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Captivating elementary school students' interests in solving mathematics word problems with the use of comics

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Abstract. This study explores the use of comics in teaching elementary school students on solving Mathematics Word Problems. A total of 12 Year 2 students from an elementary school in Brunei Darussalam were chosen to participate in the study. A series of comics were created and some exercises included characters that were adapted from a local popular culture for utilization in teaching the students in order to engage their learning. The method chosen to conduct the research is of mix method adapted through usage of the action research model. A pre-test was conducted before the lesson intervention to assess the students' prior knowledge of the content on the terms used in mathematics word problems. Subsequently a post-test was administered right after the intervention lessons were completed in order to discern if there were any significant improvements. Based on a classroom observation that was video recorded when the intervention was carried out, the children were highly motivated and very much interested in the content of the comics. Furthermore, the findings from the interviews revealed two major themes, which are 'Enjoyment' that detailed the students enjoying and had fun with the usage of the comics in the classroom, whereas 'Interest' tied in with the students' enjoyment that resulted from their interest in the comic books. It is recommended that educators use comics in classroom due to its potential, especially in mathematics, where certain concepts can be quite challenging for some students to grasp.

Keywords: Elementary Mathematics; Action Research; Comics; Word Problems.

1. Introduction

There is a strong emphasis for The National Education System of the 21st Century (or SPN21: *Sistem Pendidikan Negara Abad ke-21*) on the nation's numeracy and literacy standards in Brunei Darussalam. In 2017, the Literacy and Numeracy Coaching program framework came about to reach the ministry's efforts towards achieving an increase in the number of well-educated and highly-skilled generation towards achieving the highest international standard. In Brunei, there exists an integration of studies that are especially linked to language and ICT. For instance, in the Mathematics curriculum, there is a connection between language and mathematics, particularly in areas where it is required for students to solve problems [1-4].

As in most countries, problem solving plays a huge role in the Mathematics syllabus because it promotes development in a deeper understanding of a concept as well as the thinking skills of students [5]. Problem solving revolves around a mathematical thought process that can be used to solve daily life problems. It often requires an implementation of a mathematical technique, a particular concept or



process in finding a solution pertaining to a problem. This entails students to be able to use the fundamental concept of mathematics to help them solve real-life problems [6-9].

However, a previous study [10] indicated that students in Brunei do not apply any mathematical thinking as they have no interest in mathematics and they have difficulty in understanding the concept. A majority of students prefer practicing memorization without any understanding and are lacking in the ability to have deeper thinking. Due to this, students tend to not have a grasp of understanding the concept of problem solving.

There have been many techniques and interventions that have been introduced to help students with solving word problems. This includes using the keywords approach to solving a problem [11, 12], using thinking aloud pair strategies [13, 14] and graphic organizer based on the Pólya problem solving model [15, 16] and also by drawing a bar model where it helps in representing the whole concept as well as the parts to students [17, 18]. Nevertheless, a different method of intervention was chosen in order to help the students' understand the mathematical concept of problem solving. By introducing the use of comics in the classroom, there is the potential in utilizing the visual representation as a form of teaching aid that could capture the interest of the students easily [19].

To help measure the main objective in investigating the effects of using comics to aid lower elementary school students to solve word problems in mathematics, this present study aims to focus on the perception of the students as well as the effectiveness of using comics to solve words problems in mathematics.

2. Methodology

The method chosen to carry out this research exercise is a mixed method that comprised of tools such as the pre-test and post-test, interviews and classroom observations. In order to carry out the chosen methods, an action research has been adapted as the research design for this study. This study has adapted the extended action research model by Kolb [20], the model helps with practitioners learn and create knowledge through critical reflection based on their own actions and experience they have faced, practitioners can gather their own knowledge perception and create an understanding of a situation they have faced previously and applying it to the research, therefore, improving their practice, as well as advancing their knowledge in the field. Hence, the decision to adapt the action research cycle as the main goal of this research is to investigate the effects of using comics to help elementary school students in solving lower elementary syllabus on word problems.

2.1 Planning stage

The lesson plans for each cycle was created by the first author during the planning stage. The comics were also generated and they are modeled in a way that the character resembles as the students themselves in order to have some associative link and relation between the learner's and the characters in the comics. Additionally, some classroom exercises were also prepared. The first author also purposely made some of the exercises into characters that were widely popular among the students at that time. The purpose for the exercises to be created in such way is so that the student would feel excited and more engage between the classes.

A set of pre- and post-test papers were also prepared in order to carry out the effectiveness on the usage of comics in learning Year 2 Mathematics Word Problems. The pre- and post-test questions are divided into two sections. Section A consisted of questions where the students would have to read the passage and identify what operations needs to be done by writing down the symbols for the following operation. Meanwhile, Section B focused on the students having to solve said value, the question paper for both the pre- and post-tests are the same, and the only difference between the two is the subject or object represented in the questions.

2.2 Action and observing stage

Throughout the cycles, all the sessions were recorded in which the intervention is being carried out. This method of classroom observation was chosen in particular due to the fact that the recorded videos can

be watched and analyzed in order to interpret the behavior of the student's while measuring out their engagement. Towards the end of the intervention, and right after handing out the post-test questions, the student whose parents have consented in allowing their child to be interviewed would have an individual session with the first author, all of the conversations between two parties are recorded and, are later analyzed and transcribed. The analysis based on the interview helped with identifying the effects and perceptions of the students in using comics in teaching elementary school mathematics. The interviews from the teacher and student were then loosely transcribed, and the students were given pseudonyms, in order to protect their identity.

2.3 Reflective Stage

The whole purpose of this stage is that it gives space to do self-reflection and questioning to allow any changes that can be made on the teaching strategy set during the planning stage. Hence, from this stage, the reflection plan for the next cycle can be improved before moving on to the next cycle.

3. Result and discussion

3.1 Student's perception on the use of comics

The interview process requires the first author to record the student whose parents have agreed to partake in the interview session. However, in the midst of analyzing the interview recording, two more of the students' parents made contact and declined any involvement in the interviewing process. Thus only leaving 9 out of 12 student whose parents have agreed to let their child to partake in the interview session. Let it be known that the following respondents are given pseudonyms. Based on the data recorded from the participants, the interviews were transcribed before breaking it down to themes found during the analyses of the transcription. Table 1 showcases the themes and sub-themes that have been uncovered during the analyzing process.

Table 1. Themes and sub-themes collected from interview data.

Themes	Definition	Sub-Themes
Enjoyment (88.9%)	Enjoy the usage of comics in class	<ul style="list-style-type: none"> • They enjoy the comics • They had fun
Interest (38.9%)	Nature of the comics	<ul style="list-style-type: none"> • They like reading comic books • They like the pictures that are in comic books • They like the characters used in the comics

There are a few sub-themes that have helped create and mould the major themes mentioned in Table 1. The top theme of Enjoyment, which refers to the students' response that they have enjoyed the usage of comic books in class, consists of the sub-themes of enjoying the use of comics and having fun with them. Additionally, the students chosen for this study have not experienced any form of intervention in their study in which comics were involved. Whereas the other major theme is Interest, in which is defined as the student's liking comics books, where the sub-themes include i) they like reading comic books, ii) they like the pictures in comic books and iii) they like the characters used in the comics. From the interview data, majority of the responses based on the two questions in the interviews, often overlapped with each other, in which the major theme is Enjoyment (88.9%). It details that students enjoy and had fun with the usage of the comics in the classroom, whereas Interest (38.9%) ties in with the students' enjoyment that resulted from their interest in the comic books.

The data gathered concluded that all of the respondents from the interview had enjoyed or loved having learnt with the use of comics due to the fun nature of comics (55.5%) or their overall love of reading (22.2%). The following interview excerpt showed an example of a student's verbal response to the interview questions: "It is fun and I enjoy reading it. And reading the comics makes me understand better on how I can solve the problems (word problems)" [*Respondent 2*].

The nature of the comic books makes it more enjoyable and fun, as evidenced by the students' responses. Ahmed et al. [21] stated that helpful teaching aids, such as the comics used, improves the quality and acts as a guide for students to help them understand better the mathematical concept. Additionally, the comics here serves a purpose as a medium for the students understanding, as Hobbs and Moore [22] states that comics help bridge students from understanding simple concepts and can better adapt to a more complex concept.

There was 3 out of 12 of the student population who enjoyed the comics due to the usage of known comic book characters that the students could identify with. There was noticeable contrast of behavior between the sessions where the students were shown the comics first hand, in comparison to their more excitable behavior during the activity session where characters that were popular to children were included. This is so that the children would feel motivated to do their work, as it makes solving problems more fun for them in class. The following response showed a student's interest in the characters that were used in the comic exercises: "I enjoy it. I like the Spider-man part (referring to the Ant-man character used in one of their exercises), I like Spider-man" [*Respondent 4*].

Dyson [23] found that children are more motivated to read and write when popular culture, in which the children are familiar with, was included in school assignments. There were 5 out of 9 responses where the students liking the comics due to its readability and the nature of the comics having pictures in them. The students were more engaged with the presence of the bright colorful pictures that are present in comics, and would rather read the comics as opposed to having to read standard lines and questions that are in word problems. The following response is from a student who enjoy looking at informative texts in a form of comics: "I had fun! I like comics because it has pictures on them. I like it (when there's pictures). I like the cats (referring to a section of the comics involving cats)" [*Respondent 7*].

The students were highly engaged in class during the session in which the comics were used as a teaching intervention, and this coincides with Wright and Sherman's [24] report that children are attracted to comics and they tend to spend their time more in reading comics, thus increasing the level of engagement. The introduction of comics in classroom makes learning mathematics more of an enjoyable experience [25].

The usage of comics had also helped the students with learning disabilities, four out of the 12 students from the sample have difficulty in reading, and with one of these students having special needs. Due to the nature of the comics, it had helped these students greatly by providing the information in a way that can also be conveyed through a series of images in order for them to understand the concept. The following is a response from a student who requires special needs in education: "I like it. I want comics; there are pictures in comics. But I want Batman" [*Respondent 9*].

Comics can be a promising pedagogy as it helps further enhance student learning in mathematics [26]. According to their study, the usage of comics in classroom helps the students with learning disabilities in giving them an opportunity to be a self-directed learner that can withstand any assignments handed to them in school.

3.2 The effectiveness of using comics in learning word problems

To measure the effectiveness of using comics in learning mathematics word problems, pre-test and post-test papers were prepared to check for comparison. Additionally, a classroom observation was also conducted to help measure out the effectiveness. During the data collection of the pre- and post-test scores, all of the students' parents have consented for their child to participate in taking the tests and to have their scores revealed in this research. They were also informed that the names of all the children would be given pseudonyms to protect their child's identity. Table 2 contains the results from the pre-test and post-test question papers. It shows the overall results from both papers, with the total full score of each paper equating to 14.

Table 2. Student's total scores for both pre-test and post-test.

Student ID	Pre-Test Scores	Post-Test Scores
F1	11	12
F2	8	6
M1	10	11
M2	9	7
F3	11	5
M3	3	3
F4	7	7
F5	6	7
M4	7	8
M5	5	8
M6	2	4
M7	2	5

Before comparing the data gathered from the pre-test and post-test results, a normality test was needed be conducted beforehand to determine the usage of parametric or non-parametric test to calculate the difference on the scores from the overall results of the pre-test and post-test. The procedure is then followed by calculating the effect sizes as it allows comparison between the magnitudes of experimental treatments from one to another.

To check for normality, the total scores for each student on both papers are compared. An assumption was made that the null hypothesis should be accepted where the results will determine the signification ($P > 0.05$) that points out to normality, hence data should be approximately distributed. Due to the smaller sample size pertaining of 12 students, a Shapiro-Wilk test was chosen to find the significant value (P-value) for each test. The results gathered from the data show that the significant value for each test, pre-test (0.591) and post-test at (0.548), determines that each test point out to be normally distributed. Hence, the assumption for normality is accepted.

As a result of normally distributed data, a parametric paired samples test was done to compare the means for both pre-test and post-test in order to evaluate the effectiveness of using comics in the classroom.

Table 3. Results from paired samples test.

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	prt- pst	-1.167	1.240	.358	-2.205	-.629	-3.957	11	.002

At the same time, the effect size needs to be calculated. The assumptions were made that the two-alternative hypothesis should be accepted when the mean differences does not equal to 0. The results showed that there was a significance between the pre-test ($M=6.5$, $SD = 3.03$) and post-test ($M=7.92$, $SD=2.968$; $t(11)=3.957$, $p=0.002$, two tailed). The magnitude in differences in the means (means differences = -1.167, 95%CI: -2.205 to -.629) and was indicated as large effect size (eta squared = .61).

$$eta = \frac{t^2}{t^2 + (N - 1)}$$

$$\begin{aligned}
 \eta &= \frac{(3.957)^2}{(3.957)^2 + (11 - 1)} \\
 \eta &= \frac{15.658}{15.658 + 10} \\
 \eta &= \frac{15.658}{25.658} \\
 \eta &= 0.610
 \end{aligned}$$

Upon collecting the pre-test data, there were few students from the sample who were having difficulties in reading and required further guidance.

3.2.1 Results from the classroom observations

The effectiveness of using the comics in teaching Year 2 Mathematics can also be measured based on the findings from the classroom observations. The students' behavior was measured using the checklist source form International Centre for Leadership [27]. Apart from the technical issues that surfaced during the first session, as there were some disruptions with the wiring between the interactive whiteboard and the display, the students were paying maximum attention in the classroom and there were minimum occurrences of out-of topic discussions amongst themselves. It was observed that there were some slight behavior changes in between the first and second sections of the session. For instance, the first section involved candies, in which an assumption made that the students would feel excited and could relate to the idea of candies. However, the reactions coming from them were lackluster where excitement was expected and in turn, received a mundane reaction to an everyday object.

In contrast to the second section, which involves having a pet cat, the reactions were much more excitable as each student start to clamber over each other to relate their experiences with their pets at home. This is where the students were observed to have a tendency to connect more with their experiences at home more than they do at the aspect of going out to buy some candies.

This was also prevalent during the activity section where the students are required to do a number of exercises that involves solving a mathematical word problem, with the use of comic book illustrations from popular cartoon characters. In one question, the characters that they were introduced to was a copyright image recreated into a comic book from Disney's Cars, a famous Pixar film that involves a talking animated car that displays personifications of a human being, in terms of its emotions and personalities. However, the students did not feel as much excitement as was expected. As opposed to the next question, where the characters were from a completely different franchise. This time, the first author had created questions based on the characters from the American toy company Hasbro's My Little Pony. The students were showing higher levels of excitement in terms of the excitement especially the girls.

From these findings, it can be concluded that educators should be up-to-date with the current trends with the students to delve in more on the students' engagement in class, seeing that the students are more comfortable and excitable when they get to meet familiar characters. Dyson [23] concluded that curriculum should reflect the cultural texts that are familiar to the students. His study also identified that the texts that are most familiar to the children are multimodal texts that relate to media [28].

Based on the checklists adapted from International Centre for Leadership in Education [27], it was concluded that the overall engagement of the students in the class is between neutral and high. The observation for the first session detects high levels of positive body language; the students do exhibit body postures that indicate their attentiveness to the teacher and the lesson. The students, however, have very low levels in the consistency of their focus, as there were technical disruptions in the lesson. There was an active participation amongst the students and they were all eager to come forward to the board to answer the questions given.

In terms of the students' verbal participation, they were eager to partake in giving out their answers and opinions during the session, so much so that they would often talk over each other. When a student is chosen to come forward to write their answers on the interactive board, they were able to reflect on

their answers, and explain why they answer as such. The students also exhibit high levels of fun and excitement as they exhibit interest and enthusiasm, and also exude positive humor.

The gap between the first and second cycles was a two-day gap, in which within those two days they resumed to having normal lessons with their respective mathematics teacher.

In Cycle 2, the class was more progressive, as the technical issue revolving around the usage of the interactive whiteboard had been resolved, and the lesson was able to carry on as smoothly without any disruption. The lesson began with the students being able to recall terms they learned from the previous session.

In comparison to the first cycle, the student's behavior in regards to the first section were noted where the question involves dealing with buying candy. However, for Cycle 2, to illustrate the concept of subtraction, the first author made the comic book character eat the candies, and the students would have to find out how many candies did the character have left. In this case, the students were more active in participating as they had provided their answers followed by exclamations of what their favorite candies were.

Between the two events of both cycles, Cycle 1 with the cats and Cycle 2 with the consumption of candies, children tend to relate to their experiences. This further heightens the student's interest in the classroom, as they realized that there are relations between the problems presented in mathematical word problems with real world problems.

Based on the observations for the first cycle, where the students were excited when familiar cartoon characters were introduced, the first author took the advantage and asked the students favorite cartoon characters, and the responses were various. With that in mind, two of the most popular cartoon characters that the students have suggested, were chosen. Majority wanted a Marvel character known as Ant-man, and the second option was a cartoon character from Cartoon Network, Steven Universe. These two characters were used towards the end where students were asked to complete a mini exercise. This motivates them further to complete the task as they feel as though they are playing a game. According to Vera [29], when educators associate the learning environment of the students with various popular cultures that the children could relate to, it allows the students to be more engaged in completing a task in class.

Just as Cycle 1, a checklist to measure the student's level of engagement in class was used. Based on the checklist above, it can be concluded that the overall level of the students' engagement was high. The students do exhibit positive body language and they showed consistent focus throughout the session, including during the mini exercise session. With little to no disruption, their out-of-topic discussions between each other were kept to a minimal as the students were too occupied expressing their excitement over the cartoon characters used and were very keen to do their classwork. As for active participation, there were some instances where some of the students felt too shy to express themselves in class in comparison to a number of them who were quite eager to participate in the discussion. This could be due to peer pressure, as the actively participating students in class might have dominated the discussion and in doing so, have managed to intimidate the more timid students, which could also deter their confidence in class when it comes to having discussions.

Similarly in Cycle 1, the analysis from the observation shows that the students were exhibiting high levels of enthusiasm and interest in class. This was even more prevalent during the mini exercise session, where the first author had decided to include the students' recommendations of their favorite cartoon characters, such as Ant-man and Steven Universe, and by the end of the lesson, the whole class had completed their given assignments.

4. Conclusions

The perceptions of the Year 2 students on using comics in class can be classified to two major themes, enjoyment and interest. Based on the data collected from the interview, the participants of the study have enjoyed using comics to learn in mathematics class. The results from the pre-test and post-test

proved to be significant in the students' improvements as they are able to recall certain terms and were able to apply the correct operations.

Using comics raises great potentiality in the classroom. It exudes high levels of engagement and the students enjoy the lessons. Freeman et al. [30] states that when students are active and are highly engaged in classes, they tend to lead to a better and long term learning outcome. As graphic novels are already popular outside of school, comics have the ability to support instructions in elementary mathematics and potentially other subjects, such as Science [31].

Furthermore, introducing cartoon characters in an elementary class makes perfect sense as it makes the learning process more fun. Children who have learning disabilities could also benefit from using comics in class, and the students would not feel as though they are doing academic reading, but rather recreational reading. This could also be beneficial for students with learning disabilities as comics are a form of visual element that aids these students to comprehending the texts.

The familiarity of popular cartoon characters also helped out a lot, in terms of student engagement, as children would feel a connection and familiarity with the comic characters used due to their exposure before going to school. The use of comics in teaching mathematics, especially when involving familiar cartoon characters that the children can relate to, unlocks a potentiality in keeping the students engaged and interested, as resulted from the effectiveness on the use of comics.

It is recommended that educators use comics in classroom due to its potential, especially in mathematics, where certain concepts are quite hard for students to grasp. It is also recommended for future studies to use technology as it can help convey information to showcase a visual representation of understanding concept. However, it is important to keep in mind that there can be some issues, in terms of power failure or incompatible with various devices. It is also recommended that the comics that are to be implemented should contain ample amount of print that makes it interesting for students. This could mean incorporating a brighter color scheme or include characters that children are familiar with to make the learning experience more fun and engaging.

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