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USING COMICS FOR CLIMATE CHANGE IN SCIENCE EDUCATION: STUDENTS' SOLUTIONS AND AESTHETIC SUBTLETIES

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Abstract. *To constitute awareness of climate change, hearing the solutions of students in their words and seeing visual products by creating experiences in schools is vital. This case study was limited to sequential implementations of climate change in the natural sciences teaching process in 5th grade. After an education process on using Pixton, 12 students transformed their learning into digital comics. This research aimed to reveal the problems created by students through digital stories about climate change, solutions they suggested for climate problems, and aesthetic subtleties they applied to express themselves. Digital comics created by students, researcher notes, observations, and students' view forms were used as data collection tools. Finally, vital solutions to problems such as global climate change, pollution, destruction of the natural environment, and extinction of living creatures were created by students during this case. Important solutions consisting of preventing global warming, making peace with nature, vital measures and efforts to protect the soil were suggested. Besides, interesting aesthetic subtleties such as storification, positioning of the characters, place preferences, expression of emotions, and time depiction were applied. Teachers can use comics to see students' tendencies, raise awareness, encourage them, and help them develop solutions for current socio-scientific problems.*

Keywords: *case study, digital comics, digital story, digital storytelling, secondary school students*

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Introduction

Comics from Papyrus to Digital Media

Literature with all its genres is the art of expressing the thoughts, feelings, and ideas on events and dreams shaped as a result of the past experiences of the individual. Language, which is an ordinary way of communication in daily life, appears aesthetically in literary texts. Literature is not limited to the practical use of language but is also closely related to felt experiences and creativity (Eagleton, 2013, p. 206). Literary works are created within the possibilities given by the imagination, which is the source of creativity (Çakmakçı, 2019). Literary genres such as legends, tales, fables, stories and novels, which are considered fiction, are in contact with non-real ones due to fiction (Atasoy, 2013, p. 74). Any verbal, written, or visual text or form of presentation (performance or picture presentation) containing a story: movies, games, comics, cartoons, and similar fiction should be considered as examples of narrative (Jahn, 2021, p. 18). The reason why comics are positioned as a literary type of narrative is that they contain plot-based stories. The works in which the series of pictorial and non-pictorial images, which are deliberately added one after the other, are used together in an effort to convey the information desired to be given to the audience and create an aesthetic effect on the viewer, are named as comics (McCloud, 1994, p. 8-9). Similarly, according to Kireççi, comics are expressed as "a picture system which tells a story by flowing within a certain fiction" (2018). Although comics are perceived as events in a magical imaginary world, they actually create a world parallel to the real world (Orçan & Ingeç, 2016).

It is known that comics, the foundations of which are thought to have been laid in the early ages, are in development towards digitalization nowadays. When the ancient papyrus manuscripts and the miniature manuscripts of the Middle Ages are examined, various works have been discovered in which visual and written expressions are divided into panels on a surface (Bozhüyük, 2022). According to Wiegand (as cited in Bozhüyük, 2022), the stories of mythological characters and saints in miniature manuscripts in medieval Europe have similar qualifications to the superheroes of comics. Johannes Gutenberg's invention of printing technology has been accepted as an important breaking point for

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comics. Thus, the comics, with the interest of superheroes such as Iron Man and Batman which started to appear in newspapers and magazines at the beginning of the 20th century, have spread to large masses and became known to all segments with the adventures of Mickey Mouse, Asterix Obelix, Tintin and Spiderman (Sarıkaya, 2021). As a result of digitalization, which provides unlimited opportunities for personal productions, comics appear as digital stories nowadays. The fact that digital comics contain textual and visual contents together makes abstract concepts perceived easier and remembered. Since there are no long and tiring texts to read, they make the concepts easier to understand (Lestari et al., 2016). Digital comics have an important role in learning as they increase motivation (Toh et al., 2016). Nowadays, comics are used by educators in an effort to provide information about sociology, philosophy, history, anthropology, science, mathematics and medicine (Kuttner et al., 2021; Weiner & Syma, 2013). Comics are used to attract students' attention towards science in terms of its features such as adventure and immersion (Farinella, 2018).

Tatalovic has stated that the motivation provided by comics is effective in education, social assistance and raising awareness (2009). To this extent, comics can be used to create questions in minds in a way that the content of the education is suitable for the target age groups (Friesen et al., 2018). When the studies conducted in the educational context are examined, it is seen that the comics prepared by the researchers have frequently been used to educate students with the presentation method at various teaching levels (Ak et al., 2020; Cabrera et al., 2018; Damopolii, et al., 2021; Hermita et al., 2020; Roswati et al., 2019; Silva & Oliveira, 2018; Topkaya, 2016; Ünal & Demirkaya, 2019). Within the scope of bachelor's level Ataturk's Principles and Revolution History lesson, there is also a study (Erol Şahin & Kara Erol, 2022) in which digital comics are used in the learning processes of students. There are also studies on digital comics created through Belief Comix (Kılıçkaya & Krajka, 2012), Comic-life (Çolak Seymen & Saka, 2022) or Toondoo (Silva et al., 2017; Maharani et al., 2019).

Digital Stories in Educational Processes

The use of materials like stories gains importance in the transfer of content to students in teaching processes, in order to gain knowledge structures cognitively and experientially by creating experience-based environments. A story can be defined as a literary work that contains a context or situation which implies that life is relatively in balance while expressing how and why it changes (Woodside, 2010). The story is based on four basic elements: message, conflict, plot and characters (Fog et al., 2010, p. 32). The structure of the story consists of three stages, exposition, knot and resolution, and a good story becomes meaningful when it includes all the elements (Talu, 2021). With storification, which is defined as "the narration of experience", the information obtained by the brain from its experiences with the external world is recorded and stored and then designed as narrative patterns (Shankar et al., 2001; Woodside, 2010). In storification, how things work, the purposes and roles in a particular event are explained (Randall, 2014, p. 114). Through storification, which allows people for feeling some emotions more deeply, internalizations are also provided in their patterns of behavior (Gallo, 2016, p. 151).

Stories, which are the building blocks of knowledge, can be seen as the basis of memory and therefore learning with its fictional aspect. Stories that can be told in written, oral and visual form are the link that structures our experiences and strengthens communication between people (Randall, 2014, p. 114). Stories that can shape people's perspectives on events by pulling them in different directions can turn eyes from a dark area to a fun, living space (Legorburu & McColl, 2016, p. 31). Good stories should generally be unusual, controversial, engaging, or inspiring. In other words, good stories answer questions, tell failed or successful attempts based on personal experiences, and in this way aim to make people decide or change something (Serrat, 2017, p. 3). As a way of conveying culture and knowledge, works of fiction type are seen as a tool for revealing a social problem, bringing possible solutions to these problems, and also raising awareness about the inward change of individuals (Çağlakpınar, 2019). According to the 2023 Education Vision adopted in Turkey, the education system should be able to develop a holistic responsibility for all material and moral elements of human nature. Thus, it is planned that students will benefit from electronic media for "making their dreams come true", "production" and "developing solutions to problems" (Ministry of National Education [MoNE], 2018c). However, the National Educational Technology Standards (NETS) recommends that students develop ideas and produce solutions to real-world problems by using digital tools (International Society for Technology in Education, 2021). The TIMSS (Trends in International Mathematics and Science Study) and PISA (Program for International Student Assessment) data, which measure and compare the realization of these suggestions in education processes on the basis of countries, are crucial. According to the results of international education research such as TIMSS and PISA, in countries which remain under average scores, the lessons continue to be carried out with methods and techniques mostly based on traditional science education in the classroom even if they have a contemporary curriculum. It is

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stated that interdisciplinary studies and projects in lessons such as Science, Information Technologies and Software, and Social Studies will be supported in order to rank higher in international exams (MoNE, 2018c). In this context, an inquiry-based learning approach with an interdisciplinary perspective is utilized in the current Science Curriculum in Turkey (MoNE, 2018a). Turkey ranks 39th in science among 79 countries for the age group 14-15 participating in PISA 2018, and 15th among 39 countries participating in TIMSS 2019 (MoNE, 2020; OECD, 2019). According to the results of TIMSS 2019, it is seen that the 4th-grade students in our country have the most difficulties in the fields of life sciences and earth sciences (MoNE, 2020). Moreover, TIMSS also expects the 8th-grade students to have knowledge about solving problems related to the use, conservation and management of the earth's resources (Mullis & Martin, 2017). When the science literacy content areas of PISA (OECD, 2019) are examined, it is seen that there are many items in the personal, local/national and global context under the headings such as natural resources, environment and risks (OECD, 2019). The fact that these institutional documents are emphasized quite a lot in the context of science literacy can be considered as a motivation for more research to be conducted in this context.

Research Problem

It is obvious that climate change is a global issue that has not fallen off the agenda in recent years and cannot be postponed (Janoušková & Bílek, 2022; Mavrodieva et al., 2019). With the increase of heat-trapping gases in the atmosphere, the increase in the temperature of the earth causes climate change (The Intergovernmental Panel on Climate [IPCC], 2021). In the "Global Climate Outlook Report 2021" of the World Meteorological Organization (WMO), it is stated that the global temperature has increased by 1.1 °C compared to the pre-industrial period (WMO, 2022). The environmental problems due to climate change, whose effects are felt more and more day by day, are a serious threat to the whole world and biodiversity at the global level (IPCC, 2021). In order to combat climate change, governments have been taking global measures for carbon emissions such as the Kyoto Protocol (2005), Paris Agreement (2015), Global Methane Alliance (2021) and Glasgow Climate Pact (2022). According to the World Energy Outlook Report (2021), achieving the zero emission target by 2050 will require a great effort but will offer advantages in terms of health and economic development (International Energy Agency [IEA], 2021). The first step to combat environmental problems is to raise awareness about environmental problems (Jensen, 2010; Prasad, 2022). In this context, education is a global power. The specific objectives of the National Science Curriculum are stated as;

i. in the process of discovering nature and understanding the relationship between a human and the environment, by adopting scientific process skills and scientific research approaches, to produce solutions to the problems encountered in these fields; ii. To make the mutual interaction between the individual, the environment and the society realized; to raise awareness of sustainable development regarding society, economy, and natural resources, iii. To take responsibility for daily life problems and to provide using scientific knowledge, scientific process skills and other life skills in solving these problems (MoNE, 2018a).

In the National Science Curriculum of Turkey, about global climate change at the 8th-grade level, the learning outcomes were mentioned in the form of:

i. In the context of global climate change, it is questioned how environmental problems can affect the future of the Earth and human life, ii. They are asked to express their predictions about the impact of environmental problems on the future of the world through artistic means (MoNE, 2018a).

In the national curriculum regarding this issue, which is a global problem, the learning outcomes for the solution of environmental problems are included in the 7th-grade social studies lesson and the 5th-grade science lesson (MoNE, 2018a; MoNE, 2018b). It is thought that this research is valuable in terms of being an exemplary class study that will carry our country forward in both national and international exams. To this extent, when climate change is taken into the center; with the advantage of unlimited visual language images in comics, it is seen that it will be effective to examine students' products practically and in-depth. There is a need for an interdisciplinary study that makes use of art and technology when applying digital comics and storification to climate change, which is frequently included in science and social studies lessons. Developing awareness and sensitivity of individuals about climate change at a young age is considered important in combating environmental crises. The learning-instructing situation created throughout the subjects and learning outcomes in the "Human and the Environment" unit in this research adapts

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directly to four of the content areas of PISA that point to the global goals, and indirectly to the remaining one (PISA, 2019). For global targets set by reaching individuals to societies in educational situations, creating and realizing situations that prioritize the experience-oriented structuring of knowledge is the first step to be taken in the educational context in the solution of the climate change problem. When evaluated in terms of the use of digital comics in learning-instructing processes, many studies have been conducted for different purposes and have suggested that it is an effective way of learning. As an example of these studies, the benefits obtained in the studies conducted in the mathematics lesson (Musa et al., 2020; Oliwe & Chao, 2022; Widyasari & Nurcahyani, 2021) and in the social studies lesson (Hasanah et al., 2021) can be shown. When the literature is examined, research in which the comics created by teachers at Pixton for high school students are used in mathematics lessons (Hobri et al., 2019) and foreign language lessons are discovered (Cabrera et al., 2018). There is also a mixed study examining the effects of digital stories on the success, attitude and motivation of primary school students which are 3rd grade, in science lessons (Başar, 2022). However, the digital stories in this study were created by the researcher using the Powtoon software. Experimental studies (Damopolii et al., 2021; Malau et al., 2021) and adopting the design-development model (Özdemir, 2017; Roswati et al., 2019) have been carried out in order to investigate the effect of using digital comics on learning in science lessons. Since the aforementioned studies aim to develop effective material, it is seen that they have been carried out in line with different research questions and with various methods. The fact that most of these were realized through digital comics created by educators shows that there is an important gap in the literature.

When investigating the effects of digital storytelling on students' learning, motivation, and participation in class, basing it on plans created by experts is insufficient to create individual awareness. This situation reveals a problem that the power of the conflict-oriented story-making experience is ignored and an approach that prioritizes the student's experience cannot be adopted. It is thought that comics have a positive effect on learning because they provide students with opportunities to solve contextual problems (Istiq'faroh, 2020). The digital comic book genre, which has become widespread nowadays, is characterized as low-cost and easily accessible, as it appears on screens such as computers and tablets, unlike pages that can be held by hand (Sarıkaya, 2021). Based on this gap, designing an exemplary case in which digital comics prepared by students for the problem of climate change are used in learning and teaching processes and describing the results is scientifically important in the educational context through this study. Presenting a sample case in which students express themselves in digital comics by showing sensitivity to current environmental problems can be a transferable implementation for science, social studies, and classroom teachers. It is a fundamental and undeniable fact that approaching the problems through the eyes of students has shed light on science by providing important data not only in the field of science education but also in the fields of social sciences such as art, psychology, and sociology.

Research Purpose and Research Questions

The purpose of this study was to depict an exemplary case in which digital comics prepared by students by creating a problem, suggesting a solution, and adopting aesthetic subtleties to them express themselves on climate change through science lessons. When an exemplary case was designed in which students could express themselves in digital comics by showing sensitivity to current environmental problems, answers to the following questions were sought:

1. Which problems do students create through digital comics about climate change?
2. Which solutions do students suggest through digital comics about climate change?
3. Which aesthetic subtleties do students adopt to their digital comics about climate change?

Research Methodology

Research Design

In this study, the basic principles of the case study design, which is one of the qualitative research designs, were adopted. A case study is defined as a research design that studies (1) a current phenomenon in its real-life context, (2) the phenomenon and its boundaries are not clearly defined, and (3) situations when there is more than one evidence or data source is available (Yin, 1984, p. 23). In this study, the case was limited to the sequential implementations covering the problem of climate change related to the functioning of the "human and the environment" unit in the 5th-grade science lesson and its transformation into a teaching process. When the case contains

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more than one sublayer (unit) within a single case, it is called an embedded single-case design (Çepni, 2018, p. 78). In the research, the problems and solutions created by the 5th-grade students on climate change within the scope of the science curriculum constituted the first unit of the case. The second unit was the aesthetic subtleties of the problems and solutions created by the students. In the research, since the embedded two separate cases stated were analyzed with details in a single context, the embedded single-case design was preferred.

Sample Identification Strategy and Study Group

In this study, the criterion sampling method was used, in which all the cases containing the predetermined criteria were studied. In this type of sampling, a pre-prepared list of criteria or a list of criteria created by the researcher can be used (Marshall & Rossman, 2014). Criteria determined by the researchers in the study are: To have actively participated in the whole teaching process of the "human and the environment" unit (26 lesson hours); Participating in every stage of Pixton training (4 lesson hours); transforming an idea about the relevant unit into a product based on the criteria of the plot (exposition, knot, solution) with the Pixton implementation; is to produce products with artistic sensitivity and aesthetic subtleties. One of the basic principles of qualitative research is to study a phenomenon, situation, or program with a small group of participants (Patton, 1987). The research study group consists of 12 students which are in 5th grade and studying in three different classes in a secondary school in Bursa, one of the metropolitan cities of Turkey, in the spring term of the 2021-2022 academic year, who fully meet the specified criteria. The students who volunteered as participants before the research were informed about the data collection process and their parents' written permission was obtained. The real names of the students were kept with code names in this study. Besides, students' faces were not shown in the photographs taken through the process.

Procedures, Tools, and Researchers' Roles

The data collection process of this research was carried out in three stages. First of all, eight learning outcomes in the science lesson "Human and the Environment" unit were taught to 5th-grade students (26 lesson hours). Then, the students were given Pixton usage training for three lesson hours by the researcher and the information technologies and software teacher. Finally, the students were asked to transform the stories they would create with the information they learned about the relevant unit into digital comics products with the Pixton software (Appendix 1). The data collection process in the study was carried out simultaneously with the teaching practices in science lessons. Table 1 shows the data collection process below. Photographs of the data collection process are given in Appendix 5. Researchers of the study are coded as R1 and R2.

Table 1
Data Collection Process, Implementations and Tools

Stages of case	Implementations in the case and Researchers' (R1, R2) roles	Data collection tools	Implementation area	Lesson hours
1. Learning the subject area (28. 02. 2022-6. 05. 2022)	"Human and the Environment" unit (R1)	Researcher notes Observation Students' views form	Classroom Information technologies room	26
2. Learning to use Pixton (9. 05. 2022-12. 05. 2022)	Sign in to Pixton Using background, characters and focus, word segments effectively Creating a title for a comic Adding a panel (page) (R1)	Observation Students' views form	Classroom Information technologies room	4
3. Creating a product (9. 05. 2022-15. 05. 2022)	Composing digital comics with Pixton as students' homework (R1)	Students' product Researcher notes	Home	6

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Document Review

The qualitative analysis of written or visual materials that contain information about the facts planned to investigate is called document review (Yıldırım & Şimşek, 2016, p. 190). Lesson books, meeting proceedings, diaries, journals, teacher files, and student lesson tasks are classified as written documents while films, videos, and photographs as visual documents. Documents used in qualitative research can also be classified as official or personal documents (Bryman, 2016). In this research, various forms were prepared in order to apply the document analysis data collection technique. These were; the structured form with four items (Appendix 3) prepared to examine students' products, and the structured form used by the researcher (R1) to examine the notes taken during the process (Appendix 4).

Students' Products: Comics produced with Pixton as a data source for the document review method are considered students' products within the scope of the research. It is seen that the products created by the students selected as participants through certain criteria vary between 3 and 27 pages (Appendix 1). In this study, the Pixton software used by the students was preferred because it allows the emotional learning outcomes to be easily narrated through visuals. Pixton is a free software for the first 7 days that allows educators to create separate classes for their students, view the comics of the students in these classes one by one, and add the comics they like to the favorites list. Pixton, which is used as the main data collection tool, without the need for drawing skills in the story editing process; allows to reveal works rich in every aspect in terms of time, place, characters, plot and emotions. All joints of the characters, which appear uniquely according to the students' choices, can move in all directions. In this way, the desired gesture, mimic, and behavior can be easily exhibited (Kaba et al., 2020). The mouth, nose, eye, ear structure, beard, hairstyle, hair and eye color, height, weight, and skin tone of the characters can be shaped according to the student's will. There are many options even for accessories such as earrings, necklaces, hats, and glasses. It is possible to make clothing choices belonging to periods such as the first age and the middle age and occupations. In addition to all of these, the fact that it has numerous backgrounds makes Pixton different from other digital comic creation tools. If desired, comic book creators can add their own backgrounds to their comics (Meyers, 2014). In this research, a structured form consisting of 4 items was used, while the document review method was used to examine student products. By using this form, attention was paid to the fact that the comics created by the students' about the concepts in the 5th grade "Human and the Environment" unit had a plot in the form of an exposition, knot, and solution besides different artistic subtleties that they added to the stories. The qualities examined in the student's digital comics were as follows: Introduction or introducing information (item 1), conflict or problem creation related to the subject in the knot section (item 2), and finally, a solution suggestion to the problem created, in the solution section (item 3) were considered as important. In addition to these, in accordance with the purposes of the research, artistic subtleties (Item 4) in students' products were also included in the document review form (Appendix 3).

Researcher notes: Researcher notes were used as another data source for the document review method in this study. While using the observation method, one of the researchers kept legible and regular field notes. DeWalt and DeWalt (2010) argued that if events were not noted during the observation, the event would never have happened. In the study, the notes taken during the data collection process and data analysis were checked and organized on a daily basis in order to increase functionality.

Students' views form: Based on the fact that this research was a case study, the views form utilized was preferred in order to enter the inner worlds of individuals in order to understand their experiences, thoughts and perspectives. In this study, a structured students' views form was created by the researchers in order to determine the views of the participants on the data collection process and the interaction between a human and the environment. In order to determine the clarity of the questions of this form, a preliminary implementation had been made with five students and after then the questions were checked by two experts. The questions in the form accepted jointly within the scope of this research are as follows: *1. Which aspects of the sample implementations developed with Pixton (digital comics) did you find interesting? 2. What are the points you have difficulty in using Pixton? 3. What are your suggestions about creating digital comics based on your experiences? 4. When you think about the interaction between a Human and the Environment, which environmental problem do you find more important? 5. What are the measures that can be taken against environmental pollution?*

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Observation

During the Pixton instructing and learning, one of the researchers filled out a structured observation form (Appendix 2). Observation forms were provided to make a systematic observation, which was used in order to determine the levels of the participants and whether they had a predetermined feature in the learning process or not (Yıldırım & Şimşek, 2016, p. 178). In this study, participatory observation, which is a way of natural observation, was preferred because the researcher was trying to be an active member of the group they observed (Arthur et al., 2012, p. 271). The items in the observation form prepared within the scope of this research and checked by experts are as follows: *1. Getting support during the use of Pixton (resource books, teacher, friend, etc.) 2. Active participation in the learning process (asking, answering, commenting, etc.)*

Data Analysis

In the analysis process, in order to find answers to the research questions, an inductive approach was adopted without depending on a predetermined coding framework of the data and thematic analysis was carried out in a cyclical structure. Thematic analysis is a method, which reports experiences, meanings, and the reality of participants, besides it can be a constructionist method, which does not need any pre-existing theoretical framework. Therefore, it can be used within different theoretical frameworks, as well (Braun & Clarke, 2006). According to Saldana (2019, p. 68), there are loops in thematic analysis that make sense of data for research purposes and questions. In the first cycle of coding in this research, pre-coding, which is one of the basic methods, was carried out and the first codes were obtained by recognizing the data. Also, in the second cycle, focused coding, which is an effective way to reach the research questions directly, was carried out. In the first coding cycle, the data directly related to the research were determined and interpreted with phrases. This cycle was repeated several times within the scope of documents, which is the main data source, and similar and unrelated codes were extracted, and then the same processes were applied to other sources. In the second cycle, the codes obtained from the preliminary coding were re-examined by focusing on the aims and questions of the research, sorting was done, and the determined codes were brought together under the themes of "problems created", "solutions", and "aesthetic subtleties".

Improving Quality

In order to increase the quality of the research, some issues were taken into consideration in line with the guidelines of Creswell (2013, p. 251). *Diversification of researchers and data sources (triangulation):* In this study, researcher diversity was achieved through the participation of researchers from different fields in qualitative data analysis and the controlled studies of these researchers in reaching codes, categories, and themes. The case to be described in the research was tried to be understood in a multidimensional way by using data collection types consisting of documents, views, and observations. The credibility was increased by making detailed descriptions with observation forms, photographs, and examples of comics as students' products of the case, and by including direct quotations, sections from the products, visuals of the environment and the researcher's notes in the findings. *Transferability:* In order for researchers or readers who want to carry out similar studies in the future, the data collection process was shown with its details in tabular form in order to transfer the relevant situation to their own environment, the data collection tools, the preparation purposes and stages of the questions asked in the students' views forms were explained in the text, the periods were specified and the forms were presented in the appendices. Besides, the steps of analyses were explained. *Reliability:* Among the measures taken to increase reliability are that the analysis approach adopted was clearly presented, the coding was done with the knowledge and approaches of the researchers from different fields of expertise, the analysis was carried out meticulously in a cyclical manner and the researchers have reached a consensus in the analysis at every stage of the coding and in the creation of the categories. *Confirmability:* Due to the fact that the researcher recorded the observation data as necessary, taking into account the social and physical conditions of the context, the students' views form questions were taken in writing, and the documents examined were created with student names and passwords on the Pixton platform, possible misconceptions and manipulations of the researchers were prevented.

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Ethical Matters

In the study, all the rules that must be followed within the scope of the "Higher Education Institutions Scientific Research and Publication Ethics Directive" were complied with. In the study, the data were collected after the necessary approvals were obtained from the school principal, the directorate of national education and the parents of the students, respectively. This research was carried out with the permission of Bursa Uludağ University Rectorate, dated October 22, 2021, Ethics Committee numbered 2021-09.

Research Results

The presentation of the analysis results in the findings is shown through examples from the visuals. In this demonstration, the codename was given to the participating students and the abbreviations of the page/panel number (p. 5) of the image quoted in the student's comic book (DCB) were used. In addition, it has been abbreviated that the researcher's notes taken by the researcher while examining the comics as (RN), the observation notes (ON) during the implementations and the students' statements in the students' views form as (SVF). In the findings, the themes of problems, solutions, and aesthetic subtleties were presented separately. All the comics (Appendix 1) created by the participant students, the photographs related to the observation notes (Appendix 5) and the observation form (Appendix 2) were included in the appendices page.

Problems Created

The theme of the problems created was categorized by the combination of focused codes as a result of the cyclical coding of the data obtained from the observation and document review data collection techniques in the case study. In this process, the primary data source was digital comics (DCB), in which students developed sensitivity to problems and showed their awareness. Other researcher notes (RN), students' views form (SVF) and observation (ON) were used together with the related codes as supporting data for the main data source, for detailing the descriptions. Major themes are: *The problems created*, *solutions, and aesthetic subtleties.* The theme of the created problems consists of the categories of *global climate changes, pollution, destruction of the natural environment, extinction of living creatures and waste.*

The codes of *turning from green to brown, drought, rapid concretion, logging and polluting the living space of animals,* which are in the category of the *destruction of the natural environment*, were obtained from the written expressions used by the students in the comics documents and from the researcher's notes. In Buse's comics, the characters who had previously camped in a green and clean nature find an arid, treeless and brown environment when they go back to the same camp, which can be given as an example of the code for *turning from green to brown* (DCB. Buse, p. 1, 2-15). In her comics, Irem realized that when a character from the future teleports another to the future, there will be a dry, extremely hot, and breathless environment in which living creatures disappear in the future (RN. Irem). The 5th panel of Irem showed a visual example of the *drought* code (DCB. Irem, p. 5). Oğuz's comic began with the conflict of two opposite characters who are aware of the importance of nature and who argue that trees can be cut down to build buildings, unaware of the functions of forests, with the words "Why do you love them so much, we can build buildings instead of them because I don't think they are useful" (RN. Oğuz). The problem code in this comic was an example of *rapid concretion* (DCB. Oğuz, p. 1-3). Another example of *rapid concretion* code was the fourth panel in Yiğit's comic book. In the dialogues in this panel, sentences such as "The air in the city is too polluted, it is almost impossible to breathe" and "We would have a much cleaner air if we did not destroy the forests and replace them with buildings, forests are the lungs of the world" drew attention (DCB. Yiğit, p. 4). As an example of the *excessive logging* code, Yiğit's comic book, which started with panels where there is no precipitation in the atmosphere as a result of the destruction of forests and animals are lost, was a finding (DCB. Yiğit, p. 2-4). In his comic book "Forest Protector", Mete also touched upon the problem of *excessive logging* with the dialogues between the president and the forest protector, and with the symbolic subtleties of the main character, who has become a superhero (DCB. Mete, p. 1-2). In Murat's comic book "Nature", two deer figures complained about the *pollution of the living space of animals* (DCB. Murat, p. 1-8).

Under the *pollution* category, there was *sultriness, chemicals left in food, graying of water, early chirping birds,* and *hearing loss* codes. The mention of unbreathable polluted air in Yiğit's comic was an effective example of the *sultriness* code. (DCB. Yigit, p. 4). In Irem's comic book "Environmentalist", attention was drawn to the sultry atmo-

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sphere both in the striking visuals and in the dialogues. In response to the words of one of the characters in the comic book "Environmentalist", "Oh, I can't breathe"; it was seen that the character in astronaut clothes from the future said, "This is fine here, now I'm going to take you to another place". Between the panels, a transition from a gray city with human skeletons and a scrap car to a desert with cacti and yellow sky was made (DCB. Irem, p. 4-5). In Yağmur's comic book, the main character who consumes fruits washed insufficiently got sick because of *chemicals left in the food* (DCB. Yağmur, p. 1-8). As an example of the code for the *graying of water*, the dialogues between pages 20 and 25 in Ela's comic can be given as an example (DCB. Ela, p. 20-25). Examples of *early chirping birds* and *hearing loss* codes were the examples between panels 9 and 11 in Ege's comic book (DCB. Ege, p. 9-11). In this comic book called "Awareness", the student's question "Teacher, how do people live in such a noisy environment?"; it was seen that the teacher responded to this question with the words "You are right, that's why the birds think it's morning because of the sounds and it causes hearing loss in people also". Observation data such as "Students raised their hands and listed the sounds of drums, zurna, bomb, or drill can cause hearing loss" would be another example of the *hearing loss* code (ON-item2/whole class).

The rise in sea level, *extinction of polar bears*, *melting of glaciers*, *uncertain weather changes* codes, observation notes, students' views forms and written expressions used in digital comics documents, which are included in the category of *global climate changes*, are presented together. Ela's answer to the fourth question in the students' views form is presented as an example of the *rising sea level* code. Ela talked about the problem of *sea level rise* with the expression "If the world gets too hot, everything changes. The seas will overflow, and our houses will be flooded" (SVF. Ela). *The rise in sea level, the extinction of polar bears, and glacier melting* codes were mentioned in response to the question of the student character in Yiğit's comic book; "Teacher, I have a question for you, how does global warming affect the world?" (DCB. Yiğit, p. 6). In addition, the code for the *glacier melting* is presented with the observation data of Irem. "When Irem was given the right to speak, she complained that everyone was using deodorant. She talked about how air conditioners and ovens heat the air. She said that when the weather gets too hot, the glaciers will melt" (ON. Irem). In Ege's comic book, the sentence "…. I said it wouldn't rain in this weather, but it did." In the first panel is an example of the code of *uncertain weather changes* (DCB. Ege, p. 1). The words of one of the characters in the third panel of the comic book by Yiğit that "it never rains" and the change in the color of the air and the environment between panels 2 and 3 were examples of *uncertain weather changes* (DCB. Yiğit, p. 2-3).

Under the category of *extinction of living creatures*, there are codes for the *disappearance of animals*, *causing the death of birds*, and *ignorance about living creatures.* These codes were presented together with the students' views forms and the written expressions they used in their documents. One of the characters in Yiğit's comics "Why aren't there any animals around here?" can be shown as an example of the *disappearance of animal* code (DCB. Yiğit, p. 2-4). Oğuz's answer to the fifth question in the students' views form pointed to the code of *disappearance of animals*. Oğuz's statement: "We complain about the heavy traffic. But we don't go to our destination by bike. The weather is getting warmer, the animals are migrating to colder places. Dinosaurs also disappeared as the seasons changed. If we think about the world, not ourselves, the animals will not go either" (SVF. Oğuz). The main character's statement in the comic book "Awareness", "The main problem is that the chewing gum thrown into the environment can cause deaths as a result of trying to be consumed by birds as food" can be shown as an example of the code to *cause the death of birds* (DCB. Kutay, p. 7). The statement of the main character in the comic book "Anatolian leopard" said, "For my science homework, I need to research one of the endangered animals, but which animal? I found. Anatolian leopard. I can go to the time when the Anatolian leopard lived with my time machine" can be presented as an example of the code of *ignorance about living creatures* (DCB. Nisa, p. 1). Under the name of the *waste* category, there are codes for *power outages* and *depletion of water resources*. These codes were presented together with the students' views forms (SVF) and the written expressions they used in their documents (DCB). Expressions such as "I think the electricity went out", "now let's give an example of a wrong behavior", "I washed my hands, but I won't turn off the light" in Ada's comic book, which warned the readers that they should turn off the lamps they are not using, can be given as examples of the *power outages* code (DCB. Ada, p. 3, 5, 6). The dialogues among the characters in Ege's comic book such as "…. people are unconsciously consuming water resources…", and "Yes, teacher, if it continues like this, 40% of the world will suffer from water shortage in 2050" were presented as a data source for the *depletion of water resources* code (DCB. Ege, p. 7). In the presentation of solution suggestions found by Ege, most of the class expressed their approval through loud participation. Almost everyone wanted to share their comics with their friends raising their hands at the same time" (ON. Ege). The picture of the observation is presented in Appendix 5. In Ege's students' views form, "Water flows unnecessarily in houses because timed taps

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are not used. Water is wasted because of the fountain pools. Let's not waste the cold water flowing while waiting for the hot water while taking a bath" and the expression "We'll wait for rainwater to have a shower in the future", pointed to the code of *depletion of water resources*.

Solutions

The theme of solutions was categorized by the combination of focused codes as a result of the circular coding of the data obtained from the observation and document review data collection techniques in the case study. In this process, the primary data source was digital comics (DCB), in which students developed sensitivity to problems and showed their awareness. Other researcher notes (RN), observation (ON) and students' views forms (SVF) were used as supporting data for the main data source, together with the relevant codes to elaborate the descriptions. The theme of solutions consists of the categories of *preventing global warming*, *making peace with nature*, and *vital measures* and *efforts to protect the soil*.

The codes related to the category of *preventing global warming* are presented with written expressions and researcher notes (RN) used by the students in their comic book (DCB) documents. Codes in the category of *preventing global warming* were*; Control with drones, not logging, planting trees, using solar energy, attaching exhaust filters, warning people, and using public transportation*. "My people, hundreds of trees are cut down every day in our country", "Trees are very important for us and other living creatures to survive. That's why we will now control every woodland with drones. In this way, we will identify those who cut down trees and punish them. Are you up for this job with me"?" said the president in the "Forest Guardian" comic book and the code for *control with the drones* was indicated with these expressions. The words of the character in Buse's comics, "Yes, my son, unfortunately, because people throw their wastes into forests or nature and because they cut down trees unconsciously, nature is disappearing" was an example of the code of *not logging* (DCB, Buse. p. 16). In Buse's comics, the characters who had camped in a green and clean nature before, went to the same camp again and suggested solutions to protect nature by raising people's awareness about the problem of the camp being arid, treeless, and brown, by *not logging* and *not polluting the environment*" (RN. Buse). The expression of the character in Yiğit's comic, "We should use public transportation rather than our own car, plant trees and use solar energy" was an example data source for the codes of *using public transportation*, *planting trees*, and *utilizing from solar energy* (DCB, Yiğit. p. 7). The expression of the character in Ege's comic book "The gases coming out of the factory chimneys must be filtered first" was an example of the code *to install a filter* (DCB, Ege, p. 4). Through the character in Ege's comics, he was in an effort to *warn people* with the words "If we do these and warn those who do not, air pollution will disappear" (DCB, Ege, p. 5).

Regarding the category of *making peace with nature*, *cooperation between humans and animals*, *loving nature*, *living without harming* and *creating environmental awareness* codes have been determined. These codes are presented together with the written expressions used by the students in their comics (DCB) and the students' view forms (SVF) data. Murat's comic showed *cooperation between humans and animals* in order to *make peace with nature*. In the comic book "Nature", sentences like "They always throw garbage here, we must find a solution", "Deer brother, I wish we lived in such a beautiful place" and "I agree with you, we should do this with the help of people" were examples of the *cooperation between humans and animals* code (DCB, Murat, p. 1, 2). The following statements of Murat in the students' views form were examples of the code of *loving nature*: "We cannot find clean water if it continues like this. We go to cities with water. Let's say there is only water left in our country. All countries come to our country and want our water. When we see something newfangled, if we have them already, there is no need to buy them. Loving nature requires it" (SVF. Murat). The following statements on the last panel of Buse's comic book were remarkable as well: "Yes, my dear friends, if you have seen my comic, protect our nature. Because our nature will be destroyed if it continues like this, protect your nature". It is thought that these expressions in the comic book "Save nature" pointed to the code of *living without harming* (DCB, Buse, p. 17). In Oğuz's comic books, expressions like "Now I understand how important nature and trees are, and now I am more conscious about nature. Thank you also for informing me about this issue" were intended to *create environmental awareness* (DCB, Oğuz, p. 8).

Codes for *avoiding waste*, *not leaving the tap on*, and *not playing loud music* were determined for the *vital measures* category. These codes are presented with written expressions and researcher notes (RN) used by students in their comics (DCB). Ada, one of the participant students, suggested not to waste electricity for the problem of power outages (RN. 11). With the words "It is very important not to waste electricity" in the comic book "From the light to the dark", readers are warned to *avoid waste* (DCB, Ada, p. 4.). In the comic book "Natural Heritage" there were expressions like "We will avoid waste first. We will not leave the tap on while brushing our teeth". These ex-

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pressions in Ege's comics directly indicated that it is important *not to leave the tap on* (DCB, Ege, p. 8). The following words were mentioned in Ege's comic book "Natural Heritage": "First of all, loud songs should not be played late at night, people working in loud places should definitely take precautions". Ege so warned about *not playing loud music* (DCB, Ege, p. 11).

The codes for the category of *soil conservation efforts* were presented with the written expressions used by the students in the comic book (DCB) documents, researcher notes (RN), students' views forms (SVF) and observation data (ON). Under the category of *soil conservation efforts*, the codes were *to wash foods effectively, not to drain sewers into water sources*, *to use natural fertilizers* and *to collect batteries separately*. The necessity of *washing foods effectively* was revealed in Yağmur's comic book "Soil Pollution", who is one of the participating students. When the main character, who consumes fruits washed insufficiently in Yağmur's comics, had a stomachache, she obtained information about soil pollution from her mother and the doctor in the hospital and produced the solution of not eating again vegetables and fruits washed insufficiently" (RN. Yağmur). In the last panel, towards one of the characters' words "I won't eat anything again without washing it thoroughly which I am going to eat ", the other character responded with the words "I am glad that you have taken this responsibility" (DCB, Yağmur, p. 8). An exemplary solution suggestion was presented for the code of *not draining the sewers into the water sources,* with the words of the character in the comic book titled "Natural Heritage", "We will not drain the sewers into the water" (DCB, Ege, p. 8). Mete's answer to the question "Which environmental problem do you find more important when you consider the interaction between a Human and the Environment?" in the students' views form was an example of the code not *to drain sewers into water sources*. In Mete's view form, there were expressions such as "Frying oil and sewage water should not be disembogued into the sea. We pollute the water. Leaking taps should be repaired" (SVF. Mete). Kutay's observation and students' views data are presented as an example of the code for *using natural fertilizers*. "The use of Pixton was taught. In this lesson, the practice of creating comics on the smart board and tablet is done. In Kutay's comic, animals were angry at the boy for throwing chemical fertilizers and garbage on the soil. There are warnings that if people continue to do so, animals will become homeless, and people will be homeless, hungry, thirsty and without clothes" (ON. Kutay). In Kutay's view form, his answer to the question "What are the measures that can be taken against environmental pollution?" was as follows: "I think the world is most likely sick right now. If it goes to the doctor, the doctor will say to it; Don't allow animals to be killed. Don't let the flowers be plucked to make someone happy. Ban the use of chemical fertilizers. If we love all living creatures, not just the dogs in our house, there will be no environmental problems" (SVF. Kutay). Buse's answer to the same question was an example of the code *to collect batteries separately*. Buse's statements about this question were "We also live in nature. We are part of nature. It should be treated like family. Soils are polluted with waste batteries and polluted water. In order to avoid drought, garbage should not be thrown into the waters. The association that collects waste batteries separately should be called and let them come to get waste batteries" (SVF. Buse).

Aesthetic Subtleties

In the data analysis process of this research, it was aimed to investigate and reveal all dimensions of the process in accordance with the principles of the case study. Digital comics, which are students' products, were also analyzed in terms of their visual qualities for this purpose. In this analysis, in the preliminary coding, the symptoms, indicators and symbols that have visual qualities suitable for the purpose of the research were determined and coded, and then the cycle of creating categories was started by making focused coding and sorting out the research purpose. The categories obtained were gathered under the theme of *aesthetic subtleties*, and this theme consisted of a total of five categories. The codes included in the *"storification"* category were determined as a *linear narrative, a change-oriented narrative, and a reverse narrative*. Oğuz's comics can be cited as an example of *linear narration* (DCB. Oğuz, p. 1-12). It is thought that the comic book "Save the Nature" is an example of a *change-oriented narration* (DCB. Buse, p. 1-15). Yiğit's novel, which began in a barren, orange-toned, windy place, displays a *reverse narrative* (DCB. Yiğit, p. 9).

The codes included in the category of *"positioning the characters"* were determined as *outside the place, inside the place* and the *use of nature concept* in terms of figure and backdrop relationship. It is seen that the characters in Ege's comics took place both outside the place such as a park, lake, or street; and inside the place such as a factory. The first three panels in Yiğit's comic can be shown as an example of the *use of nature concept* code (DCB. Yiğit, p. 1-3). Codes included in the category of "*place preferences"* were determined as *physical reality*, *surreal places,* and the *use of synthesis of places*. Ela's comic book, which occurred in places such as a park, bathroom, and bedroom,

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can be presented as an example of the *physical reality* code (DCB. Ela, p. 1-27). Panels with the time machine of the character in Nisa's comic book (DCB. Nisa, p. 1, 2, 11) were a data source for the code of *surreal places*. The use of different places such as the garage in which there is a time machine, the bedroom of the character, the desert, an ancient city, and the forest in the fiction has been interpreted as the *use of synthesis of places* (DCB. Nisa, p. 1-14). The codes included in the "*expression of emotions*" category seen in Table 1 were determined as *subjective use of color* and *gestures- facial expressions* which are among the expressive artistic expression ways. The purple sky at night in Ege's comic was an example of the *subjective use of color* (DCB. Ege, p. 9-11). The confused facial expression of the character in Ela's comic can be interpreted as *expressing of emotions* in the form of *gestures-facial expressions* (DCB. Ela, p. 13). The jumping of the boy in Buse's comic when he said "Hooray! We are going to the camp" was an example of the code of *gestures-facial expressions* (DCB. Buse, p. 9). Finally, the codes included in the "*time depiction*" category were determined as *nowadays, indefinite time* and *intertemporal*. It was seen that Kutay's comic book "Awareness" takes place *nowadays* (DCB. Kutay, p. 1-10). In Oguz's comic book, when trees disappear in the World is depicted as an *indefinite time* (DCB. Oğuz, p. 6-11). As an example of the *intertemporal* code, the panels between Nisa's journey with the time machine and her return can be shown. (DCB. Nisa, p. 3-10). It was thought that Irem's going to the future with a person from the future and then returning to the time she was in is an example of the *intertemporal* code (CB. Irem, p. 2-5).

Research Limitations

Since this research is a qualitative study conducted with a small study group, it is aimed to generalize for the readers individually, as opposed to generalizing the results to the population. The limitation of the research is that this research was conducted at the 5th-grade level and within the scope of the "Human and the Environment" unit.

Discussion

The discussion has been written in light of the findings. The case that occurred in this research has shown that 5th-grade students can also develop a high level of awareness about climate change and responsibility towards it by accepting that there is an external world that needs to be protected. The issue of the destruction of the natural environment, which the students included in their stories, showed that they had concerns about the future. The fact that they created stories on the extinction of living creatures and global climate change issues proved that students developed a universal sensitivity to climate change. In this respect, the outcomes of the research correlated with the studies that talk about the effect of comics on raising awareness (Çağlakpınar, 2019; Tatalovic, 2009). Furthermore, the fact that students created current daily-life problems was one of the results of this research that should be emphasized. These results are suitable for the affective and cognitive learning outcomes of the lesson. The science curriculum in Turkey aims that 5th-grade students to develop sensitivity to environmental problems that arise as a result of human activities and to have knowledge and skills for the solution of environmental problems. (MoNE, 2018a). Pollution and waste problems seen in students' digital comics can be defined as problems that are directly experienced today. One of the important results was that students who created digital comics about climate change used current and vital problems in an impressive way by applying aesthetic subtleties with Pixton, which offered many options in terms of design and application. In this direction, these results in the research are compatible with Farinella (2018) in terms of endearing science.

Practical solutions to climate change, which students expressed in their students' views form and conveyed in stories of their digital comics, were among the results of this research. Solution suggestions were divided into four different approaches: preventing global warming, vital measures, making peace with nature, and efforts to protect the soil. These solutions also reveal the individual differences of the students when all the contents included in the findings are evaluated. One of the students appeals to the metaphor of "being reconciled with nature" and carried the storification to a strong level of empathy by using metaphor. One of the solution suggestions that should be emphasized is the suggestions for soil conservation efforts. These suggestions are advanced suggestions that can be realized at the institutional level, which emerge from the opinions of the students and the ideas seen in their stories. These are advanced suggestions that can be realized in the theoretical dimension that emerges from students' opinions and the ideas seen in the stories. By using the roles that the characters they created are adorned with, the students made attempts to think at the social and even universal level, separated from their personal areas. These trials are related to arousing interest and curiosity about the events occurring in

https://doi.org/10.33225/jbse/23.22.215

nature, as well as its immediate surroundings and developing an attitude, which is among the special purposes of the science curriculum (MoNE, 2018a).

The creation of a comic book that was not limited in terms of character, place, time, and plot has laid a foundation in which students feel themselves unlimited and free in their thinking skills. In this respect, this study matches up with the study of Damopolii et al. (2022) who reported that comics contribute to creative thinking in biology lessons. This experience of the students supported the development of field-specific skills in the curriculum, as well as being compatible with cognitive learning outcomes (MoNE, 2018a). Finally, among the solutions of some of the students, vital measures that can be taken in the individual area are mentioned. Contributing to students' self-control through this case study strengthens the educational belief about the realization of a change that will develop from the individual to the society. The fact that the students used various figures for different purposes in their comics, gave various roles to the characters, and placed them in new problematic situations, showed that they acted like a director managing the conflict. In this study, the students, who created many different settings with their choices of color, place and time, applied many aesthetic subtleties that would involve the reader in the phenomenon by acting like a director. As a result of the case framed in this research, it can be summarized that the students realized the product creation step, which was the last goal of a constructivist learning hierarchy on climate change, by loading aesthetic subtleties that could create a high impact. Everything in all students' questioning of climate change in product creation processes is related to an important step towards developing life skills such as creative thinking, communication, and decision-making, which are emphasized in the Science curriculum, as well (MoNE, 2018a).

The fiction of the stories in the comics was supported by the differences in the choice of places. In this regard, each student's preference for different places enabled them to strengthen their expressions even more. In particular, the design of surreal places and the use of places in synthesis can be considered as an aesthetic value in the viewer's participation in the importance of the problems created and their solution suggestions. It was seen that the students did not interrogate the climate change problem to another-centred questioning. These results of this research coincide with an important study that confirmed the positive contribution of the comic booklet used in the physics lesson to the students' critical thinking (Orçan & Ingeç, 2016). The determination of dates from the past and the future beyond the present in most of the temporal fiction used in the stories showed that the students did not approach the problem purely self-centred. The transformation of remembering/knowledge into a product was a significant change in terms of raising awareness and transferring the converted information in the learning-teaching processes. Studies which found that comics developed and presented by researchers for use in foreign language and mathematics teaching increased learning outcomes and motivation (Cabrera et al., 2018; Hobri et al., 2019; Musa et al., 2020; Oliwe & Chao, 2022; Widyasari & Nurcahyani, 2021) share similarity with the implications of this research about learning. In addition, the findings of this study largely correlate with the results of other studies which reported that students like to use tools of comic composing and that they develop competence in decision-making, creativity, self-determination, and teamwork (Kılıçkaya & Krajka, 2012; Silva et al., 2017). It can be claimed that this research resembles design-based research in terms of contributing to science teaching and enabling students to think deeply about a subject (Damopolii et al., 2021; Hermita et al., 2020; Malauat et al., 2021; Özdemir, 2017; Roswati et al., 2019).

Conclusions and Implications

In view of the findings obtained in the study, a number of significant conclusions were reached. These conclusions are fourfold. The first remarkable conclusion is about the case study. The case that occurred in this research has shown that 5th-grade students also developed a high level of awareness about climate change and responsibility towards it by accepting that there is an external world that needs to be protected. The issue of the destruction of the natural environment, which the students included in their stories, showed that they had concerns about the future. The fact that they created stories on the extinction of living creatures and global climate change issues proved that students developed a universal sensitivity to climate change.

The second marked conclusion is about the cognitive outcomes of the study. This conclusion is that the students showed the expected behavioral change as a result of an experience-centred education through creative products. It was observed that all students in the study group added many aesthetic subtleties to the narrative beyond storytelling and made creations at a level that could communicate with the audience. Students used linear, change-oriented and reverse narration with creative approaches in storification through the digital comic book

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application Pixton. The transformation of remembering/knowledge into a product was a significant change in terms of raising awareness and transferring the converted information in the learning-teaching processes. Besides, the determination of dates from the past and the future beyond the present in most of the temporal fiction used in the stories showed that the students did not approach the problem purely self-centred.

The third brilliant conclusion is about the aesthetic outcomes of the study. This conclusion is that the fiction of the stories in the comics was supported by the differences in the choice of places. In this regard, each student's preference for different places enabled them to strengthen their expression even more. In particular, the design of surreal places and the use of places in synthesis can be considered as an aesthetic value in the viewer's participation in the importance of the problems created and their solution suggestions. It was seen that the students did not interrogate the climate change problem to another-centred questioning. The fact that the students used various figures for different purposes in their comics, gave various roles to the characters, and placed them in new problematic situations, showed that they acted like a director managing the conflict expected in all structuralist approaches.

The fourth remarkable conclusion is on the widespread of the exemplary case. In this research, the steps for the use of storification with comics in learning environments are explained in detail. Teachers who want to make storification practices in their own classrooms in the future can follow the steps in this study. In this research, it is presented from which aspects the students approach the subject which is in the environment unit in the science lesson. In this direction, teachers during the teaching of natural sciences can guide students in preparing comics in order to see their tendency to the subject, raise awareness and encourage them to develop solutions for current problems. In addition to these, students can print the comics they created with Pixton through this app and present their products in the form of booklets in the classroom. From scientific process skills to self-expression and communication to STEAM, it has been seen that creating digital comics is suitable for the sustainability goals of the TIMMS, OECD, NETS, and PISA. Teachers who want to support discussion environments where students can freely express their thoughts can benefit from programs like Pixton in their lessons.

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Declaration of Interest

The authors declare no competing interest.

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