# INFLUENCE OF STUDENT WORKSHEETS BASED ON HISTORICAL COMICS TOWARD LEARNING OUTCOMES FOR INTRODUCING PYTHAGOREAN THEOREM

**Alfi Nur Hidayanti**

Mathematics Education, Faculty of Mathematics and Natural Science, Universitas Negeri Surabaya

email: alfihidayanti@mhs.unesa.ac.id

**Pradnyo Wijayanti**

Mathematics Education, Faculty of Mathematics and Natural Science, Universitas Negeri Surabaya

email: pradnyowijayanti@unesa.ac.id

**Abstract**

In a study found that the higher the interest and motivation of students towards learning, the higher the learning outcomes that can be achieved by students. In order students to be able to enjoy the learning process, a fun learning is needed to please students. Based on the results of student questionnaire responses, more than a few students like comic reading literature with various images and information presented in it. Some studies have developed comic into worksheet in order to gain students attention so then their learning out comes could be increased. The purpose of this study is to analyze whether the comics worksheet can affect to learning outcomes or not. This study will focused on analyze a comic worksheet based on mathematics history. The research used pretest-posttest method to collect data with paired t-test and N-Gain analysis techniques. The results showed an increase in student learning outcomes from an average of 54.1875 become 77.9688. From the results of the N-Gain calculation, the increase is included in the high category with a value of 1.0794. Thus, it can be concluded that the historical comic worksheet can improve student learning outcomes.

**Keywords**: Historical comic worksheet, learning outcomes.

## INTRODUCTION

Now days, mathematics teaching method has develops and leads into improving students' learning outcomes. Learning outcomes are the results obtained from learning activities both independently and in learning process (Ratumanan and Laurens, 2015). Learning outcomes can represent how far a learning goal is achieved. So then many efforts tried to be developed to improve students' learning outcomes. Some teachers also try to design the learning process as fun as possible so then students can enjoy and interest to the learning process. Aritonang (2008) states that the higher the interest and motivation of students towards learning, the higher the learning outcomes that can be achieved by students. Based on the results of student questionnaire responses, more than a few students like comic reading literature with various images and information presented in it. This result can drive chance to develop a learning which uses comics as media to gain students attention. In this decade there have been many studies that develop comics as learning media to deliver mathematics concept in various ways and titles. One of those studies is a study about developing a mathematics historical comic worksheet. Mathematics historical

comic worksheet is a guidance sheet used by students for completing an activity in an educational comic form with mathematical history storyline. In those study the comic was made into worksheet form with some histories inserted in it.

History has been used in learning process to attract interest and help students to understand the concepts taught. It corresponds with Ernst statement (in Reece, 2003), he believes that individual development (ontogeny) is a reflection of the history of its evolution (phylogeny). Thus if it is associated with mathematics and the history of mathematics, the development of mathematics in a person is in line with the development of the history of mathematics itself so that it will be easier to understand mathematical concepts if they are related to its origin (history).

Due to that statement, this study will focused on analyze the influence of student worksheets based on historical mathematics comics toward student learning outcomes for introducing Pythagorean theorem material. This study take Pythagorean theorem to be introduced because students still have difficulty in mastering the Pythagorean theorem

concept, especially in terms of finding one of the lengths of the triangular side if the length of the hypotenuse side is known (Guntoro, 2016). Therefore this study will analyze if there is an effect of students understanding in learning outcomes when historical comic worksheet is used in learning process.

## METHOD

This study use one group pretest-posttest method to collect data from subject. Due to Pythagorean Theorem as chosen material, the subject of this study are students grade VIII of junior high school which is studying Pythagorean Theorem. The pretest-posttest method that will be used is following these scheme.

$$ \boxed{O_1 \quad X \quad O_2} $$
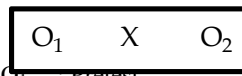
O₁  : Pretest

X  : Treatment

O₂  : Posttest

In those method, students are asked to do the pretest questions first and then carry out the activities contained in the mathematics historical comic worksheets given. After students done with the worksheet, then they are asked to do posttest questions. Then the collected pretest and posttest result are analyzed by using paired t-test and N-Gain analysis techniques. Before using paired t-test the data must satisfy two terms, they are normalization and homogeneous term. For normalization term, the data are tested by using Kolmogorov-Smirnov formula Wulandari (2010) as bellow.

$$ KS = |F_{n(Y_i-1)} \quad F_{0(Y_i)}| $$

KS = Calculated Kolmogorov-Smirnov value

$F_{n(Y_i-1)}$ = Cumulative percentage before i

$F_{0(Y_i)}$ = Data frequency of normal distribution at i

For homogeneous test, homogeneity testing done to find out uniformity of research data. In data regression analysis good research must have data distribution homogeneous. The test are following Levene test formula (Sugiyono, 2007) as bellow.

$$ L = \frac{(N \quad k)\sum ni(\bar{V} \quad \overline{vk})^2}{(k \quad 1)\sum(\overline{V_{I_J}} \quad \overline{V_l})^2} $$

$$ V_{ij} = |X_{ij} \quad \bar{X}| $$

L = Calculated Levene value

X = Data Residual value

$\bar{X}$ = Residual average

N = Sample amount

K = Group amount

If the data have satisfy normalization and homogeneity term, those data can be tested whether there is effect or not toward learning outcomes improvement by using paired t-test as follows (Surbakti, 2006).

$$ t = \frac{\overline{X_1} \quad \overline{X_2}}{\sqrt{\dfrac{S_1^2 + S_2^2}{n_1 + n_2}}} $$

$\overline{X_1}$ = Posttest average

$\overline{X_2}$ = Pretest average

$S_1^2$ = Posttest variance value

$S_2^2$ = Pretest variance value

$n$  = Sample amount

After t-test value is gained, then the counted t-test value is compared to table t value. If table t value > counted t value then accept H₀. If table t value < counted t value then reject H₀ and accept H₁.

Then to determine the increasing level of learning outcomes improvement, it uses N-Gain formula stated by Heeke (in Nani and Kusumah, 2015) as follows.

$$ (<g>) = \frac{\text{Posttest Score - Pretest Score}}{\text{Ideal Score - Posttest Score}} $$

The N-gain value is categorized based on this improvement value.

| | | |
|---|---|---|
| $(<g>) > 0.7$ | : | High |
| $0.3 < (<g>) \leq 0.7$ | : | Middle |
| $(<g>) \leq 0.3$ | : | Low |

## RESULT & DISCUSSION

This study analyze the influence of a worksheet based on historical mathematics comic in Pythagorean Theorem toward learning outcomes improvement. The worksheet used is titled as 'Wonder Math' comic. In those comic, Pythagorean Theorem used is a Pythagorean Theorem in Ancient China of Zhou Bi Suan Jing book.

The comic implemented to junior high school grade 8 to get the data that will be analyzed. The data that obtained can be shown as follows.

**Pretest**

Pretest is done to 32 students as subject. This pretest is given before students receive any worksheet of

Pythagorean Theorem. The pretest result can be shown in **Table 1** bellow.

Tabel 1. Pretest Scores

| No. | Nama | Pre-Test |
|---|---|---|
| 1 | MW | 33 |
| 2 | FZ | 58 |
| 3 | AAR | 80 |
| 4 | AS | 44 |
| 5 | ADP | 80 |
| 6 | SNA | 33 |
| 7 | FRA | 50 |
| 8 | EAS | 65 |
| 9 | AK | 48 |
| 10 | HRA | 33 |
| 11 | KWA | 60 |
| 12 | LKS | 54 |
| 13 | RNA | 50 |
| 14 | AB | 46 |
| 15 | MS | 40 |
| 16 | MB | 45 |
| 17 | HF | 65 |
| 18 | MFA | 45 |
| 19 | PEP | 68 |
| 20 | NVI | 50 |
| 21 | DA | 64 |
| 22 | NA | 54 |
| 23 | LI | 45 |
| 24 | HFS | 50 |
| 25 | FT | 85 |
| 26 | DKJ | 80 |
| 27 | MAF | 54 |
| 28 | RLA | 50 |
| 29 | AZL | 54 |
| 30 | MSD | 36 |
| 31 | SAZ | 60 |
| 32 | IAA | 55 |
| Average | | 54.1875 |
| Failed | | 28 |
| Passed | | 4 |

In those pretest score can be shown that there are only 4 students be able to meet the passing grade. Meanwhile there are 28 of students are failed to meet the passing grade score. It have been more than a half from total tested students. Therefore the class average score is under the passing grade which is only get 54.1875.

**Posttest**

Posttest is tested after students accepting and doing worksheet based on historical mathematics comic given. This posttest is done with the same subject as previous pretest. The posttest result can be shown in **Table 2** as follows.

Table 2. Posttest Score.

| No. | Nama | Post-Test |
|---|---|---|
| 1 | MW | 85 |
| 2 | FZ | 85 |
| 3 | AAR | 100 |
| 4 | AS | 60 |
| 5 | ADP | 100 |
| 6 | SNA | 80 |
| 7 | FRA | 75 |
| 8 | EAS | 83 |
| 9 | AK | 80 |
| 10 | HRA | 75 |
| 11 | KWA | 83 |
| 12 | LKS | 80 |
| 13 | RNA | 95 |
| 14 | AB | 75 |
| 15 | MS | 75 |
| 16 | MB | 45 |
| 17 | HF | 65 |
| 18 | MFA | 88 |
| 19 | PEP | 65 |
| 20 | NVI | 83 |
| 21 | DA | 75 |
| 22 | NA | 83 |
| 23 | LI | 55 |
| 24 | HFS | 75 |
| 25 | FT | 93 |
| 26 | DKJ | 100 |
| 27 | MAF | 78 |
| 28 | RLA | 76 |
| 29 | AZL | 78 |
| 30 | MSD | 75 |
| 31 | SAZ | 80 |
| 32 | IAA | 78 |
| Average | | 77.9688 |
| Failed | | 6 |
| Passed | | 26 |

Based on table above, the average of posttest are increasing from 54.1875 into 77.9688. Not only the average, but also the students who succeed to meet the passing grade are increasing into 26 students. Therefore the posttest score is greater than pretest score obtained. But those result have not been the final result, the data need to be tested to measure whether the improvement is significant or not. To test the significance of its improvement, the data are tested by using paired t-test.

Before using paired t-test, the data must be satisfy normality and homogeneity terms. The normality test is done by using Kolmogorov-Smirnov test with SPSS application. The following result of Kolmogorov-Smirnov test can be shown in **Table 3**.

Table 3. Result of Kolmogorov-Smirnov test.

**One-Sample Kolmogorov-Smirnov Test**

|  |  | Unstandardized Residual |
|---|---|---|
| N |  | 32 |
| Normal Parameters[a,b] | Mean | .0000000 |
|  | Std. Deviation | 8.85863086 |
| Most Extreme Differences | Absolute | .142 |
|  | Positive | .142 |
|  | Negative | -.124 |
| Test Statistic |  | .142 |
| Asymp. Sig. (2-tailed) |  | .100[c] |

a. Test distribution is Normal.

b. Calculated from data.

c. Lilliefors Significance Correction.

From the results of the normality test above, the tested data obtain a significance value of Asymp. Sig. (2-tailed) of 0.100 which is greater than the value of 0.05. So according to the basis of the decision making of Kolmogorov-Smirnov normality test, it can be concluded that the data is normally distributed so that the normality term can be met.

Furthermore, the data were tested for homogeneity using the Levene formula in SPSS to see the level of homogeneity of the data and as a condition for the t-test. The following are the homogeneity test results obtained.

Table 4. Result of Levene test.

**Test of Homogeneity of Variances**

posttest

| Levene Statistic | df1 | df2 | Sig. |
|---|---|---|---|
| .365 | 1 | 30 | .550 |

In the homogeneity test above the significance value of Sig. is 0.550, because $0.550 > 0.05$ then based on the basis of decision making of Levene homogeneity test, it can be concluded that the data is homogeneous so that the terms of homogeneity are met.

After both normal and homogeneous conditions are met, the data can be tested by paired t-test. The paired t-test will show whether there are any significant changes in the data before and after giving historical comic worksheets through student pretest and posttest score. There are two hypotheses that will be tested, they are:

$H_0$ : There is no significant difference between the results of the pretest and posttest.

$H_1$ : There are significant differences between the results of the pretest and posttest

Those two hypotheses were tested using SPSS to obtain the decision of the t-test. The following are the results of the paired t-test on SPSS.

Table 5. Paired t-test result.

**Paired Samples Test**

|  |  | Paired Differences | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
|  |  |  |  |  | 95% Confidence Interval of the Difference | | | | |
|  |  | Mean | Std. Deviation | Std. Error Mean | Lower | Upper | t | df | Sig. (2-tailed) |
| Pair 1 | pretest - posttest | -23.781 | 9.964 | 1.761 | -27.374 | -20.189 | -13.502 | 31 | .000 |

Based on the results of the paired t-test, the mean obtained is -23.781, this value represents the difference of average between pretest and posttest score. The average value is between -27.374 and -20.189 with a significance level of $\alpha = 5\%$ or 0.05. From the results above also obtained a t-test value of -13.502 with a degree of freedom (df) of 31. In the t-test test table with 31 degrees of freedom obtained table t test as 2.03951. The value of the calculated t-test in SPSS is negative because the pretest value is lower than the posttest value. In this context, the value of counted t test can be considered as positive so that the value of counted t test is 13.502. This value is more than the value in table t test. Because the value of counted t test greater than the value of table t test, then $H_0$ is rejected and $H_1$ is accepted. Thus, it can be concluded that there is a significant change in average.

Then by using the N-Gain test formula, we will find out how high the improvement of learning outcomes seen from the students pretest and posttest scores. The following is the N-Gain test result obtained.

$$\text{N-Gain } (<g>) = \frac{\text{Posttest Score} - \text{Pretest Score}}{\text{Ideal Score} - \text{Posttest Score}}$$

$$= \frac{77.9688 - 54.1875}{100 - 77.9688}$$

$$= \frac{23.7\ 8\ 13}{22.0312}$$

$$= 1.0794$$

From the results of N-Gain values above will be categorized based on N-Gain category. Then the data obtain high category based on the N-Gain category. Therefore, from the results of the pretest and posttest there was a relatively high improvement of learning outcomes after students received the worksheet based on historical mathematics comic. Then there is influence of learning outcomes when the worksheet based on historical mathematics comic is given.

**CLOSURE**

**Conclusion**

In summary, the worksheet based on historical mathematics comic gives influence to improve students learning outcomes. It can be proven by several test done before. In paired t-test found that there is significant improvement of learning outcomes. Then those significant improvement is tested to find out how high the improvement. From N-Gain value obtain that there was a relatively high improvement of learning outcomes after students received the worksheet based on historical mathematics comic.

**Suggestions**

Based on the conclusion above and the condition of the researcher during the field, the researcher gives this following suggestions:

1. For educator, the worksheet based on historical mathematics comic can be used as alternative and variation in teaching the Pythagorean theorem concept to students so that learning does not seem monotonous and more interesting. With students who are interested in learning, learning will be more meaningful and able to improve student learning outcomes.
2. For researchers who want to conduct research that is relevant to this study.
   a. It is better to prepare learning plan which is suitable with the worksheet form.
   b. Prepare the other support tools to facilitate student so then the learning process could done smoothly.

**REFERENCES**

Aritonang, Keke T. 2008. "Minat dan Motivasi dalam Meningkatkan Hasil Belajar Siswa." *Jurnal Pendidikan Penabur* (10): hal 45-51.

Guntoro, Syaiful Ali, Novisita Ratu dan Tri Nova Hasti Yunianta. 2016. "Konsepsi Siswa Tentang Teorema Pythagoras Kelas Viii Smp Negeri 10 Salatiga". Jurnal Prodi Pendidikan Matematika Universitas Kristen Satya Wacana, 1 (1): hal 1-41.

Nani, Karman La dan Yaya S Kusumah. 2015. "The Effectiveness Ofict-Assisted Project- Based Learning In Enhancing Students' Statistical Communication Ability." *International Journal of Education and Research Vol. 3* (8): 187-196.

Ratumanan, Tanwey Gerson dan Theresia Laurens. 2015. *Penilaian Hasil Belajar pada Tingkat Satuan Pendidikan Edisi 3*. Yogyakarta: Pensil Komunika.

Reece & Mitchel. 2003. *Biologi Jilid II*. Jakarta: Erlangga.

Sugiyono. 2007. Statistik Untuk Penelitian. Bandung: CV. Alfabeta.

Surbakti, A. 2006. *Pengaruh Metode Inkuiri Pada Pokok Bahasan Lingkaran dalam Matematika terhadap Prestasi Balajar Siswa Kelas II SMP HKBP Perdamean Medan Tahun Ajaran 2005/2006*. Medan: Universitas Medan.

Wulandari, A. 2010. Metode Penelitian, (*online*) http://www.Trinoval.web.id /2010/04/jenis-ujistatistik.html. [aceessed at 20th May 2019].