Integrating physical science and the graphic arts with scientifically accurate comic strips: rationale, description, and implementation

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Abstract: Because of their visual, attractive, often-humorous perspective, and overall appeal, cartoons and comic strips have been used for many decades in the classroom, especially as pedagogical tolls in language and social studies classes. However, cartoons and comic strips can be used as effectively in the physical science classroom. The purpose of this paper is to familiarize physical science teachers with an innovative teaching strategy for high school and college science students involving the design and creation of scientifically accurate comic strips. Scientifically accurate comic strips are an original, student-generated sequence of cartoon panels that correctly present a scientific idea or principle, either directly or indirectly, in a humorous or reflective way. This approach departs significantly from most of the literature on cartoons and comic strips as educational aides in that already made cartoons are not used. A literature-based rationale for its use, feedback from students, and assessment criteria will be discussed.

Keywords: teaching strategies, comic strips, cartoons, science misconceptions, scientifically accurate comic strips.

Introduction

Human beings receive information from their surroundings mostly through sight. Colors, textures, and patterns are highly attractive to most students. The use of images in education has a number of important functions, including motivation, attention, exploration, presentation of content, organization, explanation, corroboration, emphasis, aesthetics, and recreation (Medina, 1992). Example of the use of images for all of the previous functions are known as cartoons and comic strips, considered by some as one of the greatest reflector's of the nation's culture.

Because of their visual, attractive, often-humorous perspective, and overall appeal, cartoons and comic strips have been used for many decades in the classroom. Effective cartoons and comic strips are amazingly simple, usually with a single message and organized display that is easy to read and remember. For students, they might be more understandable than a newspaper article or a book.

Historically, some educators have considered comic strips as educationally unsound and as examples of character stereotyping, inferior and idiomatic writing, and weak plot structure (Thomas, 1983). However, the combination of the students' familiarity and acceptance of them, along

with careful pedagogical integration, makes of this resource an excellent and refreshing complement to instruction.

In most instances, teachers draw their own cartoons, or use already-made cartoons and comic strips for a variety of purposes: to introduce a lesson, to emphasize a concept, as a closing activity or as special projects, just to mention a few. A less common use of this strategy is when students do research on a topic to draw their own cartoons, or when students create a story and use drawings to illustrate it.

The purpose of this paper is to familiarize teachers with the use of cartoons and comic strips as a pedagogical resource, with particular emphasis on the physical sciences. An innovative class project where students research and draw self-generated and scientifically accurate comic strips will be described.

Cartoons and comic strips: a formal definition

According to The American Heritage Dictionary (2000), a cartoon is "a drawing depicting a humorous situation, often accompanied by a caption". A cartoon is, most of the time, a single drawing, as opposed to a comic strip, which is defined by the same source as "An usually humorous narrative sequence of cartoon panels". It is during the sequence of panels where the story is presented, usually by dialogue, narration, or purely visual symbols. Both are usually drawn without great detail, capturing the essence of an idea, concept, situation, or person. Generally, longer comic strips contain all the elements of a short story: characters, dialogue, plot, conflict, and climax (Wright, 1979).

Although entertainment and marketing are the main goals of cartoons and comic strips, they can also serve a social, political, historical, or educational function within a particular culture, place, or time. This means that the implicit and explicit messages of cartoons are not necessarily universal.

A rationale for using comic strips as a pedagogical strategy

First of all, most children and young adults love comic strips! Research supports the fact that students enjoy reading comics and that comic strips have a potential motivational value (Wright, 1979). Since students already have the motivation to use cartoon materials, they should not be ignored for educators as a potential aid in the classroom. Ball (1976) summarized the advantages of comics for classroom use:

The comic strip has proven to be an exceptional communicative device. It uses a language common to most members of society. It presents a written text that augments the visual form. Visual forms are often presented with such pictorial quality and clarity of image that the fidelity of the communicated message is superior to many other media using similar visual/verbal displays (p. 17).

Similarly, Brocka (1979) provides a strong argument in favor of comic strips:

> "Comics are a dynamic combination of visual image and written word, of narrative and dialogue. They have just the cohesive and choreographed imagery we need to reach our students (p. 27)".

Secondly, comic strips and cartoons are also extremely flexible for the needs, experiences, and level of content knowledge of a large number of students (Wright and Sherman, 1999). On one hand, comic strips in elementary school may serve a literacy function, helping students to read, organize, and interpret a series of humorous events. For high school and college students, comic strips can be a source of insight, reflection, and critical thinking in a variety of domains: philosophy, politics, sociology, science, or art. Wright and Sherman (1999) stressed the higher levels skills potentially attainable through the creation process of comic strips:

> "The creation of comic strips allows teachers to [science, too!]. If teachers are to help students to become literate, critical, creative thinkers, then curricula, teaching strategies, and instructional resources must be align to accomplish this objective (p. 66)".

Wright and Sherman (1999) also argued that comic strips could be successful in integrating cognitive processes with the psychomotor domain because of the integration of visual, auditory, and kinesthetic learning modalities.

Third, Richie (1979) pointed out that, unlike the more formal textbook, comic strips are more casual and consumable: they can be cut apart, drawn on, and colored with more freedom. Also, because of their informality, students do not perceive them as a threat, or that reading materials is forced on them by the teacher. In addition, Richie (1979) cited literature suggesting that the use of comic strips and cartoons promote the use of various learning styles and individual differences, and argued that higher-order, critical thinking skills can be taught using this medium.

Fourth, Flannery (1993) has postulated a social rationale for using cartoons in college science courses has been suggested by Flannery (1993). She argues that science cartoons are capable of breaking the monotony of a lecture section and, in that way, keep the students attentive and intellectually engaged in the science content presented. Science cartoons also show that scientists or science instructors are human being, and not an elite of somber intellectual with no sense of humor. In addition, science cartoonists are usually very knowledgeable about the latest trends in the discipline and can help instructor keep the lesson up to date.

Flannery (1993) put forward additional reasons why science cartons can be effectively used in higher education. Science instructors usually discuss the universality of science and its permeation through most aspect of the students' everyday lives. Science cartoons provide evidence that science can be found even in the most surprising and informal places. Also, she used cartoons to emphasize a point, to explore the irrationality of scientific overgeneralizations, and to help students, especially those in required science classes for non-majors, to realize how much they really know about science:

> "These students may not have been very successful in previous science courses, and they may see science as a mass of information

> too difficult for them to even begin to comprehend. Yet they can laugh at science-related cartoons that would be incomprehensible without a science background … after showing [students science cartoons] I make appoint of complementing students on their science sophistication [because they were able to understand it]. (p. 241)".

Flannery concluded the exposition of her rationale for using science cartoons in college courses by pointing out that they can also be used to make students aware of the political implications of issues in science and of how many problems affecting the world have a scientific component.

As I mentioned in the introductory section, this medium is not perfect. The literature presents several of the criticism directed at cartoons and comic strips, especially those that are commercially available (Ball, 1976):

The use of violence and crime as a source of humor.

The lack of diversity in content and themes.

The stereotypical portray of some characters.

The hegemony of white male characters in leadership roles or position of centrality.

Women and children are usually shown in positions of passivity and domesticity.

Minorities are seldom represented or assigned positions of respect and prestige.

Poor readers might focus on the pictures rather than in reading.

Scientifically accurate comic strips

In this paper, the use of scientifically accurate comic strips as a pedagogical tool for teaching physical science is advocated. I defined scientifically accurate comic strips as *an original, student-generated sequence of cartoon panels that accurately present a scientific idea or principle, either directly or indirectly, in a humorous or reflective way*. This approach departs significantly from most of the literature on cartoons and comic strips as educational aides in that already made cartoons are not used. For this particular project, students are required to understand the material and develop their own comic strips.

An essential characteristic of scientifically accurate comic strips is that they must present a scientific idea without the presence of misconceptions. Students have received all sorts of scientific, pseudoscientific, and non-scientific information through their daily experiences, their own environment explorations, their social interactions, media, and formal instruction. As a consequence of their constant constructing, deconstructing, processing, and organizing of the received information, college students will have ideas that are not currently supported by the scientific community. The fact that science is accurately portrayed in the students' comic strips results in a very different product from commercial ones, where science misconceptions and alternative science meanings might be created and preserved.

Misconceptions have been studied extensively by physics education researchers over the last 25 years. For a thorough presentation on the topic I

refer the readers to the works of Clement (1982, 1993) and Dykstra, Boyle, and Monarch (1992). If educators want students to have an accurate perception of the content and processes of science, I think it is crucial for students, with the assistance of the class instructor, to discover their own alternative conceptions and challenge them. The creation process of scientifically accurate comic strips is one powerful way for students to confront their incorrect ideas about a physical science topic.

General strategies for using comic strips in the classroom

Medina (1992) suggested a series of steps that teachers should follow in order to maximize the use of cartoons and comic strips as a pedagogical strategy, assuming that the visuals are already prepared or that the teacher will prepare them. First, teachers must do a needs assessment of their students, their previous knowledge and experiences, to determine whether the cartoons and comic strip are appropriate for their age, gender, cognitive level, socioeconomic status, or reading ability. Second, research and evaluation of the resources available is essential, making sure that stereotypes are not preserved, that negative aspects of the material are minimized, and that the message is clear and simple. During this step the teachers need to verify that copyright laws are followed.

Third, the teachers must plan thoroughly, emphasizing the objectives of the lesson and how the visuals will help in their attainment (Ball, 1976). As in all planning, alignment of the topic with state and national standards is highly recommended, as well as ways to evaluate students' learning. Medina (1992) points out that piloting the material with colleagues and a small group of students can help teacher capitalize on the positive aspects observed, while unpredictable limitations or misinterpretations can be addressed.

The fourth step is the actual teaching of the material using the cartoons and comic strips. It is the role of the teachers to formative evaluate their presentation, the students' response, and the learning that is going on during the class. Feedback questions or a small quiz are just two examples of how teachers can conclude the lesson while making sure the use of the visuals was pedagogically successful. As a fifth step, at the end of the lesson, the teachers must look back an analyze to what extent the objectives of the lesson were accomplished, if the message was understood, and how the activity can be improved for future occasions. The sixth and last step recommended by Medina (1992) is to file the cartoons and comic strips, along with useful notes from the teacher about the activity and ways to improve it. Although it sounds obvious, it is very important to keep the material adequately preserved, especially the originals.

If the cartoons and comic strips will be generated by students, the general steps still need to be followed, but with some modifications. For example, planning is even more important to make sure the students' contributions have some didactic value and are not just cute drawings. During instruction, students can be even more involved in the lesson by showing their productions and explaining how the topic of the day is represented in them. Although most times students keep their work, it is

recommended that the teacher keep some examples and exemplars for future reference.

Designing scientifically accurate comic strips: project description

First, I must provide my students with a rationale for doing this project. We talked about misconceptions, higher order thinking skills, and how the creation process results in better and more meaningful science learning, compared with traditional methods of instruction. Then, I ask students to select a physical science topic from the textbook. In my physical science class we cover a range of topics, including kinematics, dynamics, energy, optics, electricity, magnetism, modern physics, the solar system, start formation and evolution, cosmology, weather, and geology. Three basic criteria for choosing a topic are:

The student must feel at ease with the topic and must understand it well.

The topic must have a humorous or reflective potential.

The topic should lend itself for a pictorial representation.

After they chose an appropriate topic, students will brainstorm a variety of ways to integrate the topic into a comic strip. This is an intensive process for some students. For other, the ideas will come relatively easy, depending on their creativity and imagination. Students are strongly encouraged to ask the instructor for his opinion on the comic strip previous to the project's deadline. The instructor's prior approval to the comic strip topic is particularly important in order to identify potential student's misconceptions associated with the chosen topic. It is my experience that students do a good job researching a topic, but some still include incorrect information, either from their own ideas or from websites with incorrect information. Once the students have some ideas they like, they must do the scripting of the story. Wright and Sherman (1999) summarized this important step:

> "This step entails thinking and drafting an idea which, after editing, is placed in a format much like that of a play or a movie script … It cannot be stressed too strongly that the script is the single most important component of a comic strip. Before the comic strip panels can be illustrated, there must be first a story to illustrate (p. 67)".

Finally, the students will create a comic strip in which the science concept is both accurately and humorously presented.

For the technical aspect of the comic strip several strategies can be used, including clip-art, cut-and-paste, or free-hand drawing. Each student will follow the suggested format and guidelines. In the cover page, students must include their name, ID number, and the title of the project. In the introduction: The student must write a one full-page narrative (essay) in which the following questions are addressed: (a) What is the physical concept presented? (b) Why was this concept selected? and (c) Why is it important to present science in an informal context, such as a comic strip? The answer to these questions must be based both on the student's own opinion and the research made at the library or through the Internet. Answering these questions will help students to organize and think about the information they gathered, and to understand that science is not a hard,

unfathomable subject, but a subject with an entertaining and humorous potential.

Next, students will show his/her scientifically accurate comic strip. It will be presented in three pages, with five frames (two per page and the last frame on the third page) that must include action, humor, and dialogue/narration. Each frame will be about 16 square inches. The information in the comic strip must be scientifically accurate and free of misconceptions, but entertaining, reflective, and humorous at the same time. A specific format was suggested to standardize the presentations, however an instructor may want the comic strips to be less restricted in size and number of frames or panels. Sixteen square inches is an adequate size to include detailed drawings, dialogue, and narration.

Finally, in the conclusion section, students will write a one-page narrative (essay) in which the following questions are addressed: (a) What did you learned from this project? (b) How useful did the project was in learning about the physical science concept selected? In the concluding remarks, the students should be able to present a broad view of what they learned from the project, including their struggle to come up with a good idea, technical difficulties for preparing the comic strip, and their reaction when the project was completed.

Evaluating a project like this is not always easy because of its subjective nature. How to evaluate humor, reflection, or technical achievements? I am not an art instructor, however, some predetermined criteria must be used for assessment. These are the criteria I used. The reader might add, modify, or remove some of the items:

Appropriate choice of material for comic strip.

Originality and creativity of choice of material chosen for comic strip.

Originality of thought and insightfulness reflected in comic strip.

Clear understanding of material chosen reflected in comic strip.

Accurate portrayal of the science topic on the comic strip.

Humorous situation is thoughtfully constructed.

Appropriate writing construction and neatness for all parts of assignment.

Evidence of appropriate time and effort spent on assignment.

I would recommend a 1 to 5 Likert scale for each component. Despite the numerical scale, the evaluations are still subjective. The teacher must be aware of this to avoid a harsh assessment. One of the goals of a project like this is for students to explore their creative side while have fun by perceiving science as accessible and humorous.

Designing scientifically accurate comic strips: student feedback

Students' reaction to the creation of scientifically accurate comic strips was overwhelmingly positive. There is no better way to present the students' feedback than to let them speak by themselves. The following are a selection of comments from the written section of the project. Jennifer, for example, explain how comic strips make science less threatening:

> Presenting science in a comical manner such as through a cartoon is an excellent way to grab someone's attention. Many people view science as dull; others feel that it is just too complicated for them to understand. By presenting a concept in a simple way, like a comic strip, one could avoid intimidating [science] students.

Similarly, Katrina emphasized the attention-grabbing and non-threatening nature of comic strips:

> Science is a subject that is taken seriously and often fear by many. In presenting this idea of physical science [weight and mass] in an informal way, it allows people to be less threatened by the technicality of the issue. Also, the humor that is brought about by a comic strip is more likely to attract the attention of people who would normally frown on the ideas of science.

On the other hand, Lance reflects on the efficiency of visual materials, such as comic strips, in promoting learning:

> It is proven that people learn better if they have a picture to go with it. But if the picture is funny, the chances of remembering the concepts will be better … Why not use this powerful tool to expand our learning ability?

Allison aimed her comments as the pedagogical advantages of the project for the students' learning and motivation:

> Asking a student to have fun with learning by doing something such as making a comic strip is a very important technique. One reason for this is that the information students research and discover by themselves is better learned than information that is just told to them. Another reason that this technique works is that students who have fun with their homework tend to retain the information than work that isn't fun and that they are forced to do.

These four themes (how comic strips make science less threatening; the role of comic strips as attention-grabbers; the efficiency of visual materials in promoting learning; and pedagogical advantages of comic strips) were consistently found among students' responses. Most of them also pointed out at the difficulty of the creative process while scripting and designing scientifically accurate comic strips.

Conclusion

Cartoons and comic strips have been used in the teaching of science at all levels. Despite some concerns regarding their use, thoughtful integration of this strategy, which includes extensive planning and a structured assessment, resulted in a high-quality product from my physical science students.

Scientifically accurate comic strip are an innovative way to promote higher order thinking skills by presenting scientific knowledge in a popular form that is enjoyed by most students. My students' responses to this project were both positive and enthusiastic, demonstrating that students can see science as interesting if they are engaged in innovative and challenging science activities. Based on feedback received from my

students, I am convinced that this strategy helped them remember their chosen science concepts because it departs from traditional assessment and lecture dynamics, helped students to see science in a new way, addressed some of the students' science misconceptions, and promoted the incorporation of their artistic minds in the final product. I strongly recommend a scientifically accurate comic strip project, or any other project where science and the arts are integrated (For example, Shakes, 1995).

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Natural Science, Scientific literacy, Scientific knowledge (concepts), Scientific process skills, Scientific values and attitudes, Foundation Phase, Outcomes-based education, Integrated curriculum, Constructivist perspective, Teaching methodologies. OPSOMMING.Â Scientific literacy is also increasingly important in the workplace. The rapid pace of technological change and the globalisation of the marketplace have resulted in the need for individuals with a broad general education, good communication skills, adaptability and commitment to lifelong learning (Goodrum, Hackling and Rennie 2001). People are required to think critically, to solve problems and to use technology effectively. A technology-driven environment depends on a scientifically literate public. Integrating physical science and the graphic arts with scientifically accurate comic strips: Rationale, description, and implementation. Revista Electronica de EnseÃ±anza de las Ciencias, 2(1). 2003. Physics education research in the United States: A summary of its rationale and main findings. Journal of Science Education/REC, 4(1), 5-7.2003. Thermal behavior inside an igloo: An improved model. 1 INTEGRATING SCIENCE & LANGUAGE ARTS VIA TRADEBOOKS: AN ANNOTATED BIBLIOGRAPHY Dr. Thomas O'Brien Binghamton University (SUNY) School of Education and Human Development P.O. Box 6000, Binghamton, New York 13902-6000 607-777-4877(voice mail)/777-6041(Fax)/ Effective science and ELA (especially whole language) instruction share the philosophical assumption that the primary role.Â Science with Lights and Mirrors and Science with Magnets. A Elsohn Ross, Michael.Â Blends factual and funny text, scientifically accurate & offbeat watercolors in a story of Henry, an Australian boy, who tells a rude bus driver exactly where he lives both locally and in the universe at large. M Hoban, Tana.