Representation of Science, Environment, Technology, and Society in Science Comics for Junior High School

Ani Widyawati¹, Laily Rochmawati Listiyani², Krida Singgih Kuncoro³
¹, ² & ³ Universitas Sarjanawiyata Tamansiswa, ¹, ² & ³ Indonesia

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Ani Widyawati 1, Laily Rochmawati Listiyani 2, Krida Singgih Kuncoro 3
Universitas Sarjanawiyata Tamansiswa 1,2,3, Indonesia 1,2,3
ani.widyawati@ustjogja.ac.id 1

Abstract
Advances in technology cause a lot of damage to the environment and cultural shifts in society. This condition requires learning to integrate technology with the environment and society. Society-based industrial era 4.0 towards 5.0 studying and technology must pay attention to the preservation of nature and culture in society. The approach that fits this mandate is SETS (science, environment, technology, and society). The SETS approach can be applied in various media, methods and learning models. One of them is a science comic for junior high school that has included the SETS component in its material. This research is a qualitative descriptive study about the relationship between SETS components in junior high school science comics. The instruments in this study were data cards and operational definitions. The data in this study are in the form of words, language, pictures, and behavior that show the representation of the SETS components. The analysis results show that all SETS components have been represented in the science comics. SETS which is integrated into the learning process is expected to improve the quality of students in facing an increasingly advanced industrial era but still environmentally friendly.

Keywords: SETS, Science, Comics

Introduction

The concept of science is closely related to events that occur in the daily lives of students (Sinatra, Heddy, & Lombardi, 2015; Sithole et al., 2017; Vieira & Tenerreiro-Vieira, 2016). At present, students' daily lives are not far from technological developments, as well as various environmental issues (Lee, 2018; Takei, 2019; Wyner & DeSalle, 2020; Zimmerman & Weible, 2017). How students can play a role in society related to technological advances and nature conservation through the scientific concepts they learn. From this phenomenon, science learning should reveal various contextual problems and can be studied from various perspectives of science, technology, the environment, and its benefits for society. Science, Environment, Technology and Society (SETS) is a learning approach that links the concepts and content of science studied with the environment, technology and society that are relevant as a form of integrated science learning (Atmojo, Rusilowati, & Dwiningrum, 2020; Hairida, 2017; Usmeldi, Amini, & Trisna, 2017). Students are invited to link and analyze the linkages of various knowledge with other elements in SETS so that a complete understanding is formed both in the form of strengths and weaknesses of the information obtained.

The linkage of SETS elements in learning activities is a characteristic in understanding information so that students can benefit and make decisions in a problem faced (Binadja, 1996; Budi & Sumarno, 2018; Maimunah, 2017). Another benefit of the integrated SETS approach in learning is the transformation of science in the form of technology, science is not just a science but as one of the keys in the development and utilization of technology for the benefit of society, especially in solving practical problems, of economic value with environmentally friendly products (Imaduddin & Hidayah, 2019; Prasasti & Listiani, 2019). This is the basis for the SETS approach that will continue to be of interest in the development of education in Indonesia.

Hasanah & Mahdian (2016) argue that science learning does not only emphasize understanding but needs to connect with other elements such as technology, the environment and society because the position of science has an essential role in responding to various issues in society as a result of the development of science and technology. SETS-based learning begins with simple or complex concepts that appear in the daily environment of students
(Khasanah, 2015). Students are given the freedom to explore the relationship between the concepts they learn and the environment and technology.

The characteristics of science learning with the SETS approach include 1) students are faced with a problem situation to understand the benefits of learning science to a form of technology that is needed by society; 2) students analyze the possible impact that occurs in the transfer of science to technology; 3) students are asked to explain the relationship between the science concepts studied with other elements in the relevant SETS; 4) students analyze the benefits or disadvantages of using the concept of science when it is changed in the use of technology; and 5) provide opportunities for students to express ideas about solving problems in their environment by constructivism theory. Besides, (Retno & Marlina, 2018) stated that the SETS approach invites students to look for the impact of losses that may arise from the application of technology on the environment and society.

The National Science Teacher Association (NSTA) compiles the learning stages using the SETS approach as follows: 1) the invitation stage; 2) exploration stage; 3) the solution stage; 4) application stage; and 5) concept maturation stage (Khasanah, 2015). In order to integrate the SETS approach in science learning, of course, various forms of media, learning tools, and learning models are needed that support the delivery of material to students. (Yulistiana, 2015) explained that SETS-based science learning, accompanied by interactive multimedia was effective in improving students’ process skills.

Based on researchers’ observations on the content and use of learning media, many media have not integrated various elements or material components in an integrated manner. So far the integration has been limited to cross-material only and does not reach broad and comprehensive benefits, even though the use of exciting media is a learning strategy that leads students to understand the concept of the material as a whole. Visual media is an alternative delivery of information that can explain in detail various phenomena that cannot be encountered directly by students. One example is by teaching science concepts through science comics, to create exciting and fun learning. The function of comics in conveying ideas, transport a substantial amount of information through imagery, an excellent way of encouraging students to think creatively and have the potential to make scientific subjects more accessible. (Farinella, 2018; Friesen, Van Stan, & Elleuche, 2018; Koutníková, 2017; Purwanto, 2013).

Comics are a form of visual communication media to convey information to make it easier to understand because they contain pictures and writing in one storyline and causing an aesthetic experience (Farinella, 2018; Koutníková, 2017; Waluyanto, 2006). According to (Enawati & Sari, 2010), comic media can improve student learning outcomes, increase activity and motivation during learning because of the delivery of exciting concepts. Meanwhile, (Puspitorini, Prodjosantoso, Subali, & Jumadi, 2014; Shurkin, 2015; Spiegel, McQuillan, Halpin, Matuk, & Diamond, 2013) stated that comic media was able to improve the cognitive and affective learning outcomes of students on science material. Based on these observations, the SETS approach that is integrated into science comics is fascinating to present. Therefore, this research will examine the benefits and suitability of science concepts with SETS contained in science comics as one of the learning media for junior high school students.

**Method**

This research is qualitative research with descriptive analysis. Qualitative descriptive research is the most basic research that describes natural occurrences without giving any engineering to the object under study (Sukmadinata, 2012). Qualitative descriptive research aims to describe a data or phenomenon according to the facts without engineering or treating the object under study. In this study, a junior high school science comic book entitled "Tanah Surga" was written by Ani Widyawati and Laily RL. The data in this research is a representation of the components of Science, Environment, Technology and Society (SETS) in the Science comic for junior high school entitled "Tanah Surga".

Researchers are a vital instrument in qualitative research "the researcher is the key instrument” (Sugiyono, 2015). (Creswell, 2012) states that researchers, as a critical instrument, use documentation, observation, or interviews in collecting data. Researchers do not usually use other people’s instruments in qualitative descriptive research. The instrument in this study is the researcher himself who is equipped with theories, concepts, and data cards about the representation of Science, Environment, Technology and Society (SETS) from various reliable sources.

Sugiyono (2015) states that in qualitative research, data collection is carried out in natural settings (natural conditions), primary data sources, and more data collection techniques are participant observation, in-depth
interviews, and documentation. The data collection technique in this study was to record documentation. This reading note technique was used because the source of the data the researcher had was comic book documents.

Results and Discussion

The source of data in this study is a science comic book entitled "Tanah Surga" which consists of 6 episodes in a separate book. The titles of each episode are as follows: 1) “Kue Lapis Raksasa” (Giant Layer Cake), 2) “Di Atas Langit Ada Langit” (Above the Sky There is Sky), 3) “Selimut Api” (Blanket of Fire), 4) “Bumi Berguncang” (Earth Shakes), 5) “Pasak Bumi” (Earth Pegs), and 6) “Sumber Kehidupan” (Source of Life). The results of the analysis of the representation of Science, Environment, Technology and Society (SETS) from each episode in the science comic book entitled “Tanah Surga” are as follows.

Science

The science element is based on the core competencies (KI) and basic competencies (KD) that comics will make. Knowledge material that includes in the comic is adjusted to the material according to basic competency and in the teacher's book. Basic competencies that used as references in the making of these comics are KD 3.10 and 4.10, as shown in Figure 1. These basic competencies are translated into indicators of competency attainment that become references for the content of science in each episode.

The science component of episode 4 is shown on all pages of the comic. In episode 4, students were invited to learn about earthquakes in a comprehensive manner starting from the causes, effects, how to protect themselves
during an earthquake, the epicenter, the hypocenter, and how to measure the strength of an earthquake. Science in episode 5 contains lessons related to volcanic structure, volcanic characteristics, rings of fire, signs of an eruption, the process of erupting, and solutions to overcome the risk of volcanic eruptions. The science elements in the last episode discuss water, rain, the hydrological cycle, hydrosphere characteristics, flooding, and flood prevention solutions. The science element in the “Tanah Surga” comics shows that the concepts discussed refer to KD 3.10 and 4.10 where students are invited to learn concepts about the structure of the earth which are discussed comprehensively in each episode. One representation of the science components of each episode is shown in Figure 2. This is in line with research conducted by (Muslimin, Sugianti, Febianti, & Putri, 2019) which states that the material taught using SETS can be easily absorbed and understood by students. This is in line with the results of (Affeldt, Meinhart, & Eilks, 2018) research which states that comics are seen as a more open force. Connecting comics to the context of everyday life make learning experiences more vibrant and allows students to connect with science questions.

![Science elements representation](image)

**Figure 2. Science elements representation**

**Environment**

The relationship between environmental elements is shown with pictures of the school environment and green roads full of shady plants and trees, clean and comfortable beach conditions. An example of the relationship between environmental elements in the science comic “Land of Heaven” is shown in Figure 3.
This depiction invites students to keep the environment green and clean. One of the environmental representations is shown on page 5 of episode 1, which shows a beautiful, clean, and comfortable beach condition. In each episode, the environmental conditions around the house, school, and road are described as green and clean areas. Environmental representatives in the comics also take the form of an invitation to keep the environment clean, the prohibition of throwing garbage in any place including rivers or gutters because it can cause flooding, besides teaching students how to treat waste or garbage by reduce, reuse, and recycle. Environmental components are also depicted through terasering and reforestation images which teach students how to protect the environment from flooding and landslides. The environmental concept in the comics is also shown through stories about ozone damage that causes global warming and how students play an active role in reducing ozone damage, for example reducing the use of air conditioning, minimizing motorized vehicle use, and keeping forests from burning. The environmental concept in SETS is intended to teach students how to preserve nature and protect the earth from more severe damage related to the development of science and technology so that people's lives are safe and comfortable. The representation of environmental elements in the comics is complete and depicted. This is in line with the results of research conducted by (Munawwaroh, Priyono, & Ningsih, 2018), which states that comics present real-life situations in the form of fun illustrated stories and inserted with moral values that provide a positive impact on character education, especially caring for the environment.

**Technology**

The technology element in SETS aims to invite students to be creative and innovative while still thinking critically. This was intended so that students could continue to learn about the increasingly rapid technological advances but remain critical of the side effects of technology on the environment and society. This learning aims so that students can choose environmentally friendly technology and minimize technology that damages the environment. The application of technology in science comics is very diverse because the material is indeed diverse and comprehensive in each episode. Some examples of technological elements in comics are shown in Figure 4.
The representation of technology in each episode varies according to the material discussed. One example of the application of technology is to show images of several tools related to matter, for example, a tool for measuring the magnitude of an earthquake, a filtration device for a chimney in a factory, advances in equipment from time to time, and simple scientific equipment such as a thermometer. The representation of technological elements is still lacking in detail and is not up to date. The technology shown in several episodes is still simple and does not match the material discussed. This is in accordance with the results of research conducted by (Lin, Lin, Lee, & Yore, 2015) that learning technology through comics is more interesting than just through text because it is able to change science into simple words to make science easy to learn.

**Society**

The SETS approach invites students to learn how to construct knowledge in order to produce technology that is environmentally friendly and safe for society. The society is very influential also on the preservation of the environment. Increasingly sophisticated technology is also the role of the scientific society. It is the people who study science to produce technology. Finally, in one sentence, it can be concluded that all come from society and will return to society. The SETS approach requires students to think creatively and in solutions in order to solve problems in society related to advances in science and technology.

The application of the society component in the comics does not appear explicit. The elements of society are depicted through several things in the form of pictures and conversations of characters in comics. The connection with the society is also shown through conversations that tell the impact of floods, landslides, tsunamis, volcanic eruptions and global warming on humans and other living things. Conversations in the comics also teach students the effects of technological advances on public health such as smoke emitted by factory chimneys, motor vehicles, the causes and effects of acid rain on humans, and the impact of using plastic. The evidence of the application of elements of society in comics is shown in Figure 5.
The relationship between the elements of society is still not explicitly depicted in the comics. The conversations and pictures in the comics in each episode have not discussed in-depth the relationship between the concepts learned and technology on people's lives. However, the results of research conducted by (Farinella, 2018) reveal that comics can be a useful solution for dealing with sensitive subjects, which may resist cognitive elaboration because of conflicts of interest and/or lack of interest among readers.

**Conclusion**

Based on the results and discussion of the relationship between each SETS element in the science comic entitled "Tanah Surga", it can be concluded that each component of SETS, namely Science, Environment, Technology and Society, has appeared in the comic. The representation of each SETS element is not as deep as in the comics. This is because comics are the teaching material used by teachers in the learning process in the classroom so that it focuses more on the content of the material (science) which is entirely written in the new comics and then linked to other elements (technology, environment, and society). The representation of knowledge is evident and comprehensive, as well as the relationship between environmental elements. The connection between the elements of technology is still not deep enough, and not all episodes show advanced technology and are by the material discussed. The representation of elements of society is also considered to be still not being thoroughly discussed in comics.

**Recommendations**

This article is recommended to all educators in the world that the concept of the SETS approach can also be integrated into learning media in the form of comics. We also recommend that learning remains SETS-based or known to be mutual so that students become superior and environmentally friendly.

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**References**


# Authors Information

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<tr>
<th>Author</th>
<th>University</th>
<th>Contact Information</th>
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<tbody>
<tr>
<td>Ani Widyawati</td>
<td>Universitas Sarjanawiyata Tamansiswa</td>
<td>E-mail Address: <a href="mailto:ani.widyawati@ustjogja.ac.id">ani.widyawati@ustjogja.ac.id</a></td>
</tr>
<tr>
<td></td>
<td>Yogyakarta, Indonesia</td>
<td></td>
</tr>
<tr>
<td>Laily Listiyani</td>
<td>Universitas Sarjanawiyata Tamansiswa</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Yogyakarta, Indonesia</td>
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<tr>
<td>Krida Kuncoro</td>
<td>Universitas Sarjanawiyata Tamansiswa</td>
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