mind mapping instructional materials for statistical mathematics; and (3) to determine the level of practically of integrated subject based mind mapping instructional materials for statistical mathematics.

2 METHODOLOGY

This study falls under the category of Research and Development (R&D). The research and development method is a method applied to analyze, design, create, and test the validity of the develop product (Sugiyono, 2019:396). In this study, the product developed and tested for validity and practically is a VAK based teaching material integrated with mind mapping for statistics. The development model used is based on Sugiyono's development model, which was modified up to the limited pilot test stage. The product feasibility validation team consisted of mathematics lecturers, vocational high school (SMK) Indonesian language teacher, and junior high school (SMP) mathematics teachers. The research subject were sight grade students in Class VIII G at SMPN 9 Tegal, sho served as the limited pilot test for the developed product.

According to Sugiyono as cited in Sa'adah & Wahyu (2022:70) the steps in development research can be modified as shown in table 1 below:

Table 1. *Modified steps of Sugiyono's development model*

Stages	Steps Taken
Analysis	1. Analyze instructional material needs
	2. Analyze student characteristics
	3. Analyze curriculum content
Initial product development	4. Determine instructional material components
	5. Incorporating VAK elements into the instructional materials
	6. Incorporating mind mapping into the instructional materials
Expert validation	7. Validation by validators
	8. Revising the product
Limited testing	9. Assessing practically

In this study, data analysis will be conducted in the form of expert validation and practically assessment by students. Expert validation is conducted to obtain data on the validity of the developed product, after the product is declared valid based on expert assessment, it will be given to eight grade in Class VIII G at SMPN 9 Tegal to assess its practically.

According to Akbar as cited in Slamet (2022:60), the validity criteria for assessing the validity of teaching materials are presented in the following table 2.

Table 2. *Validity criteria for instructional materials*

Score Intervals	Validity Criteria
85%<V≤100%	Highly valid
70%%<V≤85%	Valid
50%<V≤70%	Less valid
V≤50%	Invalid

According to Riduwan as cited in Sa'adah & Wahyu (2022:97), the description of score interpretation for the practicality questionnaire is presented in the following table 3.

Table 3. *Description of score interpretation for the practically questionnaire*

Score interpretation	Practicality criteria
$80\% < P \leq 100\%$	Very practical
$60\%\% < P \leq 80\%$	Practical
$40\% < P \leq 60\%$	Fairly practical
$20\% < P \leq 40\%$	Not very practical
$0\% < P \leq 20\%$	Impractical

The instruments used in this study were (1) A validation form for the teaching materials; (2) A questionnaire used to collect data on the practicality of the teaching materials directly from users, in this case, the students.

3 RESULTS

The following section describes the research findings and discussion of VAK based teaching materials integrated with mind mapping for teaching statistics in Junior High School mathematics.

3.1 Research Findings

The research findings are as follows:

3.1.1 Analysis

The first stage was the analysis, the results obtained at this stage were used as a reference in developing the instructional materials. The following steps were taken during the analysis stage.

a) Needs analysis
   Based on interview mathematics teachers and direct observations during classroom instruction, it was found that the instructional materials used for eight grade mathematics at SMPN 9 Tegal featured monotonous visual presentations, failed to present concept in sufficient detail, offered a limited and unvaired selection of examples and practice problems, and did not accommodate students' three learning styles.
b) Characteristics analysis
   Based on interviews with mathematics teachers, it was found that students heterogeneous comprehension abilities, possess different learning styles, and still struggle to identify information contained.
c) Curriculum analysis
   According to interviews with mathematics teachers, instruction at SMPN 9 Tegal currently follows the Merdeka Curriculum. The curriculum analysis was conducted by determining the content based on the Leaning Outcomes and Learning Objectives for Phase D in the statistics section as outlined in the Merdeka Curriculum.

3.1.2 Initial Product Development

The initial product development phase focuses on the design and components of the instructional materials, in line with the first phase that was crried out. The instructional materials are recognized to include content on data centralization and data distribution, with components consisting of (1) The identity of the instructional materials; (2) Instructions for using the instructional materials; (3) Learning outcomes and learning objectives; (4) Concept maps and keywords; (5) Learning content; (6) VAK based instructional material features; (7) Mind mapping related instructional material features; (8) Supporting supplements for the instructional materials; (9) Learning assessment; (10) Glossary; (11) Bibliography. The initial product that has been designed will then be sumitted to validators to essess its validity.

3.1.3 Expert Validation

The develop instructional material prototype was then validated by four validators. The validation process conducted by the validators was designed to evaluate all aspects listed on the validation sheet. Additionally, the validation sheet included a suggestion box for improving the instructional materials. The quantitative assessment, in the form of scores from validation questionnaire, is presented in Table 4.

Table 4. *Results of the quantitative assessment of instructional material validation*

Assessment Aspect	Aspect Score	Maximum Score for Aspect	Aspect Average	Category
Content validity	101	112	90,179%	Highly valid
Presentation validity	100	112	89,286%	Highly valid
Linguistic validity	110	112	98,214%	Highly valid
Graphic validity	89	96	92,708%	Highly valid
Total score			92,593%	Highly valid

Based on Table 4, it can be seen that the initial prototype of the VAK based teaching material which integrates mind mapping into the mathematics subject's statistics content received an average score of 92,593% from the validators, falling into the "Highly Valid" category. This means the developed teaching material is suitable for use and ready for limited testing. Following validation, the product was revised based on comments and suggestions from the validators. These revisions were made to refine the initial prototype so that it better aligns with students' learning objectives.

3.1.4 Limited Pilot Test

The next step involved conducting a pilot test on the revised prototype. This pilot test was carried out with 31 eight grade student from class VIII G as participants. The pilot test was conducted to gather data on students' responses regarding the practicality of the developed instructional materials. The assessment of the materials' practicality by student covered aspects such as readability, ease of use, appeal, alignment with the VAK principle, and integration of mind mapping. The results of the student questionnaire on the practicality of the instructional materials are presented in Table 5.

Table 5*. Students' responses regarding the practicality of teaching materials*

Assessment Aspect	Aspect Score	Maximum Score for Aspect	Aspect Average	Category
Readability	559	620	90,161%	Very practical
Ease of use	492	620	79,355%	Practical
Engaging	429	496	86,492%	Very practical
Alignment with VAK principles	505	620	81,452%	Very practical
Mind mapping integration	428	496	86,290	Very practical
Total score			84,607%	Very practical

Based on the results of the student response questionnaire, the final score was 84,607%, which into the "Very Practical" category. This means that the VAK based teaching materials integrated with mind mapping for the statistics unit in the mathematics curriculum received a positive responeses and meet the practical criteria for use in the classroom.

3.2 Discussion

3.2.1 Validity of The Development of VAK Based Instructional Materials Integrated with Mind Mapping as an innovation Mathematics and Statistics Education

Based on the validators' assessment, the average total score for each aspect of the instructional materials was 92,593%. Thus, this average score falls into the "Highly Valid" category. The content appropriateness aspect received an average score of 90,179%, which indicates it is "Highly Valid". These scroes indicate that the statistics material presented in the teaching materials aligns with the Learning Outcomes and Learning Objectives. Furthermore, the material presented using in VAK approach is a key strength of the teaching materials because it is abel to present the material through various learning styles, including the visual learning style which is supported by illustrations, mind mapping, and an attractive color scheme; auditory learning styles are facilitated through various group discussion activities and the use QR codes containing instructional videos and audio questions; kinesthetic leaning styles are supported through leaning activities tha direcly involve student participation. The examples and practice questions presented in the instructional materials are also highley varied and included in every subtopic, so teachers do not need to search for them in other references. The diverse presentation of content, example questions, and practice

questions make the instructional materials more engaging, systematic, and meaningful, thereby potentially helping students understand the concept being studied.

The presentation feasibility aspect received an average score of 89,286%, falling into the "Highly Valid" category. This score indicates that the instructional materials have been presented systematically and coherently, progressing from the most basic material subtopic 1 data centralization to more advanced material subtopic d data presentation allowing students to learn is a logical sequence. However, the initial prototype of the instructional materials di not include an answer key as a tool for evaluating students' level of understanding, consequently the presentation suitability aspect received the lowest score among the other suitability aspects. Another factor contributing to the lowest score for presentation suitability was that one indicator received a score of 2 from the validator, this indicator pertained to the presence or absence of logical connections between subtopics.

The language suitability aspect received an average score of 98,214%, falling into the "Highly Valid" category. The strength of the instructional materials in this aspect lies in the use of clear and simple sentences, which make it easier for students to understand the material, usage instructions, and steps for solving problems. Additionally, the inclusion of a glossary ensures that the language used is easy to understand, does not lead misconceptions, and conforms to Indonesian grammar rules.

The glossary ensures that the language used is easy to understand, does not lead to misconceptions, and conforms to Indonesian grammar. The graphic design aspect received an average score of 92,708%, falling into the "Highly Valid" category. The strength of the instructional materials in this aspect evident in the harmonious color combinations,the selection of font types and sizes that are easy to read, and the inclusion of icons representing each feature within the materials, which enhance their appeal. Thus, goor graphic design gives the instructional effectiveness in conveying the content.

During the validation process, several validators provided suggestions that served as the basis for revising the initial version of the instructional materials. These improvements were made to enhance the quality of the instructional materials as tools to support the learning process.

3.2.2 Practicality of Developing VAK Based Instructional Materials Integrated with Mind Mapping as an Innovation in Mathematics and Statistics Education

In this study, the practicality of VAK based instructional materials integrated with mind mapping was measured through a student response questionnaire covering five aspects, including: readability, ease of use, appeal, alignment with VAK principles, and integration of mind mapping. The student response questionnaire was administered to 31 students after they used the instructional materials developed during the learning process. The results of the student response questionnaire showed an average final practicality score of 84,607%, falling into the "Very Practical" category. This percentage indivates that the instructional materials were effectively utilized by students during the learning process for the statistics material.

The highest score was achieved in the readability aspect at 90,161%, categorized as "Very Practical", proving that students were able to understand the insturctions or information presented in the instructional materials. Thus, the high scre in the readability aspect made the instructional materials easier to use, enhanced the learning experience, and supported students in understanding the concept of the material and solving mathematical problems more effectively.

The aspect with the second highest percentage score was engaging, with a score of 86,492% and a rating of "Very Practical". The strength of the instructional materials in this aspect are evident in the inclusion of a solustion map zone and summaries and branches that facilitate understanding and retention of the material and help motivate students.

The aspect of mind mapping integration received a high scroe of 86,290%, falling into the "Very Practical" category, indicating that students felt assisted in learning the material due to the role of mind mapping in the instructional materials. The solution map zone and summary features, presented in mind mapping format, were assessed as helping students understand and retain concepts and develop their mathematical problem solving skills.

The aspect of alignment with the VAK principle received a high score of 81,452%, falling into the "Very Practical" category, which demonstrates that student felt they had a more meaningful learning experience because they could learn through sight, sound, and hands on practice.

The ease of use aspect received a score of 79,355%. This aspect received the lowest score because student felt that the instructional materials developed contained practice questions that were quite difficult

for them. This low score was influenced by the unclear presentation of the audio questions, as they were not accompied by accompying text. Student found it difficult to grasp the information while listening to the audio recordings when the classroom was noisy. Student also continued to ask question about how fill in the blanks in the discuss questions feature. These findings indicate that the presentation of the material, practice questions, and sample questions in the instructional materials is not yet fully optimized.

4 CONCLUSIONS

Based on the results of the research and development conducted using a modified version of Sugiyono's R&D model, the following conclusions were drawn:

1) The output of this study consists eight grade teaching materials based on visual, auditory, kinesthetic learning styles, integrated with mind mapping, for the mathematics subject's statistics unit. The teaching materials developed include various learning features that facilitate visual learning styles through the presentation of material using a balanced color scheme and the use of diagrams, tables, and mind maps. Auditory learning is supported by a QR code scanning feature that provides access to instructional videos and audio questions. Kinesthetic learning is supported by a scaffolding based problem solving feature. These teaching materials also include a solution map zone and summaries in the form of mind maps, which help students remember and categorized each formula from concept they have learned.
2) The VAK based instructional materials integrated with mind mapping that were developed received a "Highly Valid": category, with an average validation score of 93,056% across all aspects assessed by the validators. Therefore, tehse materials are suitable for use in the mathematics learning process for grade eight statistics after revisions are made according to the validators' recommendation.
3) The developed instructional materials were rated "Very Practical", with a total final score of 84,607%, based on positive student feedback regarding the presentation, ease of use, readability, alignment wit VAK principles, and integration of mind mapping

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