

Implementation of Statistics Textbook Support with ICT and Portfolio Assessment Approach to Improve Students Teacher Mathematical Connection Skills

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Abstract. Statistics needed for use in the data analysis process and had a comprehensive implementation in daily life so that students must master the well statistical material. The use of Statistics textbook support with ICT and portfolio assessment approach was expected to help the students to improve mathematical connection skills. The subject of this research was 30 student teachers who take Statistics courses. The results of this research are the use of Statistics textbook support with ICT and portfolio assessment approach can improve students mathematical connection skills.

1. Introduction

Data analysis is an important part of the research process that is often regarded as a difficult thing. Data analysis is very important in research process because after processing and analysing data, the researchers can draw conclusions and make generalisations framework uses concepts or theory. Statistics subjects discussed various statistical methods that to obtain a conclusion that will be useful for decision making. Statistics help the process of data analysis in real life and has a broad implementation. By understanding the concept of Statistics, students are expected to implement the knowledge into various real-life cases related to the application of statistics and can solve complex problems related to the analysis of statistical data.

During this time many students are still experiencing problems and made mistakes in analysing cases related to statistical data. Difficulties and mistakes that occur include inaccuracy in calculating the data analysis and the precision and accuracy of the resulting solutions [1]. Information technology is growing today, especially the development of the computer, software, and various applications that can be used to help speed up and simplify the process of understanding and analysis of statistical data, which is expected to improve the competence of students in Statistics lectures. The process of data analysis for decision-making has a fairly broad implementation in real life, so this research is important to carry out.

Nowadays, many criticisms of the low quality of education in the various educational unit. One of the highlights is an instrument or tool of evaluation used considered not valid and reliable, as well as the aspects that are less complete. It will eventually come to a conclusion, that the assessment approach now needs to be updated with other approaches. Portfolio-based assessment is an assessment model which is expected to reveal and assess students with more accurate and more complete based on the evidence possessed by students.

In this study, the Statistics textbook design that already developed will provide wider opportunities for students to go directly into the field to learn the source of the data and issues surrounding, then



analysed to obtain solutions using various materials have been studied in the lecture. In this case, students are trained to be able to connect the knowledge obtained with real cases encountered in life and then provide a solution that is accurate and communicate appropriately and effectively. Mathematical connection capability is the ability of high-level mathematical thinking that either directly or indirectly have contributed greatly to the success of a student's study. The design of this course collaborated with a team of lecturers/computing laboratories so that the data can be simulated and analysed more systematically. The work of the students subsequently compiled into a set of tasks that form a portfolio.

Mathematical connection ability is an ability relating mathematical concepts either among mathematical concepts themselves (in mathematics) or relating mathematical concepts with other scopes beyond mathematics [2]. Because the material of mathematics is an interconnected unity, the mathematical connection ability is required in the learning process. Connection questions are important to be studied by the students because the concept in mathematics related to each other not only in mathematics theory but also among mathematics branch [3]. According to [4] the indicators of mathematical connection ability are (1) searching for the relationship of any concept and procedure representation; (2) understanding the relationship among mathematics topics; (3) applying mathematics in other fields or in daily life; (4) understanding the equivalent representation of a concept; (5) searching for the relationship between one procedure to another procedure in an equivalent representation; (6) applying the relationship among mathematics topics and between mathematics topics and topics beyond mathematics. There are three kinds of connections i.e. the connection between new information and current knowledge, the connection between mathematical concepts, and connection with everyday experience [5].

Nowadays, ICTs that used digital technologies such as computers and the internet are potential and powerful tools for education change and reform [6]. The use of ICTs in education help raise educational quality, helping teaching in learning process into an engaging and active that connected to real life.

The abstract object of mathematics can study easier with ICT so that the occurrence of students' misinterpretations can be avoided. [7] State that abstract mathematics is easier to understand and more interesting to learn by using ICT. Lack of lecturers' creativity that makes monotonous learning usually makes students bored and not interested in the mathematical subject. ICTs potential to innovate, accelerate, enrich, and deepen skills, to motivate and engage the student, to help related school experience to work practices, and strengthening teaching [8].

Learning mathematics in college is not just memorise or only apply a simple mathematical formula, but requires a High-Level Thinking Skills Mathematically that would be beneficial to the students themselves [9] [10]. This research will develop mathematical connection abilities that are part of the high-level mathematical thinking skills that important regarding data analysis in the course of Statistics. Statistics Textbook development of ICT-supported approaches designed a portfolio that is expected to improve the ability of students' mathematical connections in addition to improving learning outcomes.

2. Method

This research uses a quasi-experimental design with pre-test post-test control group design. This study used time series design which does not use a control group and only one group using all subjects in the group for treatment. Research conducted at the Department of Mathematics Faculty of Mathematics and Natural Sciences, Universitas Negeri Semarang. The population were all students of Mathematics Education in the second semester of 2015/2016 at the Department of Mathematics, Universitas Negeri Semarang in Statistics course. The samples in this research were selected using simple random sampling technique, and select one group of students learning group were given treatment learning using Statistics textbook supported with ICT and portfolio assessment approach. The variables observed in this study is students' mathematical connection ability and Statistics learning outcomes. These variables were measured before and after implementation of using Statistics textbook supported with ICT and portfolio assessment approach in the learning process.

2.1. The Steps of Research

The first steps in this research were determined to sample and trial class from a population of the study. Develop research instruments include syllabi, lesson plans, pre-test and post-test. After that, perform the test questions in trial class that have received Statistics material and then analyse the results of trials test to determine validity, reliability, the level of difficulty, and index of differentiated power. Next, set items that will be used in the pre-test and post-test in the experimental class. Items that do not meet the criteria are not used in the test. Before treatment, a pre-test was given to measure students' mathematical connection ability. Then, conduct learning in experiments class using Statistics textbook supported with ICT and portfolio assessment approach and give post-test to measure students' mathematical connection ability after treatment. After all, data was collected then analyse the data from the pre-test and post-test to verify the hypothesis.

2.2. Data Collection Technique and Research Instrument

The data collected in this research consisted of quantitative data. The students GPA in odd semester 2015/2016 was the data that collected with documentation method. Tests method conducted to test student mathematical connection ability. Tests carried out before the students acquire treatment (pre-test) and after the students treated using Statistics textbook supported with ICT and portfolio assessment approach (post-test). Data were then used to test for normality, homogeneity, and the average similarity.

Instruments in this research were tested item to measure students' mathematical connections ability, and lesson plan. Mathematical connections ability test consist of pre-test and post-test. The pre-test was used to determine students' ability before the treatment is given. Post-test was used to noticing an increase in students' mathematical connection ability after getting treatment. The material contained in the test question is all of the material in the Statistics course for one semester. The lesson plan was made for one semester in 11 meetings. Lesson plan made accordance with the curriculum used in Statistics.

3. Result

3.1. Preliminary Data Analysis Result

The initial analysis conducted before students were given treatment. The sample consisted of 30 students. The analysis carried out in the early stages of grade point average (GPA) data in the odd semester of the 2015/2016 academic year. Initial data taken from the odd semester GPA is used to determine the category of students' initial ability. The division of students initial categories and distribution of the sample based on students initial ability are summarised in Table 1.

Table 1. Criteria of Students Initial Ability

Interval	Category	Quantity
$GPA \geq 3.00$	High	27
$2.20 \leq GPA < 3.00$	Medium	3
$GPA < 2.20$	Low	0

Modified from [11]

From 30 students subject of the research, based on early data analysis from GPA score, obtained students grouping according to student initially ability. There were 27 (90%) of students who fit high capability, 3 (10%) of students in moderate ability category, and there was no student in low ability category.

3.2. Data Analysis Mathematical Connections Test

After doing the research and the data obtained from the results of tests that measure the ability of mathematical connections, then tested the hypothesis that has been proposed. Analysis of test data is performed to determine whether the results of the pre-test and post-test mathematical connection satisfy the hypothesis formulated or not. Before the test, the hypothesis of differences average of pre-test and post-test first tested the prerequisites normality test.

3.2.1. Test Difference Average Pre-Test and Post-Test Students Mathematical Connection Ability

Normality Test of pre-test and post-test mathematical connection ability scores aims was to determine whether the results of the pre-test and post-test mathematical connection ability have a normal distribution. Table 2 shows the results of Kolmogorov-Smirnov test with sig 0.004 worth less than 0.05 so that H_0 is rejected. While the value of sig to post-test mathematical connection ability was 0.096 greater than 0.05, then H_0 is accepted. It shows the value of data pre-test of students mathematical connections were not normally distributed, while the post-test scores mathematical connection ability were normally distributed.

Table 2. Normality Test of Pre-test and Post-test Student Mathematical Connections Ability

Statistic	Mathematical Connections	
	Pre-test	Post-test
N	30	30
Kolmogorov- Smirnov Z	1.770	1.232
Sig.	0.004	0.096
H_0	Reject	Accept

The hypothesis of students' mathematical connection difference testing students' mathematical connection ability before and after treatment using Statistics textbook supported with ICT and portfolio assessment. This test was performed to determine the average difference in the improvement of student mathematical connection abilities before given treatment using Statistics textbook supported with ICT and portfolio assessment (μ_1) and after treatment (μ_2). Based on normality test, the hypothesis of difference used nonparametric Mann-Whitney.

Table 3 shows that Mann-Whitney U (Z) value -6.720 with sig 0.000, so accept H_1 . It means that there are differences in student mathematical connection ability average using Statistics textbook supported with ICT and portfolio assessment approach. It shows that the implementation of Statistics textbook supported with ICT and portfolio assessment approach significantly proven make a difference and increase the student's mathematical connections ability. Improved connection ability, the increase in the average value of the pre-test and post-test which initially 0.67 in the pre-test score increased to 8.93 on a post-test. The use of ICT in learning has also been widely perceived benefits on several previous studies which have been carried out [12], [13], [14], [15] and [16].

Moreover, regarding the category of post-test connection capabilities mathematically students, there were 21 students (70%) belongs to a high category, 6 students (20%) included in medium category and 3 students (10%) belongs to a low category.

Table 3. Mann-Whitney Test of Mathematical Connections

Statistic	Mathematical Connections	
	Pre-test	Post-test
N	30	30
Mean	0.67	8.93
Mann-Whitney U		-6.720
Sig.		0.000
H ₀		Reject

3.2.2. *Test of Mathematical Connection Ability Achievement Based on Initial Ability*

Normality test of post-test mathematical connection ability based on students' initial ability aims to determine whether the results of the post-test scores have a normal distribution.

Table 4. Normality Test of Post-test Student Mathematical Connections by Initial Abilities

Statistic	Mathematical Connections	
	High	Medium
N	27	3
Kolmogorov- Smirnov Z	1.368	0.583
Sig.	0.047	0.886
H ₀	Reject	Accept

Based on the result in Table 4, Kolmogorov-Smirnov value for mathematical connection ability with higher ability category was 1.368 with sig value 0.047 so that H₀ rejected. Moreover, Kolmogorov-Smirnov value for mathematical connection ability with medium ability category was 0.583 with sig value 0,886 so that H₀ accepted. It shows that post-test of students' mathematical connection abilities with high ability category were not normally distributed, while post-test for medium ability category students were normally distributed.

Hypothesis testing of students mathematical connection ability differences based on initial ability GPA scores performed to determine the difference in student mathematical connection ability achievement of high ability category (μ_1) and medium ability category (μ_2). The achievement of students' mathematical connection ability was indicated by the value of post-test mathematical connections ability. A different test average of students' mathematical connection ability calculated using Mann-Whitney test because post-test scores were not normally distributed. Based on the result of the difference in mathematical connection ability achievement in Tabel 5, it obtained Mann-Whitney U (Z) -1.816 and sig value 0.086, so can conclude to accept H₀. It means that there was no difference in the average of students mathematical connection ability achievement using Statistics textbook supported with ICT and portfolio assessment approach in students with high and medium ability categories.

It shows that the implementation of Statistics textbook supported with ICT and portfolio assessment approach significantly proven increase the ability of students' mathematical connection ability. These results correspond to the results of the research [17] that computer-based can increase students scores in low and average achievers. Achievement of the mathematical connection ability on high and medium ability category have post-test mean score consecutive 9.22 and 6.33. It shows that with Statistics textbook supported with ICT and portfolio assessment approach, students' mathematical connection ability achievement give high ability.

Table 5. Mann-Whitney Test of Achievement Mathematical Connection

Statistic	Initial Ability	
	High	Medium
Mean	9.22	6.33
Mann-Whitney U		-1.816
Sig.		0.086
H ₀		Accept

4. Result

Based on the results of this research can be concluded that the Statistics textbook supported with ICT and portfolio assessment approach can improve students mathematical connections ability in Statistics lectures of Mathematics Education students that seen with the increased scores of the mathematical connection abilities.

References

- [1] Hendikawati P and Arini F Y 2016 The Development of Statistics Textbook Supported with ICT and Portfolio-Based Assessment *Journal of Physics: Conference Series* 693 (1) 012020 (IOP Publisher)
- [2] Ruspiani 2000 *Kemampuan Mahasiswa dalam Melakukan Koneksi Matematika* Thesis (Bandung: PPS UPI)
- [3] Ruseffendi E T 2006 *Pengantar Kepada Membantu Dosen Mengembangkan Kompetensinya dalam Pengajaran Matematika Untuk Meningkatkan CBSA* (Bandung: Tarsito)
- [4] Sumarmo U and Nishitani I 2010 High Level Mathematical Thinking: Experiment with High School and Under Graduate Student using Various Approaches and Strategies, Gunma University, Maebashi. Vol 58, 14 pages, (<http://www.des.emory.edu/mfp/Bandura1989.pdf>)
- [5] Mousley J 2004 An Aspect of Mathematical Understanding: The Notion of “Connected Knowing” *Proc. 28th Conference of the International Group for the Psychology of Mathematics Education* 3 p 377-384
- [6] Tinio, V.L 2002 *ICT in Education: UN Development Programme* (Retrieved from <http://www.epimers.org> on September 2015)
- [7] Wintarti I A Yamasari, Y Johan A 2009 Pengembangan Media Pembelajaran Matematika Berbasis ICT Untuk Menumbuhkan Minat dan Motivasi Siswa dalam Memahami Konsep Matematika *Jurnal Pendidikan Matematika dan Sains* **16(2)**
- [8] Amin S N U 2013 An Effective Use of ICT for Education and Learning by Drawing on Worldwide Knowledge, Research, and Experience: ICT as a Change Agent for Education *Scholarly Journal of Education* **2(4)** pp. 38-45 Online at <http://www.scholarly-journal.com/SJE>
- [9] Dwijanto 2007 Pengaruh Pembelajaran Berbasis Masalah Berbantuan Komputer Terhadap Pencapaian Kemampuan Pemecahan Masalah dan Berpikir Kreatif Matematik Mahasiswa Ph.D. thesis, (Bandung: UPI)
- [10] Sumarmo U 2005 Pengembangan Berfikir Matematik Tingkat Tinggi Mahasiswa SLTP dan SMU serta Mahamasiswa Strata Satu (S1) Melalui Berbagai Pendekatan Pembelajaran Report Penelitian Hibah Penelitian Tim Pascasarjana-HTPT Tahun Ketiga (Bandung: UPI)
- [11] Tandililing E 2011 The Enhancement of Mathematical Communication and Self Regulated Learning of Senior High School Students Through PQ4R Strategy Accompanied by Refutation Text Reading *PROCEEDINGS International Seminar and the Fourth National Conference on Mathematics Education* ISSN 978-979-16353-7-0
- [12] Oviawe J I and Oshio L E 2011 Impact of Information and Communication Technology on Teaching and learning Ability of Education Students in Universities in Edo State Nigeria *International Review of Social Science and Humanities* **2(1)** pp.126-133 www.irssh.com ISSN 2248-9010 (Online) ISSN 2250-0715 (Print)
- [13] Eisenberg M et all 2010 Information, Communications, and Technology (ICT) Skills Curriculum Based on the Big6 Skills Approach to Information Problem-Solving *The Big6 Library Media Connection* May/June pp. 24-27

- [14] Shade O K et al 2012 ICT: An Effective Tool in Human Development *International Journal of Humanities and Social Science* **2(7)** pp.157-162 April www.ijhssnet.com
- [15] Fuglestad A B 2004 ICT Tools and Students' Competence Development *Proceedings of the 28th Conference of the International Group for the Psychology of Mathematics Education* **2** pp.429-446
- [16] Marshall S and Taylor W 2016 Editorial: Adoption, Integration and Use of ICT in Teaching *International Journal of Education and Development using Information and Communication Technology (IJEDICT)* **12(1)** pp.2-3
- [17] Afzal M T et al 2014 The Effect of Computer Based Instructional Technique for the Learning of Elementary Level mathematics Among High, Average and Low Achievers *International Journal of Education and Development using Information and Communication Technology (IJEDICT)* **10(4)** pp.47-59