Design textbooks based linguistic intelligence towards representation ability on statistics

Setiyani1* and Y Gloriani2

1*Department of Mathematics, Universitas Swadaya Gunung Djati, Jl. Perjuangan No.1 Cirebon, Indonesia
2Department of Indonesia Language, Universitas Swadaya Gunung Djati, Jl. Perjuangan No.1 Cirebon, Indonesia

*Email: setiyani_0401509081@yahoo.com

Abstract. An introduction to statistics is a compulsory subject taken by Indonesian Language and Literature Education (Diksatrasia) students. In this course, whether or not Diksatrasia students who have SMA / SMAK / MA cannot understand mathematical concepts. This is a challenge for lecturers who teach these subjects, because most students do not like mathematics. The results of the development of textbooks are based on linguistic intelligence on the ability of statistical representation. This study uses the ADDIE research and development method (Analysis, Design, Development, Implementation, Evaluation) that has been modified and is limited to the development stage. The results of this study indicate that textbooks are very well used with total expert validation of 94% with very valid interpretations. It can be concluded that the introductory statistical textbook that has been developed can be used in subsequent implementations

Keywords: ADDIE, Representation Ability, Linguistic Intelligence

1. Introduction

One of the strong reasons why students choose the Dikbasia study program is to avoid calculating numbers, formulas that must be memorized, and complicated reasoning logic. It becomes a challenge for lecturers who teach this subject, because most Dikbasia students do not like mathematics. Even though today, education in general does not only emphasize language intelligence but also mathematically [1].

Statistics which is a branch of science from mathematics, plays an important role in education. The development of mathematics education has several basic competencies that students must possess to improve the mastery ability of the material taught. According to National Council of Teachers of Mathematics (NCTM) there are five main standard competencies in learning namely problem solving ability, communication ability, connection ability, reasoning ability and reasoning and proof, and the ability of representation [2]. One of the abilities that is the focus of this research is the ability of mathematical representation. This ability is an integral part of solving mathematical problems. Through problem solving, there are two types of abilities that can be developed, namely the ability of understanding and mathematical representation [3]. According to Kaput (1987, 1995) the role of representation itself in mathematical activities is often considered to be doubled namely supporting cognitive processes, and communication [4]. Representation is a form of interpretation of students' thinking about a problem, which is used as a tool to find a solution to the problem. The form of
interpretation can be in the form of words or verbal, writing, images, tables, graphics, concrete objects, mathematical symbols and others [5].

But in reality in the field, students' mathematical representation ability is still low. In the initial observation, students are unable to restate data or information from a representation to a diagram, graph, or table representation. This can be seen in Figure 1.

![Figure 1. One of the results of student answers](image)

Most students work on the problem by presenting directly the data presented from the table form to a circular diagram, even though what is asked is a bar chart. Ahmad, et al said that the difficulties of students in working on story problems usually had to connect between the unknown and the unknown [6]. Students are less able to determine in advance the angle or percentage as part of the element of the pie chart.

Some forms of mathematical representation such as verbal, image, model, numerical, algebraic symbols, tables, and graphics are an integral part of mathematics. However, generally in the learning process, representation is a complement in solving mathematical problems rather than as an important component of learning [7]. Based on research that in the problem of the story, students also have difficulty in connecting between the unknown and the unknown. Montague asserts that lecturers can model how to draw or make diagrams that show the relationship between parts of the problem using linguistic and numerical information in the problem [8]. So it can be concluded that in mathematics teaching and learning, language / linguistics plays a very important role [9].

One of the efforts made to develop mathematical representation capabilities for Dikbasia students is to design teaching materials based on linguistic intelligence. According to Armstrong linguistic intelligence is the ability to use words effectively, both oral and written [10]. Because mathematics is basically a language, that is mathematical language, the use of words and good language is needed in translating mathematical problems in everyday life. Next, solutions will be found by connecting mathematical concepts. Daily problems related to mathematical concepts require the ability of mathematical representation to find a solution. Representation is basically part of mathematical communication that can be shaped as an ordinary language (ordinary language), mathematical verbal language, symbolic language, visual representation, and quasi-mathematical language [11]. Wiwitan said that ability of mathematical representation requires rhetorical skills (reading, listening, writing, and speaking), mnemonics (remembering), explanations (giving information), and metabahasa (understanding the problem language). Which, according to Gardner, these skills are indicators that determine linguistic intelligence [12].

Several studies that link linguistics and mathematics have been carried out. Fathani and Nursit research that students have a tendency in linguistic intelligence in comprehending the material of Function Limits thoroughly and correctly [13]. This is because in understanding the Limit Function material, students optimize the tendency of their learning styles. Furthermore, based on research results of Fitriani, et al, show that linguistic intelligence has an influence on students' mathematical connection skills in completing open ended [12]. The increase in linguistic intelligence of students is directly proportional to the ability to solve mathematical questions in the form of narratives on the subject matter.
of class XI opportunities in MAN Kendal [14]. Furthermore, the relationship between the two variables shows a positive relationship, meaning that the increase in linguistic intelligence is directly proportional to the increase in the ability to solve questions in the form of narratives, as well as the decline in the two variables. Based on some research results, the authors are interested in designing a teaching material in introductory statistics based on linguistic intelligence.

2. Method

This research is a development research. The development model used in this study is the ADDIE model. The ADDIE development model includes Analysis, Design, Development, Implementation, and Evaluation [15]. In this study the authors modified the ADDIE development model into ADD, namely Analysis, Design, and Development. Because in this study limited time, the implementation and evaluation stages are not implemented, this is intended so that the process of making teaching books can be maximized.

![Figure 2. ADDIE Model](image)

The analysis phase consists of two steps, namely needs analysis and material analysis. The analysis phase is carried out to determine the learning needs and competencies that must be mastered by students. Details of activities at the analysis stage, namely needs analysis and material analysis. Needs analysis is done by conducting unstructured interviews with students. Interviews were conducted namely to gather
information about the problems that occurred during learning in introductory statistics, obtain data on the availability of teaching materials that have been used so far, and identify the characteristics of Dikbasia students. From the results of the needs analysis, the next step is identifying statistical introductory material. Material analysis is used to determine the material to be used in research. Test questions were given to determine the representation ability of Dikbasia students in statistical material. From these data, the researcher knows the solutions that need to be proposed in designing linguistic intelligence based teaching materials so that the competencies that must be mastered by students are achieved.

The second stage is the design stage. The activity carried out is the design of teaching materials based on the results of the analysis phase and formulating competencies that must be mastered by students.

Third, the stage of development. At this stage, the development of the results has been arranged at the planning stage. The outcome of this stage is the draft I teaching theoretical basis of linguistic intelligence. Then at this stage a formative assessment was also conducted by experts aiming to find out whether the draft I of the teaching materials for the linguistic-based linguistic-based development material was valid or not. If the results of expert assessment of the draft I was valid and feasible, then continued with the trial draft I. However, if the results of an expert assessment of the draft I draft is invalid, then a revision is made to obtain a draft II.

The instrument for knowing validity consists of teaching material validation sheets. Data analysis techniques used in this study are (1) qualitative data in the form of comments and suggestions analyzed qualitatively, then used as input to revise the developed product, (2) quantitative data with a scale of five converted into qualitative data.

The validity of this teaching material was analyzed by validating data analysis based on data obtained from the assessment of media experts and material experts. The following formula is used [16]:

$$V - ah = \frac{TSe}{TSh} \times 100\%$$

Information :

$V - ah$ : Expert validation

$TSe$ : Total empirical score achieved

$TSh$ : Total expected score

The validation criteria for introductory teaching materials for linguistic based statistics are presented in the following Table 1.

| Validation Criteria | Level of Validity                     |
|---------------------|--------------------------------------|
| $85.00 \% < V \leq 100 \%$ | Very valid or can be used without revision. |
| $70.00 \% < V \leq 85.00 \%$ | Valid or usable but needs to be revised small. |
| $50.00 \% < V \leq 70.00 \%$ | Less valid or recommended not to be used because of the need for major revisions. |
| $01.00 \% < V \leq 50.00 \%$ | Invalid or unusable.                   |

3. Results And Discussion

The study was carried out from December to May 2019. The results of the study used the ADDIE development model in the form of linguistic intelligence based introductory teaching material design on mathematical representation abilities.

3.1. Results

3.1.1. The Analysis Phase. In this stage, interviews are conducted to find information on student learning needs and student difficulties encountered during the implementation of learning. This interview was conducted by interviewing one of the lecturers in introductory statistics. From the
interview results, information is obtained that students still tend to have difficulty in carrying out statistical introductory questions, especially measures of central tendency and size of dispersion. This can happen, because many use mathematical formulas while the addition, subtraction, multiplication and division operations are still wrong. In addition, the difficulty of students in introductory statistics lies in the difficulty in planning or translating the explanations of the questions given. Almost all students are less interested in mathematics since they were in high school so they took the Dikbasia study program. Through interviews, data were also obtained that there were no teaching materials made by lecturers for introductory statistics. In obtaining information, students rely more on the internet than reading statistics books. The improvement of learning that has been done so far is to use SPSS software and use methods of discussion in learning.

In order to strengthen the results of the analysis of student needs, researchers analyzed the material by giving a trial of mathematical representation questions to 35 students.

Problem No. 1: Complete the pie chart with the relevant title and elements!
Indicator: Use visual representation to solve a problem. The following is one of the student answers.

![Figure 3. Results of Student Answers in Problem Number 1](image)

Problem No. 2: Arrange a short story that matches the pie chart above!
Indicator: Make a problem situation based on data or representation given. Here is one of the student answers.

![Figure 4. Results of Student Answers in Problem Number 2](image)
From Figure 4, it can be seen that students have been able to create problem situations based on representations in the form of circle diagrams presented. As many as 82.8% of students answered correctly, while the remaining 17.2% were still wrong in answering. Of the 35 students who worked on question number 2, there were 29 students who answered correctly, while 6 students answered incorrectly.

**Problem No. 3:** The diagram below illustrates the condition of graduates from a vocational school from 2012 to 2016 graduates. Determine the number of unemployed graduates from 2012 to 2015.

Indicator: Write down the steps to solve a mathematical problem with words. Here is one of the student answers.

From Figure 5, it can be seen that students have been able to make steps in solving problems, but have not been right in answering them. Some student mistakes include miscalculating numbers in bar charts and misinterpreting questions. 17.14% of students answered correctly, while the remaining 82.86% were still wrong in answering. Of the 35 students who worked on question number 3, there were 6 students who answered correctly, while 29 students answered incorrectly.

**Problem No. 4:** Mathematics test scores of 30 students is given the following data.

| Score | frequency |
|-------|-----------|
| 5     | 7         |
| 6     | 6         |
| 7     | 4         |
| 8     | 5         |
| 9     | 6         |
| 10    | 3         |

Make a frequency distribution table with the following conditions:

a. Number of class intervals = 7
b. Length of class interval = 1

Indicator: Presenting data or information back from representation to diagram, graph, or table representation. Here is one of the student answers.
From Figure 6, it can be seen that the majority of students have not been able to present a single arranged data back into the frequency distribution table. As many as 60% of students answered correctly, while the remaining 40% still answered incorrectly. Of the 35 students who worked on question number 4, there were 21 students who answered correctly, while 14 students answered incorrectly.

**Problem number 5:** The following shows the number of students in a district according to the school level in 2016. Draw the data on the number of students from the following table into the pie chart!

| Tingkat Pendidikan | Banyaknya Siswa |
|--------------------|-----------------|
| SD                 | 175             |
| SMP                | 600             |
| SMA                | 225             |

Indicator: Make a diagram to clarify the problem. Here is one of the student answers.

![Figure 7. Results of Student Answers in Problem Number 5](image)

From Figure 7, it can be seen that most students have not been able to make diagrams to clarify the problem. Students only count circle elements, without presenting them in a circular diagram as requested in the question. As many as 34% of students answered correctly, while the remaining 66% still answered incorrectly. Of the 35 students who worked on question number 5, there were 12 students who answered correctly, while 24 students answered incorrectly.

**Problem number 6:** Look at the circle diagram below!

![Banyak Penjualan Headphone](image)

Determine the number of mobile units sold from type 4 and type 6 if the total number of mobile units sold is 1000 units!

Indicator: Write down the interpretation of a representation. Here is one of the student answers
From Figure 8, it can be seen that almost all students make diagrams to clarify the problem. Students write an interpretation of the given circle diagram representation. As many as 97% of students answered correctly, while the remaining 3% were still wrong in answering. Of the 35 students working on question number 6, there were 24 students who answered correctly, while 1 student answered incorrectly.

Problem number 7: Consider the following two pictures!

![Picture A and Picture B]

Explain the similarities and differences of the two images above!

Indicator: Answer questions using written words or text. Here is one of the student answers.

From Figure 9, it can be seen that students can use written words or texts in explaining the similarities and differences of the two line diagram images. However, some students still experience many errors, including incomplete in explaining the similarities or differences. As many as 25.7% of students answered correctly, while the remaining 74.3% still answered incorrectly. Of the 35 students working on question number 7, there were 9 students who answered correctly, while 26 students answered incorrectly.

3.1.2. Design Phase. At this stage the focus is on various activities such as initial planning to make learning media products in the form of teaching material. Based on the analysis conducted this study uses teaching materials with the format of printed media, meaning the media that we make as information conveyers that contain material, sample questions, and problem training. In line with that,
Daryanto defines the module as a subject matter arranged and presented in writing and written in such a way that the reader of the module can absorb the material by itself [17]. More specifically, the selection of printed teaching materials in the form of modules aims to make students better understand statistical material with more emphasis on aspects of representation ability. The material used is all teaching material in introductory statistics. The material has levels in learning mathematics ranging from simple to complex. On the subject of statistical tests, this teaching material is equipped with a guide to working with the SPSS program. The questions contained in teaching materials include 7 indicators of mathematical representation ability, namely using visual representation to solve a problem, make a problem situation based on data or representation provided, write down the steps to solve mathematical problems with words, presenting data or information back from representation to diagram, graph, or table representation, make a diagram to clarify the problem and write down the interpretation of a representation Answer questions using written words or text. It is intended that the questions contained in teaching materials be able to improve the ability of students' mathematical representation in introductory mathematics courses [18].

Teaching materials used have gone through several stages of making, starting from the framework of teaching materials made in the Microsoft Word application. In this stage the preparation of the framework is very important because it includes layout design, placement of materials, placement of image layouts, to detail such as placement of motivational words for students. After this stage, the module framework is converted into a storage format into a PDF format. This teaching material is based on linguistic intelligence by observing 4 indicators according to Gardner, including rhetorical skills (reading, listening, writing, and speaking), mnemonic skills (remembering), explanatory skills (providing information), and metallic skills (understanding question languages) [19].

3.1.3. The Development Phase. After the teaching materials have been designed, the final step is to develop teaching materials and then the experts will validate them. Introduction to the chapter, consisting of the start / cover pages of teaching materials, introductory words, table of contents, learning objectives, motivational words, and skills that can develop linguistic intelligence. The following is a picture of the introduction to the chapter contained in the module (Figure 10).
The material content consists of introductory statistics with reference to skills that can develop linguistic intelligence. Figure 11 is a display of the contents of the material where students must be able to explain (explanation skills) how many people in Indonesia in 2018. Students can search for information from various sources.

![Figure 11. Explanation Skill](image-url)

Next is rhetorical skills, where students must be able to read and understand the contents of the material. Figure 12 is a display of rhetorical skills on teaching materials.

![Figure 12. Rhetorical Skills](image-url)

In mnemonic skills, students can recall the material discussed. This section can be a material summary, or a short form. Figure 13 is the display of mnemonic skills in teaching materials.

![Figure 13. Mnemonic Skill](image-url)

The last skill is meta language. In this section, students are asked to understand the statistical questions given. This question refers to several indicators of mathematical representation ability. Figure 14, is the display of meta language skills in teaching materials.
3.1.4. Result of Media Validation. Media validation is carried out to two validators. The validator came from Swadaya Gunung Djati University lecturers. The following is the result of the validation of teaching materials from each aspect of the indicators of each expert as referred to in table 3.

Table 3. Results of Validation for Each Aspect of Indicators

| Valida\tor (V) | Score Achieved At Each Aspect (1 2 3 4) | Each Aspect Validation Criteria (%) (1 2 3 4) | Total Score achieved | Expected Total Score | Validation Criteria |
|--------------|----------------------------------------|------------------------------------------------|----------------------|----------------------|---------------------|
| V. 1         | 12 16 3 22                              | 100 100 75 92                                | 53                   | 56                   | 94,6 %              |
| V. 2         | 12 15 4 23                              | 100 93,8 100 95,8                            | 54                   | 56                   | 96,43%              |

Information :
Aspect 1: Feasibility of content
Aspect 2: Linguistic intelligence
Aspect 3: Mathematical representation ability
Aspect 4: Language worthiness

From the results of this validation, the validator gives advice or input on the teaching material that has been made. The following are suggestions given by the validator such as table 4.

| Validator | Advice | After revision |
|-----------|--------|---------------|
| Validator 1 | Indicators of representation ability do not yet exist and have not yet appeared in the question. There is no reference list yet Statistical applications in everyday life Add illustrations to make it look attractive There is no cover page Writing foreign words italicized | Indicator representation has been written The reference already exists Already explained statistical applications in everyday life Done Cover already exists The writing system is in accordance with the rules of language |
| Validator 2 | Add contextual issues | Contextual issues have been added |

3.2 Discussion
In this study, introductory statistical teaching materials were developed through the ADDIE development model which consisted of three stages, namely analysis, design, and development. The development method aims to produce a particular product then test the validity of the product. In this study, expert validation involved two mathematics education lecturers.

Based on the results of the validation carried out on the module conducted by two validators obtaining a very valid interpretation, this refers to Akbar's opinion the validity criteria of 85.01-100% have a very valid validity level and the module can be used without revision [16]. Data obtained from two validators is one validator with a percentage of validation criteria 94.6%, validator two with a percentage of validation criteria 96.43%. Thus it can be said that the introductory module of statistics can be tested. It can be proven from the results of validation in each aspect, the aspects that are validated in the teaching material are aspects of content feasibility, linguistic intelligence, mathematical representation ability, and language feasibility. The following are the results of the validation of teaching materials for each aspect.

In the aspect of content eligibility, the average score is 100% with very valid criteria. In the aspect of content feasibility, it was assessed on how the material conformity with the achievement of course learning, measuring the accuracy of the material, looking at the material's updating to measuring whether the modules that have been made can encourage students' curiosity. This is in line with BSNP (2014) which states that a good module must be in accordance with basic competencies, accurate and up-to-date material [20]. The curriculum contained in the module corresponds to the current curriculum in higher education namely the 2013 curriculum. Competencies presented in teaching materials include illustrations of material, providing examples, exercises, and evaluations provided in each chapter.

In the aspect of linguistic intelligence obtain an average of 96.5% with very valid criteria. In the aspect of linguistic intelligence the presentation of material in each chapter must fulfill a number of skills that can maximize linguistic intelligence in the form of explanatory skills, rhetoric, mnemonics and meta language. Explanation is how students can provide information from various sources and explain it. Rhetoric skills are how students can understand the contents of the module well. Mnemonic skills are how students can remember the material that has been presented, and the skills of meta language are how students are able to understand the language of the question well then answer it correctly. In addition, the presentation must also be coherent according to the flow of thinking from a
simple basic concept to an increasingly difficult concept. This is consistent with the opinion of Helna,S which states that a good module must have a systematic, consistent, coherent and complete presentation [21]. The illustration of the feasibility of presenting in a module is that it must have a bibliography, introduction and glossary. In addition, the way the module is presented must also be arranged so that students are more easily able to understand the textbooks that we have made. In addition to manual calculations, this textbook is equipped with SPSS methods. This aims to make the calculations accurate and easy. The steps are presented systematically, making it easier for students to understand them.

In making questions on modules, they must be in accordance with the representation capabilities that are the focus of this research. On the aspect of the ability of mathematical representation to obtain a valid average of validators of 87.5% with very valid criteria. In this case the questions contained in the module have referred to seven indicators of the ability of mathematical representation that are expected so that students can improve the ability of mathematical representation.

In the aspect of language feasibility obtain an average of 93.9% with very valid criteria. In the aspect of language feasibility we are required to obey the rules of language that apply, the criteria that must appear are in grammar must be straightforward, communicative, and interactive. In addition, the contents of the module must be adapted to the development of students. In line with the statement Islamiyah which states that a good module must adjust to the level of student development, reliability and motivating ability [22]. It aims to make the digital module that we make useful for students and can motivate students to learn mathematics, especially in introductory courses statistics.

Based on the results of the description of the trial data the introductory questions about statistics show that the representation ability of Dikbasia study program students is still low. Of the 7 questions given, only one question is almost all students answered correctly. The problem indicator is to make a problem situation based on the data or representation provided. Questions that involve mathematical calculations have not been resolved properly. So that reinforces the notion that Dikbasia study program students have a tendency in linguistic intelligence, will excel in working on questions that involve aspects of language. This is in line with the research conducted by Riswandi and Achyanadia that there is a positive relationship between linguistic intelligence and the results of learning English, where the higher the linguistic intelligence, the higher the results of learning English [23].

Developing teaching materials is one of the lecturer’s strategies to improve the quality of learning. Therefore the teaching materials developed must also be in accordance with the characteristics of the students being taught. Fathani and Nursit state that the success of the learning process is determined by the ability and learning strategy by the lecturer as the messenger of the knowledge and abilities and learning styles of students as knowledge recipients as recipients of knowledge messages [13]. Several development of teaching materials in statistical subjects have been carried out. One of them is the development of learning tools in basic statistical courses with the Problem Based Learning method [24].

Based on the revised draft 1, the developed textbook has good and very good ratings. After being implemented in the Basic Statistics course 12.5% of students got an A score, 75% got a B score, and 12.5% got a C score. The basic statistics course textbook was used by mathematics education students. Textbooks that have been developed in this study to bridge Dikbasia Study Program students who have a linguistic intelligence tendency towards mathematical abilities, especially representation ability. Based on the results of research conducted by Dumilah, there is the influence of linguistic intelligence on the ability to solve mathematical story problems on the subject of flat fields of 54.1% [25]. Therefore the presentation of this teaching material is based on linguistic intelligence by applying explanatory, rhetorical, mnemonic and meta language skills to the ability of mathematical representation.

In the process of making this teaching material there are still limitations and constraints. Time limitations make this research only until the development stage. The implementation of teaching materials has not yet been carried out to see the effectiveness and practicality of learning. The obstacle in this study is not getting references from relevant research about the relationship of linguistic intelligence to the ability of mathematical representation. To address the limitations and constraints faced, in further research there will be more in-depth experimentation of teaching materials and theoretical studies.
4. Conclusion
Based on the results of research conducted by the researcher, it can be concluded that the teaching material for introductory statistics based on linguistic intelligence on the ability of mathematical representation made by researchers can be said to be very valid, this is indicated by the percentage of validator-1 of 94.6% and validator-2 amounting to 96.43%, if the overall percentage is obtained an average of 95.5% of the total number of validators. The design of this teaching material is still limited to the stages of development, henceforth it can be continued until the implementation and evaluation stages.

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