

Effectiveness of the RME Model Assisted by GeoGebra and IFP on Students' Mathematical Problem-Solving Ability

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ABSTRACT

This research examined how effective the Realistic Mathematics Education (RME) model was when supported by GeoGebra and an Interactive Flat Panel (IFP) in strengthening students' mathematical problem-solving ability on algebraic function limits. A quasi-experimental Nonequivalent Control Group Design was applied to 30 experimental-class students and 35 control-class students of SMA Negeri 1 Kampar Timur, selected by purposive sampling. An essay test of problem-solving ability served as the data collection instrument, and the data were examined through normality, homogeneity, t-test, Mann-Whitney U, and N-Gain analyses. Since some of the data departed from normality, the Mann-Whitney U test was used alongside the t-test. Both tests produced a significance value of 0.000 (< 0.05). The mean N-Gain reached 0.77 (high category) in the experimental group but only 0.06 (low category) in the control group, and classical mastery was 90.00% against 17.14%. These findings showed that RME supported by GeoGebra and IFP was effective in improving students' problem-solving ability on algebraic function limits.

Keyword : Realistic Mathematics Education, GeoGebra, Interactive Flat Panel, mathematical problem-solving ability, algebraic function limits



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1. INTRODUCTION

Problem-solving is regarded as a higher-order thinking skill central to learning mathematics, since it nurtures reasoning, perseverance, and curiosity, and gives students the confidence to approach unfamiliar situations (NCTM, 2000). Even so, students' problem-solving ability on algebraic function limits is still weak in many schools, SMA Negeri 1 Kampar Timur among them.

Several causes are suspected. Teaching tends to remain procedural and detached from context, students lack visual support for grasping the idea of a limit intuitively, and they are seldom actively involved in lessons. The limit of a function is an abstract notion that demands insight into how a function behaves near a particular point; presenting it only through formal definitions, with no contextual or visual experience beforehand, makes it hard to understand (Stewart, 2016).

Realistic Mathematics Education (RME) is a promising response, since it treats mathematics as a human activity tied to students' everyday reality (Freudenthal, 1991) and therefore begins lessons from contextual problems instead of formal definitions. RME can be strengthened with GeoGebra, which offers dynamic visualization (Hohenwarter & Fuchs, 2004), and with an Interactive Flat Panel (IFP), which lets the whole class view that visualization interactively (Betcher & Lee, 2009).

Two research questions guided this study: (1) whether the problem-solving ability of students taught with RME assisted by GeoGebra and IFP differs significantly from that of students taught conventionally, and (2) whether this model is effective for problem-solving ability on algebraic function limits. Accordingly, the study aimed to analyze the difference and the effectiveness of the model at SMA Negeri 1 Kampar Timur.

2. RESEARCH METHOD

A quantitative approach with a quasi-experimental method was adopted because the students were already placed in intact classes, which ruled out fully random assignment of individuals (Sugiyono,

2019). The design was the Nonequivalent Control Group Design, in which an experimental group and a control group each took a pretest and a posttest.

The research took place at SMA Negeri 1 Kampar Timur. Using purposive sampling, one class was designated as the experimental group and taught with RME assisted by GeoGebra and IFP, while another class became the control group and received conventional teaching. The experimental group had 30 students and the control group 35.

Data were gathered with an essay test of mathematical problem-solving ability built on Polya's (1973) four indicators: understanding the problem, devising a plan, carrying out the plan, and looking back. Prior to use, the items were tried out on 30 respondents to check validity and reliability. Validity was assessed by correlating each item score with the total score using Pearson Product Moment, with a critical r of 0.361 ($n = 30, \alpha = 0.05$). All five items were valid, with r values of 0.681, 0.669, 0.763, 0.755, and 0.768, each above the critical value. Cronbach's Alpha gave a reliability coefficient of 0.770, in the high category ($0.60 \leq \alpha < 0.80$).

The data were analyzed using the Shapiro-Wilk normality test, Levene's homogeneity test, the Independent Sample t-Test, N-Gain analysis (Hake, 1998) to gauge improvement in problem-solving ability, and classical mastery analysis with a minimum mastery criterion (KKM) of 75. The model was considered effective when three conditions held: (1) the mean problem-solving ability of the two groups differed significantly, (2) classical mastery reached at least 75%, and (3) the experimental group's N-Gain exceeded that of the control group. As the normality test revealed that some data were not normally distributed, the Mann-Whitney U test was added as a nonparametric check on the t-test results.

3. RESULTS AND DISCUSSION

A. Results

Table 1 summarizes the descriptive statistics of the pretest and posttest scores of both groups.

Table 1. Descriptive Statistics of Pretest and Posttest Data

Group	Data	N	Min	Max	Mean	SD
Experimental	Pretest	30	20	80	60.17	12.63
Experimental	Posttest	30	70	100	91.33	11.06
Control	Pretest	35	20	80	60.00	12.07
Control	Posttest	35	45	90	63.57	11.54

Median-based Levene's test indicated that the pretest and posttest variances of the two groups were homogeneous (Sig. > 0.05), as listed in Table 3. Since not every data set was normally distributed, the posttest data were tested with both the Independent Sample t-Test and the nonparametric Mann-Whitney U test, whose results appear in Table 4.

Table 3. Results of Levene's Test for Homogeneity

Data	Sig.	Remarks
Pretest	0.859	Homogeneous
Posttest	0.733	Homogeneous

Table 4. Results of Hypothesis Testing on Posttest Data

Test	Statistic	df / N	Sig. (2-tailed)	Remarks
Independent Sample t-Test	$t = 9.856$	$df = 63$	0.000	Significant
Mann-Whitney U	$U = 994.0$	-	0.000	Significant

Both the parametric and nonparametric tests gave the same significance value of 0.000 (< 0.05), meaning the experimental and control groups differed significantly in mathematical problem-solving ability. The N-Gain and classical mastery results follow in Table 5.

Table 5. Mean N-Gain and Classical Learning Mastery

Group	Mean N-Gain	Category	Classical Mastery
Experimental	0.77	High	90.00% (27 of 30 students)
Control	0.06	Low	17.14% (6 of 35 students)

B. Discussion

The analysis shows that all three effectiveness criteria were satisfied by a wide margin: the group means differed significantly, classical mastery surpassed 75%, and the experimental group's N-Gain was higher. RME assisted by GeoGebra and IFP can therefore be considered effective for students' problem-solving ability on algebraic function limits. That the t-test and Mann-Whitney U test agreed increases confidence that the difference does not merely result from partial violation of the normality assumption.

The N-Gain gap between the experimental group (0.77, high) and the control group (0.06, low) is very large, and the experimental group's classical mastery of 90.00% far exceeds the KKM of 75%, whereas the control group reached just 17.14%. This pattern fits several views: that RME helps students move from contextual problems toward formal concepts (Freudenthal, 1991; Gravemeijer, 1994); that GeoGebra's dynamic visualization clarifies how a function behaves near a point and thereby improves conceptual understanding and problem-solving (Zulnaldi & Zakaria, 2012); and that IFP supports interactive presentation of that visualization, raising motivation and engagement (Cutrim Schmid, 2008). The findings also align with earlier studies showing that RME (Arsaythamby & Zubainur, 2014; Sari, Ikhsan, & Saminan, 2017) and GeoGebra (Sulistyaningsih, Waluya, & Kartono, 2012) each improve students' problem-solving ability when used separately.

4. CONCLUSION

The study concludes that students taught with RME assisted by GeoGebra and IFP differ significantly in mathematical problem-solving ability from students taught conventionally on algebraic function limits, as confirmed by the Independent Sample t-Test and the Mann-Whitney U test ($\text{Sig.} = 0.000 < 0.05$). The model also met the effectiveness criteria for mean ability, classical mastery (90.00% versus 17.14%), and N-Gain improvement (high versus low category). Mathematics teachers are encouraged to adopt it for topics that benefit from concept visualization, and future researchers are advised to test it on other topics and to examine variables such as learning motivation or mathematical critical thinking ability.

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