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Example of a Socio-Scientific Issue: Nuclear Energy

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ABSTRACT

The purpose of this study is to develop a lesson plan that will facilitate the instruction of socioscientific issues and the acquisition of twenty-first century skills. To this end, a lesson plan comprising four hours of instruction was devised and presented in comprehensive detail. Three distinct activities were devised and executed as part of the lesson plan. The initial activity is the Nuclear Energy Panel Event, which serves to elucidate the nature of nuclear energy. The second activity is the 6 Thinking Hats Technique and Different Perspectives on Nuclear Energy Activity, which permits the consideration of the nuclear energy issue from a multitude of perspectives. The third activity is the Let's Create Dilemma Cards Activity with Canva, in which a nuclear energy poster was designed to facilitate comprehension of the positive and negative aspects of nuclear energy. Aspects that were liked, disliked, and wanted to be changed in the implemented activities were determined by the activity evaluation form applied to the students. According to the findings obtained from the activity evaluation form, students expressed positive opinions about the activities implemented. It is thought that the designed and implemented lesson plan will serve as an exemplary socioscientific lesson plan for teachers and teacher candidates.

Keywords: Socio-scientific issues, nuclear energy, panel, 6 thinking hats technique, Canva

Sosyobilimsel Bir Konu Örneği: Nükleer Enerji

ÖZET

Bu çalışmanın amacı, sosyobilimsel konuların öğretilmesinde ve 21.yy becerilerinin kazandırılmasında rehber olacak bir ders planı hazırlamaktır. Bu amaç kapsamında dört ders saati süren bir ders planı tasarlanmış ve ayrıntılı olarak sunulmuştur. Ders planı için üç farklı etkinlik tasarlanmış ve uygulanmıştır. İlk etkinlik olarak, nükleer enerjinin açıklanmasına yönelik Nükleer Enerji Paneli Etkinliği'dir. İkinci etkinlik olarak, nükleer enerji konusunu her açıdan ele almayı sağlayan 6 Şapkalı Düşünme Tekniği ile Nükleer Enerjiye Farklı Bakışlar Etkinliği'dir. Üçüncü etkinlik olarak, nükleer enerjinin olumlu ve olumsuz yanlarını anlamayı sağlayan, nükleer enerji afişi tasarlanan Canva ile İkilem Kartları Oluşturalım Etkinliği'dir. Uygulanan etkinliklerde beğenilen, beğenilmeyen ve değiştirilmesi istenen yönler; öğrencilere uygulanan etkinlik değerlendirme formu ile belirlenmiştir. Etkinlik değerlendirme formundan elde edilen bulgulara göre uygulanan etkinliklerle ilgili öğrenciler genel olarak olumlu görüş bildirmiştir. Tasarlanan ve uygulanan ders planının öğretmenlere ve öğretmen adaylarına örnek bir sosyobilimsel ders planı olacağı düşünülmektedir.

Anahtar Kelimeler: Sosyobilimsel konular, nükleer enerji, panel, 6 şapkalı düşünme tekniği, Canva

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INTRODUCTION

Socio-scientific issues (SSI) are social issues that concern society and also have scientific content (Sadler, 2004). These issues, referred to as SSI, are characterized as open-ended, complex, and controversial, with no definitive resolution (Sadler, 2004; Topcu, 2010). There are five dimensions to SSI. These dimensions necessitate a nuanced approach, encompassing a multifaceted examination of the subject matter, the consideration of diverse viewpoints, and a critical stance towards the information presented. They must be viewed within the context of the possibilities and limitations of scientific inquiry (Zeidler, Herman & Sadler, 2019). In conclusion, the foundation of socioscientific issues is scientific inquiry. These issues lack a singular, definitive solution and often manifest in real-life and media contexts. They necessitate prompt, socially and personally informed decision-making (Sadler & Zeidler, 2005).

The media frequently addresses a range of topics that have become increasingly prominent in contemporary discourse, including acid rain, nuclear energy, organ donation, genetically modified organisms (GMOs), global warming, organic agriculture, cloning, environmental issues, stem cells, and space research. These subjects have emerged as some of the most significant social issues (SSI) of our time. For example, it can be argued that nuclear energy is harmful because it has a detrimental impact on both nature and human health, and it can be used as a nuclear weapon (Toktaş & Genç, 2023). Conversely, the inability of renewable energy sources to generate substantial amounts of power and their high cost have prompted countries to consider nuclear energy as an alternative. Conversely, the utilization of nuclear energy has been demonstrated to possess advantageous qualities, including the potential to diminish reliance on foreign energy sources (Sevim & Ayvacı, 2020). It is evident that SSI's are complex issues that present a multitude of challenges, are intertwined with scientific and societal considerations, possess multiple potential solutions, and are subject to personal sentiments, values, and experiences. Given that these issues are pervasive in our daily lives, it is imperative for individuals to possess a comprehensive understanding and the capacity to devise effective solutions to these challenges (Aydın & Mocan, 2019).

The Science Curriculum has been designed with two specific aims in mind. Firstly, it aims to ensure that students take responsibility for solving everyday problems. Secondly, it seeks to develop students' reasoning abilities, scientific thinking habits and decision-making skills by engaging with socio-scientific issues. These aims were set out by the MEB in 2018.

In alignment with these objectives, it is imperative that these issues be addressed by educators to equip students with the competencies targeted for development in SSIs that encompass real-world challenges. One of the key advantages of integrating SSIs in the classroom is that students can forge a meaningful connection between their daily experiences and academic pursuits (Dawson, 2015).

The utilization of SSI in an educational context is designed to cultivate "functional scientific literacy." This approach facilitates students' capacity to make informed decisions, critically analyze diverse data and information sources, synthesize and evaluate these data and information based on their analysis, and reason logically on ethical and moral issues (Zeidler et al., 2019).

It is recommended that SSI be taught in the classroom setting, as it is included in the curriculum and is a topic that is frequently encountered in daily life and even in the media. The learning environment for SSI should include active student participation, collaboration, and mutual respect among students. Students should have opportunities to reason and/or interact with scientific ideas and real data, as well as discuss the social aspects of

problems (Eastwood et al., 2012). In this manner, upon reaching adulthood, students will be equipped with the ability to identify solutions to their problems, make informed decisions, evaluate situations from diverse perspectives, and demonstrate respect and tolerance for alternative viewpoints.

The preparation and development of guide materials for SSI teaching in Turkey, as in countries that integrate and implement SSI into their programs, will contribute significantly to the integration of SSI into the science program in Turkey (Topçu, 2019). The incorporation of socioscientific issues into the curriculum by science educators has been demonstrated to enhance students' interest in science (Tal & Kedmi, 2006; Ekborg, Ottander, Silfver & Simon, 2013). Concurrently, the integration of these issues into the curriculum is intended to cultivate the critical thinking, scientific thinking, and decision-making abilities that are expected of students (Babacan, 2017).

SSIs appear to be employed as both goals and tools, yet there is a paucity of research examining the optimal pedagogical approaches for teaching and addressing these topics in the classroom (Topçu, 2019). The objective of this study is to develop a lesson plan that is aligned with the characteristics of SSI and serves as a reference for practitioners. The objective of implementing the prepared lesson plan is to ascertain the most effective methodology for teaching and processing a sample SSI in the classroom. This process will involve identifying the strengths and weaknesses of the plan, organizing it based on student feedback, and finalizing it for use. Furthermore, the plan incorporates the competencies that SSI seeks to impart and those delineated in the Ministry of Education and Science Curriculum. The objective is to facilitate the acquisition of abilities such as decision-making, analytical thinking, teamwork, and communication. Furthermore, the curriculum elucidates the processes by which electrical energy is generated in power plants, which encompass hydroelectric, thermal, wind, geothermal, and nuclear power plants. Additionally, it prompts students to conceptualize the advantages and disadvantages of power plants, prompting them to evaluate these facilities in terms of their benefits, harms, and risks and to defend their positions (MEB, 2018). The objective is to prepare a sample SSI lesson plan to provide students with the aforementioned achievements.

APPLICATION OF THE LESSON PLAN

This lesson plan presents a series of ideas regarding the advantages and disadvantages of power plants in the context of the conversion of electrical energy, as part of the "Electric Loads and Electric Energy" unit of the 8th grade science curriculum. (The students are required to generate ideas regarding the evaluation of power plants in terms of benefits, harms, and risks and to defend these ideas.) The lesson plan has been developed in accordance with the five-step 5E model, incorporating the introduction, discovery, explanation, deepening, and evaluation phases pertinent to the subject of nuclear energy. The objective is to devise a comprehensive lesson plan aligned with the educational requirements of 8th grade students, facilitating the attainment of meaningful learning outcomes on the topic of nuclear energy, a socio-scientific issue. Additionally, the plan aims to foster the advancement of students' scientific reasoning abilities.

The lesson plan is designed to be completed in four 40-minute sessions. However, students who were unable to complete their assigned product in class were instructed to do so at home. Three distinct activity designs were developed for implementation in the course. These include: 1. A Nuclear Energy Panel, 2. Different Perspectives on Nuclear Energy with the 6 Thinking Hats Technique, and 3. The creation of Dilemma Cards with Canva.

Nuclear Energy Panel Effectiveness Implementation Steps

A week prior to the commencement of the course, students are informed that the subsequent subject will be nuclear energy, with a panel discussion scheduled on the topic. The panel technique is then elucidated, with students being told that the issues of concern to society are elucidated and discussed by experts in their respective fields. It is also explained that the individuals responsible for conveying the topic are referred to as panelists.

The five students who have expressed interest in serving as panelists will be selected on a voluntary basis. The students are required to conduct research and prepare a PowerPoint presentation on five topics, selected by the instructor, within a one-week period. The topics are as follows: 1. What is nuclear energy, why is it established and why is it used, 2. Nuclear power plants in the world, 3. Nuclear Power Plants in Turkey (Sinop and Akkuyu nuclear power plants), 4. Benefits of Nuclear Energy, 5. Harms of Nuclear Energy.

In preparation for the presentation, the panelists informed the students that the presentations should be visually appealing, elucidate the core tenets of the subject matter in an engaging manner, incorporate a sufficient number of images and videos, limit the amount of text on a slide to five or six sentences, and prioritize the use of color design.

At the outset of the lesson, the students are presented with a video, entitled "Genetic consequences of consanguineous marriage," on the EBA platform. This video recounts the tale of siblings in a family who endeavor to arrange marriages between their children. The video elucidates the potential complications associated with consanguineous marriage and the genetic tests that are recommended prior to matrimony.

Figure 1. Genetic Consequences of Consanguineous Marriage

Subsequent to the initial phase of garnering attention, the panelists disseminate information about the presentation they have prepared on their respective topics to their acquaintances. At the conclusion of the event, other students pose questions to the panelists, who then provide a comprehensive explanation of the subject matter. One might inquire as to why there is a greater prevalence of nuclear power plants in developed countries. What are the reasons for the establishment of nuclear power plants in our country? "What are the potential consequences of nuclear accidents? What are the factors that influence the selection of nuclear power plants? When weighing the advantages and disadvantages of nuclear energy, would you advocate for its implementation in our country?" These and other thought-provoking inquiries were posed during the panel discussion, which spanned two class hours (2x40 minutes). The panel event served as an exploratory phase, facilitating a deeper examination of the subject matter.

Sample photographs of the prepared presentations are shared below.

Figure 2. Nuclear Power Plant

Figure 3. Nuclear Energy Source

Figure 4. Power Plants in Turkey

Figure 5. Nuclear Energy Harms

Different Perspectives on Nuclear Energy Activity with 6 Thinking Hats Technique Application Steps

In order to implement the six-hat technique, the class is divided into six groups. The assignment of hats to each group and the designation of their significance are explained. The students are instructed to compose written works, including pictures, poems, songs, and other forms of creative expression, according to the perspective of the six distinct colors. In other words, the students are encouraged to express themselves according to their individual point of view (color of the hat) and their assigned group. The activity is designed to be completed within the span of one class period, with 40 minutes allotted for its completion. Students who were unable to complete their work were advised to continue it at home and present it to the instructor during the subsequent lesson.

White hat: The term "white hat" is used in the context of cybersecurity to describe a person or entity that engages in ethical hacking, that is, the penetration testing of a system or network to identify vulnerabilities and weaknesses for the purpose of improving the system's security. It should present concrete studies and data on nuclear energy, energy consumption in Turkey over the past decade, and potential future trends. Additionally, it should address the contributions and risks associated with nuclear energy, including an evaluation of the benefits and drawbacks of its use.

Red hat: The creation of poems, paintings, songs, and compositions can be undertaken to explore the potential impact of nuclear energy on individual and collective emotional states.

Black hat: It is recommended to provide information and present examples of the social, psychological, and biological destruction that the construction of nuclear energy can cause to nature and the environment..

Yellow hat: It is imperative that nuclear energy elucidate its operational principles for the betterment of society.

Green hat: All groups are expected to contribute ideas that are not merely extensions of their own.

Blue hat: In order to gain a comprehensive understanding of nuclear energy, it is requested that all participants engage with the subject through a medium of their choice, whether that be a painting, poem, song, or composition.

- In the song, the red hat is a prominent symbol, representing the impact of nuclear power plants on people and society.
- All resulting products have been thoroughly discussed, and the deepening step has been completed.
- For illustrative purposes, sample photos of the event are provided below.

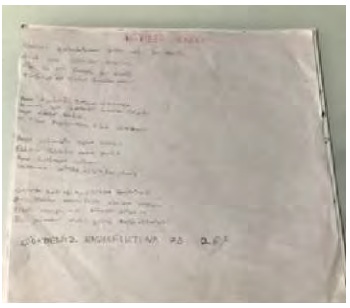

Figure 6. Nuclear Energy Poem

Figure 7. Nuclear Energy Cartoon Study

Figure 8. Nuclear Energy Painting Study

Let's Create Dilemma Cards with Canva Activity Implementation Steps

The following equipment is required: This activity should be conducted in a classroom with an internet connection and computers. The Canvas platform may be utilized for the preparation of various forms of digital content, including presentations, videos, posters, and resumes. As a Web 2.0 tool, Canvas enables the creation of online content (Temizyürek & Öncül, 2022). For students who opt not to utilize the Canva application for the creation of benefit-harm cards, alternative materials such as cardboard, paper, glue, and colored pencils are necessary. This activity is designed to be completed within the span of one class period, with an estimated duration of 40 minutes.

- This activity is planned as an evaluation step.
- Since the Canva application is an application that students already know, what to do in the application was briefly explained to the students.
- In the light of the information learned in the previous two activities, students were asked to discuss nuclear energy
- They were asked to prepare benefit-harm cards.
- The teacher emphasized that students who only gave information about nuclear energy should correct their work, and corrections were requested to ensure that the work included benefit-harm information.
- The prepared cards were shared with all students.
- Students made constructive comments about each other's cards. Aspects that needed to be corrected or changed were discussed.
- Nuclear energy awareness was created by displaying the cards liked by everyone on the school board.
- Sample photos of the event are shared below.

Figure 9. Nuclear Energy Damage Card

Figure 10. Nuclear Energy Benefit Card

Figure 11. Nuclear Energy Dilemma Card

Figure 12. Nuclear Energy Benefit-Harm Card

FINDINGS

An Activity Evaluation Form was prepared to evaluate the lesson plan on "Nuclear Energy", a socioscientific subject. In this form; Open-ended questions were asked to the students regarding the three activities implemented. For each event; It was tried to determine the liked aspects of the activity, the disliked aspects and the aspects that wanted to be changed.

The findings regarding the "Panel Activity" in the Activity Evaluation Form are given in Table 1.

Table 1. Student Opinions on the Panel Event

	Student Opinions (Sample Expressions)							
Liked Aspects	It was effective that the panelists explained both visually and with presentation.	One of the things I liked about it was that the students in the class were willing to present and that everyone was having fun.	I learned more permanent information while doing research and presenting to friends.	It was fun to make videos and explain the subject in detail.	I really liked how the presentation was like a cartoon.	I liked using technological devices while learning new information.	It was very informative that they included visuals and videos in the presentation.	I liked how the panelists explained it like teachers.
Dislikes	I didn't like it when my friends talked for too long.	I didn't like that only a few people prepared and explained it.	Being a panelist was very challenging.	I didn't like it because it was boring.	Some friends talked about the same things.	While preparing slides, I had difficulty finding photographs on the subject.		
Aspects That Want to Be Changed	We could have explained it in a group instead of a few people.	The teacher should have checked the presentation before the presentation.	Animation could be done.	Shorter presentations should have been prepared.	More visuals and videos should have been added to the presentations.	More visual materials should have been added to the presentations.		

The findings regarding the "6 Hats Activity" in the Activity Evaluation Form are given in Table 2.

Table 2. Student Opinions on 6 Hat Activity

	Student Opinions (Sample Expressions)						
Liked Aspects	I liked that we acted according to our imagination. It was better to look at the issue from different aspects.	I liked writing poems by putting my feelings in writing. Writing poetry and drawing made me happy.	I created my own scenario and told it as a story, it was a great event. It revealed my artistic vision.	It was fun, funny and more memorable. I liked that the stories written were realistic.	My friends' creativity in writing poetry was beautiful. Our two friends wrote very beautiful poems.	I liked how funny poems came out. It was nice that everyone got different hats.	I liked writing poetry and turning it into a rap song and singing it.
Dislikes	The task of the green hipster hat was very difficult.	I think the work took a long time in the 6 hat application we made.					
Aspects That Want to Be Changed	We could turn the written stories into theatre.	It would be nice if there was a drama.	Everyone had to choose their own hat colors.	We could prepare a video and present our perspective on hat colors.			

The findings regarding the "Canva Activity" in the Activity Evaluation Form are given in Table 3.

Table 3. Canva Activity Student Opinions

	Student Opinions (Sample Expressions)						
Liked Aspects	I can do anything I want in Canva. I liked that it was intertwined with technology.	I liked that there were so many options in Canva. I liked that it was catchy.	The posters we prepared were memorable. I liked preparing the benefit and harm card.	I liked that it was with technological devices.	It was nice that the teacher asked for accommodations.	It was a lot of fun to make applications on the computer	Using smart boards and computers increased memorability.
Dislikes	At first I had difficulty using Canva.	When entering the application, I had difficulty creating an account and logging in.	Canva was tedious and time consuming.	The Canva app was complicated. The task was very difficult.			
Aspects That Want to Be Changed	We could hang the posters we prepared in Düzce and let everyone see them.	We could use not only Canva but also other applications.					

CONCLUSION AND RECOMMENDATIONS

The results of the research indicated that the students who completed the Activity Evaluation Form had positive, negative, and constructive feedback regarding the panel activity, as well as the Canva activities. Based on this feedback, six activities were identified for further improvement.

Students who participated in the panel event indicated that they found the topic to be more engaging and informative when it was presented with visual aids, videos, and presentations by their peers. One area for potential improvement identified by students was the limited number of panelists, which was perceived as a drawback of the event. It is deemed appropriate to appoint willing students as panelists during the event's design phase. In other words, if the number of students who wish to prepare a presentation exceeds five, it may be suggested that another dimension of the nuclear energy issue be presented and that topics be distributed to the panelists. At the same time, there are also students who criticize that the process takes too long. To circumvent this issue, the lesson period can be divided into five segments, with a stipulation that each student must complete their presentation within the allotted time. To obviate repetition, the instructor may wish to review the presentations prepared by the students prior to the lesson. The common aspect that the students desired to modify in this activity was to guarantee that the subject was elucidated in groups. Despite the potential contravention of the panel, students who are capable of working collaboratively may be assigned the task of preparing and presenting a joint presentation. Sagmeister et al. (2021) posit that, in particular, the panel discussion contributes to the transformation of socioscientific issues into a longer-term memory.

The participants expressed appreciation for the literary and artistic creations produced by the students in relation to the Six Hats Activity. These included poems, stories, drawings, and songs. Additionally, the event was met with high praise for its ability to foster a multifaceted perspective and showcase artistic expression and creativity. However, the observation that the written narratives were transformed into theatrical performances represents a potential area for improvement in future iterations of the event. Consequently, a narrative that resonates with students can be adapted into a theatrical or dramatic format. It was noted that some students may find the concept of green hats (which are perceived as innovative) challenging. As a result, it was recommended that students be given the autonomy to select their own hat color, which was identified as an area requiring improvement. The rationale behind the distribution of hat colors to the groups is to ensure that each group is assigned a distinct color. Nevertheless, students may select their own hat color to ensure diversity. The Six Thinking Hats Technique assists students in making more informed decisions when confronted with diverse scenarios, broadening their perspectives and enhancing their cognitive networks (Güngör et al., 2023). This approach facilitates the development of decision-making and multifaceted thinking skills in the context of socio-scientific issues and beyond.

The activity that students expressed the greatest enthusiasm for was the Canva activity. The students indicated that their preferred aspect of the activity was the opportunity to engage with computers and technology. Concurrently, the most highly regarded aspects of the event were that it was more memorable and that it permitted an examination of the subject from two distinct perspectives, thereby facilitating an evaluation of the subject. Nevertheless, the instructor's subsequent request for editing and correction enhanced the overall quality of the final products. The students expressed appreciation for the instructor's guidance in establishing clear standards for the project. During the implementation of this lesson plan, the instructor may require that all products resulting from all three activities be corrected and given their final form. For students who are uninterested in technology and have no prior experience with applications such as Canva, this activity may appear somewhat challenging and complex. It would therefore be beneficial for students to be encouraged to utilise the Canva application in advance of implementing this activity, in order to facilitate their adaptation to the task. Alternatively, students may engage with the Canva application in collaboration with the information technology teacher, as part of the information technology course curriculum. One proposed modification to the Canva application is the concept of displaying prepared posters on public street signage. The most popular posters were subsequently displayed on the noticeboards located within the school corridors. As a result, the students at the school became more aware of the subject matter. The utilisation of Web 2.0 tools facilitates a more enjoyable learning experience for students, while simultaneously enhancing the efficiency of the learning process. The Canva application, in particular, has been shown to enrich the learning environment by enabling the creation of a diverse range of materials (Temizyürek & Öncül, 2022). In their study, Yazıcıoğlu, Zirve, and Yıldırım (2023) found that students in web 2.0 supported courses reported that the course was memorable, entertaining, and facilitated learning.

The implementation of the aforementioned activities enabled students to examine events from disparate perspectives through group work, in alignment with the intrinsic nature of socioscientific issues. The activities were implemented in a similar manner and are believed to assist students in developing their communication, questioning, reasoning, and analytical thinking skills. While the activities are related to the topic of nuclear energy, they can be readily adapted to address other socioscientific issues, including those related to

acid rain, genetically modified organisms (GMOs), global warming, and stem cell research. This flexibility allows teachers to easily convert the activities into a format that aligns with other relevant topics.

This lesson plan is designed to serve as a reference for science educators, including both current and prospective teachers.

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