USE OF CARTOONS AND COMICS TO TEACH ALGEBRA IN MATHEMATICS CLASSROOMS

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Literature abounds in using cartoons and comics, instead of the usual textbooks to teach students reading. However, little study has been undertaken on using cartoons and comics to teach mathematics. It has always been a challenge for secondary school teachers to teach algebra to under-achieving students. In this note, the author proposes the use of cartoons and comics, which are usually enjoyed by school-going children, in teaching algebra. Feedback from teachers showed that their students became more motivated to learn the subject through the use of cartoons and comics in algebra lessons. The teachers were able to engage their students in the process of learning elementary algebra.

Introduction

Modern education programs generally disadvantage less academically inclined students. This group of students are often visual and kinesthetic learners (Amir & Subramanian, 2007; Rayneri & Gerber, 2003), while modern education programs are more theory-based than skill-based (Glass, 2003), compounding their disadvantage.

Throughout this chapter, the term "under-achieving students" will be used to refer to those students whose performance in the national streaming examination is ranked among the lowest 30% of the entire cohort in Singapore. Teachers have been involved in various innovative ways of teaching mathematics to these under-achieving students (Lui, Toh & Chung, 2008).

Teachers may be more successful in their lesson delivery if they are more conscious of the different learning styles of their students and attempt to use different teaching methods for different types of students (Myron & Keith, 2007). This is especially important when teachers are teaching abstract topics like algebra.

The reason why this paper places the emphasis on algebra is that there is a worldwide push to make algebra a required part of most mathematics curricula in the world. According to NCTM use expanded form of NCTM for first use, students are required to have strong background in algebra by Grade 8 (NCTM, 2000).

NCTM (2000) suggests that algebraic concepts need to be presented in a context that is meaningful to students. However, in schools, anecdotal evidence suggests that algebra is not usually presented in a meaningful or interesting way, causing students not to enjoy learning the subject.

For more than five years, mass communication research has raised exciting ideas on how the commercial world has managed to tap on cartoons and comics successfully to attract teenagers to commercial products. This is the genesis of the idea of linking cartoons and comics to mathematics education: since most students in schools enjoy reading cartoons and comics, why not use them in teaching mathematics? In this paper, the author proposes the use of cartoons and comics in teaching algebra in the secondary school curriculum.

Cartoons, Comics and Algebra

Cartoons and comics have traditionally been seen as "enemies" of the schools; students caught reading comics in schools were likely to be disciplined (Cleaver, 2008). However, today, some teachers are beginning to view comics as potential educational tools, as a way to arouse students' interest in academic subjects (Cleaver, 2008), and also an avenue to improve their students' academic literacy (Tilley, 2008).

While reading comics can never approach the complexity of reading 'real' texts, "compared to reading 'real' books, reading comics appears to be a simple task and compared to reading no books, reading comics might be preferable" (Tilley, 2008).

Research has provided evidence that cartoons and comics have particular attraction among school age children (Wright & Sherman, 2006). Students are generally at ease in combining visual and text information in reading comics. The use of comics in teaching can thus provide opportunities for skill-building, creativity and reading for content (Urbani, 1978).

Research highlights particular difficulties which students find in learning school algebra? According to Lee (2007, pp 34 – 35), the difficulties can be broadly classified under three main categories:

- Students are not familiar with the syntax of algebra;
- Students are confused over the different uses of letters in algebra;
- Students find algebraic procedures too abstract.

Difficulties occurred in students' learning of algebra because of their wrong interpretation of algebraic objects (Kirshner, 1989). The wrong interpretation appeared to have resulted from the visual presentation of the algebraic objects. Kirshner (1989) suggested that algebraic skills developed not only from learning or practising explicit rules but also from recognising visual patterns on printed pages.

Teachers may also contribute to part of the misconceptions in the students' mind about the learning of algebra (Baroudi, 2006), if their emphasis in teaching algebra is placed solely on the computation and the procedural processes of algebra. This is especially true when teachers do not strive to achieve in their students a relational understanding of the algebraic operations (Knuth, Alibali, McNeil, and Weinberg, 2005, p69).

Therefore the author, who is currently involved in the mathematics education program in Singapore and was previously involved in the writing of mathematics textbooks for under-achieving mathematics students in Singapore, entertained the idea of using cartoons and comics in teaching mathematics. The author "sold" this idea to a few practising teachers (hereafter called "the teachers"), and informally convinced them to try out the idea of infusing cartoons and comics into teaching algebra before the textbooks were officially launched. The following sections describe the ideas that were "sold" to the teachers, and their feedback about the approach after experimenting with their students.

Welcome to the World of Algebra!

Students generally prefer to communicate via non-algebraic representations (Neria and Amit, 2004). The use of numbers generalized by letter designations raises difficulties for most students (Hembree, 1992). However, one has to first learn the "language" of algebra as the crucial first step to learning algebra.

According to the mere exposure theory of communication, simple *repeated* exposure to the communication can influence attitudes, provided that the people have not developed negative feeling to the "message" (Zajonc, 1968). The author suggests that repeated exposure of students to cartoons and comics that demonstrate the use of the language of algebra can be used to introduce the students the world of algebra. This process of repeated exposure will reduce the students' fear with using letters to represent numbers. Examples of comic strips that can be used are shown in Figure 1.

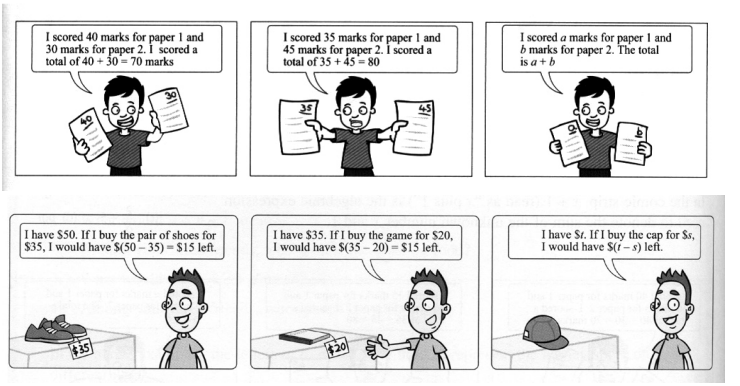


Figure 1. Comic strips used to familiarize students with the use of letters to represent numbers (Toh, Lim, Chua & Heng, 2007a, p253-254)

However, the process of introducing algebra must be gradual. Successful learning of algebra has to be built upon students' experience with arithmetic (Bednarz, 2001). Continuity between algebra and arithmetic can be achieved through a gradual "complexification of reasoning procedures" (Bednarz, 2001). To achieve this, short comic strips can be introduced as activities for students to initiate them into using algebra languages.

Introducing the language of Algebra

Comic strips such as Figure 1 are used to introduce the language of algebra as "generalized arithmetic". This is one approach to get the students inducted into the world of algebra, and, even develop the habit of using algebra in their daily language! The author strongly encouraged the participating teachers to use these comic strips to begin introducing algebra, instead of the routine way of introducing algebra from the classical textbooks based on procedural approach.

The teachers were also encouraged to use comic strips to lead their students to think more deeply into the language of algebra, and in a more humorous way. For example, students can think of $x + 1$, as "one more than x" instead of the usual arithmetic operation of addition of x and 1 (Figure 2).

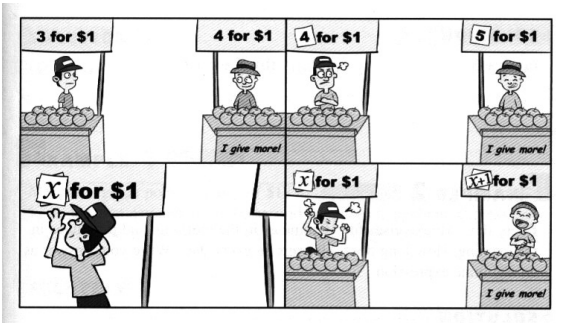


Figure 2. Another comic strip on the language of algebra (Toh et al, 2007a, p253).

The teachers agreed that the under-achieving students generally prefer drawings. Instead of fighting a losing battle against banning drawings, the author encouraged the teachers to turn the students' 'talent' in drawing to good learning opportunity in learning algebra. The author further advocated to the teachers to incorporate drawing activities in introductory algebra classes!

Drawing Activities in Algebra Classes

The teachers were urged to provide opportunities for their students to create their own cartoons and comic strips, *using the language of algebra*. A sample activity used by one teacher is provided below.

Choose two expressions below, draw cartoons for:

(a) x – 1
(b) y + 10
(c) x – y
(d) 2x + 1

You can be as creative as possible. The most creative cartoon will win you a surprising prize!

Figure 3. Sample activity used by a teacher in her introductory algebra lesson.

Feedback from the Teachers

The teachers told the author that, through using cartoons and comics to introduce algebra, the students were less resistant to learning algebra. The teachers were able to engage more students to learn more challenging algebra (such as communicating in algebra language), involved in the addition and subtraction of algebraic expressions.

By engaging the students to draw cartoons and comic strips (Figure 3) in the process of learning algebra, the under-achieving students were more willing to participate in the lessons through creating their own cartoons and infusing the algebraic language. The language of algebra also becomes more natural to them.

When asked whether there was any potential problem in the use of the cartoons (Figures 1 and 2) for teaching, the teachers commented that Figure 1 was too "noisy" in the use of language; many of the under-achieving students were also weak in language (they were not native English speakers). The lengthy sentences in Figure 1 posed some difficulty to their students. Figure 2 was less wordy and more "humorous", and that it brought out the meaning of addition of x and 1, and developed the students' understanding of $x + 1$ as "one more than x".

What teachers learn from students' cartoons?

One teacher commented that the cartoons drawn by the students could also be used by the teachers to assess the students' understanding associated with the algebraic objects. For example, $x - 1$ and $y + 10$ (activities from Figure 3) have brought across to the students the ideas of "one less than x" and "ten more than y" respectively on top of the usual arithmetic operations associated with the algebraic expressions.

On the other hand, the cartoon drawn for "$x - y$" (Figure 3) shows the students' [mis] understanding that $x - y$ is always smaller than x. Although the students had already learnt negative numbers, they had a misconception that the letters represent some unknown positive numbers, which is described as "incomplete concept image" (Tall and Vinner, 1981). The development of such incomplete concept image would cause problems later on when the students learn subtraction of negative numbers. Thus, observant classroom teachers could make use of students' work to pre-empt the students' misconceptions of algebraic objects, so as to better prepare their subsequent algebra lessons.

Solving Algebraic Equations

Students usually encounter difficulty with solving linear algebraic equations. Their conceptual understanding of algebraic equations is not well developed because they are not provided with opportunities to engage in enactive or iconic forms of the idea, while the symbolic version of algebra is beyond their grasp (Yeap, 2009, p 32). Students usually see an equation as an arithmetic process and unable to see it as an object to work on (Sfard, 1991).

Further, teachers have been using algebraic procedures like "cancel" and "bring over" in solving algebraic equations, which could have further contributed to the students' errors and difficulties with algebraic equations (Martinez, 1988).

The author proposed the contextualization of a linear equation as balancing two sides of a beam balance. The teachers could get their students to think of the physical processes of solving an equation. For example, consider Figure 4 in context: *"James is asked to find the unknown weight x. How could you find the value of x?"*

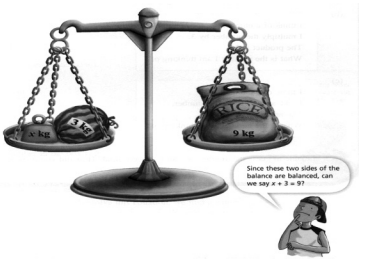
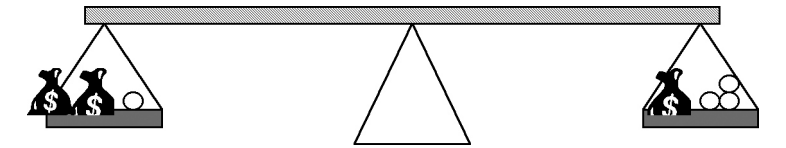


Figure 4. Comic strip used to introduce the students to solving linear algebraic equation (Toh, 2008, p83)

The above approach presents an equation as an object for students to work on: in Figure 4, one could remove the 3 kg watermelon on the left pan and 3 kg of rice from the right pan to balance both sides of the machine. Instead of rushing into solving $x + 3 = 9$ in the above case, the students are led to view an equation as an object to act on. Subsequently, teachers would be able to facilitate their students solving the more complicated situation in Figure 5, and to translate the problem into one involving a linear equation.



Ali is given a situation of balance of three bags of gold coins and four separate gold coins as shown above. Can you help him decide how many gold coins are there in each bag?

Figure 5. Using beam balance to solve the equation 2x+1= x+3 (Toh, 2007)

Feedback from the Teachers

The teachers generally felt that this approach of solving linear equations helps their students more than the traditional approach of introducing the section on solving algebraic equations. It helps the students to move beyond the guess-and-check processes, and transcends the process of solely focusing on algebraic procedures. It helps students to visualize the solving a linear equation by balancing both sides of beam balance through a visual context.

Conclusion

The commercial world has found the effectiveness of using the products of popular culture in communicating with the general public. However, not much has been done in the mathematics education research on the effect of these products on the students' learning of the subject. Perhaps, more interested researchers and educators could look into this field to capitalize on the benefit that pop culture could bring to education.

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