Comic Mathematics: A bridge to understanding the concept of social arithmetic for secondary school students

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Abstract. Several studies have concentrated on the development of mathematics comics that are used to help students understand mathematical ideas. There are still a handful, however, who create mathematics comics at the secondary school level on social arithmetical content. Therefore, this study aims to describe the development process in designing mathematics comics and to analyze their effectiveness in helping students understand the concept of social arithmetic. The process of developing mathematical comics in this study uses the Brog and Gall[1] stage by modifying it into 8 development stages, including (1) initial observation; (2) plans; (3) making products; (4) product validation test; (5) limited scale test ; (6) small size research revision; (7) field testing; (8) field performance review. In addition, the field test was carried out in one of the VIII Grade Secondary Schools in Indramayu Regency, Indonesia, for students. Based on the results of the analysis, the mathematics comic design that had been created was properly checked by media experts and mathematics teaching content design and students after observing the characteristics of the material. The feasibility test results achieved an average score of 3.61 for the very feasible category, while the feasibility test results tested by the students in the limited scale test obtained an average score of 4.65 for the very feasible category. In comparison, based on the field test, the mean score of the comprehension of social arithmetic content by secondary school students was 19.43 from the mean score of the successful criterion 15. Based on the effects of the parametric statistical test, t_{obs} = 14.89 and t_{k} = 1.94 were obtained. It can also be concluded that the use of comics focused on mathematics learning is successful in helping to teach concepts of social arithmetic.

1. Introduction

Mathematics Subject Guidelines (PMP) Curriculum 2013, Indonesia [2], stipulates that the aims of mathematics learning are to help students to: (1) understand mathematical concepts; (2) use the pattern as a guess to solve the problem; (3) use reasoning on characteristics; (4) express ideas; (5) appreciate the utility of mathematics in life; (6) have attitudes and be attitudes students are expected to possess all the abilities that have been described above. (7) perform motor tasks using mathematical knowledge; (8) perform mathematical activities using simple teaching aids and technical outcomes. Students are supposed to acquire all the skills that have been listed above. However, without the assistance of all learning materials, including pupils, instructors, textbooks, instructional strategies, teaching aids, instructional media, current buildings, and school resources, as well as learning tests and others, this would not be recognized.

Based on the results of preliminary observations made on students in Indramayu, Indonesia, at class VII secondary school, it was observed that many students felt that mathematics was complex and...
difficult to learn. If they already understand the basic principles, especially if they understand and memorize the material formulas, some consider mathematics simple, students often think that mathematics is like a game since there are several puzzles and problems that need to be solved. Some of them also recognize that mathematics is very important and needs to be incorporated in daily life, but what students know is that mathematics just counts plus ambiguous teacher execution, leading students to struggle to grasp the instructional content. Although some learners prefer mathematics because the content is called very rational. Most students face difficulty in studying mathematics in learning mathematics because the learning process is considered complex and the content is often difficult to comprehend so that it makes students dissatisfied with learning mathematics and that it is important to explain certain mathematical formulas.

There are several ways this question can be resolved. Usage of the new technology-based media [3], [4] or supported comic media [5], for example. Several research, such as [6] designing mathematics comic media, have built mathematics comics to help teach linear equations and linear inequalities of one component. The findings of his study concluded that the use of comic media to teach the substance of linear equations and linear inequalities of one variable is valid and practical. In addition, his research [7] concluded that studying mathematics facilitated by e-comic media focused on flip books would strengthen the critical thinking abilities of junior high school students. Furthermore, the findings of his research [8] concluded that learning using comic media in mathematics could enhance the mathematical literacy skills of high school students.

Although the use of mathematics comics as media has been widely used, scholars to help teach social arithmetic concepts have not yet used mathematics comics. This study therefore offers another means, namely by generating social arithmetic content for mathematics comics. Certain innovations are not used for the mathematics comics built in this report. But by actually writing on paper. In addition, the narratives in the mathematics comics produced in this analysis are based on the student's everyday background. So that students know the storyline better, as well as the flow of the topics being taught.

2. Methodology
The method of developing this study uses the stages of developing the Borg and Gall[1] model by modifying it into eight stages. Preliminary findings were made in the first stage; the researcher carried out the process of defining issues and needs derived from data collection using observations and questionnaires at the initial observation stage. At this stage, the researcher carried out (a) formulating indicators and learning goals in the second stage, formulating a manufacturing plan; (b) evaluating the characteristics of the products that can be used for media production; (c) the collection of resources to determine the content guidebook and instruction to be used, the plot design, the characterization of comic book characters, modes of language and dialogue, story points, and environments. The researchers carried out the product production process in the third stage; at this point, the researcher conducts the process of creating an initial drawing, stabilizing the drawing, and printing the product to be first tested by an expert. The product validation test was then carried out in the fourth stage; at this stage, the validator makes an evaluation of the product produced, which is provided in the questionnaire on media viability. In addition, there are four components of measurement at this point to assess the viability of learning material, including presence, composition, material, and language. The investigator proceeded to the fifth phase, namely the small scale evaluation, after obtaining input from the validator. The substance produced will be tested on five grade VIII learners on a small scale evaluation. This phase attempts to gain input on the use of facets of architecture and function. In addition, the researchers updated it for use on a field test scale in the sixth step. A field test was performed in the seventh level. In this phase, the researchers performed treatment for secondary school students in class VII on social arithmetic content. At this point, since it coincides with the COVID-19 pandemic, with the aid of the Google classroom, the field test process is performed online (on the network). The eighth method, namely the study of the efficacy of the use of comic media in
mathematics, was carried out after the field test. The efficacy test used a one-sample t-test in this study.

3. Result and Discussion

Analysis Result
1. The process of initial observation
In the observation process, data was gathered that the instructor was still teaching using traditional approaches so far, including seminars, in assignment groups, and then collected and based exclusively on the instructor. In the learning process, this results in students becoming slow and quickly bored. Also, knowledge was gathered on the basis of preliminary findings that many students felt mathematics was difficult and difficult to learn. If they already understand the basic concepts, some consider mathematics simple, especially if they understand and memorize the material formulas. Some students often assume that mathematics is like a game, since there are many problems that need to be solved. Some of them still realize that mathematics is really important and requires its use in daily life, but what students realize is that mathematics just counts plus ambiguous teacher transmission that leads students to struggle to understand the material being taught. However, since it is considered a very rational stuff, some students like mathematics.

2. The process of preparation
The investigator made a proposal after doing the initial observation level. There are several processes carried out at this level, including (1) planning of scenarios for learning implementation; (2) model review involves the specifications for the equipment that can be used to operate the media to be used. (3) Look for book sources that can be used to help the development of mathematics comics; (4) explore the plot and characters that will be generated in the mathematics comic.

3. Material development process
In the course of creating a mathematics comic, this period is the period. At this point, there are many processes conducted. The first approach is to make an original drawing of two sections, including: (1) making a template for each character's characteristic faces and clothes; (2) designing a comic layout design by changing each scene's paper scale, voice, character speech, background, and separator (frame). The second approach is the modeling procedure that the researcher creates for black and white findings manually. Making at this point first utilizes coloring with a pencil. (1) comic covers; (2) prologue; (3) comic content; (4) epilogue. The composition found in the comics. The method of stabilizing the drawing until it is finished. After the original sketch outline is judged by the researcher's standards, everything is finished. At this point, using markers and drawing pens, the comic, which originally used a pencil, is then changed.

![Figure 1. Initial Sketch and Sketch Stabilization](image-url)

4. Expert validation test stage
It was carried out by 6 expert experts at this stage, including 4 lecturers and 2 students. The purpose of the expert validation is to evaluate the quality of the generated social arithmetic comic media and obtain from each element a decent product, such as presentation, writing, material, and language. Revisions are then made according to the feedback and guidance from the test results and on the evaluation process of the mathematics comics that have been made. The researcher made changes to the usage of terms that were not polite with smoother terms from some of these ideas and provided numbers to the dialogue to make it easier for students to read the created comics.

5. Limited scale test phase
During the COVID-19 pandemic, the small-scale test phase was performed at this point. Therefore, at this point, implementation is not at school, but conducted directly (face-to-face) at the home of one of the students and still obeying government regulations, including using masks and holding a distance. The comic was tried on 5 grade VIII pupils. The real mean score was achieved based on the appraisal = 4.65 > 4.6, which means that the consistency of the comic’s eligibility follows the five (very feasible) requirements.

6. Revision stage of product
The point in the implementation of the revision process from the outcomes of small-scale trials is at this point. The findings of the examination of five grade VIII students indicated that it was very practical to use the social arithmetic comic medium and there were no comments / suggestions for change. Thus, at the next stage, namely field testing, the media of mathematics comics on the subject of social arithmetic material is declared ready for use.

7. Step of Field Test
The process is conducted using online learning in the field test phase. During the online learning process, there are different kinds of tools, programs, and learning methods used by students, one of which is the use of Google Classroom. Only nine students out of 30 students in one class can follow the class that the researcher created in the classroom. This reveals that in studying, students feel laziness and a lack of confidence and inspiration. Any students do not have Android-based mobile phones. Then, for the first time during online study, the use of Google Classroom was also introduced, but some students find it challenging to understand. As a result, researchers can only collect the results of 7 students, namely 5 Google Classroom students and 2 other students through personal chat on the Whatsapp application, even when collecting assignments via Google Classroom, there are obstacles.
8. Analysis process of field experiments

The process performed in the field research study stage was to evaluate the feasibility of using comic-assisted learning in mathematics. The one-sample t-test is used to assess the efficiency of learning aided mathematics comics. Based on the outcome of the estimation, the normal distribution of data was collected. A one-sample t-test was subsequently performed.

| N | \( \mu_0 \) | \( \mu_k \) | \( t_{obs} \) | \( t_k \) |
|---|---|---|---|---|
| 7 | 19.43 | 15 | 14.89 | 1.94 |

It indicates the mean score of social arithmetic comprehension = 19.43 with the successful criterion, namely 15, based on the data in table 4. \( t_{obs} = 14.89 \) and \( t_k = 1.94 \) were obtained. Since \( t_{obs} > t_k \) then avoids \( H_0 \), which means that the learning medium is used successfully in learning for mathematics comics on the question of social arithmetic.

Discussion

Based on the outcomes of the mathematics comic media creation process, it was found that comic media in mathematics could help students understand arithmetic concepts. This can be understood because the learning media can provide more empirical data, especially in mathematics research, for the optimization of learning [9]. Comics are one of the means of contact used. Not only does literature fans or only entertainment today love comics, but comics can also be used as a learning medium. Comic refers to a medium in which ideas are communicated (which may be actual or imaginative, and maybe humorous) with graphic images or collection of images, typically consisting of cartoons-visual arts intended to generate comedy when communicating valuable messages [10]. According to [11], comics can only be used as a learning tool if they are built in conjunction with the content to be provided.

In comparison, this study is also in line with his research [12], which notes that mathematics comics have been shown to help boost the comprehension of the notion of multiplication and division of whole numbers by students, so it is best to provide and full support facilities for instructional and enjoyable learning media such as comics. Tuition. Schooling. In the meantime, the growth of learning media for mathematics comics will help high school students learn algebra, according to [13]. [14] With an ethnomathematics approach, the production of comic math will help teach cubes and bricks.

4. Conclusion

Based on the research results, the mathematics comic media are properly tested by media experts and mathematics teaching material design and students after evaluating the characteristics of the material, the mathematics comic design that has been created. Based on the outcome of the media feasibility
evaluation measured by specialist researchers, the overall average score for the four feasibility aspects is 3.61 for the feasibility group, while the media feasibility measured by the students received an overall average score of 4.65 for all feasibility aspects of very high feasibility categories. In learning, mathematics comics on the subject of social arithmetic are often used successfully. Researchers are aware of this study's many limits and limitations. This offers an incentive for additional researchers to use other tools to create comic book culture. In addition, other researchers may also produce more fun animation designs or produce more fun comics or use such tools as well.

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