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The Development of Module for the Subject of Statistics Based on the Higher Order Thinking in University

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ABSTRACT
This research aimed at examining the feasibility and effectiveness of the module of statistics in college. The type of this research is research and development using Borg & Gall model that consists of nine stages: theoretical studies, pre-survey study, model design evaluation, validation, limited try out, revision, product try out, product perfection, and limited dissemination. The subjects of this study were 41 undergraduate students of Technology Education, Faculty of Educational Sciences. Validation test were carried out by material experts and media experts using Aiken's Validity. Based on the result of Aiken V, all of the items were categorized as feasible. The reliability test through Alpha Cronbach presented that the material and were categorized as good. The module was proved to be effective based on the increased of score from pre-test to post-test. The result of the homogeneity proved to be homogenous and the normality test showed that variable distribution was normal. The findings of this study presented that the module of statistics is feasible and effective to be used.

Keywords: *Module, Higher Order Thinking, Technology Education*

1. INTRODUCTION

For some college students, statistics course is what hinders them for completing their study since it is somehow labeled as a difficult subject that it makes the weary. [1]. College students consider statistics as next-level-mathematics. Due to their unpleasant experience of learning mathematics during high school or even before they get to formal education, their perception on statistics is influenced negatively [1].

Though, as we know, statistics have been taught in high school within mathematics subject and also implemented in the real-life, yet statistics still somehow trigger anxiousness among the college students. [2].[1]. This is because statistics requires high accuracy and precision as any fallacy in the calculation would affect the result of analysis and ruin the research. [3].

Such a situation usually occurs when the students have a negative experience in doing mathematical exercises, then it influences their attitude towards any subject or courses related to calculation like mathematics and statistics when they grow older [4]. This issue in learning mathematics may be caused by the curriculum, teaching method, students, or the combination of them [4].

Mathematics is the subject closest to real life and applicable in any field of science. However, the teaching and learning method tends to be procedurally followed with training and practice. As the consequence, students become passive and unable to think mathematically. Additionally, the students find it difficult to comprehend mathematics due to the teacher's lack of ability and the absence of a mathematics laboratory. Teachers also merely act as the source of information and prioritize questions/exercises that require memorization [5].

To make statistics more interesting, lecturers are suggested to create learning innovations, such as making Higher Order Thinking (HOT) based Student Teaching Material (STM) that is composed of the order of analysis, synthesis, and evaluation. This would help motivate the students to learn further.of

The development of STM in the form of a statistics module is covered in the research of the technology of education since the development of modules is classified

as creating. In other words, it is related to study/research to provide learning facilities and improve working competence by creating the correct teaching material. Student Teaching Material (BAM) should be developed based on the research and practice in composing the material, creating the situation and learning condition, as well as the whole related learning aspect. [6].

The module is one of the teaching materials that contains a set of materials that composed systematically, portraying the whole set of competence the students should master. The module allows the students to learn competence orderly and systematically, hence they could accumulatively comprehend all the competence holistically and integrated. Furthermore, it is mentioned that the module serves as 1) the guidance for teachers or lecturers during the teaching process and as the substance of competence that should be taught to students. 2) the guidance for students during the learning process, along with the substance of competence that should be mastered by students, and 3) the tool of evaluation learning achievement. A module is a set-off material constructed systematically to create the proper environment/condition for students to learn. [7] The module is a book made for students to learn independently without the teacher's direct guidance, therefore it should at least contains: 1). Learning instruction (student/teacher instruction), 2). Competence needs to be achieved, 3). Material content, 4). Supplementary information, 5). Practices, 6). Work instruction, it could be in the form of Working Sheet, 7). evaluation, 8). Feedback for the evaluation result. A module is considered to be good when students can utilize it easily.

Thinking skill is required for students to learn statistics. By using thinking skills, students are trained to solve problems in the current situation or the future. Thinking skill is categorized into two categories, those are Lower Order Thinking Skills (LOTS) and Higher Order Thinking Skills (HOTS); both are parts of the cognitive field. [8] [9]. In developing HOTS learning, the teacher should not only involve the students in learning to achieve 'comprehension', but students should also be able to apply, analyze, synthesize, and evaluate while processing the information. That is because HOTS is a thinking skill that does not only require remembering or memorizing information [10].

The science of statistics expects the students to think using HOTS; not only understanding data and formula, but also analyzing, concluding, and evaluating a problem using statistics calculation. On the other hand, remembering, understanding, and evaluating is classified as Lower Thinking Skill. HOTS deals with the ability to implement knowledge, skill, and values of logic, reflection, problem-solving, decision making, innovation, and creation. [11]

Based on the observation conducted by the researcher on a statistic course, students still could not optimally using HOTS and tend to think using LOTS. This is because the lecturer, during the course, only giving trivial questions that do not require HOTS. Thus, they only sit, listen, and write. Students had a lack of exposure in analyzing, evaluating, and creating. So far, students could easily complete the exercises given to them since it only involved memorizing or remembering formula. When they were faced with more complex exercises, they tend to find it difficult to solve.

2. METHOD

This study is a descriptive qualitative and quantitative study that is conducted to examine the effectiveness of the statistics module for students in the third semester. It took place in the Educational Technology Study Program. In this research, two classes are involved in the research. Class A acts as the experiment class and class B as the control class. Class A receives the lecture by utilizing the statistics module, while class B only receives a regular lecture. The subject of this research is selected through simple random sampling. This choice is taken since the researcher consider that the population is homogenous [12]. The sample of research for experiment class consists of 30 students, while the control class consists of 25 students.

The validity test is conducted using the Aiken's validity. One is considered to have high validity when it could present accurate data that correctly portray the measured variable accordingly [13]. Meanwhile, for reliability tests, a measurement is deemed reliable when the relatively same results are gained after measuring the same subject group and the same aspect to be measured several times. The reliability test is carried out using alpha Cronbach [13].

Before the module is compiled, the researcher is ought to identify the main issue in statistics subject learning by undergoing the following stages: , 1) the preliminary survey is done to find out the practice of teaching of Statistics in the TP major. Information is gained from the observation, documentation and interview, 2) model design is needed to create the module prototype that will be used for the subject of statistics, (3) the validation for the module prototype before it is tested is done by the expert (expert judgment). The validity test used Aiken's Validity. Meanwhile, the validators are a)media validation by the expert of teaching media consisting of 4 lecturers, having no less than a master degree, b)content validation by the expert of statistics consisting of 4 lecturers, having no less than a master degree, (4) limited testing here is used as the facility in gaining the empirical data about the degree of quality for the module. The limited test is directed to 3 students (5) revision or improvement for the module prototype based on the information from the limited testing, (6) extended

testing upon the module for the subject of statistics with the material that is done to more students (7) finalization of the product or the revision that is done after the module gained the scoring from the extended testing by the students, so that it is gained the final product.

3. RESULTS AND DISCUSSION

3.1. Results

The validation result from the expert judgment upon the scoring instrument of the material in media and module, as well as from the students are as follows: the scoring of the teaching module instrument from the material expert used the Aiken validity test. The scoring for the instrument is done by the expert judgment that consists of 4 raters and Number Rating Categories (c) = 5, Lower Limit = 0.88 and Upper Limit = 0.94

The Score of Aiken Validity for the scoring of teaching module by the material expert is in the level between Lower Limit and Upper Limit, even some items are located above the Upper Limit. Thus, all items on the instrument are classified as valid. [14] mentioned that " if the item obtains a score of 0.79 or more, it is maintained ". This means that the Aiken score V≥ 0.79 is the standard score that must be achieved.

According to [15], the coefficient of reliability for Alpha Cronbach is between 0 and 1. The Alpha coefficient can be classified to have a high reliability if the score is close to 1. [15] made a practical rule in the following: "α > 0.9 = very good; α > 0.8= good; α > 0.7= acceptable; α > 0.6= in question; α > 0.5= bad; and α< 0.5= unacceptable."

The scoring instrument for the material is tested to 5 lecturers of the State University of Surabaya. The result presented that the score is 0.817, which is classified as good.

Table 1. Material Reliability

Reliability Statistics	
Cronbach's Alpha	N of Items
.817	5

The scoring of the teaching module instrument by the Media Expert using the Aiken validity test. The instrument scoring is done by the expert judgment that consists of 4 assessors and Number of Rating Categories (c) = 5. Based on the table of Aiken V, it is gained that Lower Limit= 0.88 and Upper Limit= 0.94.

The Validity Score of Aiken to the teaching module scoring by the expert media is in between the Lower Limit and the Upper Limit, even some items are in the level of Upper Limit. Thus all the items on the instrument are considered valid.

The scoring instrument of the media is tested to 5 lecturers of the State University of Surabaya. Based on the test, it is found that the coefficient of reliability of Cronbach Alpha is 0.710, which is considered acceptable.

Table 2. Media Reliability

Reliability Statistics	
Cronbach's Alpha	N of Items
.710	5

The instrument scoring for the teaching module for the students used the Aiken validity. The scoring of the instrument is done by the expert judgment that consists of 5 assessors and the Number of Rating Categories (c) = 5. Based on the table of Aiken V, it is gained that Lower Limit = 0.80 and Upper Limit = 0.90.

The instrument scoring of the statistical module by 10 bachelor students of TP with 23 questions, it is gained that the approval percentage is 97.91%. The module for the subject of Statistics is said to be suitable to the target if the level of approval is >70% so that it can be concluded that the module for the subject of Statistics is accurate with the target and deserved to be used for the subject.

To identify the effectiveness of the statistics module, the analysis technique of a quasi-experimental group is needed to be done. It requires the data from the experiment class and control class that is collected using pre-test and post-test control group design. The design of the research is presented in Table 3.

Table 3. Research Design

Experiment class	O	X_1	O_1
Control class	O	X_2	O_1

Note:

X = Treatment given (media CAI)

O1 = Score of *pretest* (before treatment)

O2 = Score of *posttest* (after treatment)

To identify further the difference between pre-test and post test result in the experiment and control class, it could beseen in Figure 2.

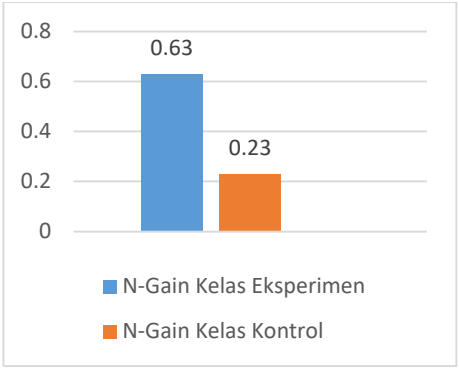

Figure 1. Average Result of Pretest and Posttest

Based on figure 1, it can be inferred that the N-Gain of Pre-test and post-test results in the experiment class is .63 which is categorized as adequate, while the N-Gain in the control class is .23 and considered as not adequate. Hence it is clear that there is a quite significant difference between experiment class and control class regarding the students' learning achievement.

Table 4. Category of N-Gain efektiveness interpretation

Percentage (%)	Interpretation
< 40	Not Effective
40 – 55	Less Effective
56 – 75	Fairly Effective
>76	Effective

The result of the t-count is 2.628 while t-table = 1.68. Since the score of t-count > t-table, then it can be concluded that there is a significant difference between the score of pre-test and post-test. It means the module of statistics is very effective to be used.

The homogeneity test for the pre-test and the post-test is gained that the F-count is 1.88 with the F-table is 4.08. Since the F-count ⩽ F-table (1.88 ⩽ 4.08), then it can be concluded that the data presented are homogeneous. The normality test of the experiment group can be seen in Table 5.

Table 5. Kolmogrove-Smirnov

	Class	Kolmogorov-Smirnov[a]		
		Statistic	df	Sig.
N-Gain	Experiment	.129	30	.200*
	Control	.161	25	.093

Based on table 5, Kolmogorov-Smirnov: output Test of Normality above, it is presented that the Significance (Sig) value in Kolmogorov-Smirnov for the N-Gain of experiment class is about 200 and for the control, the class is 93. Since the Sig. value for both classes is higher than 05, then it is considered that the data used in this research are normally distributed. Hence, the requirement for an independent sample t-test has been fulfilled.

Based on the output above, it is gained that the significance score (sig) Based on the Mean is .110 > .05 so that it can be concluded that the variant of the posttest group of the experiment class and posttest of the control group is the same or homogeneous. The result of the homogeneity test can be seen in Table 6.

Table 6. Test of Homogenety of variance

		Levene Statistic	df1	df2	Sig.
Result	Based on Mean	2.606	1	80	.110
	Based on Median	2.126	1	80	.149
	Based on Median and with adjusted df	2.126	1	70.477	.149
	Based on trimmed mean	2.522	1	80	.116

3.2. Discussion

The effectiveness of the statistics module is indicated from the improvement in students' learning achievement as seen from the N-Gain analysis. Based on figure 2, the average of N-Gain in the control class is 23 and it is considered low or not adequate, while the N-Gain in experiment class is 63 and classified as fair or adequate. The significant improvement in N-Gain from control class to experiment, class, is affected by several characteristics required in the module, those are: a) self-instructional, b) self-contained, c) stand-alone, d) adaptive, and e) user friendly. The usage of language that is simple, easy to understand, and utilize general terms that are commonly used are the attempt to make it user-friendly [17].

4. CONCLUSION

Based on the result of the research and the discussion, it can be concluded that:

1. The module of statistics can increase the learning result of the bachelor students of TP. This is proven with the increase of average score from 70.5 (pretest) to 80.36 (posttest)

2. Module of statistics can be announced deserved to be used. This is proved by the validation score from the expert of material and media which is located between the Lower Limit = 0.88 and Upper Limit = 0.94
3. The module of statistics can be announced effective to use based on:
    a. The average score of N-Gain= .63 which is fairly effective to be used.
    b. Homogeneity test based on the mean is .110, which is higher than 0.05
    c. Normality test with the significance score of Kolmogorov-Smirnov with the pretest and posttest score, each of which are .200 and .09, which is bigger than 0.05
    d. Response from the students is that they are enthusiastic in using the module of statistics for the learning achievement so that this module can be used as the complementary material for the subject of statistics.

Suggestion: for the future researcher, the findings of this research may be developed further as the sole of a more thorough study, for example changing the subject from college students to learners from other level of education such as elementary school, junior high school, senior high school, vocational high school and the equivalent. Furthermore, the study may not only focus on the effectiveness of statistics module as teaching material but also other discipline of science such as Natural Science, Social Science, etc. Finally, the objective could also be leveled up, not only to improve the learning achievement, but also improving Higher Order Thinking (HOT).

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