The effect of comic-based realistic mathematics approach on students’ learning motivation and conceptual understanding

T N Sipayung, S D Simanjuntak, A Wijaya, and S Sugiman

1Department of Mathematics Education, Catholic University of Saint Thomas, Indonesia
2Department of Mathematics Education, Yogyakarta State University, Indonesia

E-mail: tetty_sipayung@ust.ac.id

Abstract. Comics are reading material that is generally more desirable than textbooks by children, especially teenagers. Based on its characteristics, comics contain stories in the form of pictures and text which is contained in the balloons of text and presented in the panels. If the comic is presented in line with the application of a realistic mathematical approach, especially in learning mathematics, it hopes to create an interesting learning atmosphere for students. However, in this case, the contents of the comic story presented are in the form of learning about integers that are connected with a realistic mathematical approach. Therefore, this study aims to determine the effect of learning with comic-based realistic mathematical approaches on learning motivation and students' understanding of mathematical concepts. This research is a quasi-experimental study. The population in this study was all the students of class VII of Junior High School of RK Serdang Murni Lubuk Pakam in the Academic Year of 2019/2020. While the sample was the class VII-1 as a control class of 31 students and class VII-2 as an experimental class of 32 students. The instruments in this study were two tests of the ability to understand the mathematical concepts and a learning motivation questionnaire. The normality test uses Liliefors test and the homogeneity test uses the Levene’s test with significance. The data were analyzed using the Manova test. Based on the data analysis, the results show that there was a significant effect of comic-based realistic mathematical approaches on students’ learning motivation and conceptual understanding of integer’s material.

1. Introduction

Education that is accompanied by changes in a better direction is something that is good and expected. Therefore, efforts are needed to achieve this. One alternative that can be done is to innovate in learning. Given the development of the times, new problems will arise in learning. Actually, in general, problems in recent learning have not yet been completely resolved. However, efforts are always made to minimize these problems. Therefore we need creative ideas related to innovation in learning mathematics. One idea that can be applied is to develop a learning media that attract students' attention. One way is to apply to learn by using comics.

Comics are more popular books than other textbooks. Comics can be said to be part of innovation related to human thought and flexibility. Besides that, it can be said that comics are similar to cartoons which require delicate drawing skills in making subject matter with conceptual storylines [1].

Comics use images with incomplete text. Weiner states that children prefer comics over other textbooks because comics offer visual images and other arts not just something that is read but seen at
the same time [2]. Long texts cause students to become bored with reading them. Several things that appeal to comics, especially for children and school students. One of them is the picture which is packaged in a comic that is interestingly designed so that it motivates the reader more.

Therefore, one of the teaching aids that can be used to motivate students in learning is comics [2]. Comic is a visual literacy book that is popular with young people. Visual tools are seen as very important in providing information and understanding in learning situations [3]. Thacker stated that comics can meet the needs of students in a variety of academic abilities [2]. If it is designed to be interesting and well applied in learning in the classroom, comics provide extraordinary power in conveying messages and contribute to motivating students to be active [4]. The contents of stories in comics can be presented by connecting mathematics with problems of daily life. That has become one of the alternative ideas that can be applied in mathematics learning. Comics related to mathematics and connecting mathematics with everyday life are still relatively minimal and rare. Mostly the comic outstanding so far generally tells about non-educative problems. Therefore it is necessary to design learning using realistic mathematical comics. Realistic mathematical comics that are intended is to apply learning with comic-based realistic mathematical approaches.

The realistic mathematics approach is a learning theory that is suitable to be applied which makes mathematics more meaningful because it connects the real world that starts with students' own experiences so students can participate in learning activities [5]. Bray & Tangney stated that Realistic Mathematics Education (RME) is one approach that addresses problems caused by abstract mathematics learning [6]. With a realistic mathematical approach, it allows students to understand mathematical concepts by thinking about the problems of daily life [7]. Realistically in RME has broader connotations. Realistically what is meant is students are offered a problem situation that they can imagine [8]. Realistic Mathematics Education (RME) is realistic because students learn mathematics through involvement in solving problems in contexts that are meaningful to students [9]. In a realistic mathematical approach, the problems presented to students come from problems related to the real world which can also be interpreted as long as the problem is really in the student's mind experience [7].

Given the low conceptual understanding of students towards the material that has been studied, surely a comic-based realistic mathematical approach can be used as an alternative solution to improve students' conceptual understanding. In learning activities, a concept is a thought about something generalized so that facts and perceptions are needed in constructing a concept [10]. Santrock states that conceptual understanding is one of the keys to learning that can be a benchmark of successful learning [11]. However, on reality, students' understanding is still relatively low. This can be known based on the score of the National Examination results. Examination scores in mathematics at SMP/MTs in 2019 are presented in the following table:

| Table 1. The Average Data of National Examination Score at Mathematics Subjects in 2019 |
|---|---|---|---|
| Subject | Average National Examination Score | Regency City | Province |
| Mathematics |  | Deli Serdang | North Sumatra | National |
|  |  | 42.40 | 43.60 | 45.52 |

In mathematics learning, not only cognitive ability that requires attention but the affective ability is also something important [12]. Based on facts in the field, many students dislike mathematics because mathematics is confusing and scary. This causes the low motivation to learn mathematics students. Therefore a comic-based realistic mathematical approach can also be applied to analyze student learning motivation and it is expected that student learning motivation will increase.

Based on the description above, it is necessary to conduct a study conducted with the formulation of the problem is whether there is the effect of learning with comic-based realistic mathematical approaches to students' learning motivation and conceptual understanding. The existence of this research is expected to provide an alternative solution for teachers or education practitioners in general in improving the quality of mathematics learning as well as providing information about the influence of
learning approaches on student motivation and conceptual understanding. The approach applied to find out whether or not the effect is a comic-based realistic mathematics approach.

2. Research Method

This research is a quasi-experimental research with a pretest-posttest control group design. The variables in this study include independent variables, namely learning approaches that include comic-based realistic mathematical approaches and expository approaches and dependent variables, namely increasing the ability to understand student concepts and special learning motivation on integer material.

The study population was all VII grade students of Senior High School of Serdang Murni Lubuk Pakam in the 2019/2020 Academic Year consisting of five classes. The sample selection in this study was carried out by using simple random, namely taking random sample members from the existing population. Based on the sampling technique, the control class was selected, namely class VII-1 as many as 31 people and experimental class that was class VII-2 as many as 32 people. The experimental class was taught with a comic-based realistic mathematics approach while the control class was taught with an expository approach. Some comic picture displays used in learning integers in experimental class can be seen in the following pictures:

![Comic-based realistic mathematics approach](image1.png)

Figure 1. Parts of Realistic Mathematics Comic for Integers Material
The sampling process is explained in the figure 2:

![Sampling Process Diagram](image)

**Figure 2.** Sampling Process

Instruments in this study include learning motivation questionnaires, pre-test questions, and post-test conceptual understanding. Recapitulation of the results of the questionnaire test results and pre-test and post-test conceptual understanding questions is presented in the following table:

**Table 2.** Recapitulation of Data Analysis of Conceptual Understanding Tests

| Type of Data | Question Number | Validity | Reliability | Distinguishing Power | Difficulty Level |
|--------------|------------------|----------|-------------|----------------------|------------------|
| Pre-Test Conceptual Understanding | 1 | 0.80 | | 0.67 | Good | Good | Medium |
| Post-Test Conceptual Understanding | 2 | 0.68 | | 0.68 | Excellent | Excellent | Medium |
| | 3 | 0.68 | Valid | 0.81 | Reliable | 0.64 | Good | Good | 0.40 | Medium |
| | 4a | 0.82 | | 0.86 | Excellent | Excellent | Medium |
| | 4b | 0.85 | | 0.89 | Excellent | Excellent | Medium |
| | 1a | 0.68 | | 0.47 | Good | Good | Medium |
| | 1b | 0.77 | | 0.78 | Excellent | Excellent | Medium |
| | 2 | 0.79 | | 0.67 | Good | Good | Medium |
| | 3a | 0.77 | | 0.67 | Good | Good | Medium |
| | 3b | 0.74 | | 0.61 | Good | Good | Medium |
| | 4 | 0.56 | | 0.22 | Fair | Fair | Medium |
The research procedure is a step that is applied from the beginning to the end of the study. The procedures in this study are explained in the following figure:

3. **Results and Discussions**

The results of this study indicate that the post-conceptual understanding of students in the control class has an average is 35.6177 and the standard deviation is 19.59724. While the experimental class has an average is 71.8741 and the standard deviation is 17.39027. For learning motivation in the control, the class has an average is 1.096 and the standard deviation is 14.16. While in the experimental class has an average is 1.17 and the standard deviation is 12.07. This can be shown in the table 3:

| Treatment          | Mean    | Std. Deviation | N  |
|--------------------|---------|----------------|----|
| Control            | 35.6177 | 19.59724       | 31 |
| Conceptual_UnderstandingPost_Integers | 71.8741 | 17.39027       | 32 |
| Total              | 54.0337 | 25.90152       | 63 |

*Figure 3. Research Procedures*
To test the variance of each dependent variable is the same or not (Manova assumption), we need a Levene's test. Manova's assumption must have the same variant so that the analysis can continue. For the post variable conceptual understanding of integers, it turns out that it is not significant at 0.005 which means it has the same variance by the assumptions. Likewise, the post motivation variable for learning integers turned out to be insignificant at 0.05, which means having the same variance also by the assumptions. Both assumptions of the two dependent variable variants are the same so that the analysis can continue. The data is presented in the following table:

**Table 4.** Levene's Test of Equality of Error Variances

|                      | F   | df1 | df2 | Sig. |
|----------------------|-----|-----|-----|------|
| Conceptual_Understanding_Post_Integers | .981 | 1   | 61  | .326 |
| Learning_Motivation_Post_Integers       | .026 | 1   | 61  | .874 |

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + Treatment

To test the Manova assumption which requires that the variance/covariance matrix of the dependent variable is the same as using the Box's Test. It appears that the Box's M Test value is 1.153 with a significant probability of 0.774 so that the null hypothesis is accepted. It means covariance dependent variables are not the same across groups. The results of this test are by Manova's assumptions. The data is presented in the following table:

**Table 5.** Box's Test of Equality of Covariance Matrices

|                      | F   | df1 | df2     | Sig.   |
|----------------------|-----|-----|---------|--------|
| Box's M              | 1,153 |     |         |        |
| F                    |      |     |         | .371   |
| df1                  | 3    |     |         |        |
| df2                  | 693137,195 |     |         |        |
| Sig.                 | .774 |     |         |        |

Tests the null hypothesis that the observed covariance matrices of the dependent variables are equal across groups.

a. Design: Intercept + Treatment

Meanwhile, to test whether there are differences in the average post-conceptual understanding of integers and prior learning motivation for each treatment category, a multivariate test is used. Decisions were analyzed with Pillai Trace, Wilk Lambda, Hotelling Trace, Roy's and F tests. The results of all tests are significant at 0.05 so that it can be concluded that the two variables post-conceptual understanding of integers and previous learning motivation are different for each treatment category. The data is presented in the following table:

**Table 6.** Multivariate Tests

| Effect                | Value | F     | Hypothesis df | Error df | Sig. |
|-----------------------|-------|-------|---------------|----------|------|
| Intercept             | .987  | 2.335E3^a | 2.000        | 60.000   | .000 |
| Wilks' Lambda         | .013  | 2.335E3^a | 2.000        | 60.000   | .000 |
| Hotelling's Trace     | 77.817| 2.335E3^a | 2.000        | 60.000   | .000 |
| Roy's Largest Root    | 77.817| 2.335E3^a | 2.000        | 60.000   | .000 |
| Treatment             | .499  | 29.835^a | 2.000        | 60.000   | .000 |
| Wilks' Lambda         | .501  | 29.835^a | 2.000        | 60.000   | .000 |
While to show the relationship between support posts, understanding conceptual can be seen based on test results between-subject effects. The test results show the calculated F value of 60.422 with a significant 0.00. This means different opinions about conceptual understanding between categories of giving. Likewise with the relationship between learning and previous learning motivation gives an F value of 5.946 with a significance level of 0.018 which also defines what is meant by the previous learning motivation post between giving categories. Data presented in the following table:

**Table 7. Tests of Between-Subjects Effects**

| Source           | Dependent Variable                        | Type III                                      | Mean Square | F    | Sig.  |
|------------------|-------------------------------------------|-----------------------------------------------|-------------|------|-------|
| Corrected Model  | Conceptual_Understanding_Post_Integer      | 20698.486a                                   | 1           | 20698.486 | 60.422 | .000  |
|                  | Learning_Motivation_Post_Integer          | 1026.627b                                    | 1           | 1026.627 | 5.946  | .018  |
| Intercept        | Conceptual_Understanding_Post_Integer      | 181937.335                                   | 1           | 181937.335 | 531.099 | .000  |
|                  | Learning_Motivation_Post_Integer          | 813526.183                                   | 1           | 813526.183 | 4.712E3 | .000  |
| Treatment        | Conceptual_Understanding_Post_Integer      | 20698.486                                   | 1           | 20698.486 | 60.422  | .000  |
|                  | Learning_Motivation_Post_Integer          | 1026.627                                    | 1           | 1026.627 | 5.946  | .018  |
| Error            | Conceptual_Understanding_Post_Integer      | 20896.622                                   | 61          | 342.568 |       |       |
|                  | Learning_Motivation_Post_Integer          | 10532.230                                   | 61          | 172.660 |       |       |
| Total            | Conceptual_Understanding_Post_Integer      | 225532.139                                  | 63          |       |       |       |
|                  | Learning_Motivation_Post_Integer          | 826208.000                                  | 63          |       |       |       |
| Corrected Total  | Conceptual_Understanding_Post_Integer      | 41595.108                                   | 62          |       |       |       |
|                  | Learning_Motivation_Post_Integer          | 11558.857                                   | 62          |       |       |       |

- a. Exact statistic
- b. Design: Intercept + Treatment

Based on the information above, it can be concluded that there is an effect of a comic-based realistic mathematics approach on students’ learning motivation and conceptual understanding. Through the results of this study, it was concluded that several findings were also obtained from the study sample. In the implementation of learning the classroom, students in the experimental class are more responsible, more supportive to excel, prefer challenges, more independent, more patient and resilient than students in the class control. In other words, students learn the experimental class better than students in the control class. For this reason, one alternative to learning with a comic-based realistic approach.
mathematics approach is against student learning. This contradicts research conducted by Fiona Affeldt, Daniel Meinhart, dan Ingo Eilks where one of the conclusions of their result is related to positive research on comic-based experimental experiments. Besides finding related to learning motivation, it was also found that students were more easily obtained by conceptual mathematics in the presence of comics that were questioned by the daily problems given to students in the experimental class compared to students in the control class. This is supported by the result of research by Hosler, J. & Boomer, K. B. which states the potential for effective conceptual understanding by using comics in learning as well as research of Lestari, L. & Surya E. that supports realistic mathematics approach research more effectively increasing students conceptual understanding. Therefore, it is hoped that with previous studies discussing and supporting this research, the results of this research will be strengthened to be alternative in designing innovative learning to increase students’ learning motivation and conceptual understanding.

Through research that has been carried out and obtained research data that has been explained, it is found that there is an effect of realistic mathematical comics on student motivation and conceptual understanding. Based on the motivation questionnaire given to students, the data obtained that students' motivation in the experimental class was higher than in the control class. This has also been analyzed by statistical tests. Observed from the situation of students in the two classes, it is known that both in terms of responsibility, trying to excel, like challenges, independence in learning, fortitude and perseverance in solving problems superior in the experimental class, these are aspects of student motivation to learn. One example of aspects of trying to excel is seen students competing to convey what mathematical material is presented in the comic directly in their groups and trying to solve the problems given on the board.

This is in line with the research of Hosler, J. and Boomer, K. B. who found that learning using comics appeals to students and thus motivates learning [13]. It also affects the conceptual understanding of students. But the difference in this research comic is packaged by connecting mathematics with problems of everyday life with a realistic mathematical approach. Özkaya A and Yetim K revealed that with a realistic mathematical approach students easily understand conceptual mathematical problems that are associated with everyday life [7].

4. Conclusion

Based on the results and discussion, it can be concluded that there is an effect of learning with a comic-based realistic mathematics approach on students' learning motivation and conceptual understanding. This can be seen from the difference in the average student learning motivation and conceptual understanding where the average student learning motivation and conceptual understanding in the experimental class are better than students in the control class.

Acknowledgments

On this occasion, the authors would like to thank the Director of Research and Community Service of the Ministry of Research, Technology, and Higher Education who have supported and financed this research based on decree number 7/E/KPT/2019 and contract agreement number T/87/L1.31./PT.01.03/2019 so that the authors can carry out research and compile articles that are the results of the author’s research and publish it in this article.

References

[1] Te Tsai S 2018 Design of intelligent comic make system for educational application based on comic script creation *Eurasia J. Math. Sci. Technol. Educ.* 14 (3) pp 1023–1041
[2] Arini F D, Choiri A S, and Sunardi 2017 The Use of Comic As a Learning Aid To Improve Learning Interest of Slow Learner Student *Eur. J. Spec. Educ. Res.* 2 (1) pp. 71–78
[3] Affeldt F, Meinhart D and Eilks I 2018 The use of comics in experimental instructions in a non-formal chemistry learning context *Int. J. Educ. Math. Sci. Technol.* 6 (1) pp. 93–104
[4] Weber K C, Saldanha T C B, Dese K K, Santos P M M, Souza D D D and Arroio A 2013
Introducing Comics As an Alternative Scientific Narrative in Chemistry Teaching Bath Anadolu Eğitim Bilim. Derg. 8 pp 1–14

[5] Arsaythamby V and Zubainur C M 2014 How a Realistic Mathematics Educational Approach Affect Students’ Activities in Primary Schools? Procedia - Soc. Behav. Sci. 159 pp. 309–313

[6] Laurens T, Batlolona F A, Batlolona J R and Leasa M 2018 How does realistic mathematics education (RME) improve students’ mathematics cognitive achievement? Eurasia J. Math. Sci. Technol. Educ. 14 (2) pp. 569–578

[7] Özkaya A and Yetim K 2017 The effects of Realistic Mathematics Education on students’ achievements and attitudes in fifth grades mathematics courses Int. Online J. Educ. Teach 4 (2) pp. 185–197

[8] Tanton J 2014 Ability Grouping in Mathematics Classrooms Encycl. Math. Educ pp. 1–577

[9] Dickinson P and Hough S 2012 Using Realistic Mathematics Education in UK classrooms (United Kingdom)

[10] Arista F S and Kuswanto H 2018 Virtual physics laboratory application based on the android smartphone to improve learning independence and conceptual understanding Int. J. Instr. 11(1) pp. 1–16

[11] Winarto, Khiyarusoleh U, Ardiyansyah A, Wilujeng I and Sukardiyono 2018 Pocket book based on comic to improve conceptual understanding of Child Sex Abuse (CSA): A case study of elementary school Int. J. Instr. 11 (4) pp. 889–900

[12] Putri S K, Hasratuddin H, and Syahputra E 2019 Development of Learning Devices Based on Realistic Mathematics Education to Improve Students’ Spatial Ability and Motivation,” Int. Electron. J. Math. Educ. 14 (2) pp. 393–400