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Source	*Asia Pacific Journal of Education, 37*(4), 437-452
Published by	Taylor & Francis (Routledge)

Citation: Toh, T. L., Cheng, L. P., Ho, S. Y., Jiang, H., & Lim, K. M. (2017). Use of comics to enhance students' learning for the development of the 21st century competencies in the mathematics classroom. *Asia Pacific Journal of Education, 37*(4), 437-452. http://dx.doi.org/10.1080/02188791.2017.1339344

Use of Comics to Enhance Students' Learning for the Development of the 21st Century Competencies in the Mathematics Classroom

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Abstract

This paper discusses the use of comics in teaching mathematics in the secondary mathematics classroom. We explicate how the use of comics in teaching mathematics can prepare students for the twenty-first century competencies. We developed an alternative teaching package using comics for two lower secondary mathematics topics. This alternative teaching package consists of (i) several sets of comic strips expounding all related mathematical concepts in a lively way; (ii) tiered practice questions for learning reinforcement; and (iii) a set of proposed lesson outlines with suggestions on how to use the comics for mathematics teaching. We also report how one of the teachers in our study used this teaching package in her mathematics lessons. Her lessons were video-recorded and eleven students were interviewed to help us understand how the mathematics comics lessons were enacted and the students' perception of comics as instruction. We identified instances in which the teacher tweaked the provided resource to further enhance student learning and incorporated elements of the twenty-first century competencies during her lessons. Through selected student interviews, we also identified instances in which students commented on their gain from the new approach from the perspective of the twenty-first century competencies.

Introduction

Students have to be prepared to face the challenges of the future, which is driven by the key forces of globalization, changing demographics and technological advancements (Ministry of Education, 2015). Although it is impossible to predict exactly the skills that would be needed in the future, the Singapore 21st century competencies (hereafter, we shall abbreviate it as 21cc) framework identifies (1) Critical and Inventive Thinking, (2) Civic Literacy, Global Awareness and Cross-cultural skills, and (3) Communication, Collaboration and Information Skills as the key skill set to prepare Singapore students for the future. The 21cc framework aims to develop an individual into a confident person, self-directed learner, concerned citizen and an active contributor (Ministry of Education, 2015).

Since 2012, Singapore academic subjects at the primary and secondary level have aspects of these 21cc skills incorporated into the curriculum. Further to this point, in his keynote address at the Singapore Economic Policy Forum 2016, the Singapore Minister of Education Mr Ng Chee Meng stressed the importance of applying subject knowledge and skills to real-world scenarios (Ng, 2016).

The impetus to prepare students for the future is not unique to Singapore. In the United States, in particular, the P21 Partnership for 21st Century Learning (Partnership for 21st Century

Learning, 2016) envisions that students are able to prosper "in a world where change is constant and learning never stops". Three types of skills that surface from the mastery of the various academic subjects are (1) Learning and Innovation Skills; (2) Information, Media and technology Skills; and (3) Life and Career Skills (cited in Toh & Kaur, 2016).

There are many educators worldwide who propose different approaches of preparing students for the future. Some educators have suggested that, in an effort to prepare students for the rapidly changing world, conventional teaching models must be shifted to a more "transformative" style of education for the twenty-first century (e.g. Bell, 2016). In the language of Mezirow (1996), education should be transformative in the sense that learning should be perceived as "a process of using a prior interpretation to construe a new or revised interpretation of the meaning of one's experience in order to guide future action." (p. 162). Other educators emphasize the importance of harnessing on technology (e.g. Coyne, Potter & Hollas, 2013) with our students, who are often referred to as "digital natives" by researchers (e.g. Prensky, 2005). In fact, a recent newspaper reported that seven in ten Singaporeans are active social media users on the go (Loh, 2017).

It appears that the issue of preparing students for the 21st century is not so much as an attempt to decide on the coverage of the content knowledge for the curriculum of the future, but more of meeting the challenges of delivering content and skills in a rich way that improves students' learning outcome (Rotherham & Willingham, 2010). From the student learning perspective, the 21cc is an emphasis on what students can do with knowledge, how they apply knowledge, whether they are able to assess accuracy of information presented to them, rather than what knowledge they acquire (Silva, 2009).

The 21st Century Competencies (21cc) Framework

The Singapore Ministry of Education has emphasized that Singapore students must be prepared to face the challenges and seize the opportunities posed by the three key driving forces of the future - globalization, changing demographics and technological advancements.

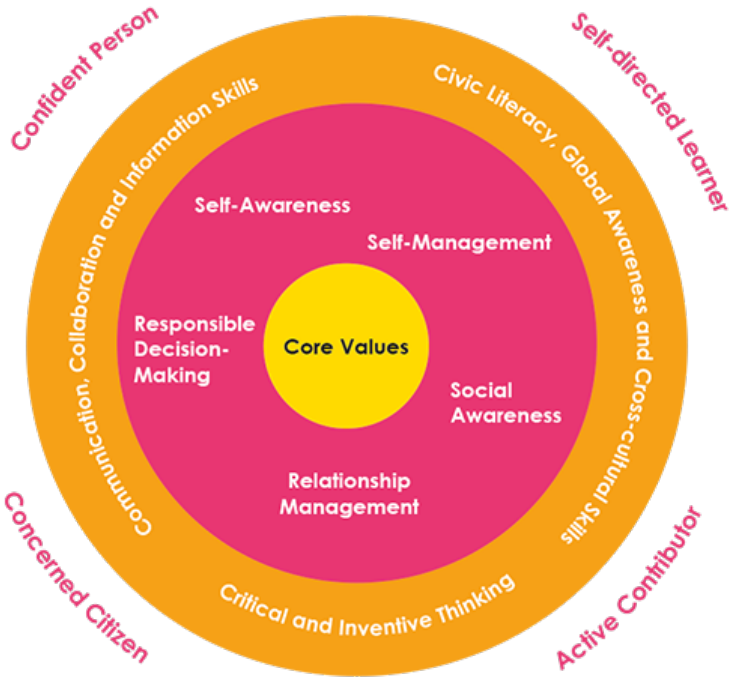

Figure 1. The framework of the 21cc and Student Outcomes (MOE, 16 April 2015)

In the 21cc framework (Figure 1), it is reflected in the outermost ring that the outcome of the formal education in Singapore is a learner who is a confident person, concerned citizen, active contributor and a self-directed learner. In short, such a person is one with a "sound moral compass" and able to take on the challenges of the future. As mentioned by Wong (2016, p. 34), the 21cc "is often related more to soft skills or life skills than to technical or academic competencies". The term "soft skills" is defined as "interpersonal qualities, also known as people skills, and personal attributes that one possesses" by Robles (2012, p. 453).

At the heart of the framework is the set of core values (Respect, Responsibility, Integrity, Care, Resilience, Harmony), followed by the Social and Emotional Competencies (Self-Awareness, Self-Management, Social Awareness, Relationship Management and Responsible Decision-Making) stated in the middle ring, and the 21st Century Competencies (as mentioned in the introduction) indicated in the outer ring. Further elaboration of the competencies can be found in https://www.moe.gov.sg/education/education-system/21st-century-competencies .

Before we present how comics can help develop 21st Century Competencies in our students, the distinct features of comics and its use in the mathematics classrooms are discussed.

Use of Comics in Teaching

Comics refer to media in which ideas (could be either realistic or imaginary, and possibly humorous) are conveyed through the use of visual images or series of images, which are usually made up of cartoons – visual art designed to create humor while conveying important

messages (Toh, Cheng, Jiang & Lim, 2016). We shall discuss the two key features associated with comics described in Toh, Cheng, Jiang & Lim (2016) above: the use of (1) visual art; and (2) humor.

The visual art of the comics enhances and extends the communication provided in the text by facilitating the reader to create their own understanding of the setting of the text after being attracted to the visual (McVicker, 2007). In addition, visuals are instrumental in guiding the readers' perception of spatial relationship within the context (Pratt, 2009). Not only that, the use of visuals in comics develops in students the ability to construct knowledge in more than one modality (Bolton-Gary, 2012). This is crucial for the preparation of students in the unknown world in the future.

The second feature - humors in the form of jokes, is usually used in comics in an attempt to capture attention and impress upon the readers key mathematical ideas. Humor both encourages student retention of information and creates a welcoming atmosphere which is conducive for student learning. Studies by Wanzer, Frymier and Irwin (2010), and Segrist and Hupp (2015) in fact showed the closed connection between instructional humor and information processing of students. Further, according to Kaplan and Pascoe (1977), humorous examples to illustrate concepts during lessons produce the effect of long-term retention of the concepts.

Traditionally, comics were banned from schools and were commonly seen as "enemies" to the schools. Today, some teachers have started to appreciate comics as potentially important educational tools to develop students' interest in various academic subjects (Cleaver, 2008), in order to improve their students' academic literacy (Tilley, 2008). Some affordances of the use of comics in education were reported, such as, in Japan, it was found that the use of *manga* (Japanese version of comics) has motivated learners who are highly engaged in reading (e.g. Allen & Ingulsrud, 2003). This is not surprising as readers of comics tend to develop a range of strategies to facilitate them in understanding texts (Guthrie & Anderson, 1999).

Studies have shown that comics and cartoons increased students' motivation and interest in learning mathematics specifically (Cho, 2012; Sexton, 2010). Not only that, other studies have shown that teaching mathematics using comics has the ability to reduce students' anxiety level about mathematics (e.g., Sengul and Dereli, 2010). Comics and cartoons were also reported to increase the level of engagement and enjoyment with mathematics for pre-service teachers when they were exposed to cartoons and comics in their mathematics content courses (Cho, Osborne and Sanders, 2015).

Comics need not necessarily distract students' learning if these comics are appropriately crafted based on two sound pedagogical principles: (1) contextually situating the storyline that are interesting to the students; and (2) meaningful bridge between the mathematical concepts and students' real life (Toh, Cheng, Jiang & Lim, 2016, p. 246 - 247).

The use of cartoons and comics also does not "dilute" the mathematical content at the expense of increasing level of student engagement and motivation. As an illustration, Cho

(2007) proposed that the entire course of Differential Equations, a relatively advanced undergraduate mathematics course, be taught through the use of comics. Schwartz (2010) used a comics book to illustrate large numbers in a lively manner, which was a publication by the American Mathematical Society. Toh (2009) elaborated on how comic strips could be used to illuminate various mathematical concepts, especially abstract algebra concepts. Subramaniam (2016), in his response to the newspaper report on using comics in Singapore mathematics classrooms, echoed that comics are an efficient teaching tool as "it conveys a large amount of information in a short time."

Toh and Lui (2014) found in their survey among a group of Singapore teachers that some teachers were already using comics to entice their students in the mathematics classrooms, especially for the less academically motivated students. However, there is a lack of concerted effort in the development of instructional materials using comics among the teachers. There is also a lack of research in the usefulness of comics among Singapore students. Based on the above review of existing literature, we strongly believe that the use of comics is one area worth exploring to engage students with the mathematics. Furthermore, school-going children are particularly attracted to comics, as shown by Wright and Sherman (2006). According to the report, children are willing to invest more time on reading comics itself.

In the subsequent sections, we will discuss how comics could further enhance the development of 21cc among students.

The Teaching Package (Percentage and Statistics)

In this paper, we shall refer to the teaching package we developed using comics as the *alternative teaching package*, which serves to replace the conventional instructional materials for the corresponding topics. That is, instead of using the standard school mathematics textbooks, teachers in our study would use the alternative teaching package to teach exactly the same mathematical concepts in the Singapore mathematics curriculum instead of the usual textbook resource.

In designing this alternative teaching package using comics, we rode on the affordances of the resource to also incorporate active engagement of the students, in addition to the usual practice questions to reinforce student understanding. In order to deepen students' understanding of mathematical concepts, we included opportunities for students to problem pose, that is, to create their own questions after they are familiar with the concepts in the practice questions related to Statistics – in mathematics education literature, it is usually known as problem posing (Silver, 1994).

The authors of this paper (hereafter, the researchers) also provided the teachers with proposed lesson outlines associated with each set of comics, and suggested ideas on how the teachers could enunciate the various mathematical concepts at various junctures of the lesson, through storytelling and appropriate forms of student engagement through the comics in the package. The researchers also designed tiered practice questions, both using the context of the comics and beyond, to be used by the teachers during their lessons.

Focus of this Paper

This paper reports part of the work done by the researchers on developing comics for teaching mathematics for Lower Secondary students on two selected chapters (Percentage and Statistics) in the school mathematics curriculum.

We provide illustrations to teach students in ways that prepare them or the 21cc skills base on the design and use of the comics teaching package. The illustrations are provided through (i) unpacking the researchers' perception of how the package enhance the development of such skills; (ii) identifying classroom instances when the teacher develops and elicits 21cc skills; and (iii) students' responses and perceptions towards mathematical learning through the use of comics.

In this paper, we examined the comic strips and lesson outlines for Percentage and Statistics, and studied the detailed work of teaching of Miss Amelia[1], a Secondary one mathematics teacher. Interview transcripts from selected students from Miss Amelia's class were also examined to help us gain some understanding of students' responses and perceptions towards mathematical learning through the use of comics.

Video-recordings of the mathematics lessons that involve the use of the comic teaching package for Miss Amelia was examined. Students were selected for the interview based on results of a pre- and post-survey administered to the students in the main study. The survey questionnaire consisting of 22 questions was adapted by the researchers for part of a larger study on students' academic self-concept and motivation (Marsh, 1990; Marsh, Craven, Hinkley, & Debus, 2003; Seaton, Parker, Marsh, Craven, & Yeung, 2013). From the result of this survey, we grouped the students into two categories: (1) those who showed a positive change in attitude and (2) those who did not exhibit a significant positive change in attitude. From each category, we engaged the teacher's help to identify student interviewees and who were willing to participate in the interviews.

A total of 11 students were selected for individual interviews. These student interviews were conducted after the two topics taught using our alternative teaching package were completed.. From the interviews, the researchers elicited students' general opinion about comics in mathematics lessons, how this approach has benefited them compared to the traditional textbook approach, and other recommendation on how the comics could be further refined to cater to their learning needs. All the student interviews were transcribed. This paper focuses only on their comments about their gain from the perspective of the 21cc.

Unpacking the Researchers' Perceptions

By examining samples of the comic strips on Percentage and Statistics, we illustrate how through the use of the comics, various pedagogical considerations can be implemented and how various 21cc were incorporated. The entire textbook chapters of lower secondary Percentage and Statistics are replaced by seven and eight sets of comic strips respectively.

[1] The name of the teacher and all subsequent students reported in this paper are pseudonyms. Miss Amelia co-taught her class with another teacher. In this paper, we will present findings from Miss Amelia's lessons only.

Each set of comic strips aims to complete the related mathematical concepts required in the Singapore mathematics curriculum (which is usually represented by one subtopic in the traditional textbook). The matching of the seven sets of comics with the seven subtopics on Percentage, in the Secondary One mathematics syllabus document is shown in Figure 1. Similarly, the matching of the comics with the eight subtopics for Statistics is shown in Figure 2.

Table 1

Matching between the comic strips and the mathematical concepts in Percentage

Set	Comics Title	Mathematical Concepts
1	Let's go shopping	1. Meaning of "percentage" and its symbol % 2. Conversion from percentage to fractions and decimals
2	Go for whale watching in Singapore?	3. Conversion from fractions and decimals to percentage 4. Finding a quantity given its percentage of the whole
3	Tell your future	5. Percentage more than 100% 6. Finding a quantity given its percentage (more than 100%) of the whole
4	Having fun in wonderland	7. Calculating the percentage given the part and the whole
5	Discount	8. Finding a quantity given its percentage of the whole in the context of discount
6	Office politics	9. Finding the whole given the percentage and quantity of a part
7	Getting expensive	10. Calculating percentage increase and percentage decrease

Table 2

Matching between the comic strips and the mathematical concepts in Statistics

Set	Comics Title	Mathematical Concepts
1	Sam the daydreamer	• Use of frequency table for representation of data
2	Oh my boss!	• Use and reading of a pictogram
3	Employee of the year	• Use and reading of bar graphs
4	Beautiful picture versus graph	• Reading from a line graph
5	Hair tonic	• Reading of a pie chart • Conversion of representation between bar chart, frequency table and pie charts. • Calculation of the angles on a pie chart.
6	Support your idol	• More on calculation of the angles on a pie chart
7	Who is better?	• Interpretation of statistical diagrams
8.	Asking for a pay raise	• Discussion on the abuse of statistics due to misrepresentation

The first set of the comic strips on Percentage, "Let's go shopping" has been reproduced in Toh, Cheng, Jiang and Lim (2016) and can be downloaded from the website http://math.nie.edu.sg/magical/preview. This set narrates the story of two fictitious characters, Sam and Sarah, going through a shopping trip and discovering that the percentage symbol (%) was very commonly used throughout their entire shopping trip. This led to their curiosity to study the use of percentage in daily life.

Jokes were used throughout the comics to attract students' attention. One of the jokes involves the case when a boy entered a salon which offered a 50% discount, only to discover that he only got half of his hair cut. This provides the opportunity for students' discussion on the relationship between 50% and $\frac{1}{2}$. Another joke involves a special 40% discount offered by a pizza shop which was observed by another boy, and who was upset to realize that he only got $\frac{2}{5}$ instead of the entire pizza. According to the proposed lesson outline, the teachers could tap on this occasion to lead their students to discuss the idea of conversion between percentage and fractions. These two instances enable students to make connections across various mathematical topics in a humorous and non-threatening way. They also provide teachers the opportunity to challenge the students to critically examine the notion of "discount", and whether 50% discount associated with half haircut and 40% with two-fifths of the entire pizza are in fact accurate reflection of the information. Critical thinking and the ability to assess the accuracy of information are important aspects of 21cc. Through these humorous examples in the first set of comics and subsequent sets of comics on Percentage and Statistics, students are challenged to critically examine the given information that they are exposed, building their ability to be discerning so that they can extract and interpret information intelligently in the real world.

Mathematical Content with Other Competencies, Skills and Values Incorporated

In the process of developing these comic strips with suitably designed stories, the researchers were encouraged to observe that soft skills and values associated with the 21cc could be conveyed to the readers in addition to the mathematical contents through the use of comics. These additional skills associated with each set of comics outlined in Tables 1 and 2, are presented in Tables 3 and 4. In particular, several key components of 21cc, both skills and values, fit in naturally in designing the comics for teaching. Table 3 also illustrates how the skills and values fit in with the 21cc framework (within the parenthesis in each point).

Table 3
Skills and values associated with 21cc linked to each set of comic strips for Percentage

Comics Title	Skills and Values linked to 21cc
Let's go shopping	• Appreciation of how real world data is presented (Social Awareness) • To examine information critically and appreciate information in the real-world context (Critical and

	Inventive Thinking)
Go for whale watching in Singapore	• Awareness of the current affairs in Singapore and beyond (Social Awareness) • To examine information critically in the local context (Critical and Inventive Thinking)
Tell your future	• To examine the credibility of information (Social Awareness) • To be discerning of data available so that one can prevent oneself from harm (Communication, Collaboration and Information Skills)
Having fun in wonderland	• To appreciate and respect the different perspective that might not be familiar to oneself (Social Awareness) • To examine information critically for accuracy within a given context (Critical and Inventive Thinking)
Discount!	• To be discerning of data available so that one can prevent oneself from harm (Communication, Collaboration and Information Skills)
Office politics	• To be mindful of one's social responsibility as an adult (Social Awareness, Relationship Management, Responsible Decision-Making) • To examine information critically and appreciate information in the real-world context (Critical and Inventive Thinking)
Getting expensive	• To examine information critically and appreciate information in the real-world context (Critical and Inventive Thinking)

Table 4

Skills and values associated with 21cc linked to each set of comic strips for Statistics

Comics Title	Skills and Values linked to 21cc
Sam the daydreamer	• To think from different perspectives (Social Awareness) • To examine information critically and appreciate data in the real-world context (Critical and Inventive Thinking)
Oh my boss!	• To be socially responsible in handling information that might be contextually sensitive (Responsible Decision-Making) • To examine information critically and to creatively explore different alternatives in representing data (Critical and Inventive Thinking)
Employee of the year	• To appreciate different ways of solving the same problem (Critical and Inventive Thinking) • To be aware of the importance of precision and accuracy of tasks assigned to oneself (Critical and Inventive Thinking)
Beautiful picture versus graph	• To appreciate and respect the different perspective that might not be aligned to oneself (Social Awareness)
Hair tonic	• To be discerning of data available so that one can

	prevent oneself from harm (Communication, Collaboration and Information Skills) • To encourage collaborative working in the context of data collection (Communication, Collaboration and Information Skills)
Support your idol	• To be mindful of one's social responsibility as an adult (Social Awareness, Relationship Management, Responsible Decision-Making)
Who is better?	• To critically examine all available information instead of forming conclusions based on a small part of information (Critical and Inventive Thinking)
Asking for a pay raise	• To be able to discern the truth of all available information (Communication, Collaboration and Information Skills) • To be socially responsible by being a socially ethical person (Social Awareness, Relationship Management, Responsible Decision-Making)

Figure 2 shows part of a full question for which students were required to answer after the comic strip on Line Graph. In part (H) of this question, students were required to create a question related to the Line Graph for which the answer is "November". This effort to engage students to problem pose perpetuates throughout the subsequent sets of comics on Statistics.

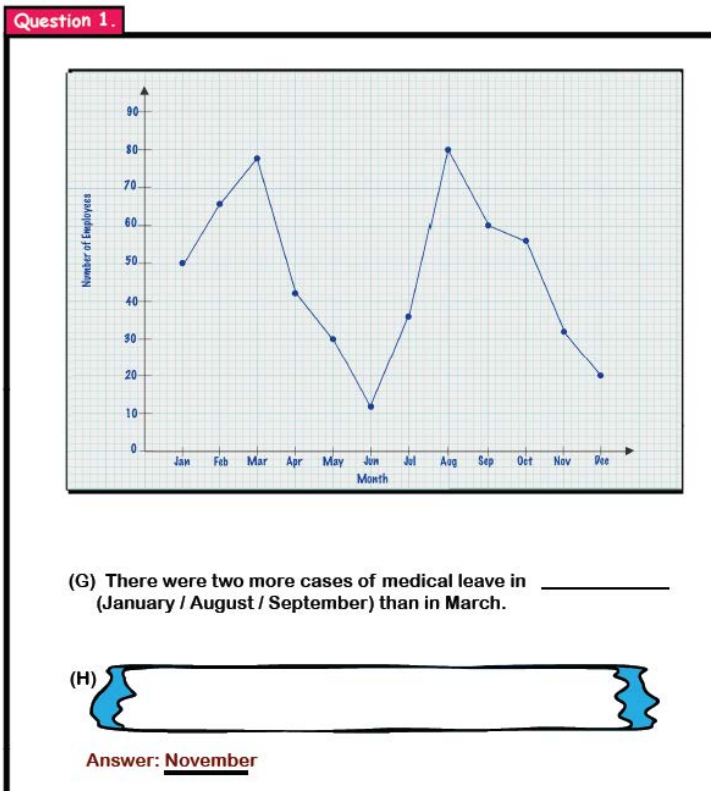

Figure 2. Part of a question leading to students' problem posing

The importance of problem posing in mathematics has been widely discussed in literature. It has been investigated and was found to influence both students' attitude and aptitude towards mathematics and, more importantly, their sense of ownership of their own learning (English, 1997a, 1997b; Grundmeier, 2002; Knuth, 2002; Perrin, 2007; Yeap, 2009). Students' sense of ownership for their own learning in turn develops them to be self-directed learners, who question, reflect and persevere in the pursuit of learning, thereby taking responsibility for their own learning. This is an important outcome of the 21cc.

We also incorporated opportunity for students to create their own story based on a statistical graph that has been covered in the comics "Beautiful picture versus graph" (comics set 4 in Table 2). Through working on the task (Figure 3), students can be given the opportunity to exercise their creativity while deepening their understanding and interpreting of statistical diagrams. In cases where students found writing their own story too challenging, they were provided with a plausible scaffold in the form of a cloze passage in relation to the graph.

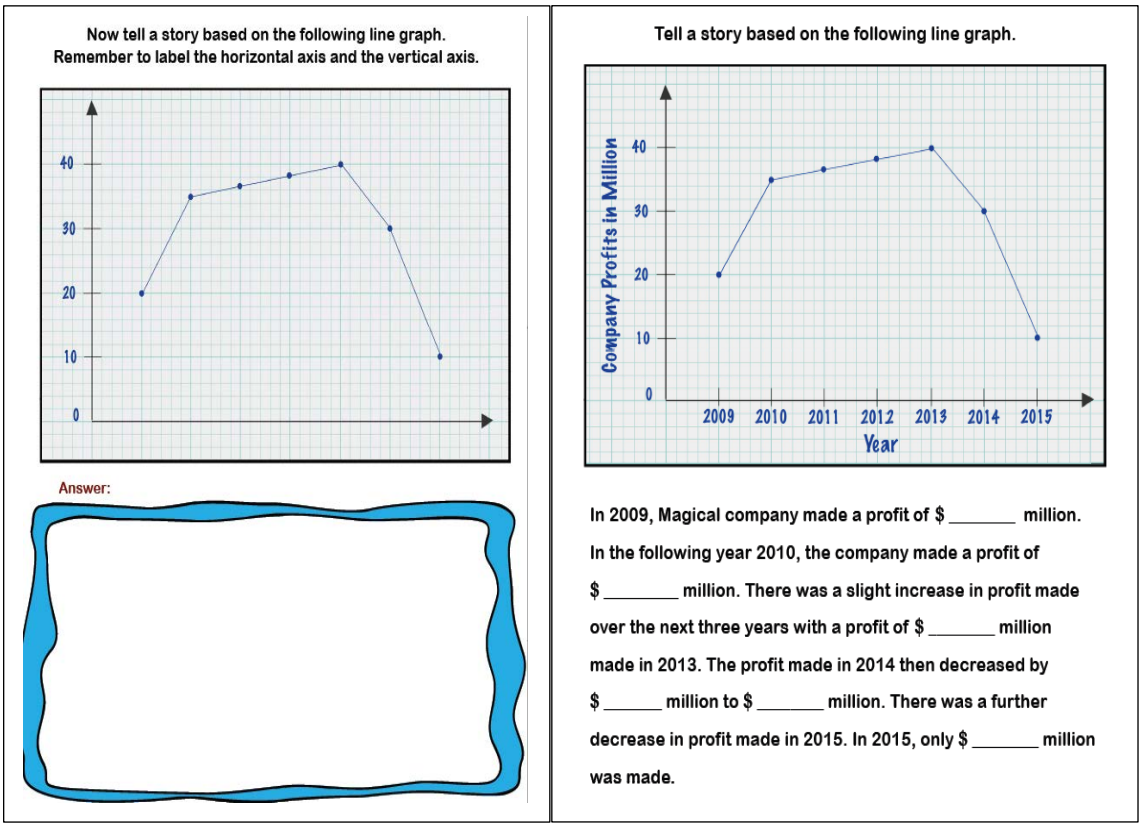

Figure 3. Sample of a storytelling task (left) and a plausible scaffold (right)

Classroom Situations where the teacher develops and elicits 21cc skills

Due to space constraint, we present and discuss one lesson on Statistics and illustrate the key elements of the 21cc that Miss Amelia incorporated into her lesson to elicit 21cc skills. Questions that Miss Amelia posed to her students were extracted from the video recordings to

illustrate her use of comics to develop 21cc. Students' responses will not be reported in this paper as our focus is on Miss Amelia.

This lesson discussed the first comic strip of the Statistics lesson package, Sam the daydreamer. The story begins with two characters Sam and Sarah attending a meeting that lasted four hours. The story in this set of comics aimed to bring out the importance of clear presentation of data in a frequency distribution.

21cc framework - Social Awareness

We now illustrate how Miss Amelia used the comics to develop social awareness in her students.

L1 Miss Amelia : How long were they at the meeting?

…(Students deduced that the duration of the meeting was 4 hours)

L2 Miss Amelia : Is it 9 p.m. to 1 a.m.? or is it 9 a.m. to 1p.m.?

From the above questions, Miss Amelia facilitated the students to extract information from the visual cues found in the comic strips by determining the number of hours of the meeting (L1). Miss Amelia continued (L2) to get her students to decide which is more plausible; was the meeting held in the morning from 9 a.m. to 1 p.m., or was it held at night from 9 p.m. to 1 a.m.? To us, this is evident of the teacher's emphasis on the awareness of the environment, or real-world contextual knowledge. The teacher continued by inviting the students to consider different contexts beyond the comics by switching to different contexts (comparing the effect of playing computer games for more than 4 hours versus attending a mathematics lesson for 4 hours).

21cc framework – Critical & Inventive Thinking

This lesson continued with the next part of the comic strips on the character, Sam, being tasked by his boss to conduct a survey (Figure 4) on five products (which are unknown).

Figure 4. The comic strip linking to the idea of conducting survey

Miss Amelia continued to engage the students to make sense of what the five products from five different companies involved. This is a crucial part of the lesson where students were

challenged via the following questions (L3 & L4) to put a context into the storyline using their background knowledge, and also to think critically about how real-world surveys are conducted (L5).

L3 Miss Amelia: What do you think the [five] shapes (see Figure 4) are for?

L4 Miss Amelia: What kind of surveys can you conduct with 5 different companies?

L5 Miss Amelia: How do you think surveys in the real world are conducted?

21cc framework – Communication, Collaboration and Information Skills

Here is another instance where Miss Amelia, through the use of comics, helped her students to connect and make sense of Statistics to real-world situations

The teacher questions below (L6 to L10), extracted from Miss Amelia's lesson are also related to the comics in Figure 4.

L6 Miss Amelia: Why do you conduct a survey at the shopping mall?

L7 Miss Amelia: Do you think the survey result will be accurate? Why not?

L8 Miss Amelia: Is it good enough to represent everyone in the market?

L9 Miss Amelia: Anyone participated in any survey?... in schools or on the streets?

L10 Miss Amelia: Will you do the survey without the vouchers?

The above excerpt (L6 to L10) is an instance where the teacher challenged her students to think about the accuracy of the survey results in the context of the choice of sample. Although the idea of sampling is beyond the students at the lower secondary level, the underlying principle of survey was discussed through developing students' critical thinking, an important skill of 21cc.

As the lesson unfolded, the students were led into the importance of presenting data in a tabulated form through the use of a frequency table. This was done intuitively and in a humorous way via the comics, rather than introducing the mathematical concept formally at the beginning of the lesson. We argue that this approach unfolds the mathematical concepts in a more intuitive way; more students are likely to accept such a humorous approach to mathematical concepts as elicited through the students' learning.

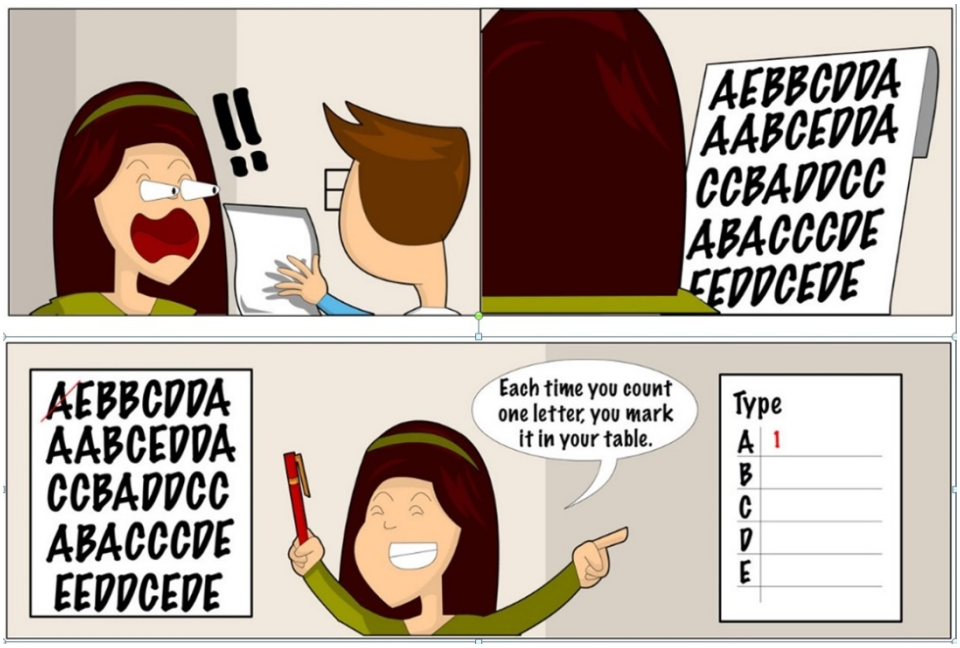

Figure 5. Comic strips leading to the importance of clear data presentation

Throughout the lesson, Miss Amelia utilized both the online and hardcopy versions of the comics provided by the researchers. In addition, Miss Amelia used worksheets which she had modified from hardcopies of the comic strips. She had inserted blank spaces at specific parts of the worksheets to engage her students during the lessons to work through carefully selected mathematics questions as a class. For example, the teacher modelled the strategies (Step 1: Determine the number of different types; Step 2: Remember to strike out the letter to ensure you do not miss out any letters) to construct the frequency distribution table for a set of collected data (Type A as shown in Figure 5). The students would have to complete the table in their worksheets. While the students were engaged in practicing and transferring the skills (i.e., tabulation of data) learned by completing the worksheets, the teacher checked the students' responses in the worksheets and provided immediate feedback to students' work. The opportunity to practice coupled with immediate feedback to students helped students to experience small success in their mathematics lesson. These small successes comprise both the attainment of 21cc skills and positive motivation in achievement in mathematics.

21cc framework – Civic Literacy, Global Awareness & Cross-Cultural Skills

It was interesting for the researchers to observe that as the lesson continued, the teacher attempted to infuse civic literacy among the students as opportunity arose. When the comics proceeded to the case when the character Sam disposed his data sheet (in Lesson 2), the teacher discussed with the students on the ways to dispose of waste paper and how confidential documents should be handled.

Figure 6. Comic strips depicting in which the character Sam disposed papers carelessly

L13 Miss Amelia: Do you think this is a proper way to dispose your waste?

Thus, it is clear that in addition to the ideas offered by the researchers in the adoption of the comic strips in teaching mathematics, Miss Amelia seized opportunities throughout the lessons to bring across many additional skills, values and competencies that are crucial for developing 21cc through the context of the comics. It is evident from this episode to conclude that the use of comics provides a useful platform for teachers to infuse 21cc into their lessons.

Students' Responses and Perceptions

As this paper focuses on its relation with the 21cc, only the aspects of the 21cc that the use of comics has achieved from the perspective of the students were identified and illustrated in the following paragraphs.

21cc Outcome: Active Contributor

When asked to compare a regular mathematics lesson with a mathematics lesson using comics, the student Ravi commented that he preferred the comics lesson. In a lesson using comics, students are given a chance to actively contribute to the classroom discourse, discuss with his peers, and read the passages in the stories.

Ravi: Er, the regular maths lesson is quite boring. But in this the comic thing, it is more interesting. Because they are cartoons in them. And all of us can have our chances to talk, read and read the passages in these.

Another student Michael liked the comics lessons because it gave him a chance to discuss about mathematics with his friends. Thus, the comics lessons have facilitated the students in the communication of their ideas. In the 21cc framework (Figure 1), this translates to an active contributor who is being able to communicate and work with teams.

21cc Outcome: Confident Person

A confident individual has a sense of right and wrong, is adaptable and resilient, knows himself or herself, and is discerning in judgment. The use of comics could enhance student confidence is very clearly illustrated in the interview excerpt of Ravi, who demonstrated this quality during the interview. When asked to identify a comic strip that he liked most, he commented the comic strip involving a fortune-teller. He was able to critically identify the act of the fortune-teller in using figures to justify her fraud.

Ravi: I think is the woman..is the..the fortuneteller [the title of the comic strip]. She is cheating them, and they have to solve and they have to find out.

Another student Richard said that the comics lessons was fun when students were given the chance to assume the role of the fictitious character in the comic strips (the teacher Miss Amelia had incorporated role play in the subsequent lessons). By participating in role-play, students could move towards developing an understanding of different perspectives, having a strong sense of right and wrong, and being discerning in judgement. Role-playing also encourages students to communicate effectively, an important ingredient in becoming a confident person.

21cc Outcome: Self-directed Learner

Comics provide the opportunity for students to discuss contextualized mathematics problems, and can even spur their further use of the context to generate new problems within the context. In this way, the use of comics could provide the opportunity to develop an individual who questions, reflects and perseveres in the pursuit of learning; in other words, this facilitates the development of a self-directed learner who takes responsibility for his or her own learning. This is evident from the interview with another student Emmeline, who particularly liked the comic strip "Let's Go Shopping" which provides the real-world context of a shopping experience. According to Emmeline, the comic strips allow her to replace the given problem with her self-created problem using the context of the comics. An excerpt of her interview is shown below.

Interviewer: Can you share with us why you like this story?

Emmeline: Because…we can try different type of working from this… Er, like instead of this, you can change to other forms of sentence… then try another working…'I can pay 50%' and then you can fill in the fraction yourself and check whether it is correct?

A Case of a Student with Dyslexia

In our data analysis, the case of another student Amos caught our attention as he is identified as dyslexic. The researchers felt strongly that by understanding how the comics assisted Amos in learning mathematics, how comics would be helpful towards other students in

learning mathematics could be further illuminated. Throughout the interview, it was evident that the visual component (pictures) of the comics teaching package changed his initial negative attitude towards learning mathematics to a positive one – becoming a self-directed learner. In addition, the format of comics (i.e., picture-from) related well to his learning style. The following excerpts show his preference having visual aspects in the form of pictures (in the comics) in his learning.

Interviewer:	Can you tell me something about your favourite subject in school?
Amos:	My favourite subject is actually English. But then when I started having the new comic, I get to be in love with Maths. So now I am in love with Maths.
Interviewer:	Why in love with Maths?
Amos:	Because ah last time I'm not really good in maths and my teacher keep telling me not to think about that, just study hard. But for me, maths is just too hard for me. I can't do it. Then after that the comic came out, then I every day read the comic. Got funny funny stuff, it make me er makes me like more interested in maths. So I keep on reading the comic. Then I do revision. That's why I start to love maths.
Interviewer:	Is it because of the pictures?
Amos:	The pictures and the story. It's like funny funny.
Interviewer:	So do you find with stories, it helps you learn maths better?
Amos:	Yeah.
Interviewer:	So last time, last time there were no stories..
Amos:	No.
Interviewer:	And you find math hard..?
Amos:	Yeah.
Interviewer:	Is it because the symbols are difficult to understand? Or..?
Amos:	It's too difficult. Because I'm dyslexic. So if I see some numbers, then I feel like..I..I must read more than once la..so I feel like stress like that if I may forget.

Amos was motivated by the use of comics in his mathematics lessons. He became more willing to persevere in the pursuit of learning mathematics, which he had originally perceived as difficult. He had become more persevering due to his being attracted to the comics. He had become more of a self-directed learner - a desired outcome of the 21cc.

Amos was next asked on his perception on the importance of the subject. An excerpt of the interview is appended below.

Amos:	For me, maths is an important subject because in the future if we want to count our money, or if we become a cashier, we have to er know how to count and to, and give the change back to our customers.
Interviewer:	Okay.

Amos:	And we must also learn maths because it is important in life. So that we can know how to count, know how to divide, times, minus, plus.
Interviewer:	Do you think maths is important to you *now*?
Amos:	Now it is important to me because it it really helps to count money and plus some like example we have some interviewees, then we have to count how many people is there. So we must do fraction or to see how many people like this stuff or that stuff.
Interviewer:	So when you go out with your family, do you do any maths?
Amos:	When I go out with my family, I do maths at the shop. So when I pay, if the person, the cashier give[s] me the wrong change, I would count back.

Amos clearly appreciated the importance of mathematics both in the future and at the current state. He was affirmative on the importance of mathematics, which would help him to be discerning in real-world situations and be a confident individual, another desired outcome of the 21cc. In fact, recognizing the importance of mathematics in the real-world is echoed by all the other interviewees in the school.

When asked how different is the comics lesson different from the usual mathematics lessons, Amos responded as follows:

Amos:	The normal lesson is "a bit hard for me because it is confusing like there is no helping words or what, then just give us the answer and we just need to read. And I'm dyslexia so I am read a lot of times, then I can get the answer. So, comics help me because like story plus maths. So that's why when I read, I can understand the question better. The difference would probably mean like..if you forget how you do the situation, you can look back. Whereas if you, if the teacher give you a situation where you don't understand, you have to keep asking and she might get irritated.
Interviewer:	Is it because of the pictures, they help you?
Amos:	Ya, it is because of the pictures. Normally, I have to read "almost four times" before I understand a problem. [Without the use of comics,] I read once. Then I look at the question. Then I read again. Then look again. For comics, I need to only read one or two times, I will understand. If there are pictures in the examination and short stories, they will help me better.

The above portion of the transcript further shows that the use of comics provides ample opportunity to prepare Amos to be a self-directed learner who will persevere in the tasks assigned. Not only that, the combination of pictures and storylines makes learning of

mathematics easier for him as compared to the traditional mathematical tasks which could be flooded with lengthy sentences.

Conclusion

This paper discusses the use of a comics teaching package in one participating Secondary School. Nevertheless the data shows that the use of comics is a promising pedagogy to enhance students' learning of mathematics including the case of Amos, a dyslexic student. As shown and discussed in this paper, comics helps sustain students' interest in learning mathematics, developing the 21cc skills at the same time. The value of comics, it appears, is that it is a medium that is attractive to students, non-threatening, engaging, fun and for dyslexic students, de-emphasizes reading that thwarts their understanding. Several stages were envisioned by the research team for the development of the comics teaching package: (1) at the stage of designing the comics material, much thought was dedicated to having 21cc skills be seamlessly infused through the context in the comics; (2) at the implementation level, teachers have ample opportunities to expose students to and develop in them the 21cc skills; and finally, (3) students also developed interest and motivation towards the learning of mathematics and acquire 21cc skills.

Acknowledgement

This research is funded by the National Institute of Education research grant DEV 07/14 TTL.

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