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Effectiveness of Progressive Learning Approach toward Enhancement of Students' Competency on Mathematics Journal Writing and Mathematical Proof

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Abstract

This is quasi-experimental research of two different groups of 41 and 46 mathematics students. This research was conducted at Haluoleo University of Kendari South-East Sulawesi Indonesia. Progressive learning approach was applied to group of 41 students as an experimental group and conventional learning approach was applied to the other group of 46 students as conventional group. The students were also categorized by their grade point average (GPA) into higher, medium, and lower levels. Mathematical journal writing and mathematics proof competencies were measured by pre-test and post-test on both areas. Scores of these tests were analised with Anacova test, two-way Anova, t-test, and Mann-Whitney U test. In this reaseach students were expected to have mathematics journal writing and mathematical proof competencies. The results of the research are (1) students' mathematics journal writing competency and students' increment at mathematics journal writing competency of progressive learning approach is better than that of conventional one; (2) students' mathematical proof competency and students' increment at mathematical proof competency of progressive learning approach is better than that of conventional one, but students' increment of mathematical proof competency at lower level of GPA is not significantly different.

Keywords: progressive learning approach, mathematics journal writing competency, mathematical proof competency

1. Introduction

Competencies of mathematical proof and mathematics journal writing are two important objectives for students of Elementary and Secondary Schools. These two competencies are indicated in Permendiknas Nomor 26, Year 2006. Students at all level of education in Indonesia should have these two competnecies before leaving their schools. In addition, these two competencies should be extended to higher education level of mathematics students.

In order to enhance these two competencies, progressive learning approach was applied in the class of Abstract Algebra 1 of mathematics major students of Mathematics Department of Haluoleo University, academic year 2012/2013. Progressive learning approach trains students to work together in smaller groups, focuses on student-centered learning, and encourages students to present their mathematical work to all members of their class in both mathematics journal writing and mathematical proving areas.

Three main goals were going to be discussed in this research. The first main goal consisted of five sub-goals. The progressive learning approach is better than conventional learning approach in terms of the mean score of mathematics journal writing competency. The progressive learning approach is better than the conventional learning approach in terms of the mean of gain score of mathematics journal writing competencies. The third goal included three sub-goals. When it is observed by the higher, medium, and lower level of students' GPAs, the progressive learning approach is better than conventional learning approach in terms of the mean of gain score of mathematics proving ability.

The second main goal also consists of five sub-goals. The progressive learning approach is better than conventional learning approach in terms of the mean score of mathematical proof competency. The progressive learning approach was better than the conventional learning approach in terms of the mean of gain score of mathematical proof competency. The third goal included three sub-goals. When it is observed by looking at the higher, medium, and lower level of students' GPAs, the progressive learning approach is better than conventional learning approach in terms of the mean of gain score of mathematical proof ability.

The third main goal consists of two sub-goals. There is interaction between students' GPAs and learning approach toward mathematics journal writing competency and there is interaction between students' GPAs and learning approach toward mathematical proof competency.

2. Mathematics Journal Writing

Journal writing is one mode of mathematics writing. Students can write their journal to learn mathematical concept, and to make use it as a strategy to solve problems (Nahgrang & Peterson, 1986). Mathematics journal can also be used to encourage students to record students' reflection of materials studied, and be used in answering open-ended tasks. In this research, students were asked to write the process of their ways in doing mathematical proving problems. When the journal was correctly writen, mathematical work would also resulted in correct answer.

Pimm (1987) stated that journal writing functions as a mode to make an exposure of students' knowledge acquired. Burns (1996) and Burns & Silbey (1999) stated that journal can give students chances to learn mathematics in their own speed, to help students become more effective in learning and to be organized. So, instructor can make use of journal mathematics writing to assess students' mathematical understanding, to encourage conceptual understanding, and to build mathematics communication through it.

Writing the process of thinking mathematically can keep and refine the development of mathematical reasoning, communication, broadening of the thinking it self (Doherty, 1996; Drake & Amspaugh, 1994; Gopen & Smith, 1990; Grossman, Smith, & Miller, 1993; Miller, 1992; Nahgrang & Peterson, 1986; Rose, 1989; and Shepard, 1993). Writing as one of communication tools must be written by applying structurized organization in order to ease reading and understanding, using coherent step orders, and containing a topic sentence in every paragraph. This writing competency must be achieved by students in all strata of elementary school to tertiary level (Bahan Uji Publik Kurikulum 2013).

Students as participants of the study were obliged to write mathematics journal four times during this reasearch conducted. They also took pre-test and post-test on mathematics journal writing. Descriptive statistics of students' Competency of Mathematics Journal Writing score is presented on the Table 1.

Table 1. Descriptive Statistics of CMJW

CMJW	N	Min	Max	Mean	Stdev	Skewness	Kurtosis
Pre-test PA	41	32,00	60,00	50,2927	6,85654	-0,791	0,614
Post-test PA	41	55,00	80,00	65,6098	4,49932	0,399	2,640
N-gain PA	41	0,10	0,90	0,3210	0,12775	2,323	9,878
Pre-test CA	46	40,00	70,00	54,6522	7,83785	-0,402	-0,221
Post-test CA	46	50,00	75,00	62,2826	5,02289	-0,219	0,721
N-gain CA	46	0,00	0,36	0,1591	0,08273	0,879	0,299

Note:

CMJW = Competency of Mathematics Journal Writing

PA = Progressive Learning Approach

CA = Conventional Learning Approach

Table 1 demonstrates that students' mean of pre-test score of progressive learning approach is low and their mean of post-test score is medium. Also, there is similar trend of mean score of conventional learning approach. However, students' post-test score of progressive learning approach is better than that of conventional learning approach post-test score. Also, students' normalized gain of CMJW enhancement of progressive group is better than that of conventinal one.

3. Mathematical Proof

Main component of mathematical proof is an argument convincing others (Bloch, 2000; Krantz, 2007) or a logical argument (Cupillari, 2005) and provided with a specific form of writing (Arsac, 2007). Moreover, mathematical proof starts with premises, deduces conclusion logically (Bloch, 2000) and makes use of agreed method of argumentation (Mitchell & Johnson, 2008). Mathematical proof is a text with exact rule (Arsac, 2007), and its truth does not have ambiguity in order to convince experts or novices (Stylianides, 2007), by using exact mathematical language (Wahyudin, 2010). Students as participant of this research must apply and follow those

main components mentined above.

Mathematical proof consists of adopting statements in which its truth is accepted by mathematics experts without any additional explanation, adopting a form of valid reasoning and well known to experts, and is communicated by precise form of argumentation. Mathematical proof is necessary because it assures that statements are true. In other words, mathematical proof is a way to communicate an idea that is intuitively true to others.

The process of writing mathematical proof is known as arranging logical argument that agrees to axioms, definitions, and theorems. Proving process is also an activity that ends at finding mathematical facts, developing conjectures, constructing reasons, and validating arguments. Proving mathematics statements can be done by direct proof, contrapositive proof, or contradictive proof.

In this research, students were pre-tested dan post-tested for obtaining their mathematical proving competency. Pre-test was conducted at beginning of the first meeting, and post-test was given after the eighth week of Abstract Algebra class. Descriptive statistics of students' Competency on Mathematics Proving score is presented on the Table 2.

Table 2. Descriptive Statistics of CMP

CMP	N	Min	Max	Mean	Stdev	Skewness	Kurtosis
Pre-test PA	41	9,00	85,00	42,1951	17,77107	0,350	-0,353
Post-test PA	41	20,00	95,00	69,2683	15,40458	-0,886	1,210
N-gain PA	41	0,12	0,81	0,4755	0,18250	-0,154	-1,051
Pre-test CA	46	10,00	75,00	37,8913	16,60820	0,451	-0,570
Post-tes CA	46	28,00	85,00	60,2826	16,46230	-0,515	-0,682
N-gain CA	46	0,04	0,70	0,3620	0,16289	0,065	-0,700

Note:

CMP = Competency of Mathematics Proving

Table 2 demonstrates that students' mean of post-test score of mathematical proving competency of progressive approach is better than that of conventional approach. Both of these two means score are categorized into average level of competency. Also, their normalized gain is categorized into average level of gain score. Normalized gain score of progressive learning approach is much higher than that of conventional approach gain score.

4. Progressive Learning Approach

Learning proccess is organised in several steps. In the beginning, the instructor deliveres some pieces of information in connection with topic of group of Abstract Algebra 1 for approximately 10 minutes. At the time, the instructor explaines what students have to do during the class, explaines theorems or denifitions and the method to prove those theorems. The instructor instructs the steps in proving them.

Next, after the instructor deliveres instructions, the instructor forms smaller groups consisting of four or five heterogeneous students. The smaller groups make instructor easier to deliver explanation regarding the problem given in students' work sheets.

Then, each student is given student work-sheet to work on it. Each group works collaboratively before presenting in front of their class. In case the instructor's support is required, the instructor's guidance is provided.

After that the outcome of group discussion is presented by representative of each group. The instructor keeps motivating the students to participate in the discussion through all the activity. So the discussion is becoming as lifely as possible.

At the end of the class, the students with the instructor's help summarize the topic discussed. The process of progressive learning approach is conducted in every class for seven meetings.

5. **Research Design**

This is quasi-experimental research. Two groups of mathematics major students of Mathematics Department of Haluoleo University academic year 2012-2013 from the Abstract Algebra 1 class participate in the research. The progressive learning approach is applied to experimental group of 41 students and conventional approach is

applied to the conventional group of 46 students. Each group consists of higher, mid, and lower level of students' GPAs. Both progressive and conventional groups are pre-tested and post-tested to obtain their mathematics journal writing and mathematics proving ability scores. Besides, they also work their weekly tasks on both areas. Pre-test is given at the beginning of the first class meeting. Post-test is conducted at the ninth teaching-learning process.

Two groups of mathematics major students are partitioned into three levels of students' GPA. Each group consists of higher, mid, and lower levels of students' GPA. The students are taught group as one topic of Abstract Algebra 1. The treatment is given once a week for seven weeks class meeting. The students are pre-tested and post-tested by a set of test of mathematics journal writing and mathematics proving of these topics and subtopics.

Two instructors are responsible for the learning process. The first instructor taught group of progressive learning approach and the second instructor taught group of conventional learning approach. They both were provided with student worksheet and planning of teaching learning process.

5. Conclusion

In general, students' achievement for mathematics journal writing ability of the progressive approach group is better than that the conventional approach group. It is also true for students' gain score on mathematics journal writing ability, students' gain score on mathematics journal writing ability of higher level of students' GPA, students' gain score on mathematics journal writing ability of medium level of students' GPA, and students' gain score on mathematics journal writing ability of lower level of students' GPA. The students of progressive group seemes to be superior at mathematics journal writing compentency than the students of conventional group.

The findings are in line with that Junaedi (2007) researching writing competency, and also in line with Baveja, Bower, & Joice (1985) grouping students based on their prior knowledge. Junaedi found that experiment group was better with regard to the writing competency compared to control group. Baveja, Bower, & Joice (1985) found that grouping students doubled students' competency to obtain mathematical knowledge.

Mathematics journal writing competency includes students' ability to communicate their mathematics understanding, and their mathematical thinking process, especially writing mathematics in regard to the process of proving. Students' competency at this area was measured by using tests and take home tasks. In order to refine students' writing, instructor gave feed back to their work and put additional information, hence students' writing became more understandable.

Table 3. Test Statistic Summaries

		Treatment Means		Test Statistic	p value	Conclusion
		PA	CA			
Competency of Mathematics Journal Writing (CMJW)		65,6098	62,2826	t = 3,259	0,001	PA > CA
Competency of Mathematics Proving (CMP)		69,2683	60,2826	t = 2,619	0,005	PA > CA
N-gain of CMJW		0,32	0,16	Mann-Whitney U (Z = -6,074)	0,000	PA > CA
N-gain of CMP		0,48	0,37	t = 2,924	0,002	PA > CA
N-gain of CMJW	Higher GPA	0,32	0,17	Mann-Whitney U (Z = -3,214)	0,0005	PA > CA
	Middle GPA	0,31	0,13	Mann-Whitney U (Z = -4,727)	0,000	PA > CA
	Lower GPA	0,35	0,20	t = 3,300	0,002	PA > CA
N-gain of CMP	Higher GPA	0,59	0,41	t = -3,129	0,0025	PA > CA
	Middle GPA	0,49	0,36	t = -2,224	0,016	PA > CA
	Lower GPA	0,34	0,31	t = -0,684	0,251	PA = CA
Interaction	GPA and Treatments of CMJW			F = 0,759	0,472	Yes
	GPA and Treatments of CMP			F = 1,108	0,335	Yes

Note:
PA = Progressive Approach
CA = Conventional Approach
GPA = Grade Point Average

The progressive learning approach encourages students to work in groups, to discuss issues at hand, and to present their work in front of their classmates. Students are given worksheet in order to prevent unnecessary discussions. Students are obliged to work on this worksheet. When students find some mathematical problems too difficult, instructor may to help them by giving questions, directing students to the right answer.

Students' achievement for mathematical proof ability of the progressive approach group is better than the conventional approach group. This is also true for students' gain score of mathematical proof writing ability, students' gain score on mathematical proof ability of higher level of GPAs, and students' gain score on mathematical proof ability of middle level of GPAs. However, students' gain score on mathematical proof ability of both progressive approach and conventional approach of lower level of students' performance was similar.

Working together in smaller groups really helps students to construct their own knowledge, especially with the help of their caring instructors. The progressive approach encourages students to construct their knowledge by working together in groups. These two findings are in accordance with Vygotsky's constructivism and Brunner's social constructivism theories.

The research also found that there is no significant interaction between two learning approaches toward students GPAs on mathematics journal writing ability. Also, there is no significant interaction between two learning approach toward students' GPAs on mathematical proof ability. Both the progressive and the conventional approach treatments increase the score of journal writing and proving mathematics ability. However, the progressive approach is proven more effective compared to the conventional approach. The combination of the progressive approach and level of students' GPAs is particularly important to enhance writing and proving ability.

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