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A SOCIO-SCIENTIFIC ISSUE ACTIVITY: GLOBAL PANDEMIC DISEASES AND METHODS OF PREVENTION[1]

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ABSTRACT

In this study, the primary goal was to enhance the knowledge and awareness of 4th-grade primary school students regarding global pandemic diseases and methods of safeguarding against worldwide epidemic diseases which are socio-scientific issues. To achieve this goal, two activity modules tailored for 4th-grade students were created. These encompassed various activities, including experiments, worksheets on scientific process skills, science-themed interactive reading, and poster development. The research was conducted at a public school during the 2022–2023 academic year, utilising a qualitative research methodology. Data were collected through pre- and post-implementation interviews. The findings of the study indicated that students were able to articulate accurate scientific information about global pandemics and protective measures. They also demonstrated an ability to implement preventive measures in their daily lives and share information about global pandemics with their families and friends. Furthermore, it was observed that students developed a more positive perception of scientists.
Keywords: global pandemics, science teaching in primary school, socio-scientific issues.

BİR SOSYOBİLİMSEL KONU ETKİNLİĞİ: KÜRESEL SALGIN HASTALIKLAR VE KORUNMA YOLLARI

ÖZ

Bu çalışmada, ilkokul 4. sınıf öğrencilerinin sosyo-bilimsel bir konu olan küresel salgın hastalıklar ve bu hastalıklardan korunma yöntemleri hakkında bilgi ve farkındalıklarının artırılması amaçlanmıştır. Bu amaca ulaşmak için 4. sınıf öğrencilerine yönelik iki etkinlik modülü oluşturulmuştur. Modüller; deneyler, bilimsel süreç becerilerinin yer aldığı çalışma yaprakları, bilim temalı etkileşimli okumalar, poster ve slogan geliştirme gibi etkinliklerden oluşmaktadır. Çalışma, 2022-2023 eğitim öğretim yılında bir devlet okulunda yürütülmüştür. Nitel araştırma metodolojisi benimsenen çalışmada veriler, uygulama öncesi ve sonrası görüşme formu ile toplanmıştır. Araştırma sonuçları, etkinlikler sonrasında öğrencilerin küresel salgın hastalıklar ve korunma yollarına ilişkin doğru bilimsel ifadeler kullandıklarını, küresel salgın hastalıkları önlemede alınacak tedbirleri günlük yaşamlarında etkin şekilde uyguladıklarını, aile ve arkadaşlarını küresel salgınlar hakkında bilgilendirdiklerini göstermektedir. Ayrıca, öğrencilerin bu etkinliklere katıldıktan sonra bilim insanlarına yönelik daha olumlu bir algı geliştirdikleri gözlemlenmiştir.
Anahtar kelimeler: küresel salgın hastalıklar, ilkokulda fen öğretimi, sosyobilimsel konular.

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INTRODUCTION

An epidemic disease is defined as the spread of infectious diseases caused by the direct or indirect transmission of a disease-causing infectious agent to a living organism, resulting in illness in a large number of living organisms (Yurdakul, 2015). The history of epidemics stretches back to ancient times, with the assumption that microbes, the most fundamental source of epidemics, predate human history (Elçi, 2020). For instance, historical records show that Ancient Greece experienced a devastating plague epidemic that claimed the lives of 30 percent of its population, while Alexander the Great's expedition to India was thwarted by smallpox (Price-Smith, 2009). In more recent history, thousands or even millions of lives have been lost due to epidemics such as the Hong Kong Flu (1968-1970), swine flu (2009-2010), and Ebola (2014-2016). Today, COVID-19, which emerged in 2020 and significantly impacted the lives of people worldwide, has evolved into a global pandemic, resulting in millions of deaths. It is an undeniable reality that different global pandemics, which have been experienced repeatedly throughout history and continue to occur today, may arise in the future.

In terms of science education, individuals are expected to demonstrate scientific literacy by comprehending explanations from various sources, distinguishing between genuine and unsubstantiated scientific claims through their own critical thinking, and making informed decisions on socio-scientific matters (Evren-Yapıcıoğlu, 2020). Socio-scientific issues, which pertain to scientific topics of social significance (Eastwood et al., 2012), involve the deliberate use of scientific subjects that require active student participation in discussions. These issues are often contentious and entail a level of moral judgment and ethical consideration in the decision-making process (Zeidler & Nichols, 2009). The objective with socio-scientific issues is to make them personally meaningful and engaging for students, necessitating evidence-based reasoning and providing a context for understanding scientific knowledge (Sadler, 2004; Zeidler, 2003). With this theoretical foundation, it can be affirmed that global pandemics, especially the COVID-19 pandemic of recent years, represent a significant socio-scientific issue. Epidemics, which have persisted in various forms throughout recorded history, underscore the importance of cultivating informed behaviours for the future. Indeed, the United Nations Educational, Scientific and Cultural Organization ([UNESCO], 2020) has emphasised the inclusion of science literacy in curricula as a concrete action following the COVID-19 pandemic. Examining the literature reveals the importance of fostering discussion and decision-making skills concerning socio-scientific issues for nurturing scientifically literate individuals who can tackle real-world problems (Driver et al., 2000; Sadler & Zeidler, 2005; Topcu, 2010; Topcu et al., 2014). Considering both the literature and the profound impact of epidemics on societies, the need for effective instructional practices related to global pandemics as a socio-scientific issue becomes apparent. Given the formative nature of childhood years in skill development, addressing such practices, particularly during the primary school phase, takes on added significance. Early childhood and primary school years assume a pivotal role in developing science literacy within a social context (Aydin-Ceran, 2021). Moreover, the ability to make informed decisions about socio-scientific issues constitutes a vital component of science literacy, which represents the ultimate goal of science education (Topcu et al., 2014). From this perspective, the research is grounded in the idea of instilling conscious awareness about global pandemics at the primary school level, recognising them as socio-scientific issues that have become an integral part of our daily lives. In this context, activity modules centred on the theme of global pandemics and protective measures were designed in alignment with the age and developmental characteristics of primary school students. The overarching aim is to empower primary school students with knowledge and awareness concerning global pandemics caused by microorganisms and their methods of protection.

ACTIVITY IMPLEMENTATION

The activities outlined in this study were conducted at a public primary school located in the Konya Province. Prior to the commencement of these activities, the necessary approvals and permissions were obtained. This included approval from the ethics

committee for the activity's implementation, permission from the Ministry of National Education, and consent from the parents of the participating students. A total of 30 fourth grade students were selected randomly from five different branches to partake in the activities.

The activities were conducted by the researcher in the school's science workshop, which took place after regular school lessons. The implementation was based on two distinct modules, namely "Open the Doors of the Micro World" and "Pasteur's Proof: How Should We Protect From Epidemics?". The first module focused on the exploration of microorganisms as the foundational components of global pandemics, while the second module centred on strategies for safeguarding against diseases caused by these microorganisms. The specific objectives and steps of execution for both modules are detailed below.

Module 1: Open the Doors of Micro World

A comprehensive activity module plan was developed to enable students to explore the impact of imperceptible microorganisms in our daily lives. This plan also aimed to foster scientific research skills during this exploration process and concurrently facilitate the comprehension of scientific concepts, some of which the students encountered for the first time, through interactive science-themed readings. The module's instructional design adopts a specific-to-general learning approach, comprising 4 distinct phases with interconnected transitions.

1. Microorganisms: Journey to the Micro World (virtual excursion, video and photo presentation, 30 min).
2. How Were Microbes Discovered? The Clothmaker Who Invented the Microscope by Mistake: Leeuwenhoek (interactive science readings, 25 min).
3. Can We See Microorganisms? (microscope, 40 min + 40 min).
4. Are Microbes Useful? Are They Harmful? Where Are These Microbes? (Yeast airy fungi experiment, 40 min).

Materials: Projector for Micropia virtual visit and YouTube video, interactive science reading fascicle, microscope, mould preparation, a packet of yeast, sugar, two transparent half-litre plastic bottles, a teaspoon, funnel, warm water, two balloons, worksheets.

Phase One: Journey to the Micro World

At this stage, I organised a virtual museum visit featuring various images from the Micropia Museum in Amsterdam. Micropia is a museum dedicated to the exploration of the microscopic world and the microbes that profoundly influence our environment. During this virtual visit, I showcased microscope images of microorganisms to captivate the students' curiosity and foster excitement for learning about these remarkable life forms. Furthermore, my goal was to acquaint the students with the diverse forms of microorganisms observable through these virtual excursions and demonstrations. As part of this stage, a brief discussion was conducted, encouraging students to speculate on the nature of the images, their potential origins, locations, methods of observation, size, and unique characteristics. I also took this opportunity to revisit the students' prior knowledge and identify any misconceptions that may have arisen. In particular, I posed the question, "How can we observe these creatures?" as I transitioned into the next phase of the activity. Below, you'll find Photograph 1 related to this initial stage.

Photograph 1. Images from the First Phase

Phase Two: How were Microbes Discovered?

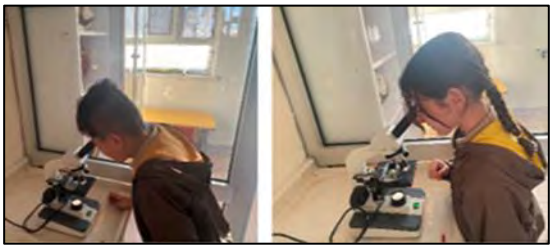
During this stage, I selected a story that catered to the students' learning needs, aligning with their age and developmental characteristics. The chosen story featured a large font size and captivating visuals of scientific objects and concepts, ensuring an engaging reading experience. The reading process was interactive, involving active participation and

dialogue between the teacher and students. Interactive reading, as defined by Thomas et al. (2020), entails bringing the book to life, fostering imagination, and reimagining the text. The primary aim of this activity was to enable students to grasp scientific concepts, some of which they were encountering for the first time, in an interactive manner, as proposed by Yore et al. (1998). The story's context revolved around Antonie Philips van Leeuwenhoek, a fabric manufacturer credited with inventing the microscope (Dikmen & Sevde 2018). Throughout the interactive reading session, students made notes about unfamiliar words and pondered questions sparked by the story's illustrations. Following the reading, the researcher facilitated a discussion with the students, focusing on the words they had noted and providing a platform for them to express their thoughts and questions. At this stage, my primary objective was to raise awareness about the existence of microorganisms imperceptible to the naked eye and shed light on the process of their discovery. Additionally, I aimed to support the students' development of a foundational understanding of scientific concepts encountered for the first time. Photograph 2 related to the second stage of the activity is displayed below.

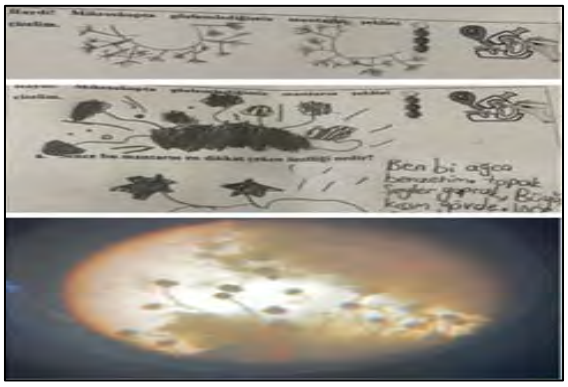
Photograph 2. Images from the Second Phase

Phase Three: Can We See Microorganisms?

In the third stage, we embarked on a journey, starting with the invention and historical significance of the microscope. I introduced the students to the microscope's mechanism, its various parts, and its fundamental functions. To provide a practical understanding, I showcased some microorganisms through the microscope. During this stage, I utilised mould fungus preparation as part of the activity. Additionally, each student received Worksheet-1, meticulously crafted by the researcher, which can be found in Appendix 1. Worksheet-1 included thought-provoking questions designed to stimulate critical thinking and engage students in the observation process. Some of these questions included, "Let's depict the shape of the microorganism we observed under the microscope (the researcher selected mould fungus). What do you find most distinctive about this microorganism? Does it bear any resemblance to the microorganisms we encountered at the Micropia Museum? Do you believe this microorganism serves a beneficial purpose, or is it potentially harmful?" Subsequently, students were encouraged to illustrate the image they observed under the microscope. Open-ended questions were employed to prompt discussion among the students. The transition to the fourth stage was facilitated by highlighting the idea that all microorganisms, including the ones they observed, have the potential for both beneficial and harmful effects. Photographs 3 and 4 illustrating activities from the third stage can be found below.



Photograph 3. Examining the Image in the Microscope



Photograph 4. Image in the Microscope and Student Drawings

Phase Four: Are Microbes Beneficial? Are They Harmful?

In this phase, I conducted the airy fungi experiment,(https://www.micropia), aimed at

providing evidence of the existence of microorganisms visible through a microscope. As part of this experiment, students were guided through a structured inquiry process with the assistance of Worksheet-2, available in Appendix 2. The experiment's primary goal was to enable students to grasp the reproductive and spreading functions of microbes and, subsequently, transfer this knowledge to the context of diseases that can be caused by harmful microorganisms. During this stage, I initiated a discussion focusing on the Corona virus. I emphasised that microorganisms, though invisible to the naked eye, could have adverse effects on human life due to their unique life and reproductive functions, as evidenced by the air mushroom experiment and microscope images. Following the experiment, I concluded the first activity with a 10-minute discussion and evaluation session with the students, framing their experiences in the context of the COVID-19 pandemic. Photograph 5 depicting activities from the fourth stage is provided below.

Photograph 5. Airy Fungi Experiment Images

Module 2: Pasteur's Proof

This module focuses on understanding how microbes infect the body, the importance of vaccination immunity, and our individual and social responsibilities in this context. Given that the module introduces scientific concepts to students at the fourth-grade level for the first time, I have enriched the learning experience by combining various activities to aid comprehension and facilitate smooth transitions between these concepts. The module is structured into five stages:

1. Transmission of Microbes (experiment, 30 min).
2. The Significance of Handwashing (experiment, 40 min).
3. Microbes Unveiled: The Story of Pasteur (interactive science readings, 25 min).
4. Vaccination and Immunisation: The Coronavirus Vaccine and its Effects (35 min).
5. Safeguarding Against Global Pandemics: Slogan Creation and Poster Design (40 min).

Materials: Three slices of bread, three ziplock freezer bags, latex gloves, worksheets, and pencils.

Phase One: How are Microbes Transmitted?

In this stage, students were introduced to a DW Turkish news report covering the coronavirus pandemic, which can be considered a socio-scientific issue. The news report discussed a simulation conducted by Japanese scientists that demonstrated how the coronavirus spreads. The video showcased Japanese researchers using a supercomputer to create a simulation, providing vivid visuals of how the virus spreads through droplets under various conditions (available at https://www.youtube.com/watch?v=Tv2wJCrVws). Following the news report, students were posed with the question, "Where did the virus spread among those who contracted the disease within your family and community in relation to the coronavirus?" This question captured the students' attention and offered them an opportunity to express their thoughts on concepts related to the epidemic. Subsequently, Worksheet-3 for the "How Microbes Are Transmitted" experiment was provided in Appendix 3.

Phase Two: Why Should we Wash Our Hands?

In this stage, the objective was to underscore the importance of handwashing with soap and water and to emphasise the significance of hygiene practices based on the locations where microbes can be transmitted and where they tend to accumulate, as observed in the previous experiment. The experiment was conducted following the instructions provided in Worksheet-3 (My Experiment/Activity Report). The experiment/activity report was designed to promote students' fundamental scientific process skills. In this context, the aim was for students to formulate predictions based on their existing knowledge, practice careful observation, devise solutions to everyday problems, and reconstruct scientific concepts. During the experiment, students were organised

into groups, with each group receiving 3 slices of bread, latex gloves, refrigerator bags, and marker pens. Each group executed the experiment in accordance with the provided instructions and placed the bread on classroom shelves to monitor its condition over the course of one week. Images depicting the outcomes of this second stage are presented in Photograph 6.

Photograph 6. Images from the Second Phase

Phase Three: Microbes are Asked of Him: Pasteur

This stage included an interactive science reading session, emphasising the interaction between students and the teacher. Through the visuals presented in scientific texts, the aim was to cultivate a positive perception of science and scientists among students by highlighting the essence of science, the scientist's working environment, and the materials used. The subject of the scientific story (Dikmen & Sevde, 2018) featured in this stage revolved around Louis Pasteur, the scientist renowned for inventing rabies and typhoid vaccines, as well as his discovery of pasteurisation. At this juncture, the text emphasised key concepts and terms such as "vaccine, rabies, typhoid, smallpox, varicella, vaccination", with students being prompted to answer questions related to these concepts. Within the interactive scientific texts (Photograph 7), the significance of vaccination was underscored by highlighting that global pandemics responsible for the deaths of thousands and even millions of people in the past are now largely absent.

Photograph 7. Interactive Reading Text

Phase Four: Vaccination and Immunisation

At this stage, the goal was to promote awareness about the immune system and vaccination through a real-life story related to the COVID-19 pandemic. To achieve this, Worksheet-4, provided in Appendix-4, was developed. This worksheet featured a narrative about the vaccination experiences of twin sisters named Selin and Bahar during the COVID-19 pandemic, accompanied by questions for students to answer based on the story. Following the completion of Worksheet-4, students were shown a video created by the Ministry of Health that explained vaccine-vaccination, immunity, and the mechanism by which vaccines operate in our bodies (https://www.youtube.com/watch?v=1OhBzgTvN5c). Given the age level of the students, this part of the activity focused on concepts such as attenuated microbes, antibodies, and immunity. While watching the video, students were instructed to record any unfamiliar concepts they encountered on their worksheets. After the video, a brief discussion ensued, allowing students to explore the concepts of vaccine-vaccination, immunity, and antibodies.

Phase Five: Slogan Creation and Poster Preparation

In this stage, students were tasked with crafting a creative slogan centered on methods of safeguarding against global pandemics, drawing upon their experiences and observations from earlier stages. They were also required to design a poster aligned with their chosen slogan. The objective here was to elicit the students' conceptual comprehension of strategies and approaches for protection against global pandemics through their imaginative slogans and visuals. To facilitate this process, students were organized into groups and encouraged to collaborate in generating ideas. The posters created were prominently displayed on the classroom walls. Subsequently, the students had the opportunity to showcase and present their posters to their peers and teachers at the school. In Appendix-5 you will find the posters created by the students.

EVALUATION OF THE ACTIVITY

The study encompassed the completion of two activity modules over 2-week implementation

period totaling 350 min. Prior to commencing the activities, an interview form was employed to assess students' pre-existing knowledge and perspectives regarding global pandemics and methods of protection. Upon concluding the activities, students' feedback on the activities was gathered through a post-activity interview form that focused on the outcomes. Both the pre- and post-activity interview forms underwent analysis and interpretation using content analysis techniques. These interview forms are provided in Appendix 6 and 7. In the initial stage of content analysis, which involves constructing meaning groups (Creswell, 2008; Punch, 2005), the researcher and a science teacher with a master's degree independently examined and analyzed the data. Codes and themes were established by each coder separately. Subsequently, the codes were compared, and discrepancies were resolved by reorganizing the codes until a consensus was reached. Once both coders reached an agreement, the list of codes and themes was finalized. The principal findings are presented in a table to provide an overview for the reader (Saldana, 2021).

Pre-Activity Pre-Assessment Findings

This section presents the findings from the pre-interview form (Appendix-6). The results of the content analysis of the interview form administered prior to initiating the activities are presented in Table 1.

Table 1. Preliminary Evaluation Findings

Main Theme	Theme	Code
Preliminary Knowledge	Global Pandemic	No knowledge
		Insufficient prior knowledge
		Correct prior knowledge
	Example	Covid-19
	Reasons	No knowledge
		Unhealthy foods
		Not paying attention to cleaning rules
Precautions and Treatment	Precautions	No knowledge
		Cleanliness rules must be observed
	Treatment Pathways	No knowledge
		Medication should be used
Trust in Scientist	Reasons to Trust	Vaccine development in the Covid-19 pandemic
		Research skills of scientists
	Reasons not to trust	Being influenced by parents' ideas

Upon analysing Table 1, it becomes evident that there are three main themes, namely *Preliminary Knowledge*, *Precautions and Treatment*, and *Trust in Scientists*, encompassing a total of seven sub-themes and 14 specific codes. Under the overarching theme of *Preliminary Knowledge*, within the subtheme of *Global pandemics*, it was observed that 68% of the students lacked prior knowledge about global pandemics and preventive measures. Furthermore, 23% of the students exhibited inadequate prior knowledge in this area. In the latter category, students referenced concepts such as bacteria, viruses, and diseases that spread rapidly but struggled to connect these concepts with the idea of global pandemics and often held misconceptions. Conversely, 9% of the students possessed an accurate conceptual understanding of global pandemics and preventive measures. These students demonstrated sufficient prior knowledge regarding vaccines the mechanism of vaccine action in the body, and provided accurate definitions and explanations of global pandemic diseases, without misconceptions in response to the posed questions. Within the subtheme of *Examples*, nearly all students (98%) mentioned the COVID-19 pandemic. In the subtheme of *Causes*, 71% of students indicated a lack of knowledge regarding the causes, while 22% attributed global pandemics to a failure to adhere to cleanliness protocols. Moreover, 7% of the students believed that unhealthy food consumption was responsible for epidemics, possibly influenced by reports of eating habits in China, such as the consumption of bats. This observation suggests that students often associate global pandemics with the COVID-19 pandemic. Student perspectives on the themes and codes within the main theme of *Preliminary Knowledge* are detailed below.

> Global pandemic is a type of disease. But I don't know what global means. (S5, Global pandemic theme)
>
> COVID-19 is an epidemic. Because it is infectious. It is very dangerous. (S18, Examples theme)
>
> Not washing our hands well, giving food to our friends with dirty hands cause epidemics. (S20, Reasons theme)

In the main theme of *Precautions and Treatment*, two sub-themes emerge: *Precautions* and *Methods of Treatment*. Concerning precautions for global pandemic

diseases, 76% of the students indicated a lack of sufficient knowledge in this area, while 22% advocated adherence to cleaning protocols. In terms of treatment methods, 79% of the students confessed to a lack of adequate knowledge, while 21% recommended the use of medication. These findings suggest that students possess limited awareness about both the preventive measures and treatment modalities for global pandemics. Below, you will find student perspectives on the themes and codes related to the main theme of *Precautions and Treatment*.

> I don't know how to take precautions, but maybe it can be like the precautions in the coronavirus pandemic. (S12, Precautions theme).
>
> When the disease comes, we should go to the hospital for treatment; we should use medicine. (S2, Treatment ways theme).

In the main theme of *Trust in Scientists*, two distinct sub-themes emerge: *Reasons for Trusting* (56%) and *Reasons for Not Trusting* (44%). Among the reasons cited for trust, students emphasised the development of vaccines during the COVID-19 pandemic (46%) and the strong research skills of scientists (10%). On the contrary, when analysing the reasons for not trusting scientists, a prevalent concern arises related to opposition to vaccination during the COVID-19 pandemic. It was observed that these students associated their mistrust of vaccines with scientists. Notably, the family factor (44%) appeared to be a significant influence in this association. Below, you will find student perspectives on the themes and codes pertaining to the main theme of *Trust in Scientists*.

> My mum, dad and brother were vaccinated during the pandemic. The vaccine protected my family from the disease. Scientists researched and gave us the vaccine as a gift. (S5, Reasons for trusting theme).
>
> My mum told me that the coronavirus vaccine is harmful and will harm us. I think scientists want to harm us. (S13, Reasons for distrust theme).

Post Activity Evaluation Findings

Following the implementation of the activity modules, students were surveyed for their feedback on these activities. In the analysis of the final interview form (Appendix-7), all of the students' multiple responses were incorporated into the analysis. This approach was taken as the students provided more varied and detailed answers in the post-interview form compared to the responses in the pre-interview form. The results stemming from the analysis of the final interview form are presented in Table 2.

Table 2. Post-Evaluation Findings

Main Theme	Theme	Code
Mindfulness	Global Pandemics	Influencing the whole world
		Rapid transmission and spread
		Microorganisms
		Diseases that can be fatal
	Examples	COVID-19
		Plague
		Smallpox
		Spanish Flu
		Influenza
		Cholera
		Ebola
		Yellow Fever
		Measles
		Other
	Reasons	Microorganisms
		Not washing hands well
		Not paying attention to personal hygiene
		Contact with some animals
		Eating spoilt food
		Contact with sick persons
		Not wearing a mask
		Not being vaccinated
Precautions and Treatment	Precautions	Hand hygiene
		Not going out when ill
		To follow the rules of cleanliness at home and school
		Healthy Eating
		Avoiding contact with sick people
		Vaccine
		Not sharing personal belongings
		Consume fresh and clean food
	Treatment Pathways	Antibiotics
		Medicines against viruses and fungi
		Foods high in vitamins and nutrients
Trust in Scientist	Reasons for Trust	Vaccination studies
		Drug development studies
		Sharing their knowledge with all people

When analysing the final evaluation findings, three main themes, six sub-themes, and a total of thirty-six codes emerged, which encompassed *Mindfulness*, *Precautions*, *Treatment*, and *Trust in Scientists*. Within the theme of *Global pandemics* under the broader category of *Mindfulness*, the following codes were identified: *Affecting the Whole World* (83%), *Rapid Transmission and Spread* (78%), *Microorganisms* (94%), and *Fatal Diseases* (88%). This framework highlighted that students had developed conceptual knowledge and heightened awareness regarding global pandemics following the activities.

In the *Examples* theme, it became evident that students exhibited an expanded knowledge of various global pandemics, contrary to the pre-evaluation findings. In addition to the COVID-

19 pandemic, students referenced numerous other global pandemics, such as the Plague, Smallpox, Spanish Flu, Swine Flu, Cholera, Ebola, and Measles. Regarding the *Reasons* theme, students articulated the following factors: *transmission of microorganisms* (96%), *failure to wash hands* (92%), *ınadequate personal hygiene* (89%), *failure to wear a mask* (83%), *contact with certain animals* (80%), *consumption of spoiled or contaminated food* (77%), *contact with sick individuals* (76%), and *lack of vaccination* (73%). This perspective indicates that students had acquired accurate conceptual knowledge about the causes of global pandemics through the activities and substantiated their understanding with rational justifications.

In the *Precautions* theme within the main category of *Precautions and Treatment*, it is evident that students primarily emphasised various measures, including *hand hygiene* (97%), *avoiding going out when sick* (91%), *adhering to cleaning rules at home and school* (90%), *maintaining healthy nutrition* (90%), *avoiding contact with sick ındividuals* (89%), *vaccination* (87%), *Not Sharing Personal Belongings* (84%), and *consuming fresh and clean food* (79%). Within this context, it can be concluded that students accurately articulated the preventive measures against global pandemics following the activities. In the *Pathways of Treatment* theme, students mentioned treatment methods such as *antibiotics* (89%), *medications targeting viruses and fungi* (83%), and *nutrient-rich foods with vitamins* (81%). This observation indicates that students acquired an understanding of the various types of drugs developed to combat harmful microorganisms causing diseases and the concept of immunity. Notably, the responses underscore the differentiation in treatment methods applicable to bacteria, viruses, and fungi. In contrast to the pre-interview analyses, an increase in students' *Trust in Scientists* was noted in the *Reasons for Trusting Scientists* theme. Students justified their trust in scientists by highlighting their involvement in vaccine studies (89%), the development of medicines (83%), and the dissemination of their knowledge and research for the benefit of all humanity (71%). This finding is considered significant in bolstering the perception and trust in scientists. Furthermore, no negative statements regarding trust in scientists were identified in the final evaluation findings.

CONCLUSION and SUGGESTIONS

In this study, the primary objective was to enhance the knowledge and awareness of global pandemics and protective measures among primary school students. To achieve this goal, two activity modules were developed and implemented. Prior to the activity implementation, interviews revealed that the students had limited prior knowledge about global pandemics, their causes, and precautionary measures. Additionally, many students struggled to comprehend the concept of "global". The pre-assessment results showed that the only example students could provide for a global pandemic was the COVID-19 pandemic. This finding is significant in highlighting the perception of global pandemics as socio-scientific issues.

However, it was noted that a majority of students held misconceptions regarding global pandemics and protective measures. Drawing upon the example of COVID-19, Dillon and Avraamıdou (2020) pointed out that the COVID-19 outbreak introduced society to numerous scientific concepts, such as viruses, epidemics, immunity, social distancing, and vaccines, challenging individuals to comprehend these concepts. Such societal events serve as training opportunities to prepare for future scientific events, phenomena, and actions (Evren-Yapıcıoğlu, 2020). Consequently, the importance of childhood education in nurturing scientifically literate individuals capable of making informed decisions in the face of socio-scientific issues becomes evident (Holbrook & Rannikmae, 2009). Indeed, the outcomes of this study involving primary school students underscore the need to raise awareness and develop skills related to global pandemics at the primary school level. One important outcome gleaned from the initial evaluation findings pertains to students' perceptions of scientists. The study revealed that a significant portion of the students lacked trust in scientists. This outcome can be attributed to the negative opinions held by parents during the COVID-19 pandemic. As noted by Zeidler and Sadler (2004), socio-scientific issues are inherently controversial, and individuals may approach them from

various perspectives. Consequently, the study's results highlight the connection between trust in scientists and vaccine hesitancy. A review of the literature underscores that the primary factor contributing to vaccine refusal or hesitation is a lack of trust in the vaccines themselves (Çapanoğlu, 2018; Hasar et al., 2021; Tavolacci et al., 2021; Vulpe & Rughinis, 2021). Therefore, it is crucial to furnish those who harbour reservations with evidence-based information (Kınalı et al., 2022). To address this issue, the study aimed to enhance students' comprehension of the work conducted by scientists through interactive science readings and worksheets specifically designed for their projects.

Following the implementation of activities developed in alignment with the findings from preliminary student interviews, it was determined that students acquired a deeper understanding of global pandemics. Consequently, they began to employ accurate scientific terminology when defining global pandemics. Furthermore, students demonstrated awareness of numerous global pandemics that have historically impacted societies. Additionally, it was noted that students had acquired conceptual knowledge concerning the causes of global pandemics and effectively articulated their interpretations. As a result, it can be asserted that primary school students achieved functional science literacy (Bybee, 1997; Shamos, 1995). This literacy extends to both the definition of scientific concepts and the use of meaningful expressions to address socio-scientific issues, such as global pandemics.

Another significant outcome was the students' progress in understanding preventive measures and treatment methods against global pandemics. In particular, students accurately delineated measures for preventing global pandemics and reported the successful application of these measures in their daily lives. The Organization for Economic Co-operation and Development (OECD, 2019) defines science literacy as the ability to apply conceptual knowledge in real-life contexts, transcending mere knowledge of scientific concepts. Therefore, the students' capacity to effectively apply their knowledge of global pandemic prevention measures in their daily routines aligns with the study's objectives in terms of skill development. Nonetheless, it is noteworthy that students learned the importance of using distinct types of drugs for each harmful microorganism in the context of global pandemic treatment methods. Consequently, it can be affirmed that the training modules implemented improved students' ability to comprehend socio-scientific issues, engage in discussions on these matters, and develop problem-solving skills (Sadler, 2004; Sadler & Zeidler, 2004).

Another significant outcome of the study pertains to the trust in scientists. Initially, the pre-assessment results revealed unfavourable findings regarding students' trust in scientists. However, following the implementation of the activities, a notable improvement was observed in students' trust in scientists. This shift is believed to be attributed to the effectiveness of interactive readings based on the work of scientists and worksheets related to vaccine and drug development. This outcome underscores the importance of nurturing individuals capable of critical thinking, questioning, and decision-making without being unduly swayed by scientific explanations and research in the realm of science education. This issue should remain a central concern on the agenda of science education. To cultivate today's children into responsible, aware, and engaged members of society who will become tomorrow's adults, it is crucial to design educational activities that tackle socio-scientific issues. These activities aim to acquaint students with such issues and empower them to develop solutions. When we examine the 2018 Science Curriculum set forth by the Ministry of National Education (MoNE), we find that although it emphasises the significance of socio-scientific issues, the current curriculum lacks specific guidance regarding what constitutes socio-scientific issues and practical implementation suggestions (Evren Yapıcıoğlu, 2020).

In this particular study, the focus was on global pandemics, which is a socio-scientific topic. This choice was motivated by the challenges faced by societies ill-prepared for the COVID-19 pandemic and the potential problems arising from various epidemics that may emerge in the future. In forthcoming studies, it is advisable to incorporate various socio-scientific issues into curricula and textbooks, with a particular emphasis on providing practical applications for teachers.

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Appendix 1

Worksheet 1

Come on! Let's draw the shape of the fungus we observed under the microscope.

a. What do you think is the most striking feature of this fungus?

b. Does it look like the microbes we observed on the screen?

c. Do you think this microbe is useful? Is it harmful?

Appendix 2

Worksheet 2

YEAST

AIRY FUNGI

You know, without microbes, your breakfast would look very different. For example, there would be no bread, cheese or yoghurt. Many other foods and drinks such as coffee, olives and chocolate would not exist without microbes. One of the most important microbes used to make food and drink is yeast. Yeast is a small "fungus" that you can buy in the supermarket. For example, you want to bake bread yourself at home. Why do we use yeast to make bread? How can this tiny creature, which I cannot see with my eyes, turn a small piece of dough into a very large piece of dough?

You will conduct an experiment with bottles and balloons to observe the existence of yeast and learn how it works.
Ingredients
- 1 sachet of yeast (Dr Oetker, 7gr.)
- Sugar
- 2 transparent half-litre plastic bottles
- 1 teaspoon
- funnel (or roll a piece of paper in the shape of a funnel)
- warm water (about 25 degrees C)
- 2 balloons

Let's get started!
1. Pour half a sachet of yeast into each bottle. Use the funnel for this to avoid spillage.
2. Put 8 teaspoons of sugar in one of the 2 bottles and make a big cross on the bottle using the waterproof pen. This way you won't forget which bottle you put the sugar in.
3. Pour 8 centimetres of warm water into each bottle.
4. Screw the cap on both bottles, shake and remove the cap.
5. Stretch the balloons a little, inflate and deflate again. This will make them a little more flexible. You can also use latex gloves and rubber bands.
6. Place the balloon on the neck of the bottles.
7. Leave the bottles for ten minutes and then check them.

Question 1: What do you expect to happen to the balloons?

Question 2: What happened to the balloons? And do you see any difference between the 2 bottles?

Question 3: Where do you think this difference comes from?

Question 4: Did it turn out as you expected or not?

Question 5: The yeast we use to make bread is a beneficial microbe. As we can see from the inflation of the balloon, it multiplies and spreads. What do you think would happen if this microbe was harmful instead of beneficial? Let's write the first 3 words that come to mind!

Appendix 3: Worksheet 3

My Experiment / Activity

1.Research Question/What am I Wondering?

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2. How should I go about finding the answers to my question?

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3. Materials for my experiment/activity……

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4.What are my predictions?

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5.Let's Collect and Record Data!

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6.What did I observe?

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7.The Results I Reached? What I learnt

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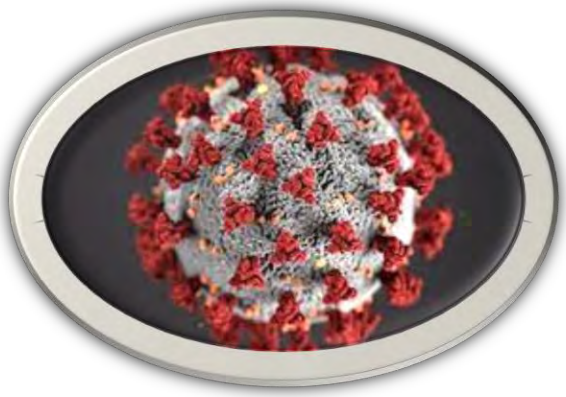
Appendix 4

Worksheet 4

VACCINE-VACCINATION-IMMUNITY



Selin and Bahar, 20-year-old twin sisters, decided to get vaccinated to protect themselves from the disease during the COVID-19 pandemic. Selin has completed 3 doses of vaccine. Bahar, on the other hand, started getting vaccinated later and had only one dose of vaccine. Selin and Bahar Ten days ago, they contracted the COVID-19 virus from a relative who came to their home. Although Selin's illness is very mild, Bahar is in the intensive care ward of the hospital.



Question 1: What do you think is the factor that causes Selin and Bahar to experience the disease at different intensities?

Question 2: What is the reason why Selin's body is more resistant to the virus?

Question 3: How would you describe the "substance" in the vaccine in 3 words?

Question 4: You have been vaccinated at least once in your life. How do you think vaccines protect you from dangers?

Appendix 5

The Posters Created by the Students

Appendix 6

Preliminary Interview Form

Dear student, with the questions here, I aim to reveal your ideas about the activities I have done together about global epidemics and methods of protection from global epidemics. The following questions are not an exam. There will be no grading. I only want you to share with me your ideas, feelings and experiences about the activities.

Thank you for participating in the activities and sharing your experiences.

Name-Surname:
Class:

1. What do you know about epidemics?

2. What are the epidemics you know or have heard of?

3. Can you share what comes to your mind when you think of GLOBAL epidemics?

4. What do you think the causes of epidemics can be?

5. Can we prevent epidemics? If yes, how can we prevent them?

6. Can we treat epidemics? If yes, how can we treat them?

7. What comes to your mind when you think of vaccination?

8. Why do you think we get vaccinated?

9. What do you think of when you think of immunity?

10. Do you think microbes are useful? Are they harmful?

11. Do you trust scientists' research on epidemics? Can you explain your answer?

Appendix 7

Final Interview Form

Dear student, with the questions here, I aim to reveal your ideas about the activities I have done together about global epidemics and methods of protection from global epidemics. The following questions are not an exam. There will be no grading. I only want you to share with me your ideas, feelings and experiences about the activities.

Thank you for participating in the activities and sharing your experiences.

Name-Surname:
Class:

After our activities;

1. What is an epidemic disease?

2. Which epidemics have you learnt?

3. What does GLOBAL epidemic disease mean?

4. What are the causes of epidemics?

5. What can we do to prevent epidemics?

6. Can we treat epidemic diseases? If yes, how can we treat them?

7. What is a vaccine? Is it useful?

8. Do you think we should be vaccinated?

9. What does immunity mean?

10. Imagine that the world is facing an epidemic! What measures would you take as an individual who cares about your community and family?

11. Do you trust scientists' research on epidemics? Can you explain your answer?