ORIGINAL SCIENTIFIC ARTICLE

STATISTIC COURSE: CAN IT IMPROVES NUMERIC REASONING ABILITY?

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Abstract

Background. Statistics courses are often one of the courses that must be taught in a college study program. Statistics help students think logically and implement a variety of problem-solving strategies. Statistical learning involves the ability of numerical reasoning to understand data processing and mathematical problems. Will statistics courses be able to improve students' numerical reasoning?

Purpose. This study aims to find out the comparison of students' numerical reasoning skills before and after taking statistics courses.

Materials and methods. A total of 63 students who took statistics courses became a sample. This research uses a quantitative approach. Data collection was conducted over a semester in an online course using a basic proficiency test of numerical reasoning section (α Cronbach = 0.899). The statistical analysis technique used is a Wilcoxon test paired sample.

Results. The results of this study showed an increase in numerical reasoning in students after attending statistics courses (M = 7.50; SD = 1.87; p < 0.05). The results of other related studies were also discussed.

Conclusion. The implication of this study is a statistical course learning model that can be replicated. The increase in numerical ability is also evidence that this ability can be trained with more exposure, the more students will increase their abilities.

Keywords: numerical reasoning, statistics, undergraduate students.

Introduction

Numerical reasoning is a fundamental ability to solve mathematical, number, or numerical problems, basic arithmetic operation, etc. This numerical reasoning can help complete data interpretation, analyze graph and others data, evaluate or critique numerical problems, and draw conclusion from existing data. In addition, this ability also involved in critical thinking, forecasting, and knowing pattern, so that numerical reasoning can be considered as one of the most basic skill (Meirisa et al., 2021; Omonity-Israel & Oluwatoyin-Faith, 2018).

Numerical reasoning has four indicators including mathematical calculation, logically thinking, the ability to solve problems and the ability to sharpness in distinguising numerical patterns and their relationships. Mathematical calculation is the ability to perform basic calculations such as ordinary calculations, logarithm, square roots and others. Logical thinking is an ability that involves logical explanation, cause and effect and systematic. Problem solving is the

ability to digest a story and formulate it into a mathematic equation. The sharpness of numerical patterns and their relationships is the ability to analyze the most logical and consistent sequence of numbers or letters that are related to each other (Isworo et al., 2014).

From all the indicators of numerical reasoning it also can be useful for students such as students will be prepared when they can master numerical reasoning by having the ability ko think logically, analitically, systematically, critically and creatively. In general, students who have high numerical easoning abilities will have an organized way of thinking in solving problems, able to filter and manage informations and be able to perform complex mathematical calculation or operation (Juita & Yulhendri, 2019). This is in lane with statements (Indrawati, 2015) which states that the numerical reasoning test can measure person's intellectual abilities, especially the ability to reason in arithmetic and think logically. In addition, there is research (Cahyono et al. 2016) which says that numerical reasoning is a special ability in counting that can help students ability to understand and solve problems that require high-level thinking skills including problem solving abilities.

Stundents with high numerical reasoning will be better at doing arithmetic, while students with low numerical reasoning will tend to have difficulty in counting. This affects the process of learning activities so that students are found who complain of having difficulty in learning mathematics because in addition to being able to understand concepts, students also have to count with the formulas that already described (Rahmawati et al., 2016). In Zaini's research (2021) mentions the things that cause the low numerical reasoning ability of students including they do not understand basic calculations, are less able to think intuitively in understanding problems, weak ability to use reasoning, can not think logically so that the components in incomprehensible material.

Learning is a system that involves various components that are interrelated and interact with each other, so as to achieve optimal educational outcomes or goals, these components can consist of teaching staff and students (Pane & Darwis Dasopang, 2017). Students who are learning can be interpreted as students who are oriented in learning so that students gain knowledge, develop attitudes and skills. The learning process can include several important components, such as the media used during learning, curriculum, and learning facilities (Firmansyah, 2017).

When studying in higher education, you will often be faced with learning statistics courses, especially when studying these subjects can pose a challenge to students as students who do not have the ability to operate mathematical calculations (Abd Hamid & Sulaiman, 2014). Moreover, the statistics course in universities is one of the subjects that must be taught by almost every study program, so that the learning of this course has a goal, which is students can understand the concepts and procedures of statistics, and be able to apply them when analyzing problems on research that will be carried out by students, especially students who will prepare their final assignments (Afifiah & Wicaksana, 2014).

Statistics courses are material that is studied in mathematics, statistics can be useful to solve daily life problems and can even be used in various scientific fields, such as sociology, economics, health and even in the office sector. This makes statistics a very important and useful science for everyday life. Statistics courses (in this case in the non-statistics department) are not intended to make someone a statistician, but to provide the knowledge needed in research activities in their respective fields (Anggraini & Syahbrudin, 2021).

Statistics learning activities will of course be related to the process of understanding mathematical data processing, moreover the material contained in this course tends to be more calculating, so that good reasoning skills are needed regarding this matter. One of the appropriate reasoning used is mathematical reasoning, this reasoning is related to calculations or numerical (Erviana, 2019). Reasoning has a term as 'reasoning' which can be interpreted as a process of reaching logical conclusions based on relevant facts or sources. Then, mathematics has a term as mathematical which means that something is related to mathematics, such as calculations or numbers (Erviana, 2019).

Numerical reasoning is one of the important skills in dealing with various fields such as mathematics, physics, accounting, chemistry, economics, engineering, banking, business, and other fields that require a mathematical component. The use of good numerical reasoning, proved to be profitable.

Someone who has high numerical reasoning will find it easy to use statistical data or data in the form of numbers and be able to use them creatively and accurately. Statistics will help individuals to think logically and clearly, and be able to apply a series of problem solving strategies (Marriott et al., 2017).

Improving the competence of learning statistics related to reasoning which is understanding of concepts, solving a problem and being able to improve communication skills. One of the goals of learning statistics is to solve, reasoning is needed to find the right solution in solving problems related to basic statistics. In solving problems related to statistics, each student has time to try various kinds of reasoning in solving these problems. Most of the material in the basic statistics course is abstract and some questions are in the form of reasoning and application questions so that basic numerical reasoning skills are needed to solve problems related to statistics (Soewandi et al., 2021).

One of the applications of numerical reasoning can be studied in statistics courses. In statistics courses, there are many concepts of calculation, data analysis, mathematical problems, and number operations, so numerical reasoning skills are needed more or less. Will statistics courses be able to improve students numerical reasoning? This study aims to determine the comparison of students numerical reasoning abilities before and after attending statistics lectures.

Materials and methods

Study participants

In this study, participants from the Faculty of Psychology, University of Muhammadiyah Purwokerto, were taking statistics courses. At the beginning of the study, there were 63 students from 2 statistics classes who were the research participants targets. At the first meeting, there were 74 students who had filled out the pre-college numerical test. However, in the second measurement, there were only 63 students who had taken the numerical test until the end of the course, and were able to complete the numerical test completely. In the end, this study only used 63 students who were directly involved in the research process. This study uses a quasi-experimental type of research, quasi-experimental research is the use of methods and procedures to make observations in a study that is structured similar to an experiment, but the conditions and experiences of the participants lack control because the research is limited to random assignments, including comparison or control groups (William & Hita, 2019).

Instrument

In the numerical reasoning test, we can use the speed test, a test that prioritizes speed, with problems consisting of: basic arithmetic, such as addition, subtraction, multiplication, division, number series) and simple mathematics such as percentages, fractions (Psychometric Success, 2013). And of course in this test it is not allowed to use counting tools (Abed, Al-Absi, & Abu Shindi, 2015).

The instrument used in this study was a basic ability test, part of a numerical scale from the Psychology Service Bureau, Universitas Muhammadiyah Purwokerto. The basic ability test on this mathematical scale is usually used to

see numerical reasoning abilities in participants who take psychological tests. This test was developed based on the assumptions of psychologist Louis L. Thurstone (1887–1955) who assumed that intelligence does not consist of only one factor but consists of several mental abilities, one of which is numerical ability that measures mathematical reasoning (Thomas, 1939). In this study, 20 items were taken from the basic ability test scale sections 5 and 6, considering the limited time for lecture meetings. Scoring is done by giving a score of 5 if the answer is correct, and a score of 0 if the answer is wrong. So, the maximum score on this test is 100, while the minimum score is 0.

Validity of the test is carried out with content validity, which is paying attention to the items in the test according to what you want to measure and ensuring that the test items are easy to understand. After the test was successfully carried out, the next step was to perform a reliability test to see the internal consistency using Cronbach Alpha. The results of Cronbach Alpha show a coefficient of 0.899. Based on the results of the alpha coefficient, it can be said that the numerical test used has a good level of reliability (Oluwatayo & Ayodele, 2012; Kaplan & Saccuzo, 2005).

Procedure

This study involved as many as 2 classes of statistics. The instrument is given in the form of a quiz attached to the campus's learning management system (LMS), with the domain onclass.ump.ac.id. LMS is a software that utilizes information technology for learning media or other activities (Gunawan et al., 2021). Each student has their own onclass account. Every assignment, quiz, material will be visible and can be accessed through the account of each student. The advantage of using onclass in learning is that students can systematically access learning materials every week. In addition, the material provided can be synchronous and asynchronous. This study uses both methods. Not every week students take virtual face-to-face lectures. Even students can access learning materials at any time, not limited to lecture meetings. They can also review or re-learn the material that has been given.

Students have sixteen meetings during one semester. Students get quizzes at the 1st and 15th meetings, when they just start lectures and before the end of semester exams. Meanwhile, the 8th and 16th meetings are the midterm and final exams.

During the test, students are asked to log into their own onclass accounts during lecture meeting hours. Then presented questions (quiz) in the form of short answer as many as 20 number questions. The researcher first asked for student approval to fill out the test. For students who are willing to take the test, they are given 30 minutes to answer each of the available questions by writing down the answers in the form of numbers. After students submit their answers, they will see the score they got.

Learning Flow

The learning flow used in the statistics course for one semester in this study includes virtual face-to-face meetings using zoom meetings, learning videos, and quizzes. In general, the pattern made in this lecture are theortical material and also practice questions at each meeting. So, every student

has to exercise solving the statistical or numerical problems. Discussion of questions is also always given face-to-face via zoom meetings after quizzes and exams did, so that students know the mistakes they made and how to do it correctly. In addition, there are consistent quizzes and exams conducted after 3 meetings so that students can prepare better by studying material and statistical issues.

Results

The results of participant descriptive analysis are in the table 1.

Table 1. Analysis Description

	Group	N	Average	Median	SD	SE
Pre	male	14	63,9	72,5	25,3	6,76
	female	49	72,2	80,0	15,8	2,25
Post	male	14	76,8	85,0	21,4	5,71
	female	49	76,0	80,0	19,2	2,74

A total of 63 participants (14 men and 49 women) took the pre-test and post-test in this study. In general, table 1 shows that there is an increase in the average, median, and SD in the post-test scores compared to the pre-test scores, both in the male and female groups. Furthermore, the change in pre-test scores in male participants was bigger than female participants. The pre-test score for men had an average of 63.9 with a median of 72.5 then the post-test score increased to an average of 76.8 with a median of 85.0.

Based on the results of the normality test, it produces a (p) value of 0.01. So, it means that the distribution of the data is not normal, so an analysis using a non-parametric test is needed.

Tabel 2. Wilcoxon Test Paired Sample

			Statistic	p	Mean difference	SE difference
Pre	Post	Wilcoxon W	418[a]	0.002	-7.50	1.87
[a]7 pair(s) of values were tied						

Based on the results of the non-parametric Wilcoxon test paired sample in table 2, there is a significance level (p) of 0.002. This value is less than 0.05, so it can be concluded that there is a very significant difference in students numerical reasoning abilities before and after the statistics course is given. In other words, studying statistics can improve students numerical reasoning.

Discussion

Based on the results of the paired sample wilcoxon test, it shows that there is a very significant difference in numerical reasoning ability, before and after the statistics course is given. The Wilcoxon test paired sample test technique is a method of testing data to measure the effectiveness of behavior, which is marked by a difference between before and after certain treatment is given (Widiyanto, 2013). In other words, statistics course is effective in improving students numerical reasoning. These results are in line with Cresswell and Speel-

man's (2020) research conducted on 123 first-year students in Australia. The results of their research indicate that mathematics training can improve mathematical problem solving skills and critical and logical thinking skills.

The results of this study can provide an illustration that the application of statistics courses has a positive impact on students, especially male students. Numerical or statistical reasoning skills are important because they are useful for obtaining, managing, and utilizing information to survive in conditions that are not permanent, volatile, uncertain, and competitive (Somatanaya, 2017). Statistics are needed in daily life. One of the skills students need is the ability to reason and prove, to help solve statistical problems in daily life (Habibatul Izzah & Azizah, 2019). If it is balanced by an innovative and creative learning system, it will improve students numerical reasoning abilities, learning motivation, critical thinking skills, and mathematical interpretation abilities (Mayang, 2021).

The application of online learning has positive sides, such as: students have a lot of time to do assignments, they do not have to come to campus, and lectures can be done anywhere so that students will be more flexible in using their time (Rochima, 2020). Moreover, online learning also makes students have the ability to learn independently and easily understand the material that given (Jamil & Aprilisanda, 2020).

On the other hand, the results of research from Maulana & Iswari (2020) which show that during online learning, students who take statistics courses have emotional and stress disorders, there is even an increase in stress in female students which tends to be higher than male students (Maulana & Iswari, 2020). This is because during online learning students find it difficult to understand the material and assignments given online and lack the opportunity to interact with their teacher or lecturer. This may also be experienced by the participants of this study. Based on the scores obtained by the women's group, the change in their scores was not higher than men. The existence of a stress factor in women during online lectures is very possible. Unfortunately, this study did not look at these factors so that further research can add other variables to enrich the results (Maulana & Iswari, 2020).

Stress when attending online lectures often occurs in students. The difficulties experienced during learning, can not always be solved. Moreover, the lectures given in this study also involve asynchronous so that students can not always ask questions directly when they are confused about learning the material or practicing questions. The ability to deal with stress is also an important asset for students. Saragih & Sari's research (2019) shows that students who have stress coping strategies will be motivated to learn. Meanwhile, students who do not have stress coping strategies when participating in statistics learning tend to have no motivation to learn so they get not really good result (Saragih & Sari, 2019). The limitation of this study is does not involve other variables related to participants internal problems, such as stress levels, stress coping strategies, personality, and motivation. For the next research, it can be suggested that the discussion of the results is more comprehensive. The methodological weakness of this research is that there is no control group, there is no exclusion criteria for students who retake statistics courses.

The advantage of this research is that the research time is relatively long, which is one semester (longitudinal study), so that the changes found can be more meaningful. Longitu-dinal studies will provide an overview of an increase in ability, from new knowledge obtained through previous knowledge students have at different times, so that later they can be compared (Ijirana et al., 2021). Another advantage is that this research fully utilizes the use of technology in learning (e-learning). This pattern in the learning flow can be said to be effective, because it was found that there was a positive increase in student abilities, so that it could be duplicated in the next statistics lesson.

Conclusion

This study found that there were significant differences in students numerical reasoning abilities before and after attending statistics lectures. In other words, statistics courses are proven to improve students numerical reasoning abilities. The explanation to problems related to numbers, calculations, which are the basis of numerical reasoning abilities, for one semester, can improve students numerical reasoning. The implication of this study is a statistical course learning model that can be replicated. The increase in numerical ability is also evidence that this ability can be trained with more exposure, the more students will increase their abilities.

Conflict of interest

The authors declare that there is no conflict of interest.

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СТАТИСТИЧНИЙ КУРС: ЧИ МОЖЕ ЦЕ ПОКРАЩИТИ ЧИСЛОВУ ЗДІБНІСТЬ?

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Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Статья: 6 с., 2 табл., 32 джерела.

Базова проблематика. Курси статистики часто є одним із курсів, які необхідно викладати в рамках навчальної програми коледжу. Статистика допомагає учням мислити логічно та реалізовувати різноманітні стратегії вирішення проблем. Статистичне навчання передбачає здатність числових міркувань у розумінні обробки даних і математичних проблем. Чи зможуть курси зі статистики покращити числові міркування студентів?

Мета. Дослідження має на меті з'ясувати ефективність курсу статистики у процесі порівняння навичок числового міркування студентів до та після проходження занять.

Матеріали та методи. Загалом у вибірку потрапили 63 студенти, які проходили курси статистики. У цьому дослідженні використовується кількісний підхід. Збір даних проводився протягом семестру в онлайн-курсі з використанням базового тесту на знання розділу числових міркувань (α Кронбах = 0,899). Методом статистичного аналізу, який використовується, є парна вибірка за тестом Вілкоксона.

Результати. Результати даного дослідження показали підвищення чисельного мислення у студентів після відвідування курсів статистики (M = 7,50; SD =1,87; $p < 0,05$). Також обговорювалися результати інших суміжних досліджень.

Висновок. Наслідком цього дослідження є статистична модель навчання курсу, яку можна відтворити. Поліпшення числових здібностей також є доказом того, що цю здібність можна розвивати з більшою експозицією, в залежності від її рівня.

Ключові слова: числові міркування, статистика, студенти.

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