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AN ALTERNATIVE TEACHING TOOL IN SCIENCE EDUCATION: EDUCATIONAL COMICS

Review article

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Abstract

Comics, which attract attention with their adaptation to changing conditions in the historical process, are increasing their popularity both in current life and in the field of education. They can be used as a powerful supplementary teaching tool concretizing abstract concepts, especially in lessons such as Science. They can also be used to convey abstract concepts to students in an entertaining way. From this point of view, the study aimed to reveal the general characteristics, structure, elements, and historical development of comics at a theoretical level. The study, which adopted a qualitative research design, was based on a wide range of a literature review focusing on comics in an educational context as alternative resources to use in science education. The data collected were coded, grouped, and reorganized as a report to present within the context of science education for the teachers who might plan to use comics in their classes, and researchers who might scrutinize the influence of comics in teaching science at different levels.

Keywords: Comics, supplementary tools, education and training, science education, abstract concepts

Introduction

Current developments in the field of education in the 21st century have led to a series of changes in our understanding of education. Meeting our teaching needs in our age has led to the necessity of preparing teaching materials with a new perspective in the classroom where modern education and training practices are performed together. It is possible to mention many positive effects of teaching materials such as increasing efficiency in the classroom, active participation of students (Tekmen, 2016), and providing permanent learning (Aşçı, 2020).

The most used course material in the process of gaining scientific knowledge of science is undoubtedly the textbooks prepared in accordance with acquisitions in the program. Textbooks allow the subject to be handled systematically as a guide both for teachers and students (Ünal & Demirkaya, 2019); however, in lessons such as science, which has abstract concepts which are difficult to understand, using only the textbook and not supporting it with other course materials may decrease students' interest in the lesson or decrease efficiency.

At this point, we come across comics that are becoming more and more popular in the field of education (Lazarinis, Mazaraki, Verykios & Panagiotakopoulos, 2015; Topkaya, 2016). The combination of images and texts in comics helps students to see the process more attractive by changing their perspective on learning processes (Astuti, Kismini & Prasetyo, 2014). In this respect, different researches have revealed that using comics as a teaching material will have positive contributions to the learning-teaching process (Mamola, 2019; Yang, 2003). In order to understand comics better, it is necessary to express how they are defined, to discuss their features and elements, and to include examples in the historical process. In addition, it is thought that focusing on the use of comics by addressing the role of comics in educational environments will be beneficial for teachers who will use them in their lessons.

1. Comics

Rapid technological developments and changes in our age change our perspective on teaching materials used in education and training environments. Comics, which have become popular in recent years thanks to their content and visuality, are one of these teaching materials. Studies refer to the difficulty of making a general description of comics. Emphasizing this issue, Kireççi (2008) suggests that comics can only be defined according to the current culture and time. At this point, it is important how Rodolphe Töpffer, who is considered to be the founder of modern comics and is also an art critic and educational scientist, defines comics. It is seen that Töpffer describes comics as a consecutive communication tool on a paper with images and texts and points out that the text would be incomplete without the image and that the image would be incomplete without the text (Paltani-Sargologos, 2011). Comics can also be defined as an art of fiction in which a narrative style, formed by the combination of two main elements, text and image, is adopted (Cantek, 2016). In another definition, it is mentioned that comics convey realistic or imaginary ideas by using visual images, and the humour aspect is also emphasized while conveying important messages (Toh, Cheng, Jiang & Lim, 2016). Looking at the definitions, it is seen that the researchers emphasized the combination of text and image. What needs to be noted here is that this combination comes together with a real composition, not as a simple match (Kunzle, 1973). In this case, it would not be wrong to say that comics consist of neither an image nor a text and that they are a synthesis which is achieved by combining images and texts (Cihan, 2014).

The comics industry has gone through many historical stages. Considering the term comics in general, it will be possible to divide them into branches such as graphic novel, newspaper strips, single-panel gag cartoon, superhero comics, web comics, manga, underground comics, alternative comics, and western comics (Bıçakcı, 2018). It is thought that comics, which are accepted as an art type formed in the modern age, carry the function of images and visuals one step further by including the text in the process (Orçan & Kandil İngeç, 2016). The purpose of comics, which contain intentional images created by the combination of side-by-side images, may be to convey information to the audience or to produce only an aesthetic response (McCloud, 1993).

Comics are a form of storytelling. They use a series of static images while presenting a story as a tool (Lazarinis et al., 2015). Unlike regular books, paintings, or movies, it would not be correct to characterize comics as better or worse than other genres; however, it should be admitted that they differ from other genres (Karczewski, 2013). It is important to reveal the basic characteristics of comics which are shaped by a writer in order to understand them better. The basic features of comics are given in Figure 1.

	Comics are a type of story in which images that support each other create a series of subject integrity and fit into a short timeline.
Common features of comics	In comics, fictional elements such as relationships, manners, emotions and thoughts, place and time, and cause and effect relationships are expressed with images and drawings.
	In comics, characters often have features that repeat each other.
	In comics, speech or text is included in the image, and the image and text form a whole. Comics dominated by pictures or texts can also be seen.

Figure 1. Common features of comics (Cantek, 2014; Uslu Üstten, 2014)

Considering the basic features in Figure 1, it is seen that the image in comics is at least as important as the story. At this point, it would be appropriate to mention a specific structural feature of comics. For the meaning integrity of comics, the relationship between the frames is important rather than the image in the frame. The meaning of comics in the spaces between two sequential images is related to the human mind. We complete the story of comics ourselves by creating what is not written and drawn on paper or what does not exist, in our mind. The reason for this is that our mind constructs meaning by establishing a connection between the total symbols formed by written and visual texts while transitioning from one frame to another (Gündüz, 2004). This connection is important for comic book readers to have actions in their minds more easily and to achieve meaningful and permanent learning (Akkaya, 2013).

1.1. Comics in Historical Timeline

Researchers have different comments and opinions regarding how old the history of comics are. According to some, the birth of comics is based on hieroglyphs in ancient times, while some other researchers point out that comics are based on illustrations in Leonardo da Vinci's notebook (McCloud, 1993; McCloud & Manning, 1998). However, comics are neither just images nor texts (Derdiyok, 2019). For this reason, there is no consensus on the starting point of the historical process of comics. One of the most important factors affecting the development of comics is undoubtedly the presence of a printing house. With the advent of the printing press, over time, pictures have taken on a complementary role to stories. It is, therefore, not surprising that the object was ultimately combined with art to make illustrated and narrated series (Olson, 1993).

Comics first became known in France and Belgium in the 1800s. The work named "Voyages et aventures du Docteur Festus" (Travels and Adventures of Doctor Festus), which is the first comic book in history, was completed in 1831 and was published in 1840 with the signature of Rudolphe Töpffer (Gündüz, 2004).

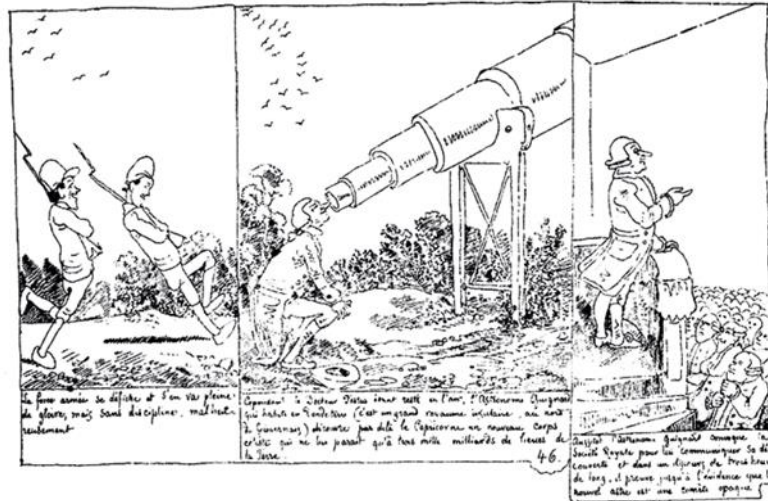


Figure 2. A section from the comic book named "Voyages et aventures du Docteur Festus" (Project Gutenberg Canada, 2013)

In the comic book seen in Figure 2, it is seen that the image and text are given together. In addition, Töpfer chose space travels with his imagination as the subject of his stories (Olson, 1993). A few years later, in 1854, French artist Gustave Doré published “L’Histoire de la Sainte Russie”, a series of 477 consecutive drawings which describe the history of Russia. Around 1865, Wilhelm Busch published "Max and Mauritz", the story of two malevolent children and their hardship and final punishment. This comic book, which has a colourful image on almost every page in addition to the text, had been popular for a long time (Olson, 1993). "Les Aventures de Tintin" (The Adventures of Tintin), published by Georges Lemi in the 1920s, is a comic book that achieved a significant success in those years (Uslu Üstten & Pilav, 2016). An example section of this comic book is given in Figure 3.



Figure 3. A section from the comic book named "Les Aventures de Tintin"

With these developments in the historical processes, comics, which created a readership in Europe, first appeared in the United States in the modern sense at the end of the 19th century (Aşçı, 2020; Symeon, 2008). For the first time, Rudolph Dirks published the comic book "The Katzenjammer Kids" for the New York Times on December 12, 1897 (Armor, 1987). Meanwhile, comics in England developed under the influence of American publications, while Germany fell behind in the field of comics due to the social and economic conditions that emerged after the war (Uslu Üstten & Pilav, 2016).

In our country, the first comics entered our lives after the First World War. When the first comic book examples in Turkey are considered, it is seen that the character of “Amcabey”

drawn by the cartoonist Cemal Nadir Güler in 1929 is important. The main character of this comic book is given in Figure 4.



Figure 4. The main character in the comic book named "Amcabey" by Cemal Nadir

In the following years, the magazine named "Binbir Roman" published in Istanbul made an important contribution with its comic book content compared to the developments in the period (Kurt, 2019). It can be stated that qualified publications started with "Phantom" in the 1940s. In the following years, comics, which won the appreciation of our country's readers, started to appear in newspapers, especially with series of drama, adventure, love, and comedy. With the publication of colorful magazines depicting western heroes such as Mandrake, Zagor, Mister No, Flash Gordon and Tarzan, a serious comic culture was formed in that period (Çetin, 2010). Turkish comics tradition, which started with the translation method at first, later had a realistic, rational, local, and national direction that fed on Turkish history (Karagöz, 2018).

When we look at the historical process of comics, it is understood that they were accepted as a second-class type of literature or a low art form for a period, and they did not, therefore, see the value they deserved (Jacobs, 2007; Upson & Hall, 2013). The fact that comics mostly consist of images and that they do not deal with subjects deeply is accepted as the main reasons for being unfairly ignored (Tatalovic, 2009). In addition, it was suggested that comics were designed for children, people who did not like reading, or adults clinging to adolescence (Lo et al., 2019). For these reasons, there was a tendency among many educators and parents to believe that comics were created only for entertainment purposes and had little or no real educational and literary values (Lo et al., 2019). In fact, these beliefs at first prevented the use of comics in the education and training process. To exemplify, similar situations were experienced during periods when it was considered objectionable to teach comics in schools, and it was prohibited to read comics during the education process (Toh, Cheng, Ho, Jiang & Lim, 2017). Comics were traditionally seen as the "enemy" of schools, and students caught reading comics in schools were referred to the disciplinary committee (Clever, 2008). However, these periods did not last long, and comics, which are now appreciated as a potentially important educational tool to attract students' interest in various academic subjects, have regained the value and importance they have deserved (Tilley, 2008; Lo et al., 2019).

Today's comic books, which are more entertaining and engaging than the ones in the past and include subjects for adults, have significantly increased their popularity through comic book films and television series in recent years (Çetin, 2010). The Road to Perdition, Ghost World, Incredible Hulk, Sin City, X-Men, The Fantastic Four and Snowpiercer are among the comics adapted into films. With these films, which are the adaptations of comic book stories, the educational value of comics, which have proven their influence on popular culture, has begun to be re-evaluated by different researches (Lo et al., 2019).

1.2. Elements of Comics

Comics have elements that ensure the integrity of their unique structures. These elements that make up comics are shown in Figure 5 (Tuncer, 1993).

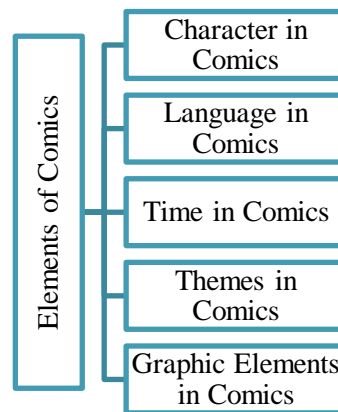


Figure 5. Elements of comics

The elements that make up comics will be explained under separate titles.

1.2.1. Character in comics

Character is the main element of comics. For this reason, many comics are named after their characters (Kireççi, 2008). The story narrated in comics is processed through characters; therefore, characters are important for the reader. Characters are in favour of goodness, direct and order (Saribıyık, 2018). The reader feels close to and embrace characters for a reason. In fact, the reader can sometimes experience the character's emotional state in their inner world.

Although comic book heroes are mainly selected from male characters (such as Batman and Superman), there are also comics (such as Black Widow and Wonderwoman) in which female heroes are the main characters (Mutlu, 2019; Tuncer, 1993). The main character can be male or female, as well as a plant or an animal. For example, "Snoopy", a comic book whose main character is a dog, thinks and speaks like a human.

1.2.2. Language in comics

It is possible to say that comics have a special language of expression. Thanks to the relationship between the frames, the idea to be conveyed is expressed clearly. In the spaces between the panels, the connections established on the basis of the reader's mind make the story complete by creating a part that is not drawn in the mind (Güdek, 2019). For this reason, it is very important to use a language based on visual experience that will attract the attention of the reader (Eisner, 2008). If we think of comics as a means of communication, the language created with text and images must find its counterpart in the imagination of the reader in order for communication to take place (Yavuz, 2011).

The language used in comics acts as a bridge between everyday language and academic language, which is thought to positively affect the success in the lesson (Krashen, 1993). In comics, language and expression are shown in speech and thinking bubbles. Understanding who it belongs to is provided by directing an arrow from the bottom of the balloon towards the head of the character (Saribıyık, 2018).



Figure 6. Speech bubbles used in comics

When the reader see the text or balloons, they understand that the character whispers (the lines that make up the speech bubble are broken), speaks loudly or shouts (text written in bold and capital letters without a speech bubble), or even thinks (the speech bubble looks like a cloud and small bubbles reaching out to the person it belongs to) (Sarıbyık, 2018).

1.2.3. Time in comics

Time is flexible and unlimited in comics; therefore, it can be directed backwards or forwards (Sarıbyık, 2018). It is possible to travel in time thanks to the writer in comics. It is thought that experiencing and transferring stories in comics in the present time attract the attention of the reader (Tuncer, 1993).

Comics inform the reader about the time they are in. Details such as the dressing style of characters, the architectural features of the place where the story takes place, the elements of life, the presence/absence of technological products, the primitiveness/modernity of the tools used are given both to reflect the time to the reader in a detailed and impressive way and to connect the reader to the story more. For example, in the comic "Redkit", the story takes place at the end of the 19th century. The time involved in the comic book story affected the communication method in the story. It is seen that Redkit often uses telegrams to communicate. For transportation, besides the horse carriage, a train road draws attention (Yavuz, 2011). With such visual schemes, it can give information to the reader about those periods about which they do not have much information (Sarıbyık, 2018).

1.2.4. Theme in comics

The value judgments of societies are different from each other. Comics are also influenced by the characteristics of the society in which they originate, and are often used to comment on current issues (Tatalovic, 2009). Different comics have been developed on different subjects for various educational purposes at educational levels (Lazarinis et al., 2015). Comics dealing with history, politics, or bureaucracy can be classified within the framework of adventure, politics, and history. Classification of comics around a category can create a certain audience (Sarıbyık, 2018). Throughout the historical process, themes in comics started with simple stories and later left their place to superheroes. After the World War I, superheroes started to lose interest and comics dealing with topics such as crime, thriller and science fiction came to the fore (Aşçı, 2020).

Comics present themes to the reader with the method of uninterrupted illustration. It is thought that it will be beneficial to reveal the details of the message that is desired to be given to the reader if the main message is presented briefly and concisely (Topkaya, 2014). The fact that people tend to and prefer topics that attract people's attention has made the concept of theme in comics one of the determining factors for the preference of the readership.

1.2.5. Graphic elements in comics

Illustrations in comics have a strong effect on keeping the story alive to the reader. Visuals in comics are effective in guiding readers' perception of spatial relationships within a certain context (Pratt, 2009). Preserving the balance between the text and the image in comics and the fact that writing does not dominate when telling the story are significant and should be considered (Saribiyık, 2018). Having more text disrupts the follow-up feature of continuity between the images and makes it boring (Cantek, 2014).

The use of images in comics is effective in terms of improving students' ability to construct information with more than one method (Bolton-Gary, 2012). This is very important for students to prepare for their future life (Toh et al., 2017).

2. The Relationship Between Comics and Other Disciplines

Different disciplines communicate with each other. This context supports each other and enables the development of related disciplines (Saribiyık, 2018). In this section, the interaction of comics with education will be examined.

2.1. Comics in the Education Process

When we look at the historical development of comics, it is seen that they were first published in newspapers and magazines and then published in print. Later, educational and informative elements were added to the contents of comics, as a consequence of which they were used in the field of education (Karagöz, 2018). This new genre was named "educational comics".

Comics can be used as an important and powerful supplementary teaching tool in various educational environments (Berkowitz & Packer, 2001; Cimermanová, 2015; Rajendra, 2015). In this respect, the potential of comics in the education and training process emerges as a subject worth researching (Marianthi, Boulodakis & Retalis, 2016). In fact, the use of comics as a tool in education is not new (Owens, Eno, Abrams & Bedney, 2020). The basis of using comics in education is based on the binary coding theory of Clark and Paivio (1991). This theory, which supports the importance of images in cognitive operations, is based on the development of recall and recognition by presenting information both visually and verbally (Marianthi et al., 2016).

Comics are generally used as an educational material or activity in a visually enriched format, preserving the features mentioned in the definitions in education and training environments (Akkaya, 2013; Joshi et al., 2019). It is thought that, if comics are prepared in accordance with two sound pedagogical principles, comics will support students' learning. The first is to position stories that might be interesting for students in a certain context, whereas the second is to establish a meaningful bridge between the concepts discussed and the students' real life (Toh et al., 2016).

Since educational comics contain two very rich forms of cultural expression, the arts of literature and painting, students actively participate in the learning process by structuring the gaps between these two panels that require active thinking while reading comics (Rota & Izquierdo, 2003). From this aspect, it can be said that this feature of educational comics is suitable for the constructivist approach model (Topkaya, 2016).

Many educators make use of comics to facilitate a better understanding of a certain subject by employing both linguistic and image systems (Liu, 2004). Comics both improve mental processes, which are the indispensable elements of the cognitive field, and develop aesthetic pleasure in students who are an important element of the emotional field (Akkaya, 2013). Based

on the researchers conducted to reveal the effect of comics in the field of education, the benefits of using comics in the education and training process are shown in Figure 7.

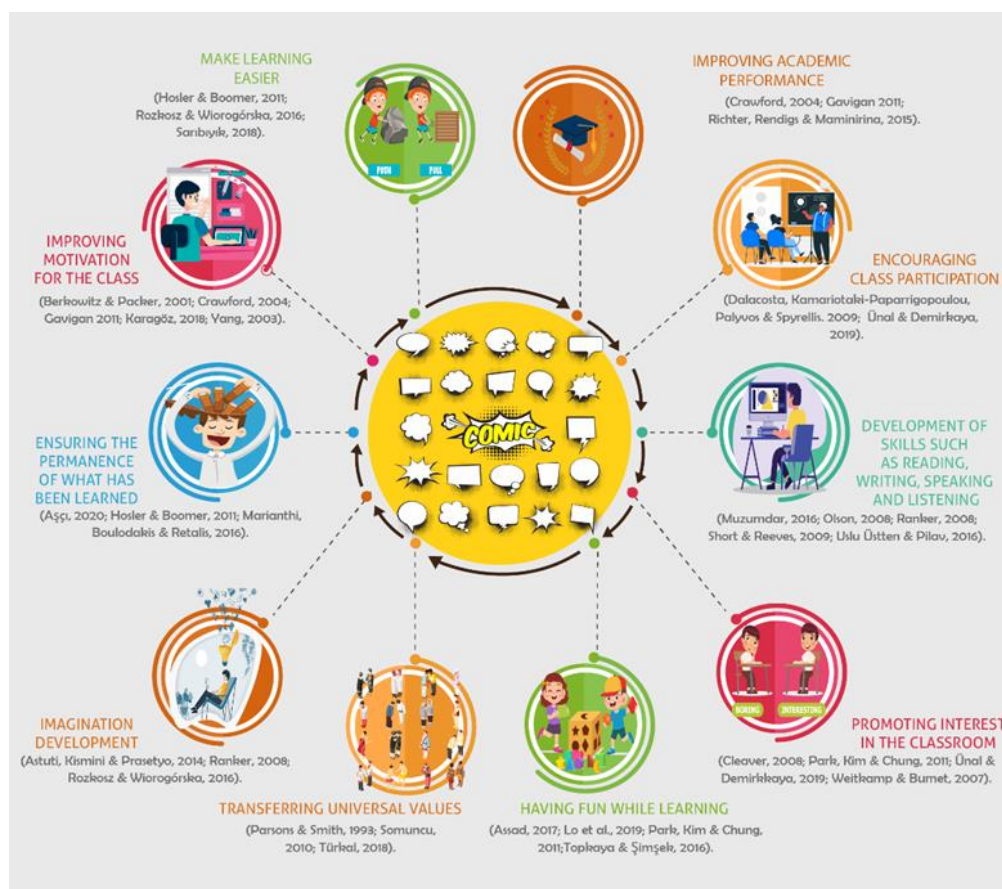


Figure 7. Benefits of using comics in education and training

As can be understood from Figure 7, the inclusion of comics in the education process affects children positively in many related ways. The fact that comics improve the level of children both in terms of skills and cognition is considered to be important for the future lives of children as well as their current experiences.

In addition to their positive contributions to learning and teaching processes, educational comics also have some limitations. Some of these are as follows: limitations arising from educational programs; difficulty in accessing educational comics; inadequate use in the classroom environment due to reasons such as additional burden on teachers (Karagöz, 2018). The small font size in educational comics is also thought to be a deficiency in these materials (Topkaya & Yılar, 2015).

2.2. Comics and Science Education

The benefits of using written teaching tools such as books and journals in science teaching are known by everyone (Falk, Storksdieck & Dierking, 2007). Today, however, these tools fall short of meeting the need to convey the fascination, joy, and utility of science (Hosler & Boomer, 2011; Roswati, Rustaman & Nugraha, 2019). Although science is still taught with written teaching tools based on the traditional education model (Eshach & Fried, 2005), it is actually a discipline that allows the use of new educational resources to encourage students' learning (Morel, Peruzzo, Juele & Amarelle, 2019). Among these new educational resources,

one of the most accessible and useful written tools in science education is comics (Roswati et al., 2019).

Besides being a popular art form especially for children, comics provide a potential environment for science education (Tatalovic, 2009). In this context, comics that address children's interests can be used as alternative resources in science education (Koutníková, 2017; Seitz, 2012; Shurkin, 2015). Comics are very useful tools for educators to teach complex science subjects in a short, appropriate and effective manner, to help explain a world made up of abstract science concepts to students (Morel et al., 2019), and to prevent misconceptions that may occur in students (Asci, 2020). Comics prepared to convey a subject in science education lead students to think about science, which can be used to explain scientific knowledge (Orçan & Kandil İnceç, 2016). Educational comics, which are used for science concepts to get rid of complexity and abstraction, can provide the permanence of knowledge and eliminate forgetting caused by rote learning since they are visually attractive to students (Şengül & Dereli, 2010). While reading comics, students try to establish a relationship between the text and the image and participate fully and actively in the learning-teaching process (Dalacosta, Kamariotaki-Paparrigopoulou, Palyvos & Spyrellis, 2009; Rota & Izquierdo, 2003).

In science education, comics are also used to involve students in complex hypothetical scenarios before the real physical classroom experience (Upson & Hall, 2013). Olson (2008) and Tilley (2008) found that using comics improved science literacy by increasing students' opportunities to read and discuss science topics. For example, a science teacher who would like his students to have a sufficient understanding of the nature of science and to be science literate can explain the process of creating scientific knowledge by using comics or use comics as documents to shed light on the relevant period. Figure 8 shows an example comic book.



Figure 8. An example comic book (Akgül, 2016)

Comics to be used in science education should have three significant characteristics which are humour, visualizing learning and contextualizing learning (Lin, Lin, Lee & Yore, 2015). The humorous aspect of comics helps students to handle the tension in the classroom, to reduce their embarrassment, and to relieve their troubles (Özdemir, 2017). The fact that children both enjoy reading comics and are affected by the visual appeal of the graphic presentation make comics an effective tool in learning scientific concepts (Weitkamp & Burnet, 2007). However, comics are effective in affecting and shaping students' attitudes towards science positively (Hosler & Boomer, 2011). They also support the development of their logical thinking (Rozkosz & Wiorogórska, 2016). However, it is not always easy to find ideal and suitable comics that can be used as a teaching tool in science education. While the content of some

comics is not proper for the culture of students, the content of some may not be suitable for learning science (Özdemir, 2017; Roswati et al., 2019). In this case, it may be necessary for teachers to prepare the teaching material to be used by themselves.

At this point, it will be useful to focus on some characteristics that need to be considered while preparing comics in science education.

- Scientific information in speech bubbles should be short and clear in order to increase the effectiveness of comics.
- The drawings of the comics to be used in science education should be simple and should be associated with the objectives of the lesson.
- The characters and texts in the comics to be used in science education must be related to daily life.
- Comics should be prepared within a fiction and should have some basic characteristics such as place, time, and character support.
- It is preferred that the comics to be used in science education are short and consist of 3 to 5 frames.
- In order to reveal whether students have acquired the desired scientific knowledge or not, a discussion environment where opinions can be expressed freely should be created and questions should be asked where opinions can be evaluated (Cantek, 2016; Kireççi, 2008; Özdemir, 2010).

In Figure 9, three separate sections of comics prepared with drawing for science lesson are given.



Figure 9. Three separate sections of comics prepared with drawing for science lesson

When looking at the sample sections in Figure 9, it is seen that different science concepts and events are discussed (Volcanoes, importance of forests, and weather events). It is understood that the comics were created by combining the texts and images effectively, reflecting the emotion of the characters through body language, drawing speech or imagination bubbles, and reflecting the relevant scientific subject correctly.

In general, studies on the use of comics in science education show that comics are an exciting tool to increase the interaction with science (Farinella, 2018a; Shurkin, 2015). In these studies, although the effect of comics in science teaching is mentioned, the quantitative effects of comics have not been explored to a large extent (Farinella, 2018b). From a more general

perspective, the common result of those studies on the use of comics in science education is that science is important and worth introducing through comics (Tatalovic, 2009).

2.3. Educational Comic Book Examples Which Can Be Used in Science Education

In this section, examples of comics that can be used as alternative teaching materials in science education will be introduced.

2.3.1. Fen Öyküleri (Science Stories)

In the relevant book, the author presents his science stories to the reader in single-page comic sections. Figure 10 contains three examples of comics in the book.

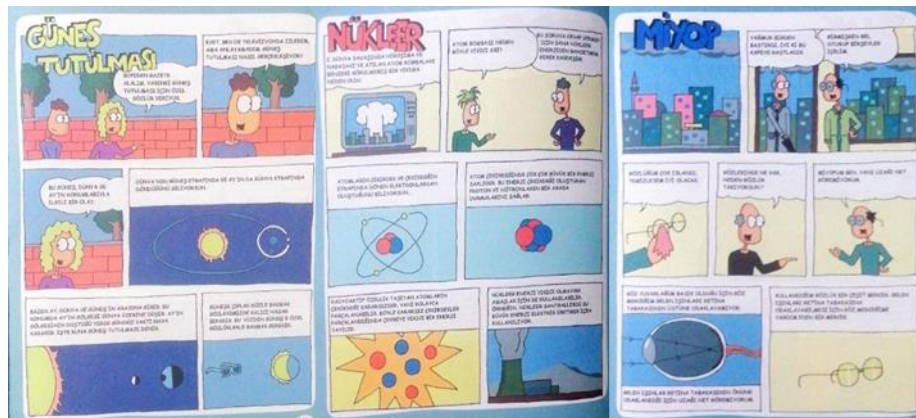


Figure 10. Fen Öyküleri (Science Stories) (Özdemir, 2006)

Figure 10 shows examples of comics under the titles 'Solar Eclipse', 'Nuclear Energy' and 'Myopia'. A striking point in the book is that the science stories are selected from concepts and events related to daily life. It is thought that the objective of establishing a connection with science concepts in daily life and explaining this with comics is to reveal the fun aspects of science and to make readers realize how much it is in our lives.

2.3.2. Robotik ile Bilim Çizgi Roman Serisi (Science Comics Series with Robotics)

This series, which consists of 8 books, examines magnets, energy, force and motion in our bodies, matter, volcanoes, and weather events and recycling, and focuses on the stories of two brothers who are interested in science and discovering science in real and daily life. Figure 11 contains a 3-page section of the "energy" book.



Figure 11. A three-page section from the book entitled Robotik ile bilim çizgi roman serisi-2 enerji (Science Comics Series with Robotics-2 Energy) (Öncü, 2020)

In the comic book in Figure 11, the combination of text and visual elements stands out. In this book, which makes it easier for readers to find something from themselves with the

selection of child characters, science concepts which are perceived as difficult are also reflected in an entertaining way.

2.3.3. Bilimin Çizgi Romanı (Comics of Science)

There is a total of 26 books in this comics series, and in this way, it is aimed for children to grasp the basics of Science and to explore the world of science in a fun way. When we look at the subjects discussed in this series, it is seen that they are selected from a wide range of subjects from electricity to heat, from magnetism to gravity, and from systems to life cycles. Figure 12 contains sections of the comics in three separate books in the series.



Figure 12. Sample sections in three separate books in Bilimin Çizgi Romanı (Comics of Science) (Midthun & Hiti, 2016a; 2016b; 2017)

In Figure 12, there are one-page sample sections from "matter and properties", "structure and classification of plants" and "sound" books, respectively. In each book, a main character is determined in relation to the subject, and the story is given over that character. Every concept mentioned by this main character in the story is explained in the glossary section at the end of the book.

2.3.4. Dünyaya Yön Verenler Serisi (Those Shaping the World' Series)

This series consists of 5 books including scientists such as Issac Newton, Albert Einstein and Aziz Sançar. In each book, a short journey is made to the lives of scientists covered in that book. Figure 13 contains a sample section from the book "Albert Einstein".

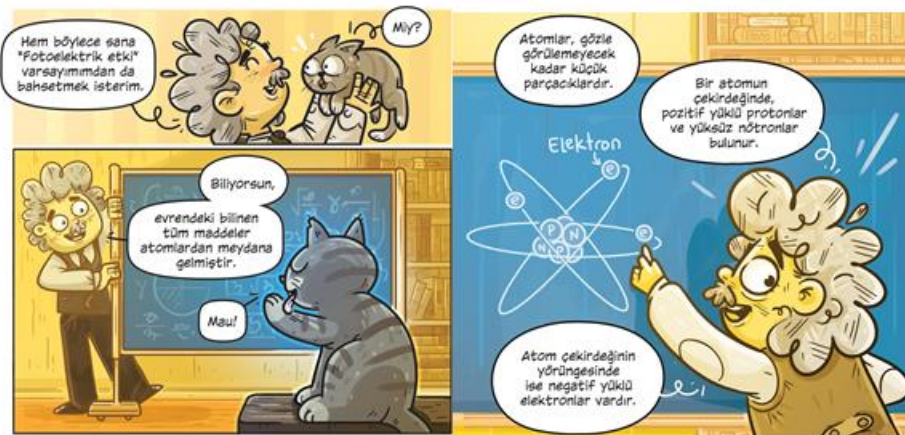


Figure 13. A sample section from the book 'Albert Einstein' (Akgül, 2017)

Figure 13 shows that an entertaining narrative style was adopted in the comic book named Albert Einstein. In this comic book drawn by the author, scientific subjects such as space-time

relationship, photoelectric effect, Brownian motion and energy are presented in a simple but understandable language from Einstein's mouth.

3. Conclusion and Recommendation

In the 21st century, educational comics have become a trend again with its power to guide students to acquire concepts in the education and training process. The complex combination of image and text and the harmony they reveal create a new context with the story they tell. In this respect, it is thought that educational comics go one step ahead of traditional textbooks. The integration of comics with teaching activities will open a new window to students' imagination and thus contribute to their creative thinking processes. In addition, these visually enriched teaching materials are considered to be important in developing children's visual perception skills and preparing them for the future world. For this reason, it is thought that the relationships students establish with comics should not be ignored.

In science classes there are huge number of concepts that are abstract and difficult to conceptualize for students and real challenges for teachers to teach. However, today, teachers, experts, academics and even parents discover numerous ways to make the educational process fruitful, joyful, interactive and memorable for the learners. Educational comics are among the most easily accessible and affordable resources to use in the classes for teaching any subject effectively. Therefore, educational comics that enable students to be interested in an academic subject can also be used easily in science education. While using educational comics in science education, special attention should be paid to the blending of entertainment or excitement elements with scientific knowledge. In these comics, it is absolutely necessary to adhere to the gains in the curriculum. From this perspective, it is thought that transferring scientific knowledge to students in an interesting way will be effective in terms of students' perception of science subjects, with which they often have a difficulty, with a clearer meaning in a more interesting way.

Choosing the topics of educational comics to be used in science education from daily life will enable students to find a harmony between their life activities and school experiences. By combining visual information with verbal explanations, the permanence of the information acquired by students will increase, and they will participate more actively in science lessons with this interesting teaching tool. This will affect students' science learning and contribute to their learning more meaningfully. In this way, it is thought that possible misconceptions that may occur in students can be prevented. At the same time, including information on social problems including science and technology in educational comics will increase students' science literacy. Considering their contribution to the education and training process, it is recommended to include educational comics in different courses, especially in science.

In this study, various samples and ideas are presented to increase awareness about how comics can be made use of in science education. The documents presented shows comics can easily be used for entertaining and educating purposes in science classes. In some documents this feature of comics makes them true edutainment tools to consider as alternative education tools. Researchers, teachers and academics may conduct deeper and wider researches on the types of comics, adopting them in to educational settings in relation with different educational theories and practices.

4. Conflict of Interest

The author declares that there is no conflict of interest.

5. Ethics Committee Approval

The author confirms that the study does not need ethics committee approval according to the research integrity rules in their country.

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