Mathematical statistics learning model based on the Indonesian national qualification framework

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Abstract. Learning model plays an important role in enhancing learning outcomes. This study aims to develop a learning model based on Indonesian National Qualification Framework. The learning model was applied in Mathematical Statistics class. The learning model trial was conducted along with Mathematical Statistics textbook trial. The trial was conducted in 8 meetings and was followed by 12 students of Mathematics Education Study Program. The trial's result shows that the learning model and Mathematical Statistics textbook have high validity. Likewise, the learning outcomes show student high ability in understanding Mathematical Statistics. The test result shows that the average score of the students is 92.

1. Introduction
Mathematical Statistics learning model referred to in this paper is a learning model that is structured to improve mathematical statistical learning outcomes. This learning model is based on the Indonesian National Qualification Framework and consists of a learning scheme, steps of the learning process, and other supporting tools in the form of Mathematical Statistics textbook. This learning model needs to be applied because, so far the Mathematical Statistics courses have been relatively difficult and student learning outcomes are relatively low. Another concern is because the Mathematical Statistics course is a basic subject for understanding applied statistics that is why this course is important to be mastered by students.

Some statistics experts call this Mathematical Statistics course as “Statistical Theory”. To study Mathematical Statistics course requires cognitive strength and proper learning model. The right learning model will produce a better level of student mastery. Syahputra and Utami [1] in their research conclude that the right learning model will give good results. In the research, they found out that a valid and reliable learning model can significantly increase students understanding in Mathematical Statistics. Other researchers such as Wasriono, Syahputra, and Surya [2] essentially state that a relevant learning model is needed to improve learning outcomes. Other than, learning model should be valid, reliable and in accordance with the topic to be taught [3-5]. There is no learning model that is suitable and fit all topics in mathematics. Whereas, a learning model basically must be constantly updated and follow the development of science [6-10]. Based on those opinions from experts above and several research results according to supporting this research [11-16], it is necessary to design and to build a learning model that is suitable and in accordance with the topics in Mathematical Statistics course so that the learning outcomes are better.
This study aims to design and build a learning model that is suitable and appropriate to be applied to Mathematical Statistics course both in undergraduate and Graduate School of Mathematics Education program. This learning model is arranged based on the Indonesian National Qualification Framework and follows the curriculum at State University of Medan. Rector Regulation No. 065/UN33/Kep/2016 confirms that Bachelor, Undergraduate, Graduate and Post Graduate students of State University of Medan must complete 6 assignments in each course taken, namely routine tasks, critical book review, critical journal review, mini research, engineering ideas, and project. The six assignments are graduation requirement for each course. That means, if one of the assignments is not completed by the student, the student’s grade will not be published even though other assignments and the midterm and final term exams have been fulfilled.

2. Method
This research is a development research using the Plomp model [6]. In the Plomp model [6-7], there are three main stages: preliminary stage, prototype stage, and assessment stage. In the preliminary stage, the following activities are carried out as follow:
1. Analyze Mathematical Statistics course curriculum based on Indonesian National Qualification Framework
2. Literature review relevant to Mathematical Statistics course
3. Compile a map of research support needs
4. Literature review relevant to Indonesian National Qualification Framework
5. Minimum competency review of Graduate School students in Mathematics Education program
6. Determine Mathematical Statistics learning material
7. Validation from mathematicians.

Furthermore, at the prototype stage the following activities were carried out as follow:
1. Design a prototype of the learning model along with the syntax of the learning model
2. Design initial draft of Mathematical Statistics textbook and other learning tools according to the curriculum applied at State University of Medan. This curriculum is based on Indonesian National Qualification Framework
3. Validate and evaluate of the designed learning model
4. Validate and evaluate the initial draft of Mathematical Statistics textbook and other learning tools
5. Revise the design of the learning model
6. Revise the draft of the Mathematical Statistics textbook and other learning tools.

Lastly, at the assessment stage, the following activities were carried out as follow:
1. Try out the learning model and Mathematical Statistics textbook and other learning tools in Graduate School of Mathematics Education program State University of Medan
2. Revise all the learning tools based on the result of the trial
3. Improve the content and layout of Mathematical Statistics textbook based on the result of the trial
All the stages and activities in this study are illustrated in flowchart of Figure 1.

Figure 1. Flowchart of the development of learning model and other learning tools

3. Results and Discussion
The result of the study is a design of learning model and its syntax that have been tested for 8 meetings in Mathematical Statistics class. The learning model is shown in Figure 2.
Figure 2. The design of Indonesian National Qualification Framework based learning model

The syntax of the learning model is shown in Table 1.

| Learning phase                          | Lecture’s activity                                                                 |
|----------------------------------------|-----------------------------------------------------------------------------------|
| 1. Introduction and delivery of lecture contracts | 1. Start the class with greetings                                                   |
|                                        | 2. Pray before class starts                                                       |
|                                        | 3. Give class material grid for 8 meetings                                         |
|                                        | 4. Present lecture contract and assignments that will be charged during class      |
| 2. Attention                           | 5. Present the purposes of the first lecture material                              |
|                                        | 6. Deliver learning benefits                                                      |
|                                        | 7. Deliver learning materials                                                      |
|                                        | 8. Provide concrete examples                                                      |
|                                        | 9. Distribute learning tools and instruction to analyze and make questions         |
|                                        | relevant to learning materials                                                    |
|                                        | 10. Assign and discuss Routine Tasks related to the learning materials             |
|                                        | 11. Assign Critical Book Review task                                               |
| 3. Relevance                           | 12. Associate learning materials to prior knowledge                                |
|                                        | 13. Give a chance for students to participate in learning process                  |
|                                        | 14. Urge students to look for other examples of the subject                        |
|                                        | 15. Assign and discuss Routine Tasks related to the learning materials             |
|                                        | 16. Assign Critical Journal Review task                                            |
| 4. Confidence                          | 17. Provide feedbacks and assignments for the students to discuss with their classmates |
|                                        | 18. Conclude all the delivered subjects                                           |
|                                        | 19. Assign Routine Tasks                                                          |
20. Assign Mini Research task

5. Satisfaction
   21. Ask the students to present the given tasks
   22. Provide responses to student presentations
   23. Pray before class ends
   24. End the class
   25. Assign Engineering Ideas and Project task

It is a report of the trial conducted at Graduate School of Mathematics Education Program State University of Medan. The trial was conducted in 8 meetings. The trial of the learning model was accompanied by the trial of other learning tools such as the Mathematical Statistics textbook and questionnaire and observation tools. The trial data were analyzed descriptively. Researchers hoped that this learning model and learning tools could improve students understanding of Mathematical Statistics. Based on the data, the result of the trial in Undergraduate School were not significantly different from the result in Graduate School.

Overall, the result of the trial in Graduate School showed that the developed learning tools including Mathematical Statistics textbook is effective, that is: (1) students activity satisfied the ideal time that had been set; (2) students respond positively towards the developed learning tools; and (3) the result of the understanding ability test of Mathematical Statistics satisfied the classical achievement criteria. It appears that the result of the trial in Graduate School is better than in Undergraduate School. It is in line with researchers’ expectation. Based on the result, it can be concluded that the learning model and its supporting tools including Mathematical Statistics textbook have satisfied the criteria of effective learning tools. Then, the design of the learning model and its supporting tools including Mathematical Statistics textbook were analyzed for effectiveness.

3.1. Student Activities in Graduate School Trial

Student activities are classified in 5 categories, namely: (1) read/finish tasks on the worksheet; (2) ask questions to the lecture; (3) discuss in a small group; (4) listen/pay attention to the lecture; (5) irrelevant actions to the learning process. Average percentage of student activities time for each category start from first to last meeting are 24.475%; 14.7375%; 30.475%; 22.9375%; and 7.375%.

In Table 2, the first column shows the average percentage of the ideal time of student activity in reading/finishing tasks in worksheet (category (1)). It shows that student activity in reading/finishing tasks in worksheet consistently increased since the first meeting to the eighth meeting and the average reaches 24.475%. It shows that almost 30% of the time was used by students to read/finish the tasks. Otherwise, category (2), asking questions to the lecture, the percentage of the ideal time was decreased from the first meeting and consistently decreased until the last meeting, with average time is

| Meeting | Average percentage of the ideal time of student activities in each category (%) |
|---------|--------------------------------------------------------------------------------|
|         | 1       | 2       | 3       | 4       | 5       |
| 1       | 20.2    | 18.4    | 28.5    | 24.5    | 8.4     |
| 2       | 22.2    | 17.5    | 28.9    | 23.2    | 8.2     |
| 3       | 24.1    | 15.4    | 30.5    | 22.2    | 7.8     |
| 4       | 24.5    | 14.5    | 29.6    | 23.3    | 8.1     |
| 5       | 27.4    | 14.2    | 28.8    | 22      | 7.6     |
| 6       | 26.2    | 13.2    | 32.6    | 20.8    | 7.2     |
| 7       | 25.6    | 12.5    | 32.5    | 22.9    | 6.5     |
| 8       | 25.6    | 12.2    | 32.4    | 24.6    | 5.2     |
| % Percentage | 24.475 | 14.7375 | 30.475 | 22.9375 | 7.375 |
14.7375%. It provides information that from the first meeting to the next ones, the time students asking questions to the lecture is decreasing. Furthermore, category (3), discussing in a small group. The time was increased from the first meeting to the next ones up to the last meeting; the average time is 30.475%. This information shows that students are actively discussing in their group. Meanwhile, category (4), listening/paying attention to the lecture, the percentage of the ideal time was relatively constant from the first meeting to the last with average about 22.9375%. Category (5) is irrelevant actions to the learning process. This does not need to be done while learning process is ongoing. However, in average, 7.735% of the time is used for it.

Figure 3. The average percentage of the ideal time of student activities in trial on the graduate school

Figure 3 shows that the “discuss in small group” aspect uses the most dominant average time in this learning process which is 30.475%. The aspect of “read/finish tasks in the worksheet” uses an average time of 24.475%. And the aspect that uses the least average time is “irrelevant actions to the learning process”. If this result is compared to the result that has been found in Undergraduate School, then this phenomenon shows a very significant increase.

3.2. Student Responds in Graduate School Trial

In this trial, a questionnaire was spread out to monitor and find out how students respond while following the learning process. There are 5 aspects will be seen, namely: (1) feeling pleased/unpleased towards the learning model and its supporting tools including Mathematical Statistics textbook; (2) novelty of used learning model and its supporting tools; (3) interest in participating in learning Mathematical Statistics; (4) the structure of the language used in book, and other learning tools; (5) student interest in the appearance of Mathematical Statistics textbook.

Figure 4. Student responses following the learning process
Figure 4 shows overall, the average results for each aspect of student responses are as follows: (1) 95.2% of the students expressed pleasure with the used learning model and its supporting tools; (2) 90.5% of the students stated that the learning model and its supporting tools were still new; (3) 100% of the students expressed interest in participating in Mathematical Statistics learning; (4) 92.5% of the students stated that the structure of the language in book and supporting tools was clear; (5) 90% of the students expressed great interest in the appearance of Mathematical Statistics textbook. This fact shows that students are very enthusiastic about the learning process. Students can enjoy and feel pleased to follow the learning process in class; in fact all of them (100%) expressed their interest in participating in Mathematical Statistics learning.

3.3. Students Classical Completeness

Classical completeness is calculated based on the result of final exam after 8 times of face-to-face meetings. From the results of the final exam, it turns out that all students passed the test with average score is about 92 out of 100. The scores of final exam can be seen in Figure 5.

Figure 5. Students’ final exam scores

Figure 5 shows that there are three students who got the same score which is 95, 1 student gets 94, 2 students get 93, 1 student gets 92, 1 student gets 91, 1 student gets 90, 2 students gets 89 and 1 student gets 88. The average score of 12 students are 92. It turned out that out of 12 students who took part in the learning process using this Indonesian National Qualification Framework based learning model, 7 of them got above average grade. Figure 6 shows the distribution of their scores.

Figure 6. The distribution of final exam scores
4. Conclusion
The Indonesian National Qualification Framework learning model applied in Mathematical Statistics class can increase student activities in learning, which are: increase the activity of reading/finishing tasks in the worksheet, asking questions to the lecture, discussing in a small group, listening/paying attention to the lecture, and reducing irrelevant actions. Besides, this learning model can increase the percentage of learning completeness. The students’ average score after the learning process is 92.0.

Acknowledgements
On this occasion, I would like to express my greatest gratitude to Prof. Bornok Sinaga, who has helped a lot until this research and article is completed.

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