Development of Case-Based Statistics Materials for Students

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Abstract. The research objective is to develop case-based statistics materials for students in the department of Pendidikan Teknik Bangunan (PTB), Fakultas Teknik, Universitas Negeri Medan. The case-based statistics materials developed relate to the fields of civil and building engineering that are around students. The development of teaching materials is carried out using the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation). The analysis stage is in the form of studies and gathering information about case-based teaching materials for statistics courses. The design stage is in the form of compiling case-based teaching materials in accordance with the objectives and achievements of the statistics course. The development stage is in the form of developing teaching materials, and validation is carried out by material, media, and language experts. The implementation stage is in the form of testing case-based teaching materials, and the evaluation stage is in the form of improving teaching materials that are arranged based on the results obtained. The results of the development of case-based teaching materials for statistics courses obtained quality in the aspect of material feasibility by 90.66%, in the aspect of presentation feasibility by 90.00%, and in the language feasibility aspect by 88.46%. So based on the results of the expert's assessment, the quality of the case-based teaching materials developed is very valid and appropriate to use. By using case-based teaching materials for statistics courses, learning is more effective and targeted and can improve students' HOTS abilities.

Keywords: Development, Teaching materials, Case Method, Analysis, HOTS

1 Introduction

The Ministry of Education and Culture issued a policy on independent learning and independent campuses (MBKM), which aims to prepare students to become true learners in higher education. The characteristics of the implementation of the MBKM curriculum in learning activities are that the learning process focuses on student activities (student-centered learning). In its implementation, students develop independence in seeking and finding knowledge in the real world. Learning activities are directed so that students can find out about various cases in their lives or in the wider community and find alternative solutions to solve these cases. The learning approach through cases (the case method) trains students to have high-order thinking skills (HOTS) in finding solutions and solving cases. Another approach to learning the MBKM curriculum is to train students to think critically, namely through a team-based project-learning approach. Learning by working or studying with a project-based team (Team Base Project) will train students to be able to work and study together with a team to complete a project that has been communicated and agreed upon with the course lecturer. As a result, the case method and team-based project will train students to

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be able to find solutions to various cases that are relevant to the scope of the course and exist in the real world (community and DUDI), as well as to work in teams to complete various projects and tasks as planned.Through this learning approach, students are trained to be able to think at a high level (HOTS) in finding solutions to various cases and completing planned projects. Thus, students have the right capital in the form of problem-solving skills.

One of the subjects for BEE students is statistics. The statistics course aims to make students familiar with the concepts and data analysis used in conducting research to complete the final project (thesis). In understanding the concepts and analysis of research data, students must be able to think at a higher level. To train students' higher-order thinking skills, a teacher must be able to present teaching materials easily and in accordance with the problems that exist in the environment around students. Higher-order thinking ability is a student's thinking process at a higher cognitive level, which is developed from various cognitive concepts and methods and learning taxonomies such as problem-solving methods, Bloom's taxonomy, and learning, teaching, and assessment taxonomies (Saputra, 2016: 91). Higher-order thinking skills include problem-solving skills, creative thinking skills, critical thinking skills, reasoning skills, and decision-making abilities. So HOTS includes critical, logical, reflective, metacognitive, and creative thinking. To be able to improve students' HOTS abilities, it is necessary to design and implement them in learning. When HOTS is applied to learning activities, it allows students to think critically, so with the right learning plan, they can improve students' HOTS abilities. To improve students' high-level thinking skills, it is necessary to develop case-based teaching material in the statistics course. With case-based statistics teaching materials, learning activities will focus on students' developing higher-order thinking skills.

Improving students' thinking skills can be done through learning designed through HOTS activities. Improving students' thinking skills can be done through increasing their critical thinking skills in receiving various types of information, practicing creative thinking in solving various problems using their knowledge, and practicing making the right decisions in a complex situation [1]. Learning activities in the 21st century are focused on improving three important abilities, including the ability to think critically, the ability to think creatively, and the ability to solve problems. This ability is known as the ability to think at a higher level [2]. The implementation of HOTS-oriented learning is carried out through strengthening character education so that students are trained in finding solutions in problem solving, thinking critically about seeing things from various angles, and practicing creative thinking skills in solving a problem. This ability can be realized by providing knowledge and skills in each subject and training students to have the ability to solve problems and think critically and creatively. Problem-based learning is student-centered and can improve HOTS abilities [3]. Learning problems can take the form of cases that occur around students.

A statistics course is one of the courses given to students majoring in Building Engineering Education (BEE) at the Faculty of Engineering (FE) at Medan State University. The statistics course aims to equip students in the form of knowledge, attitudes, and skills to be able to obtain research data and analyze it so that it is meaningful according to the focus and place of research. To achieve the objectives of the statistics course, the learning orientation is carried out through a case approach. The characteristics of statistics courses generally use HOTS abilities so that the objectives of the course are achieved. Learning statistics courses teaches students how to think critically and creatively when solving various research problems and cases, as well as how to make decisions based on the results of research data analysis.With the characteristics of the statistics course, one of the appropriate learning approaches is problem-based learning.

Case-Based Learning (CBL) is a constructivist approach to learning that focuses on material.CBL learning prioritizes student activities that pay attention to learning. The material presented is designed to address a real problem that exists among students. so that CBL learning activities reflect student experiences that are expressed naturally according to the material being studied [4]. Another opinion suggests that CBL is an effective and interesting way to improve students' thinking skills. CBL activities train students to play an active role and think creatively in conducting discussions according to material found in real life. The CBL's learning syntax is structured so that it can develop students' knowledge and reasoning skills in solving various problems that exist in their lives [5].

CBL learning conditions are carried out, namely connecting material with everyday life related to student experiences. So through CBL learning, there is a link between the material presented and its use in student life. Through CBL learning, it provides opportunities for students to analyze content contextually, thereby increasing student knowledge and encouraging them to develop other knowledge that is relevant to the problem or case given. A case is a problem that is realistic and relevant to the material being studied. Cases that arise in CBL are problems related to the environment around students, existing conditions, situations that occur, or a picture of the student's future. A case is a story, fact, or phenomenon that contains messages or information that students can analyze and consider alternative solutions to. Through CBL learning, students will be involved in learning using logic and realistic narratives. This logic and narrative provide opportunities for students to combine various sources of knowledge with authentic contextual information. CBL learning also provides students with a realistic problem scenario, or a case that can be studied holistically, and tests students on how these cases are solved interactively in learning.

CBL can be applied effectively when the lecturer integrates the learning method and the material used and invites students to play an active role in learning to find concepts, principles, and procedures and solve problems or cases based on concepts and principles that have been understood [6]. Many materials (in the form of teaching materials) that are used by lecturers are still theoretical, unconsciously and unintentionally causing the learning process to be practiced by lecturers mostly in the form of lecturing. When attending lectures, students only listen to the lectures and are limited in their understanding while taking notes. Lecturers appear to be the only source of knowledge and become the focal point of the role in achieving learning outcomes.The learning pattern of active lecturers with passive students has low learning effectiveness. Furthermore, Mentari, S., and Laily, N. suggested that the effectiveness of student learning is generally limited, occurring in the final moments approaching the exam. The learning that is applied currently focuses only on understanding the material. From the method applied, students do not have an in-depth and detailed description of the application of the material. Therefore, the materials (teaching materials) and learning methods have not been able to fully hone students' analytical skills, sensitivity to problems, practice problem solving, and ability to evaluate problems holistically. Likewise, learning activities for statistics courses in the Department of Building Engineering Education, Faculty of Engineering, and Unimed are still predominantly centered on lecturers. Lecturers have tried to encourage students to be active with various questions but have not succeeded well. With a case learning approach (the case method), it is possible for students to be more active because the material presented will be linked to problems that exist around them (the community) related to education, building engineering, and civil engineering. In implementing this case-based learning in the Department of Building Engineering Education, it is necessary to develop a material (teaching material) that becomes one of the learning resources in the implementation of case-based learning.

The HOTS thinking skills of students are needed now and in the future. Current technological developments, known as the "industrial revolution 4.0" in the era of "society 5.0," show the disappearance of many types of jobs and the emergence of various types of new fields.To accommodate these changes, the direction of 21st century education focuses on creativity and innovation skills. To train and realize these skills (HOTS), one way is through education and learning. Learning is designed so that students can adapt to changing times, so during lectures they need to be equipped with the knowledge and skills to have the ability to solve problems and think critically and creatively. One of the lessons that can develop students' reasoning abilities is case-based learning.

Through case-based learning, students will be trained to obtain data and information (qualitative and quantitative) that exist around us (the community). By obtaining this data, students will be asked to be able to analyze it and provide conclusions. The process of analyzing and reaching this conclusion is a critical thinking process that students use to solve the case.Case-based learning activities also make students active in learning to understand and solve the cases they are studying. So with case-based learning activities, it will be able to improve students' critical thinking skills.

2 Research Method

The implementation of this research was carried out at the BEE FE Unimed department. The study was conducted from March 2022 to November 2022.This type of investigation is known as research and development (R&D). The development research steps carried out consisted of eight steps based on the opinion of Sugiyono [7]. The steps for the development and research stages are: (1) formulation of potential and research problems; (2) collecting information and exploring literature according to the problem; (3) designing products to solve problems; (4) validating products that have been designed; (5) revising designs based on validation; (6) conducting a trial of the product; (7) revising the product based on the trial results; and (8) conducting a trial use of the revised product.

Case-based teaching materials for statistics courses were developed using the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation). The consideration in selecting the ADDIE model by researchers is that the concept of the ADDIE model is easy to understand and can be carried out systematically to develop case-based teaching materials in the fields of civil engineering and building engineering. The procedures carried out in developing the ADDIE model product are more rational and precise than those used in developing teaching materials. Mulyatiningsih argues that the ADDIE model can be used for developing a product that can improve the quality of learning, such as learning models or methods, learning media and teaching materials, and learning assessment tools [8]. The steps taken in developing a learning device product with the ADDIE model are as shown below:

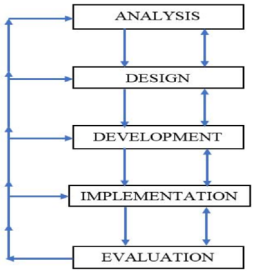

Figure 1. Steps of ADDIE Development Model

The stages of the ADDIE model carried out in the development of case-based teaching materials are as follows [9]:

a) Stage of analysis; The analysis phase aims to describe what students will master in studying statistics material. It is necessary to carry out several activities, such as needs assessment (needs analysis), identify problems (needs), and perform task analysis (task analysis) to determine statistics teaching materials.
b) Design stage; The design stage aims to formulate learning objectives for SMAR statistics courses (specific, measurable, applicable, and realistic). Develop tests based on previously formulated learning objectives, determine case-based learning strategies to achieve these goals. And determine supporting sources such as learning resources that are relevant to what kind of learning environment it should be.
c) Stage of manufacture (Development); This stage aims to make the blueprint a reality. The purpose of realizing this blueprint is, if the design stage requires software in the form of various learning cases to be completed, then the teaching materials must be developed and printed.
d) Implementation phase (Implementation); implementation is the stage of implementation or action to implement a case-based learning system with developed teaching materials. Then as a comparison, the implementation was carried out in other classes with ordinary learning (direct instruction) based on the material presented. So the implementation is carried out in two classes with different learning approaches, namely case-based learning and direct learning.
e) Stage of evaluation (Evaluation): Evaluation is a process to review whether the learning system that is being designed is successful, in accordance with initial expectations, or not. The evaluation carried out at each of the four stages above is called formative evaluation because it aims to identify the need for revision. For example, at the design stage, one form of formative evaluation is required, such as an expert review to provide input on the design being made. The stage to test the feasibility of this product is assessed by one material expert, one media expert, and one lecturer. At the product evaluation stage, students are assessed as users of teaching materials. At the implementation stage, a test on the HOTS ability of students who use case-based learning and learning can be conducted.

The subjects in this study were students taking the Statistics course in the Department of Pendidikan Teknik Bangunan, FT Unimed. sources of data from experts (lecturers) involved in the implementation of learning statistics courses. Methods and data collection tools were used to obtain data from research subjects. Methods for gathering research data include observation, testing, and distributing assessment sheets.

The data to be obtained in this study are in the form of qualitative and quantitative data. Qualitative data is in the form of information about the process and development of case-based teaching materials in the field of civil and building engineering. The development process starts with a qualitative analysis.Quantitative data is in the form of descriptive information about product quality (teaching materials, then case-based statistics lectures) in the fields of building engineering education and civil engineering. This research is development research, in which data analysis is carried out in the form of qualitative and quantitative analysis. Quantitative data analysis in this study is about the quality of teaching materials in the form of cases for improving the HOTS abilities of students majoring in Building Engineering Education at EF Unimed. Qualitative analysis was carried out through the process of developing teaching materials in the form of cases in the fields of building engineering and civil engineering. In the process of developing teaching materials in the form of cases, validation is also carried out by experts in the fields of material/content, teaching

materials, and language. This data includes qualitative data in the form of input and responses from experts analyzed descriptively regarding the product being developed.

3 Results and Discussion

Data analysis and research results obtained in each stage of development are presented as follows.

3.1 Stages of Analysis

This stage begins with a literature study related to the problems studied and the formulation of a research framework. At this stage, the researcher conducted an analysis of the problems she had raised, namely in the form of an analysis of the needs of lecturers and students. Researchers collect information based on observations about the learning model used and the objectives of the course. The results of the observations showed that there were no case-based teaching materials for statistics courses, and the tendency of the learning model to be carried out was direct. With direct learning, the lecturer in charge of the statistics course presents material according to the syllabus, followed by examples of questions. In general, the learning resources used come from textbooks on the market. The examples of the questions given are still general in nature in textbooks, so students sometimes don't understand them with the examples given. Furthermore, in the presentation of the questions, only numbers are given without meaning. Calculating the average (mean) of a number is an example of given data in the form of numbers and calculating the mean.This is less interesting and less understood by students because they do not know the use of calculating the average (mean) of a number. By working on the example questions above, students are not challenged to be able to think HOTS. For this reason, it is necessary to develop case-based teaching materials so that students have more focused learning resources and can improve their HOTS abilities.

Furthermore, the tests conducted on statistics learning were not yet HOTS in nature. From the results of the analysis of the tests assessed, there are several items that are still included in the low-order thinking (LOT) category. The questions tested are still at levels C1 (knowledge), C2 (understanding), and C3 (application). This proves that the assessment of learning in statistics courses is still focused on assessments that have not used HOTS.

To design a case-based learning approach, an analysis of the material and course achievements is also carried out. At this stage, the researchers conducted a review of the systematics and content of teaching materials. The planning for the preparation of teaching materials is based on the objectives, materials, and learning outcomes of statistics courses (CPMK). This is in accordance with the syllabus of the statistics course in the Engineering Education Study Program, FT Unimed.

The objectives and learning outcomes of the statistics course (CPMK) are: students have affective, cognitive, and psychomotor competencies in obtaining and processing research data obtained from the field (research location) and can interpret the results of the analysis according to the variables and fields of research carried out by following the rules and having a scientific attitude. To achieve the CPMK for the statistics course, the sub-CPMK is described, namely:

Table 1. Competency Formulation Based on CPMK Statistics

SUB CPMK	Competency Formulation
1. CPMK (S)	Building objectivity values in obtaining and processing research data based on morals and ethics (A4);
2. CPMK (S)	Get used to the attitude of independence in analyzing and interpreting research results objectively which can be accounted for scientifically (A5);
3. CPMK (P)	Classifying the types of research data, based on their nature and scale,
4. CPMK (P)	Presenting research data in the form of frequency tables and graphs
5. CPMK (P)	Describe the research data according to the location and research subject
6. CPMK (P)	Analyzing data for research purposes, both in prerequisite analysis, correlation analysis and comparative analysis
7. CPMK (K)	Using the SPSS computer program to analyze research data and complete the writing of the final project/thesis.
8. CPMK (P)	Interpret the results of data analysis with the SPSS program for research purposes

Source: MK Statistics Syllabus of BEE FE Unimed

Based on the CPMK formula, the material presented for the statistics course is: 1. Statistical concepts and research data, 2. Testing the validity and reliability of research instruments, 3. Presentation of research data in the form of tables and graphs 4. descriptive data analysis, including size concentration and research data distribution 5. Prerequisite analysis of research data in the form of a normality test, a homogeneity test, a linearity test, and an independence (freedom) test between research variables. Correlation and regression analysis; comparative analysis; and SPSS application in research data processing .

3.2 Design Stages

This second stage consisted of designing case-based teaching materials and making a grid of HOTS-based assessment tools. The teaching materials compiled in this study are statistical materials that can be applied in everyday life. In statistics courses, case-based teaching materials are made by paying attention to a number of signs of a good teaching material.As for the aspects of evaluating a teaching material in terms of material aspects, aspects of the quality of media or learning facilities, and aspects of the grammar and language used, all aspects of indicators are important and are carried out in designing case-based teaching materials in statistics courses. If we look more closely at the assessment of teaching materials on the material aspect, we can see indicators such as: a) the material's suitability with the objectives and CPMK, which consists of: 1) the completeness of the material and 2) the depth of the material; b) the material's accuracy, which consists of: 1) the accuracy of concepts and definitions, 2) the accuracy of facts and data, 3) the accuracy of examples and cases, and 4) the accuracy of pictures, diagrams, and illustrations in the form of This is a consideration in designing case-based teaching materials for statistics courses.

The assessment of case-based teaching materials in terms of appearance is based on the following components: a) Presentation technique with indicators: 1) consistency of presentation in learning activities; 2) concept coherence; b) presentation in learning consists of: 1) student involvement; 2) student-centered learning; 3) stimulating students in solving problems; c) complete presentation with indicators: 1) sample questions or cases in each learning activity; 2) answer keys; 3) an introduction; 4) a table of contents; 5) a glossary; and 6) a bibliography.

Based on the language/sentence aspect of case-based teaching materials, it is assessed based on the following components: a) Straightforward with indicators: sentence accuracy, sentence effectiveness, and term standard; b) Communicative with indicators: message readability, language use accuracy, c) dialogic and instructive, with indicators: motivating ability, ability to encourage higher-order thinking, d) conformity with readers' level of development, with indicators: suitability of intellectual development, appropriate level of emotional development, e) coherence and integration of the flow of thought, with indicators: coherence and integration between learning activities, as well as between sentences. f) Use of terms, symbols, and icons with indicators: consistent use of terms and consistent use of symbols or icons.

3.3 Stages of Development (Development)

Darmawan stated that in the development phase, researchers are faced with the steps of designing, compiling, and implementing a certain product to be tested and then revised. At the stage of developing case-based teaching materials, it is carried out gradually and continuously by going through various stages of responses and assessments so that revisions are made to produce better case-based teaching material [8].

At this stage, expert opinions are obtained on the designed case-based teaching materials.Experts who were asked for their opinions included material experts, media or learning device experts, and language experts. The experts who were consulted came from a team of lecturers at Unimed. The average results of the opinions of two material experts about the case-based teaching materials developed are presented in the following figure.

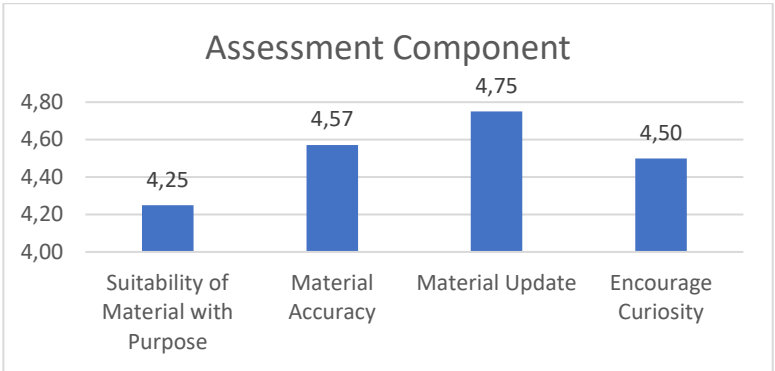

Figure 1. Average Results of Expert Validation on the Feasibility of Material/Content

Expert assessment of case-based teaching materials for statistics courses is submitted through the questionnaire method, with the assessment sheet instrument presented descriptively. The results of the validation or assessment by material experts on the feasibility

of the content of the case-based teaching materials developed obtained a percentage score of 90.66%. The percentage is obtained from the calculation:

$$Percentage = \frac{137}{15\ x\ 10} x\ 100\% = 90{,}66\ \%$$

The percentage score of the feasibility of the case-based teaching material content given by the material expert on the qualification is very valid. This demonstrates that with minor revisions, the developed-based teaching materials can be used for learning.

Furthermore, the developed teaching materials were also asked for the opinions of two experts on good media and learning tools. The results of the assessment based on media experts' feedback on the case-based teaching materials developed are presented in the following table.

Table 2. Average Validation Results of Media Experts

No	Assessment Component	Average Score
1	Serving Technique	4,50
2	Learning Presentation	4,67
3	Presentation Equipment	4,50
	Average	4,55

The results of the validation by learning media experts on the feasibility of presenting case-based teaching materials for the statistics course developed obtained a score of 90.00%. The results of the validation assessment indicate that the assessment tool that has been developed is feasible to use because it has met the assessment criteria and expert validation components. The percentage score of the feasibility of presenting the assessment instrument by the material expert on the qualification is very valid, so the feasibility of presenting the developed assessment instrument does not need to be revised.

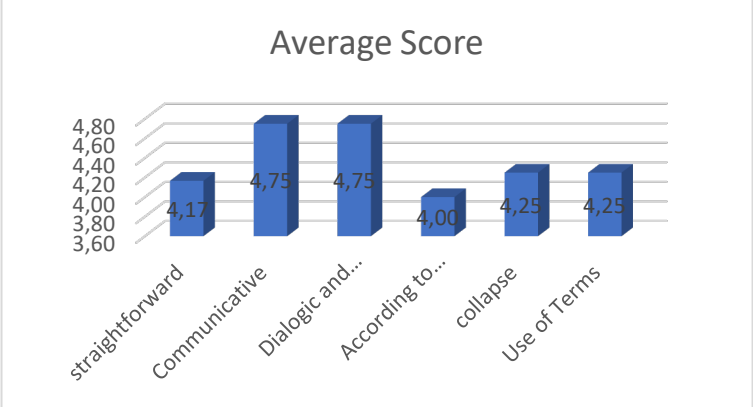

Figure 2. Average Language Validation Score from Teaching Materials

Assessment criteria must be stated clearly and concisely, be observable, state behavior, and be written in easy-to-understand language [10]. So, based on the results of the validation by material experts on the appropriateness of the language of the case-based teaching

materials developed, the percentage of the score obtained is 88.46%. The percentage is obtained from the calculation:

$$Percentage = \frac{115}{13\ x\ 10} x\ 100\% = 88{,}46\ \%$$

The percentage of language feasibility scores for teaching materials generated by these linguists is very high, so the feasibility of the language in the teaching materials developed does not need to be revised.

The results of expert validation on aspects of material depth, presentation, and language used in the case-based teaching materials for the statistics course developed are as follows:

Table 3. Results of Feasibility Validation of Teaching Materials

No.	Assessment Aspects	Frequency	Percentage
1	Feasibility of Content/Material	136	90,66%
2	Presentation/Media Eligibility	99	90,00%
3	Language Eligibility	115	88,46%

Based on the results of the analysis of the textbook developed from the three aspects of the assessment, the material feasibility aspect, according to the material expert validator, is superior with a percentage of 90.66%, while the results of the feasibility of presenting it as teaching material are obtained with a percentage of 90.00%, and in terms of language feasibility, it is obtained with a percentage of 88.46%.

4 Conclussions

Based on the results of the research and discussion on the development of case-based teaching materials for the statistics course, several conclusions can be drawn, namely:

1) The process of developing case-based teaching materials in the statistics course goes through several stages, namely: a) analysis, in the form of a preliminary study, namely research and preliminary information gathering, namely a needs analysis on case-based teaching materials for statistics courses, b) Design: in the form of the preparation of case-based teaching materials in accordance with the objectives and achievements of the statistics course. In this design process, the teaching materials are prepared in accordance with good teaching materials, c) Development: in the form of developing teaching materials that are compiled, validation is carried out by experts in the fields of material, media, and language. d) Implementation: in the form of case-based teaching materials trials on statistics students, e) Evaluation: in the form of improved teaching materials arranged based on the results obtained [11].
2) The quality of the case-based textbooks for the statistics course developed was obtained based on the results of validation from experts. The results of the analysis of the case-based textbooks are assessed on three aspects. The acquisition score for the material feasibility aspect was 90.66%, for the presentation feasibility aspect it was 90.00%, and for the language feasibility aspect it was 88.46%. So based on the three aspects of the assessment, it was found that the quality of the case-based textbooks developed was very valid and proper to use.

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