Statistical knowledge of biology education students in Malang

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ABSTRACT

Statistical knowledge is a basic competency which must be possessed by Biology Education students before conducting research. Unfortunately, Statistics is often considered a difficult subject by biology students. The purpose of this survey research was to explore the statistical knowledge of Biology Education students. A total of 40 students in the Universitas Muhammadiyah Malang were involved in this research. The data were collected using a questionnaire containing 12 statements. Descriptive statistics was used to analyze the research data. The results showed that the mean score of students' statistical knowledge was 77.92 ± 17.96; meanwhile, 52.5% of students' knowledge was categorized as good. In addition, the accuracy of student answers on several items reached over 90%, even though there were also items in which the answers were only 50% accurate. Therefore, innovation in Statistics lecture needs to be carried out to optimize the empowerment of statistical knowledge for Biology Education students.

Keywords: research skills, statistical literacy, students' statistical knowledge

INTRODUCTION

Statistics is a crucial part of a research. Almost of all research types utilize statistical calculation to infer a conclusion (Begum & Ahmed, 2015; Sendef & Robbins, 2019). As the consequence, an adequate statistical knowledge is a prerequisite before conducting research. Acknowledging the importance of Statistics, this subject is easily found in various departments in universities (Alomir, 2016; Tishkovskaya & Lancaster, 2010). Statistics provides basic concepts for students to conduct their final task.

On the flip side of the coin, Statistics is often to be issue in higher education. The plethora of students opined that Statistics was the most difficult course they learnt (Fauzi & Fariantika, 2018; Leavy et al., 2013; Zhang et al., 2012). Their statistical comprehension was unsatisfactory (Burhan, 2013; Jatisunda et al., 2020) as they considered that Statistics contained of complex materials (Fauzi & Fariantika, 2018). A great portion of calculation concepts in Statistics has been judged to be the reason of the hindrance faced by student in Statistics. In addition, attitude (Mao et al., 2021; Sölpük, 2017), perception (Ncube & Moroke, 2015; Ririen, 2019), and anxiety toward Statistics (Macher et al., 2013) are the possible factors affect students' learning achievement.

The low statistical competence is concerned to interfere the research quality done by students. It is widely known that statistical competence enables researchers to determine the data collection and analysis methods (Oster & Enders, 2018; Sendef & Robbins, 2019) as well as optimize their research design. However, the tenuous statistical competence will definitely increase the potential misused in either data analysis technique or research design. Several previous researches in Biology Education field were reported employing unoptimized methodology (Susetyarini & Fauzi, 2020). The irrelevance among research design, data collection instruments, and data analysis techniques have been found among the researches (Fauzi & Pradipta, 2018).

The errors in using statistical tools and the improperness of research design are crucial issues which need more serious handling. In addition to those issues, the inaccuracy interpretation of instrument analysis results will, somehow, brings the consequence to the distrust on the research instrument reliability (Barbera et al., 2021; Taber, 2018). Above of that, the fallacy in the use of statistical method will decrease the validity and research findings (Gogtay & Thatte, 2017; Wu et al., 2011). The improper conclusion of analysis results is potentially caused by the mistakes in conducting data analysis procedures (Burke et al., 2013). Hence, the issues in Statistics Course must be tackled immediately so that the students' research quality can be optimized.

Notwithstanding that Statistics problems are often found in education, but the researches focused on Statistics in Biology Education in Indonesia are limited. The previous researches involved students from other majors such as Public Administration (Jatisunda et al., 2020), Education (Burhan, 2013), and Mathematics Education (Azis & Nurlita, 2018). The other study done by Fatmawati & Fauzi (2019) in Biology Education Study Program was limited on the students' accuracy in choosing data analysis technique. Therefore, this research aimed at analyzing basic knowledge of biology students in Statistics. The urgency of this research is to describe statistical competence of Biology Education students. The findings of this research will contribute as the basic information for the Study Program in conducting curriculum evaluation to prepare the students before performing their research.

METHOD

This survey research involved 40 students of Biology Education of University of Muhammadiyah Malang. This research focused the investigation on students' basic knowledge of basic Statistics. A questionnaire was used to collect the data. This questionnaire was comprised of 20 statements with two answer options i.e. correct and incorrect. However, after the instrument was analyzed, there were only 12 items stated valid and the eight items were deleted. The instrument achieved moderate reliability (Cronbach's Alpha = 0.67). The 12 items of questionnaire included knowledge related to general terms in Statistics as well as types of measurement scale.

After collecting the data, several data analysis were done. The correct answer was given score 1 and the incorrect answer was given 0. The total scores were then accumulated and converted into final score with the 0-100 scale. In addition, the calculation of central tendency and dispersed measurement from the final score data were conducted to describe students' knowledge achievement. Students' knowledge was categorized using Bloom's cut-off point. The answers which reached 90% were categorized as good. The pie chart was chosen to visualize students' percentage with good category. Furthermore, the percentage of correct answers of each item was calculated to identify the concepts which were mastered tenuously by students.

RESULTS AND DISCUSSION

An instrument was distributed to measure the basic knowledge of Biology Education students about Basic Statistics. The calculation results of several descriptive statistics of students' final score are served in Table 1. Based on Table 1, the mean score of students' knowledge was 77.92 ± 17.96. Even though the highest score was 100, yet the lowest score gained was 33.33. The great range and deviation standard showed the high diversity of students' knowledge level towards Statistics. In addition, the percentage of students with good Statistics knowledge was 52.5%; while the 47.5% of the students possessed poor Statistics knowledge (Figure 1).

Table 1. The results of descriptive statistical analysis of Biology Education students' final score of statistical knowledge (N = 40)

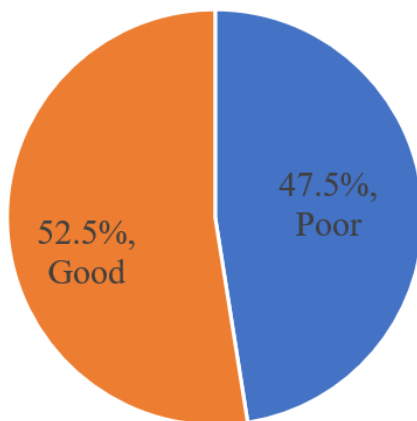| Statistics	Analysis Results
Range	66.67
Minimum	33.33
Maximum	100.00
Mean	77.92
Standard Deviation	17.96

Figure 1. The percentage of students' statistical knowledge which are categorized as Good and Poor.

To be more detail, the accuracy percentages of students' answer for each question are served in Table 2. Based on Table 2, it can be seen that there are three items which were answered accurately by 90% students. Two of the three items accessed students' comprehension toward general terms in Statistics, while the other one item is related to measurement scale. However, there were several items which were inaccurately answered by more than 40% students. One of the items was related to types of calculations in descriptive statistics.

Table 2. The accuracy percentages of students' answer on 12 statements of statistical knowledge

Statement	Percentage n(%)	
	Accurate	Inaccurate
Statistics and Statistic are two terms which have the same meaning	38 (95)	2 (5)
Variable is a character chosen to be observed and can be various from one individual another	37 (92.5)	3 (7.5)
Percentage belongs to descriptive statistic	22 (55)	18 (45)
Parameter is a number which represents data of a sample	20 (50)	20 (50)
Gender belongs to ordinal scale	32 (80)	8 (20)
Body weight belongs to ordinal scale	32 (80)	8 (20)
Score of exam results belongs to nominal scale	29 (72.5)	11 (27.5)
IQ score belongs to nominal scale	34 (85)	6 (15)
City name belongs to interval scale	37 (92.5)	3 (7.5)
Religion belongs to nominal scale	30 (75)	10 (25)
Race or ethnic belongs to ordinal scale	31 (77.5)	9 (22.5)
Academic level (high, fair, low) belongs to ratio scale	32 (80)	8 (20)

The suboptimal statistical knowledge of many students found in this research is in line with the previous researches. Fatmawati & Fauzi (2019) reported that Biology Education students less capable in answering questions related to the accuracy in choosing statistical tools. Albeit that the instruments used were different, but the research has revealed the weak ability of students in comprehending Statistics.

Besides those which involved Education Biology students, several researches which investigated the same topic in other study programs found similar results. Burhan (2013) stated that Education Department students achieved low average score in inferential statistical analysis. In accordance with this research, Jatisunda et al. (2020) argued the statistical literacy of Public Administration students far below the ideal. Even the high number of Statistics misconception occurred among English Language Department students (Arifin & Aprisal, 2020).

Besides the researches with similar findings, there are also former researches in

which the findings were in contrast. The research which was done in Baubau revealed that students performed good Statistics understanding (Azis & Nurlita, 2018), students' Statistics literacy in Bandung was also reported as sufficient (Lukman & Wahyudin, 2020). The differences emerged were assumed due to the students' engagement in research activity. Moreover, the reports which showed the satisfaction of students' statistical understanding and skills were those which included Mathematics and Mathematics Education students as the subjects.

The Statistics competence differences between Biology Education students and Mathematics students indicated the possible correlation between major background and Statistics competency. The students majoring in Mathematics own stronger mathematical skills and knowledge than those who take the other majors. It is believed that mathematical competences are strongly related to statistical competences (Lai et al., 2011; Yuniawatika, 2018). Yet, the competences owned by students who are not majoring in Mathematics were, generally, suboptimal. (Cimpoeru & Roman, 2017) supported these findings. The undergirding reason of this fact is that senior high school students who have low level understanding in Mathematics will likely to choose non-Mathematics major as they enroll higher education.

In addition with the tenuous mathematical competence, the shallow students' statistical competence was because of their attitude towards Statistics. Attitude has been reported to be correlated with individual performance (Rafiu, 2020) and students' learning achievement (Mao et al., 2021; Sölpük, 2017). By having positive attitude, students will maintain the competences they learnt and improve the skills they achieved. Hence, one of most crucial output of Statistics Course is the improvement of students' attitude toward Statistics (Ramirez et al., 2012).

Statistical competence improvement should be one of the priorities, either for Mathematics students or non-Mathematics students. Students will conduct research as their final task or the other certain interests. Considering those points, statistical mastering concepts is the main prerequisite for conducting research (Begum & Ahmed, 2015). Not only will the students with good Statistics comprehension be able to do various data analysis, but they will also be able to design their research and plan the data collection method appropriately (Oster & Enders, 2018; Sendef & Robbins, 2019). Thus, even though Statistics is often considered as a difficult material by students (Fauzi & Fariantika, 2018; Leavy et al., 2013; Zhang et al., 2012), but this subject is still to be the important part of higher education curriculum (Alomir, 2016; Tishkovskaya & Lancaster, 2010).

Of the above explanation, there are two factors need to be considered as they related to students' low comprehension of Statistics. The low level of statistical knowledge of Biology Education students may be caused of their low mathematical skills as considerable as their attitude toward Statistics. Acknowledging this facts, Biology Education Department is suggested to design lectures which can improve students' mathematical skills and attitude toward Statistics. Measurements and researches toward these variables need to be done continuously so that the improvement of the variables can be measured in valid way.

CONCLUSION

This research was conducted to measure students' statistical knowledge, particularly in Statistics Introduction and Measurement Scale materials. The analysis results showed that the mean value of students' statistical knowledge was unsatisfying. It was only 52.5% of students were categorized as good in terms of their statistical knowledge. By considering the statement items, there were many students who did not comprehend important statistical terms

yet. Moreover, there were also many of them who did not achieve the understanding of analysis types in descriptive statistics.

Responding the findings in this research, Biology Education Department needs to design lectures which can optimize students' comprehension about Statistics. The Department needs to improve students' mathematical skills and attitude toward Statistics. This effort is important to be done as Statistics is the basic competence which must be mastered by students before designing and conducting research.

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