

PAPER • OPEN ACCESS

Scaffolding for international students in statistics lecture

To cite this article: H Retnawati *et al* 2019 *J. Phys.: Conf. Ser.* **1320** 012078

View the [article online](#) for updates and enhancements.



IOP | ebooks™

Bringing together innovative digital publishing with leading authors from the global scientific community.

Start exploring the collection—download the first chapter of every title for free.

Scaffolding for international students in statistics lecture

H Retnawati¹, E Apino¹, H Djidu¹, W P Ningrum², R D Anazifa¹, K Kartianom¹

¹ Universitas Negeri Yogyakarta, Indonesia

² Universitas Islam Negeri Raden Fatah, Indonesia

heri_retnawati@uny.ac.id

Abstract. Statistics is one of the tools to draw generalization in conducting a research. However, university students still face various obstacles during statistics lectures. This study aimed to describe the students' difficulties in learning statistics and strategies for scaffolding them. It was conducted with 12 international students from different majors who were enrolled in statistics lectures in Graduate School, Yogyakarta State University, Indonesia. It employed qualitative phenomenological research. The Cresswell's model was used in data analysis covering data reduction, presentation, and verification. The data were collected through interviews and observations during 8 meetings of extra statistics lectures. The results indicated that the students' obstacles in learning statistics were caused by several factors; they were not enrolled in Mathematics and Statistics lectures during their undergraduate study, and they found it hard to perform computation, run the software, understand mathematical symbols, relate one concept to others in hypothesis testing, and present analysis results in Bahasa. Various scaffolding can be taken by lecturers to overcome these problems.

1. Introduction

Education is one of ways in improving human resources quality. One of provided education is a graduate school that prepares students to be experts in their preferred fields of study. Graduate school students, particularly at Yogyakarta State University (Universitas Negeri Yogyakarta), must be enrolled in statistics as a compulsory course. It is expected that this course will equip them a basic foundation to write their thesis as the main requirement to obtain the master degree.

In statistics, there are some materials that the students should master. They are descriptive statistics, data presentation, probability and its distribution, hypothesis testing for a population mean, hypothesis testing for two population means, variance analysis, and an introduction to regression and correlation. They are useful for the students to conduct a thesis research, especially that uses quantitative one. Reference [1] states that statistics is one of the prominent quantitative courses in a university's curriculum aiming to support the students' completion of studies.

Even though it is so, there are still many students who meet difficulties in learning it. The students' difficulties are caused by a complexity nature of statistics itself, its prerequisite materials and reasoning ability to learn it [2]. Besides, a mastery in mathematics concept is also required to comprehend statistics [3] as well as other abilities such as making a connection and interpretation ones [4]. All those abilities are basic competencies the students should have to master statistics. Previous studies have addressed issues on difficulties that international students meet in completing their studies. They experience problems related to personal and social environmental adjustment [5,6],



language barriers [7–9], academic difficulties [10], teaching and learning methods problems [10], and interaction with supervisors [10,11].

Many various skills are required in learning statistics. They include prerequisite and reasoning skills which will determine students' success in learning. Students' difficulties in learning probability and statistic are due to their lack of prerequisite and abstract reasoning skills [2]. Another difficulty is creating and interpreting graphs [12]. Some of their mistakes show that they face problems in data representation, parameter estimation, population and inference [3]. Some matters are identified as causes of those problems. The difficulty in learning is related to previous learning experiences [13]. Those problems must be solved in order to obtain successful learning mentioned previously.

Several researchers have suggested various alternatives to solve the problems in statistics lectures. Reference [14] recommend several reforms for the learning of statistics. They are statistics learning method reforms and the use of technology. This opinion is supported by [15] stating that statistics teaching and learning need to focus on training statistical thinking, using real cases, and engaging students in the whole process of teaching and learning, and utilizing technology. One of the useful strategies to interpret easier is relating research results to its significances through statistics learning [16]. To overcome the difficulty in mastering prerequisite materials, it is important to have an introduction to quantitative research in order to improve students' interests [17].

1.1. Purposes of Study

Ideally, teaching and learning statistics can be conducted as planned before. The teaching and learning statistics in a class which involves international students might face challenges. This study aims to identify their difficulties in statistics lectures and find strategies to overcome them, scaffolding students in the lecture. It should be done to find solutions i.e. teaching and learning strategies that can be implemented as the best practices in the next statistics lectures.

2. Method

This study employed qualitative phenomenological research. The participants were 12 students (3 female, and 9 male) from various countries who were enrolled in statistics lectures in Graduate School, Yogyakarta State University. Their various majors were applied linguistics, language education, arts education, education management, chemistry education and biology education. They come from Uganda, Burundi, Russia, Kenya, Bangladesh, Pakistan, and Thailand.

The extra statistics lectures were conducted to help them to learn statistics for 8 lectures. Prior to conducting the extra lectures, the researchers detected their difficulties in the statistic lectures held by their own department. After analyzing the difficulties, the researchers determined strategies to overcome them. Later the strategies were implemented in the extra statistics lectures conducted by the researchers. Data resources were obtained from interviews and observations during the extra lectures. Data were in the form of qualitative ones describing the international students' difficulties and understandings in statistics materials. Further actions were taken to overcome those difficulties in order to scaffold the students in the statistics lecture.

This study was divided into three parts. In the first part, the assistance was related to the participants' improvements in descriptive statistics and data presentation. The second part was related to strategies to overcome their problem in testing hypotheses. The third one dealt with strategies for utilizing software to perform statistical analysis.

Data analysis was conducted qualitatively using Creswell's steps [18]. The steps are data reduction, presentation, and verification. The results were then used to figure out the students' difficulties in statistics lectures and strategies to overcome their difficulties.

3. Results

During the first semester, being enrolled in statistics lecture is a must for each student in Graduate School, Universitas Negeri Yogyakarta, Indonesia. Statistics materials in the syllabus cover descriptive statistics, probability, normal distribution, mean hypothesis testing, an introduction to

regression and ANOVA. The statistics lecture aims to prepare and equip students to complete their theses and become a competent researcher in their field of study after graduating from the university. However, several students still face difficulties in passing the statistics lecture. Some of them are international students.

There were 12 international students facing difficulties in learning statistics. They took different majors such as applied linguistics, language education, arts education, education management, chemistry education and biology education. They were enrolled in different statistics lectures with various lecturers yet similar syllabus. The lectures were conducted in Bahasa since they had taken Bahasa course for six months and already passed it.

Several difficulties were faced by those international students. Some reasons for those difficulties were nine out of those 12 international students did not study statistics class during their undergraduate, and it was difficult for them to do computation, use software and understand the lecture in Bahasa. Their difficulties were expressed as followings.

“I never learned statistics in our previous study...” (S1, S2, S3)

“I dislike math. The last time I learned math was in junior high school...It is hard for me to deal with numbers” (S3, S10)

“I have never used computers to do statistics, moreover used software” (S1,S4, S11)

“My lecturer is teaching in Bahasa. When I asked him to use English, my classmates refused it, saying that we have learned Bahasa. However, when he is lecturing in Bahasa, we still do not understand” (S1, S2)

To overcome the difficulties, the international office gave extra statistics classes to help them learning statistics. Referring to the problems identified previously, the students and researchers agreed to perform some assistance steps that could help them in learning statistics. The assistance steps were giving extra statistics classes for 8 meetings, conducting them in English, training them to use the software in data analysis. The researchers then agreed to take an action for solving the problems.

Although the students had learned almost all statistics materials, they still found it hard to do data presentation and descriptive statistics. Thus, going deeper into data presentation was conducted. They also found a difficulty in changing a table into bar graphs, line graphs, pie charts, picture charts, and scatter plots, and using those graphs.

To solve it, the researchers explained ways to present data in the table and present them in graphs. Presenting some cases in which the graphs used was also added in the explanation. Since they were prepared for being a master in education, the cases presented were in the education area. After being able to draw the graphs manually, they learned ways to draw them using Excel. Simple procedures made them easier to do it. Graph scaling in Excel was so clear and able to be customized that it could be interpreted easily. Followings are their comments on drawing graphs.

“I found it difficult to draw graphs manually. However, it is very easy to do it in Excel...” (S1)

“I can do both now - drawing graphs manually and by computer” (S10)

After drawing graphs, the next objective to meet was students could use sigma notation and estimate mean, mode and median (parameter), standard deviation, and variances. At first, those materials and their applications and interpretations in education area were reviewed. Then the students applied their understanding to problem-solving. The learning process was conducted in two approaches – parameter estimation in sample/ population manually and by using Excel.

Several problems were faced by them. They found it difficult to read symbols when applying formulas, do calculations when estimating a population parameter, and for Asian students, it was difficult for them to use English. The given assistance was reviewing the materials for those who were difficult in reading symbols in formulas. The calculation was done at a slow pace when estimating the population parameter. For those Asian students, due to their adequate ability to use Bahasa, the teaching and learning process was conducted in both English and Bahasa. The researchers applied different strategies to solve their problems depending on their needs.

The aim of lecture in the second part of this study was students were able to test the hypothesis. The lecture consisted of four meetings. The materials covered probability, normal distribution,

hypothesis, and hypothesis testing. In this stage, the strategies were modified. The students were assisted by an instructor who could assist them to meet their needs and they were taught in their preferred language – the one that they could understand much better.

In this stage, they also faced some problems. They were ‘scared’ of many numbers presented and found it difficult to read tables, formulate the hypothesis into mathematical sentences, determine null hypothesis rejection criteria, draw conclusions and do interpretations. To formulate hypothesis into mathematical sentences it was hard for them to interpret contexts. When determining null hypothesis rejection criteria they had difficulty in positioning results of calculation with their criteria. This problem was solved by drawing a numerical linear, marking null hypothesis rejection area according to the criteria, then positioning the results of the calculation to draw conclusions. The problem in interpreting the results in appropriate contexts which were in line with hypothesis testing problem was solved by emphasizing an importance of interpretation in the real contexts, paying attention more closely on the results of hypothesis testing, then describing them according to problem-solving contexts. Repeated explanations to the students and applying various strategies in solving problems also made the students easier to overcome their difficulties. Followings are some of their comments.

“Reading table-z and table-t is complicated, yet it has to be learned” (S3)

“Formulating hypothesis is difficult. At first, I had difficulty in differentiating between the null hypothesis and alternative one. However, by doing many cases, I can understand now” (S2)

“Although there are many steps to test the hypothesis, I was confused and troubled. However, since the steps make sense for me, I now understand ways to test the hypothesis” (S4)

The third part of this study was giving an assistance in using data analysis software that was conducted in three meetings. Prior to it, there was a student asking, the benefit of studying statistics.

“What are benefits of studying statistics for me since I am learning applied linguistics. I do not need hypothesis testing, moreover use software so I do not need to learn it” (S3)

Responding this comment, the researchers modified strategies in giving assistance by relating the concept of hypothesis testing to examples of thesis problems. The examples of data and their analysis were organized based on the research contexts which had a greater possibility to be the students’ research interests.

For the S3 student, he was interested in English language education, the researchers explored his interest deeper. He was interested in the teaching and learning process to improve junior high school students’ writing abilities. He said he was interested in using brainstorming and mind mapping in a learning process. Regarding this case, the researchers gave an analysis example to compare the effectivity of brainstorming method and mind mapping one in English language learning by the students’ writing abilities. In formulating the hypothesis, the null hypothesis was “there is no significant difference in students’ writing abilities by using brainstorming or mind mapping methods”, and the alternative hypothesis was “there is a significant difference in students’ writing abilities by using brainstorming or mind mapping methods”. The background of hypothesis proposal by referring to literature review was also emphasized by the researchers.

Next, the students and the researchers together input data of students’ writing abilities in two classes – brainstorming and mind mapping classes in SPSS software. By clicking analysis menu, compare means, two-independent sample, data were analyzed. The two-tailed test was used to conclude the result of analysis and the result interpretation was done to explain the results.

The similar data were tested using different hypotheses. Referring to the literature review that supported the null hypothesis, then the null hypothesis was “students’ writing abilities in the mind mapping class are better than those in the brainstorming class”. In this stage, the students had difficulty in conducting some steps.

When formulating hypotheses, the students could not differentiate the use of signs ‘<’, ‘>’, ‘≥’, ‘≤’, ‘=’ and ‘≠’ especially interpret hypotheses in mathematical symbols. It made them have difficulty in determining one-way test and two-ways one. Considering that not every student once utilized the computer to do statistics, there were four students who still had difficulty in inputting the data. Those students found difficulty in picking the menu in SPSS program. When the result analysis had been

shown in their computer monitor, they had difficulty in reading and interpret the table into comprehensive result analysis.

In order to overcome those problems, the researchers re-explain the steps of hypothesis testing using the computer. When there were a few students who still had difficulty in performing them, the researchers gave one-by-one assistance – one student was assisted by one instructor. Repeated exercises were also done to strengthen the students' understanding in performing the steps to do the analysis. Providing them with various cases to apply the use of signs '<', '>', '≥', '≤', '=' and '≠' in formulating the hypotheses also triggered them to apply data analysis steps much easier.

In the lecture session that discussed hypothesis testing, there were two students who expressed their difficulty in hypothesis testing of two population means. Followings are parts of interview results with them.

"It is difficult for me because I do not know the benefits of hypothesis testing for me, in English language education. Therefore, I do not need it." (S3)

"I find it hard to interpret the result. I learn English, and I do not know the benefits of statistics for language education students" (S2)

To solve those problems, the researchers made examples of researchers in language teaching. Exploring The S3 interest in problems he wanted to research in his thesis in English language education, the researchers figured out that he was interested in strategies for improving junior high school students' writing abilities. The researchers used this context to make an example of cases to analyze. It was as following.

Mr. X. will compare the effectivity of two learning strategies to improve students' writing abilities, they are brainstorming and mind mapping. To conduct this study, two classes are used. Class A uses brainstorming while class B uses mind mapping. During the teaching and learning process, both classes get the similar treatments, except for their learning strategies.

The researchers and students then generated data for this case and analyze them using SPSS. Using this case, formulating the hypotheses were much easier for the students since Tchello had one done literature review stating that mind mapping method was better than brainstorming one. After performing the analysis including testing analysis assumptions, they found it was easier to interpret the result. After interpreting, they expressed their opinions.

"I understand know the importance of hypothesis testing. I shall use it for my thesis writing. Now I have an idea for my thesis research and I have known ways to run the analysis." (S3)

"Oh..this is the way to do hypothesis testing. I understand now. I ask you to re-explain the benefits of literature review in formulating these hypotheses." (S2)

During the lecture session on Analysis of Variance (ANOVA), the educational research case was re-used. One student was interested in conducting a research to improve students' reading skills. He would compare three strategies to improve them, they were discussion, assignments and the use of individual texts. This context was later used as a base to formulate the problems in hypothesis testing and do the interpretation. His experience in conducting the analysis of variance was as follows.

"Comparing methods or strategies in three or more groups can actually be done. Since data, in this case, are not the real ones (generate data), I am a little bit disappointed with the results. Giving individual assignments should have shown better results than other methods...However, I can do the analysis now for the sake of my thesis writing" (S2)

After the students' difficulty in analyzing Analyzing of Variance (ANOVA) had been overcome, another difficulty was raised i.e to interpret assumption test. This difficulty was overcome by explaining the analysis procedures many times and conducting a tutorial for each student. For those who came from Asia, they were explained in Bahasa.

In the end of lectures, the students were asked to comment on the extra statistics lectures. Providing scaffolding for them in the lectures was proven effective in helping them to understand the concepts, apply and do statistical analysis. Since this program was not on a routine, it was recommended to conduct it again in the future. They stated that it should have been done before the statistics class began. Followings are some of their comments.

“At the beginning, it was difficult for me to learn statistics, but in fact, it is so easy that I can understand it. I took notes every explanation so I can memorize them. After graduating, I want to teach statistics.” (S1)

“I appreciate the extra statistics lecturers. My understanding gets better including when I am in the regular class. I highly recommend the programme manager to continue the lectures for international students” (S3)

“The lectures are useful especially for the international students who do not study statistics in their countries. Thus, they are useful since they help us to understand the basic analysis of statistics. It is recommended for the future students, andit should have been conducted earlier before the regular statistics lecture started” (S7)

In the end of the lectures, they faced a new problem since they were from different majors. During the regular statistics class, they learned different materials and lecturing strategies (manual and computerized) and used different statistics programs. Some of the problems were stated as follows.

“My class does not use SPSS, but R programme. However, it is not a problem for me if I solve my problems using R. We have also learned multivariate statistics by performing MANOVA analysis” (S4)

“I do not use a computer program in my class, but all the analysis are performed manually using a calculator.” (S10)

“My statistics class runs so fast that I find it difficult to follow. We have learned path analysis” (S1)

Their comments showed the differences in the statistics lecture standard in every major. It resulted in their different understanding towards statistics, either on the ability to operate software or the mastery of statistics materials. Thus, a standardized statistics curriculum is required so that the standard of graduate competence in the graduate school will be similar. Moreover, by having the standardized statistics curriculum, it will be easier to identify the students' difficulties and solutions to overcome them.

3.1. Discussion

Findings showed that there were various difficulties faced by the international students in the statistics lecture. One of the causes was due to their different educational background. For those who had not once learned statistics during their undergraduate study, they would have difficulties in learning statistics in their graduate study for certain. The problems also occurred when they did not have a good mastery of mathematics. These phenomena indicated that the adaptation ability and previous learning experience played an important role in learning statistics [5,6] and the students' lack of acquisition in mathematics concepts [19]. Looking at the communication aspect, language barriers also became their problem in comprehending the concepts of statistics [7–9]. This resulted in their difficulty for having an interaction with their lecturers [10,11]. Therefore, they must have been given scaffolding to overcome their problems in learning statistics.

The language barriers were experienced by them when they had to present the result of their analysis especially to interpret it [3,12] and communicate in *Bahasa*. To overcome the problems, they were asked to use English in their communication while the Asian students used *Bahasa*. Thus, the lectures were delivered in two languages, English and *Bahasa*. The lecturers and teaching staffs also used English to deliver the materials and sometimes used *Bahasa* to re-explain them. By providing the lectures in the most preferred language that the international students mastered, it could help them to comprehend the statistics materials easier.

In learning statistics, each international students faced their own difficulties. Thus, an assistance must be provided by a person-by-person approach to meet their own difficulties and needs. Therefore, a professional support from competent and reliable teaching staffs is required in giving extra statistics lectures for them. Moreover, it will help them in their socio-cultural adaptation. Reference [6] stated that the socio-cultural adaptation is a significant predictor of the success of learning.

Nowadays there is so many statistics software. The problem is not every student know and is able to operate them. The strategy that can be applied is training them to be able to operate the software in learning statistics. Operating statistics software can solve the students' problems in learning statistics [14], especially in doing the computation. However, ways to interpret the output produced by the software should be emphasized. In order to students can interpret easier, using real context in teaching and learning will help them [15,20]. The statements are in line with the research results, the utilization of software and the real context that students face makes students easier to understand the statistical concepts and apply them to solve many problems.

During the learning process, the students' difficulties sometimes are caused by the materials presented are not in the correct order. The students sometimes must comprehend prerequisite materials when learning a certain new material. However, in fact, sometimes the core materials and the prerequisite ones are not presented in sequence. Thus, learning trajectory that contains the sequence of materials is required. Reference [21] stated that by learning trajectory the lecturers can plan their teaching and learning better, especially when they determine the prerequisite materials so it will help to overcome the students' difficulties in learning statistics.

In each statistics lectures, each lecturer has their own curriculum so the materials presented and learning trajectories are different. Besides, they also have different teaching styles. For example, some of them tend to use statistics software, others use manual computation (without software) and the rest combine both methods. This situation triggers the international students' difficulties in following the learning rhythm since the academic systems that are being applied are not similar. Reference [10] argued that difficulties in learning statistics might be caused by the academic system. For the students whose mathematical skill are low, they will find it difficult to do the manual computation. While if the teaching approach only applies the use of statistics software, the students will have a lack of understanding of the concepts of statistics. Thus, the standardized statistics curriculum is required to accommodate all students' needs.

4. Conclusions

The results of the analysis showed that the international students' difficulties in learning statistics were caused by several factors. They were the students did not take mathematics and statistics classes during their undergraduate study and they found it difficult to do computation, operate the software, understand the symbols, relate one concept to others in hypothesis testing, and present the result. Some assistance could be provided by the lecturers to overcome those difficulties such as (1) picking the language that would be used during the lectures i.e. English and re-explaining the materials in *Bahasa* for Asian students; (2) re-explaining the materials that had not been understood; (3) giving the person-by-person assistance to students who were still confused; (4) using various statistics software; (5) correcting the teaching and learning flows to meet the students' needs; (6) developing and standardizing statistics curriculum.

Related to the results of this study, it is highly recommended for the statistics lecturers to set the learning trajectory to meet the students' needs. A policy on standardized statistics curriculum is also required. Moreover, a statistics matriculation is necessary especially for the international students in the graduate school in order to equip them with a basic foundation to study in the graduate school. Further studies should be conduct research and development to create various learning models in statistics lectures for education in graduate school.

References

- [1] Watson J M 1997 Assessing statistical thinking using the media *The assessment challenge in statistics education* ed I Gal and J B Garfield (Amsterdam, Netherland: IOS Press and The International Statistical Institute) pp 107–121
- [2] Garfield J and Ahlgren A 1998 Difficulties in learning basic concepts in probability and statistics: Implications for research *J. Res. Math. Educ.* **19** 44–63
- [3] Batanero C, Godino J D, Vallecillos A, Green D R and Holmes P 1994 Errors and difficulties

- in understanding elementary statistical concepts *Int. J. Math. Educ. Sci. Technol.* **25** 527–547
- [4] NCTM 2009 *Focus in high school mathematics: Statistics and probability* (Reston, VA: NCTM)
- [5] Malaklolutunthu S and Selan P S 2011 Adjustment problems among international students in Malaysian private higher education institutions *Procedia Soc. Behav. Sci.* **15** 833–837
- [6] Nasir M 2012 Effects of cultural adjustment on academic achievement of international students *J. Elem. Educ.* **22** 95–103
- [7] Paton M J 2007 Why international students are at greater risk of failure: An inconvenient truth *Int. J. Divers.* **6** 101–111
- [8] Ralarala M K, Pineteh E A and Mchiza Z 2016 A case study on the language and socio-cultural challenges experienced by international students studying at cape Peninsula University of Technology *South African J. High. Educ.* **30** 231–255
- [9] Yeoh J S W and Terry D R 2013 International research students' experiences in academic success *Univers. J. Educ. Res.* **1** 275–280
- [10] Talebloo B and Baki R B 2013 Challenges faced by international postgraduate students during their first year of studies *Int. J. Humanit. Soc. Sci.* **3** 137–151
- [11] Yu B and Wright E 2016 Socio-cultural adaptation, academic adaptation and satisfaction of international higher degree research students in Australia *Tert. Educ. Manag.* **22** 49–64
- [12] Lee C 2013 Some difficulties of learning histograms in introductory statistics *Joint Statistical Meetings Section on Statistical Education* pp 2326–2333
- [13] Sawir E 2005 Language difficulties of international students in Australia: The effects of prior learning experience *Int. Educ. J.* **6** 567–80
- [14] Tishkovskaya S and Lancaster G A 2012 Statistical education in the 21st century: A review of challenges, teaching innovations and strategies for reform *J. Stat. Educ.* **20** 1–55
- [15] Kayaly D 2013 Towards more real-live teachings of business statistics: A review of challenges, teaching innovations and strategies for reform in Egypt (Working Paper Number 21, 2013)
- [16] Smith A E and Martinez-Moyano I J 2012 Techniques in teaching statistics: Linking research production and research use *J. Public Aff. Educ.* **18** 107–136
- [17] Slootmaeckers K 2012 Too afraid to learn? Attitudes towards statistics as a barrier to learning statistics and to acquiring quantitative skills *Proceedings of International Conference on Education and New Learning Technologies (EDULEARN12)*
- [18] Creswell J W 2013 *Qualitative inquiry and research design: Choosing among five approaches* (Thousand Oaks, CA: SAGE Publication)
- [19] Retnawati H, Kartowagiran B, Arlinwibowo J and Sulistyaningsih E 2017 Why are the mathematics national examination items difficult and what is teachers' strategy to overcome it? *Int. J. Instr.* **10** 257–276
- [20] Habsah F 2017 Developing teaching material based on realistic mathematics and oriented to the mathematical reasoning and mathematical communication *J. Ris. Pendidik. Mat.* **4** 43–55
- [21] Retnawati H 2017 Learning trajectory of item response theory course using multiple software *Olympiads in Informatics* **11** 123–242