

# Developing learning materials of educational statistics assisted ICT and mind map for undergraduate students of elementary school teacher education

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**Abstract.** This study aimed to develop teaching materials in the educational statistics course based on the ADDIE model (Analysis, Design, Development, Implementation, Evaluation) and its effectiveness on students' data analysis skills. The subject of this research are undergraduate students and lecturers of Elementary School Teacher Education Universitas Negeri Semarang. The data collection instruments used were questionnaires, observations, and tests. Analysis of the data used descriptive statistics, the Wilcoxon sign test and n-gain. The needs analysis stage was carried out on 56 students and three lecturers through focus group discussion activities. Seventy-one undergraduate students and twelve lecturers filled the reading questionnaire of teaching materials design. At the stage of developing the teaching materials, the material expert rated Draft 1 with a score of 87.5% and the linguists rated Draft 1 with a score of 81.25%. The learning implementation process consists of six learning experiences in face-to-face and online learning environments, with thirty-three undergraduate students' participation. According to lecturers and students' opinions about the use of ICT and mind maps as a complement in the design of teaching materials for the educational statistics, courses show that both lecturers and students had positive opinions on the usage. The lecturer used the developed learning materials according to the course contents for six weeks in their courses. At the end of the implementation, it was found that the student's ability to analyze data increases the n-gain average value is 0.55 with the moderate category

## 1. Introduction

Statistics are increasingly being used in various fields, including in the education field [1]. Thus, statistics are included in all levels of education, from primary to higher education. Mainly to prepare student careers, Statistics becomes a compulsory subject that must be taken by college students in several study programs [2], [3]

In the Primary School Teacher Education Study Program (PGSD), an educational statistics course with a load of 3 credits is given in the sixth semester. The use of technology has become an integral part of introductory statistics courses; the program usually used is a professional package designed primarily for data analysis [4] and can also be used in lectures. Research conducted on this subject shows that mind mapping helps students know the flow of thinking in the data analysis process, and SPSS software helps students who have difficulty applying formulas or statistical tests in analyzing data [5]. According



to the results of this study, it was identified that on the topic of inferential statistics, PGSD students who experience difficulties when calculations are carried out using formulas and calculators are much helped by SPSS, and their learning outcomes are better than the control class. However, from the observations of the students learning activities with SPSS-assisted mind mapping, there are still difficulty to read the output from the results of data processing with SPSS. SPSS was chosen because it is easy to use and in accordance with the academic needs [6] of undergraduate students in processing data

Other data shows that the research topics submitted by PGSD students reach up to 90% in the education research category in Elementary Schools. Some of the obstacles experienced by students in research, such as when determining samples from the population, even until they analyzed the data. So that some of these causes often make students late in completing their thesis [7].

The ability to analyze data in statistics is very important because it is directly related to students' completion and preparation in doing theses. The ability to analyze requires high-level reasoning and to think deeply about a problem. The ability to analyze data is very important for students to have, not only as a provision in thesis preparation but also in work. More profound analytical skills are a cognitive reflection needed to think more deeply about problems to arrive at the correct answer [8]. Data analysis using technology assistance results in a better learning process [9].

Seeing the phenomenon that occurs, statistics lecturers have compiled teaching materials according to the applicable curriculum in the PGSD Study Program, but it is necessary to accommodate all the obstacles faced by students when researching elementary schools. The need to provide examples of various types of educational research is one solution. Examples of primary research variables are the focus topics that need to be added to teaching materials. Moreover, always invite students to learn on the right path using a mind map.

Aligning the development of teaching materials for educational statistics courses in PGSD with the need for learning flow in a mind map and examples of research topics in elementary schools and data processing using excel and SPSS (ICT), the research was formed. This research was carried out on developing teaching materials for educational statistics assisted by ICT and mind maps to improve students' data analysis skills of the PGSD Study Program, Universitas Negeri Semarang.

## 2. Methods

The type of research used in this research is development research with the ADDIE model [10]. The ADDIE development research model's five stages include Analysis, Design, Development, Implementation, and Evaluation.

The subject of this research are undergraduate students and lecturers of Elementary School Teacher Education Universitas Negeri Semarang. The data collection instruments used were questionnaires, observations, and tests. Analysis of the data used descriptive statistics, the Wilcoxon sign test and n-gain. The needs analysis stage was carried out on fifty-six students and three lecturers through focus group discussion activities. Seventy-one undergraduate students and twelve lecturers filled the reading questionnaire of teaching materials design. The learning implementation process consists of six times of learning in face-to-face and online learning environment with the participation of 33 undergraduate students.

## 3. Results and Discussion

### 3.1. Analysis Stage: Need Analysis

The needs analysis was carried out on two groups of 56 PGSD sixth semester students, resulting in 95.17% agreeing statements regarding educational statistics teaching materials with mind maps equipped and ICT in the data processing process. The material in the educational statistics subject that is considered the most challenging subject by students is inferential statistics [11].

In a focus group discussion (FGD) with lecturers who are teaching the Education Statistics subject, there are some suggestions for the development of Educational Statistics teaching materials as follows: (1) A more complete and specific learning resource is needed, (2) Innovation in ICT makes teaching

materials easier related to the relationship between materials, the flow of thinking, and working in analyzing data in the form of a mind map, (3) Examples of problems are needed based on the problem sources under the field of educational research.

The process of developing ICT-assisted Education Statistics teaching materials begins with the analysis stage. At this stage, a needs analysis is carried out through an FGD with three lecturers who are teaching subjects and filling out questionnaires by 56 students in sixth semesters to answer what and how a lesson [12]. Subjective needs that come from cognitive and affective factors from people in the community, in this case, are represented by the lecturers of the course, while students provide objective needs in the form of facts.

The needs analysis results show the need for innovation and the suitability of the flow of thinking in the data analysis process and appropriate software assistance (ICT), namely SPSS and Excel, as a solution. The use of this technology is also expected to improve 21st century learning skills for undergraduate students [13]. Mind maps help students' difficulties in organizing and linking the flow of thinking in the data analysis process. It follows the purpose of making a mind map, namely arranging concepts hierarchically by using arrows or lines to show the relationship between levels or stages or important material [14]. Besides, examples of problems or cases in education research are important for PGSD students.

### 3.2. Design Stage: Designing Teaching Materials

At the teaching materials development stage, which consists of several topics in inferential statistics, namely correlation analysis, regression analysis, average comparison test, comparison of proportions, and analysis of variance. All the results of the needs analysis are used as guidelines in designing teaching materials. The design of teaching materials made in each chapter contains competency standards and learning objectives and a description of the material according to the sub-chapters, then continues with a summary and mind map and ends with exercises. Design of teaching materials draft 1, with prototypes tested for validity by statistical materials experts and Indonesian language experts.

The second stage in the process of developing this teaching material is designed, where the teaching materials are designed thoroughly from the beginning to the end according to the hierarchy of writing teaching materials by paying attention to the systematics, breadth, and depth of material covered as well as basic competencies to achieve planned graduate outcomes.

### 3.3. Development Stage: Development of Teaching Materials

At the stage of developing the teaching materials of Draft 1, the validity was tested by statistical material experts from Faculty of Mathematics and Natural Science, Universitas Negeri Semarang and Indonesian language experts. The results were as follows.

The material expert rated Draft 1 with a score of 87.5% (very eligible category) and gave several suggestions, namely that in some parts, it is necessary to add references from expert opinions. Linguists rated Draft 1 with a score of 81.25% (very eligible category), suggesting that the use of various informal or non-standard languages needs to be improved. Details of the two experts' assessment of Education Statistics teaching materials draft 1 are in Table 1.

Table 1 shows that the two experts who assessed Education Statistics teaching materials reached 84.38% in the very eligible category. This stage continues with the revision of teaching material products by accommodating suggestions from the two experts. The result of this revision is called Draft 2, and then it is implemented in a limited manner to see its legibility and its effect on the data analysis ability of students of the PGSD Study Program, Universitas Negeri Semarang.

The third stage is the development stage, where Draft 1 is tested for validity by material experts and language experts. Both stated that Draft 1 was very eligible (on average 84.38%) to be developed and used in Education Statistics lectures, but with some suggestions for improvement, namely the use of effective language and standard words and improving the layout of the mind map at the beginning of each chapter and add color to the mind map. Revision of Draft 1 teaching materials was carried out after material experts and language experts' advice, and the result was called Draft 2. Mind maps can be used

in various learning steps, for example, to practice, improve knowledge, and as a means of feedback. However, in this developed teaching material, the mind map serves as a trigger for early learning by displaying a map of the relationship between the material concept to be studied [15], [16].

**Table 1.** Validation on Educational Statistics teaching materials Draft 1

Eligibility Aspect	Description	Score from Material Expert	Score from Language Expert	Average Score
Content	The conformity of Basic Competency Indicator and Learning Objectives	4	4	4
	Clarity of Concept	4	4	4
	Mind Map illustration	4	2	3
	The Use of ICT	4	4	4
	The Use of Reference	2	2	2
	The Stimulation of User Activity	3	3	3
Display	Systematic	4	3	3.5
	Understandability for Users	3	4	3.5
	Average	3.5	3.25	3.38
	Percentage	87.5%	81.25%	84.38%

### 3.4. Implementation and Evaluate Stage: Implementation and Evaluate of Teaching Materials

At the implementation stage, the Draft 2 teaching materials were tested on a limited basis to 12 lecturers and 71 students (semester 6 of the PGSD Study Program at Universitas Negeri Semarang) with excellent results. Then they filled out an online questionnaire on the google form that had been made.

The recapitulation of limited test results is in table 2, consisting of lecturers and students' responses related to material content, mind map illustrations, use of ICT, and language in teaching materials Draft 2. From the questionnaire with 19 statements given to lecturers and students, the average answer agreed, and if categorized, there was a percentage of 82.29%, and it was in the very good category (table 2).

**Table 2.** The responses of lecturers and students to Educational Statistics teaching materials

Response Aspect	12 lecturers	71 students
Language	3.491	2.87
The Use of ICT (SPSS/Excel)	3.439	3.22
Mind Mapping Illustration	3.636	3.07
The Content of the Book	3.455	3.16
Average Score	3.292	
Percentage	82.29%	

At this stage of implementation, the Draft 2 Education Statistics teaching materials were tested on one group of sixth-semester students, totaling 33 people. The data was obtained from student learning outcomes, especially for inferential statistics material, as in table 3.

**Table 3.** The Competence of Analyzing Data (33 students)

Explanation	Pre Test	Post Test
Average	47.88	77.66
Maximum score	62.67	86.67
Minimum Score	10.67	68.00
Deviation Standard	12.89	4.20

The results of this description indicate that the pre-test shows better results than the post-test. Even so, the standard deviation value in the initial test was 12.89, which is a high-value variation (table 3). This is consistent with the range of values that are far from the minimum value and maximum value during the pre-test.

These results are then tested for normality. Because the pre-test data were not normally distributed, the next data processing was to test differences in learning outcomes before using Draft 2 Education Statistics teaching materials and after using Draft 2 Education Statistics teaching materials with the Wilcoxon test (table 4).

**Table 4.** Wilcoxon Signed Ranks Test

		N	Mean Rank	Sum of Ranks
Post_test	Negative Ranks	0 <sup>a</sup>	.00	.00
Pre_test	Positive Ranks	33 <sup>b</sup>	17.00	561.00
	Ties	0 <sup>c</sup>		
	Total	33		

The results of the data processing with the Wilcoxon sign test showed (table 4) that the negative rank value was 0, which means that there were no students whose post-test score were less than the pre-test score, ties 0 means that there were no students whose post-test score same as the pre-test score, while 33 students had the post-test score, more than the pre-test score. The next table showed a significance value of 0.000, less than 0.05, which increases student data analysis skills before using Educational Statistics teaching materials, and afterward. Furthermore, the increase in learning outcomes is calculated using n-gain, and the n-gain average value is 0.55 and is in the medium category.

The indicators developed to measure students' data analysis skills in inferential statistics are shown in table 5. Table 5 explains each indicator's percentage of achievement both on the pre-test and in the post-test.

**Table 5.** Indicators of data analysis competence

The Data Analysis Indicators in inferential Statistics	Pre-test Percentage	Post-test Percentage
Analyzing inferential statistical tests in accordance with the formulation of research problems and types of data.	45,2%	99,4%
Analyzing the requirements test on inferential statistics	51,5%	96,5%
Writing research hypotheses based on research objectives.	50,0%	80,9%
Calculating according to the inferential statistical test manually.	61,8%	76,0%
Identifying inferential statistical tests using software	82,4%	95,8%
Reading data processing output from inferential statistical tests	15,8%	66,2%
Writing conclusion based on data processing results.	53,0%	73,0%

Table 5 showed that all data analysis ability indicators on the final test were more than 66%, meaning that they have reached the passing standard. On the indicators of analyzing statistical tests according to the formulation of the problem and the type of data, analyzing the test requirements on inferential statistics achieves a very high score above 90%. It shows that the mind map in teaching materials helps students understand the inferential statistics data analysis process. Modern data analysis can use statistical software, such as SPSS or Excel, to store and analyze data. Minimum students' ability that should be owned is being able interpret the results of data processing [17]. Moreover because SPSS is easy to use and in accordance with the academic needs of undergraduate students[6].

From the results of the responses in table 5 on the aspect of the ability to read the results of data processing and the aspect of writing conclusions, both are interesting things for further discussion. Because there is a 21st century demand that citizens are able to ask critical questions about the information conveyed through graphics and obtain conclusion about this information[18].

#### 4. Conclusion

Based on this research, the following conclusions were obtained. First, the elementary school's teacher's perceptions about the students' mathematical thinking was that in theory and practice, the teacher had sufficient knowledge and facilitated the students' thinking of remembering aspects and applying maximally to the students. The teacher's knowledge about the thinking of the aspects of understanding, analyzing, evaluating, and creating still must be developed and in the practice in the class still must be developed. Second, the elementary school's teacher's perception about the scientific approach was in theory and practice the teacher understood and applied the observing, questioning,

associating/processing information/reasoning, and communicating facilitations, but in the practice of collecting information, teacher's facilitation was still less varied.

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