



## STATISTICS MASTERING PROFILE OF STUDENTS IN BIOLOGY EDUCATION STUDY PROGRAM

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### Article Info

Received September 2018  
Accepted January 2019  
Published February 2019

#### Keywords:

*Academic competency,  
biology education students,  
statistic concepts, statistical  
knowledge*

### Abstract

Mastering statistic concepts to be applied in research is crucial competency for Biology Education students. This research aimed to observe the competency level of Biology Education students in implementing their statistical knowledge. The population of this survey research was the students in seventh semester of Department of Biology Education, Faculty of Teacher Training and Education, University of Muhammadiyah Malang. Meanwhile, the sample were 41 students which comprised of 31 females and ten males. The quantitative data gained was analyzed descriptively to observe the statistical mastering concept of students in general. In addition, one-way ANOVA test was also conducted to determine whether there was a significant difference among students with difference academic levels in mastering statistical concepts. The findings showed that the statistical competencies of Biology Education students were low. Furthermore, the students with low, fair, and high academic abilities had no significant difference in mastering statistical concepts. Based on the findings, it is a demanding task for lecturers to create the most proper learning design in their lectures which boost students' self-efficacy as well as their motivation and positive attitude so that it will ease them to be engaged in statistical learning.

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p-ISSN 2252-6617  
e-ISSN 2252-6232

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## INTRODUCTION

Statistics has been one of the most crucial subjects in university curriculum (Alomir, 2016; Begum & Ahmed, 2015; Tishkovskaya & Lancaster, 2010; Yuniawatika, 2018). Not only does the cruciality is limited in statistics major, but statistics has been also an essential tool among various non-statistics disciplines (Alomir, 2016) such as sociology (Deckard, 2017), medical (Oster & Enders, 2018), biology, education (Fauzi & Fariantika, 2018), and so forth. Thus, an adequate knowledge of statistical basis is necessity for students who will conduct a research (Begum & Ahmed, 2015).

Notwithstanding that statistics is the important subject, but it has also been the most difficult one to be mastered by students (Deckard, 2017; Glancy, Moore, Guzey, & Smith, 2017; Tishkovskaya & Lancaster, 2010). Therefore, delivering statistics materials to non-statistics students is often challenging (Deckard, 2017). This due to the various backgrounds and abilities as well as the negative perceptions possessed by students about statistics (Tishkovskaya & Lancaster, 2010). Moreover, their obstacles in processing statistical information have led them to the negative psychological condition i.e. self-mistrust in mastering statistics (Malik, 2015). Therefore, optimizing learning process which addresses the statistics understanding of non-statistics students in particular is a challenge for statistics lecturers (Allen, Folkard, Lancaster, & Abram, 2010).

The hindrances faced by students during statistics learning processes have effected to their low statistical literacy. The statistical literacy is a technical term to describe a personal ability in interpreting and describing information she/he receives in her/his daily life (Yuniawatika, 2018). Furthermore, this term can also describe a personal ability in evaluating statistical information as well as data-related argumentations in critical way, as considerable as discussing and communicating those information (Sharma, 2017). This due to several elements learnt in statistics subject (such as mathematics and statistical knowledge) are the those which build statistical literacy (Sharma, 2017; Yuniawatika, 2018). In the other words, the higher the obstacles faced by students, the lower the statistical competencies mastered by students.

The low statistical competencies will lead the students to do mistakes in employing statistics in their researches. The most common mistakes occurred

were improperness in choosing hypothesis tests, inappropriateness in using pre-requisite tests, as significant as incorrectness in interpreting statistical test results. In addition, this leads to the low quality of research publications produced. This is in line with the previous researches which revealed that there some research publications were incorrect in using statistics (Abah, 2018; Gogtay & Thatte, 2017; Wu et al., 2011). Yet, the inaccuracy in using statistical method causing the low validity level of the research results reported. Biology education is one of the fields in which the errors were reported (Fauzi & Pradipta, 2018).

The publication blunders arose in biology education field are caused by the low competence of either authors or researcher candidates in this field. By considering that the present students of Biology Education Study Program are the future authors and researchers who will publish their research results in scientific proceedings or journals, accessing their ability in using statistical method is a crucial effort to be conducted. The statistical competency profile is represented by students' abilities in determining and implementing the statistical tools needed for various researches as well as interpreting statistical analyzing results appropriately. Moreover, not only does the student statistical competency profiling provide basis information about the effectiveness of statistics course completed by students, but it also enables statistics lerturers to propose the most proper solution based on the findings.

However, it is difficult to find the research which focused on the study of biology education student ability in determining statistical use. Some previous researches were limited in matemathics students (Azis & Nurlita, 2018; Saidi, 2013), Islamic Education (Burhan, 2015), and Education (Burhan, 2013). Thus, study of statistical competency in Biology Education students is necessity.

## METHODS

This survey research aimed to observe the competency level of Biology Education students in implementing statistical knowledge. The abilities investigated in this research were limited in the determination of statistical tests usage on various research designs as well as the reasons undergirding the decisions made. Meanwhile, the

research population was the all students in seventh semester of Department of Biology Education, Faculty of Teacher Training and Education, University of Muhammadiyah Malang. The sample were 41 students randomly selected from class A, B, and C which comprised of 10 male students and 31 female students. The all subjects in this reseach have attended Statistics, Research Method, Data Analysis and Computation courses as well as basic courses related to research design.

The collecting data process employed instrument which contained of three items (Table 1). Each item of the instrument served a research case in which the students were demanded to analyze the most proper tatistical tests for each case. The quantitative data obtained was the information of how many statistical tests properly chosen by students as the case description given. The data gained was then analized using descriptive statistics, i.e. percentage and was served as bar charts.

**Table 1.** The instrument used to measure Biology Education Students' Statistics competency

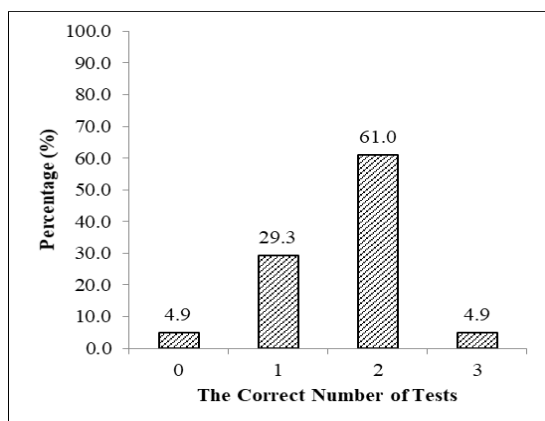
No.	Case Statement
1.	One day, Budi conducted a research addressed to reveal which is the most dominant factor influence students' learning achievement. In his research, Budi chose class XIA-2 as the research subject where he collected several data. The data were critical thinking skills, metacognitive skills, IQ, students' National Examination score (when they were in junior high school), and students' cognitive learning results. Based on this case, analyze the three tests which will be chosen by Budi for his research!
2.	Ani read a news which informed that chicken feet powder can be utilized as plant fertilizer. After reading the news, Ani would prepare a research to determine at what dosage the chicken feet powder plays a role as fertilizer for plant optimally. Based on the case, analyze four tests would be chosen by Ani!

No.	Case Statement
3.	As an educator, it is a must for us to find the most effective learning model in engaging students' thinking skills. Thus, we can conduct a quasi experiment research in the classes we teach in. Analyze what the most proper hypothesis test which can be chosen in that research!

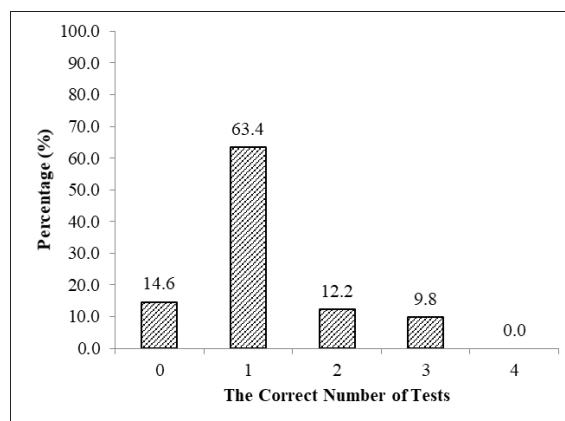
Moreover, this research revealed the difference of students' competency levels in statistics based on their academic competency levels. In accordance with the aim, the subjects of this research were divided into three academic groups i.e. low, fair, and high. The groups were determined by regarding the test of biology mastering concept completed by students before the statistical competency test done. According to the test results, as many as 14 students were classified into the low academic level, 13 students were classified as fair academic level, and 14 students were classified as high academic level. Thus, one-way analysis of variance (ANOVA) was used to ensure that the three academic groups were significantly different in biology mastering concept each others [ $F(2,38) = 52.432; p < 0.05$ ]. This test was done after the assumptions of prerequisite tests, which comprised of normality (Shapiro-Wilk) and homogeneity (Levene) tests, were fulfilled.

## RESULTS AND DISCUSSION

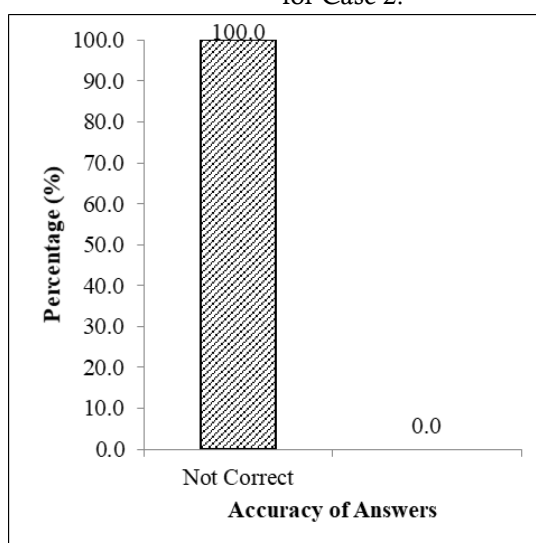
The students' ability in determining statistical tests is a crucial competence to be mastered by Biology Education students. There were three cases used in this research to measure the competency mentioned (Table 1). The percertage of students' ability in solving case 1, case 2, and case 3 were served in Figure 1, Figure 2, and Figure 3 respectively.



**Figure 1.** Students' ability distribution based on their properness in determining the suitable tests for Case 1



**Figure 2.** Students' ability distribution based on their properness in determining the suitable tests for Case 2.



**Figure 3.** Students' ability distribution based on their properness in determining the suitable tests for Case 3

The Shapiro-Wilk dan Levene tests results proved that the data were normally distributed ( $p = .151$ ) in which the three variance groups were homogen ( $p = .177$ ). These test results are served in Table 2. Based on one-way ANOVA test results, it

can be known that there was no significant difference of statistical competency among the three student groups (low, fair, and high academic levels) [ $F(2,38) = 1.152, p = .327; \eta^2 = .057$ ].

**Table 2.** One-way ANOVA analysis results of the students' academic levels differences on their statistical concepts comprehension.

Source	Hypothesis df	Error df	F	Sig.	$\eta^2$
Academic ability	2	38	1.152	.327	.057

Based on Figure 1, Figure 2, and Figure 3, it can be seen that students could not determine the use of statistical test properly. The three charts inform that there was no student who has the ability to answer appropriately for the all cases given. Besides that, generally, students could merely mention one to two proper statistical tests without giving any reason

represents their answer. This indicates that the statistical concepts comprehension of Biology Education students were low. To be more detail, the low statistical competency level was not only possessed by the low-academic students but also witnessed by those who were classified into fair and high academic levels. As the classification

done was only based on students' biology mastering concepts, it does not mean that the higher the academic level, the better the statistical mastering concepts would be. This indicated that the biology mastering concepts was not the factor determined students' statistical competency.

The findings in this research are in line with some previous researches in which the subjects were non-biology students such as education students (Burhan, 2013). Nevertheless, those kinds of research are still difficult to find in education as well as science departments. Thus, the results of this research cannot be compared one the others. On the other hand, the findings in this research strengthen the various statements stated by authors which argued that statistics is one of the most difficult subjects to be encompassed by students (Allen et al., 2010; Begum & Ahmed, 2015; Deckard, 2017; Malik, 2015; Tishkovskaya & Lancaster, 2010).

Student ability level in mastering statistical concept is influenced by several factors. One of the main determining factor is student mathematics competency (Lai, Tanner, & Stevens, 2011; Yuniawatika, 2018). Contrarily, one of the student reasons to avoid mathematics is their displeasure and less mastering in mathematical materials. Thus, they enrolled education or science departments as the consequence. Therefore, educators should realize this condition as well as capable in designing learning process which is suited to the condition.

The other influential factor for students ability in mastering statistical concepts is their self-efficacy and attitude (Gopal, Salim, & Ayub, 2018; Nikiforidou, Lekka, & Pange, 2010). The students with high self-efficacy and positive attitude towards statistics can ease them to be engaged in statistics course and enact the better achievement. Thus, educators must be able to create lecture nuance which boosts the both elements. This due to the inconvenient of psychological condition, experience, and feeling were often witnessed by non-mathematics students toward statistics (Malik, 2015; Tishkovskaya & Lancaster, 2010).

One of solutions to optimize statistics course is by designing problem-based learning. This has been reported that problem-based learning can help non-statistics students in comprehending statistics (Allen et al., 2010). By considering this learning design, the lecturers should be able to present some issues taken from their surrounding. This will lead to upsurge students affection and motivation as they learn the real data (Neumann, Hood, & Neumann, 2013).

Problem-based learning will also facilitate students to elevate their statistical literacy through hands-on practical work (Yotongyos, Traiwichitkhun, & Kaemkate, 2015) as significant as to escalate their academic achievement (Argaw, Haile, Ayalew, & Kuma, 2017; Blundell & Berardi, 2016; Jackson, 2016).

Likewise, technology utilization in statistical learning is the other suggested alternative. Besides that, integrating online sources is required in nowadays learning statistics (Tishkovskaya & Lancaster, 2010) as it is known that computer-based activities and web technology utilization are integrated-parts of present statistics (Tishkovskaya & Lancaster, 2012). The implementation of technology-based learning will be in line with the 21<sup>st</sup>-century learning which demanding educators to be used to with their digital-native-generation students (Chalkiadaki, 2018; Garraway-Lashley, 2014).

To avoid misconceptions which possibly occurred, it is important to be really careful in arranging course module (Nikiforidou et al., 2010). The statistical misconception will lead the students to improperly choose the statistical tests used in certain research design. Moreover, curriculum improvement enables the students to explore the use of various statistical tests which need to be considered. Institutions, in term of campuses are also expected can change statistics course from the activities which merely emphasizing mathematical calculation into practical tasks which involve the real data obtained from their surrounding (Tishkovskaya & Lancaster, 2010). Thus, the both lecturer contributions and institution concern can be predictor variables which are able to determine the mastering level of statistical concepts of biology education students.

## CONCLUSION

Based on the findings of this research, it can be concluded that the Biology Education students' competencies in implementing statistical concepts were low. In line with this fact, the students' statistical competency was the same low level among those who possessed low, fair, and high academic levels. Thus, it is a challenge for lecturers to design problem-based lectures which lead students to comprehend the materials through the real data from their

surrounding. Moreover, educators must be able to create a convenient nuance for students in their course which boosts students' self-efficacy as well as their motivation and positive attitude towards statistics so that it will ease them to be engaged in statistical learning processes.

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