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Science Teachers' Perspectives on Vaccination and Its Integration into the Science Curriculum

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Abstract

Socioscientific issues (SSI) are complex dilemmas that lack clear-cut answers. The purpose of this current study was to investigate in-service science teachers' perspectives on vaccination, considered as an SSI, and assess their views regarding its significance in science education and potential integration into the curriculum. Forty-nine in-service science teachers participated in this study, using convenient sampling, and collected their responses to six open-ended questions administered online. Teachers were asked whether they discuss everyday topics in the classroom, and most teachers confirmed that they integrate daily-life subjects into their lessons. Similarly, in response to questions about including science-related topics not covered in the curriculum, the majority expressed their willingness to engage in these discussions, especially regarding vaccination. Regarding their ability to provide information about vaccination, a significant portion of science teachers reported feeling confident in their capacity to do so. Additionally, when asked about the importance of students' knowledge about vaccination and its integration into the curriculum, 39 teachers advocated for its inclusion, seven opposed it, and two acknowledged its significance but not integration into the curriculum. Notably, when questioned about the difficulty of explaining vaccination-related topics, 32 teachers indicated they would not encounter challenges. This research underscores the pivotal role of science teachers in fostering informed discussions about vaccination and highlights the potential benefits of integrating this crucial subject into science education. The research results revealed that science teachers gave substantial importance to events/situations related to science that are not included in the curriculum. Therefore, it is important to include SSI, such as vaccination, in the curriculum, provided that the necessary arrangements are made.

Keywords: Vaccination, Science Education, Science Teachers, Socioscientific Issues

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Fen Bilimleri Öğretmenlerinin Aşı ve Aşı Konusunun Fen Bilimleri Öğretim Programına Dahil Edilmesine İlişkin Bakış Açıları

Özet

Sosyobilimsel konular net bir cevabı olmayan, yoruma dayalı ikilemlerdir. Bu araştırmanın amacı fen bilimleri öğretmenlerinin sosyobilimsel bir konu olarak ele alınan aşı ile ilgili fikirlerini, aşı konusunun fen bilimleri eğitimi bağlamındaki önemine ve öğretim programına dahil edilmesine ilişkin görüşlerini araştırmaktır. Araştırma kapsamında uygun örnekleme yöntemi ile 49 fen bilimleri öğretmenine ulaşılmış olup, çevrimiçi olarak iletilen altı açık uçlu soruya yanıt vermeleri istenmiştir. Fen bilimleri öğretmenlerine günlük hayatta sıklıkla karşılaştığımız konuları sınıf ortamında öğrencilerle tartışma durumları sorulduğunda, çoğunluğunun sınıfında günlük konulara yer verdiği, öğretim programında olmadığı halde fen bilimleri ile doğrudan ilgili konuları öğrenme ortamına dahil edilmesiyle ilgili görüşleri sorulduğunda çoğu katılımcının bu konuları tartıştıklarını, aşı ile ilgili soru geldiğinde kolaylıkla cevap verebilme durumları sorulduğunda çoğunluğun kolaylıkla cevap verebilirim dediği tespit edilmiştir. Öğrencilerin aşılanma ile ilgili bilgileri bilmesi ve öğretim programına dâhil edilmesi ile ilgili görüşleri sorulduğunda 39 öğretmen 'evet konu önemli ve programa dahil edilmeli', yedi öğretmen 'hayır konu önemli değil ve programa dahil edilmemeli' ve iki öğretmen 'evet konu önemli ama programa dahil edilmemeli' olarak yanıtlamıştır. Aşı ile ilgili bir konu anlatırken zorluk yaşanması ile ilgili öğretmen görüşleri incelendiğinde 32 öğretmen zorluk yaşamayacağını belirtmiştir. Bu araştırmayla, aşı hakkında bilinçli tartışmaları kolaylaştırmada fen bilimleri öğretmenlerinin rolüne ve bu önemli konuyu fen bilimleri eğitimine entegre etmenin potansiyel faydalarına ışık tutmayı amaçlanmıştır. Araştırma sonuçları, fen bilimleri öğretmenlerinin müfredatta yer almayan ancak fen bilimleri ile ilgili olaylara/durumlara büyük oranda önem verdiklerini ortaya çıkarmaktadır. Dolayısıyla, gerekli düzenlemelerin yapılması koşuluyla aşı konusu gibi sosyobilimsel konuların müfredata dahil edilmesi önemlidir.

Anahtar Kelimeler: Aşı, Fen Bilimleri Eğitimi, Fen Bilimleri Öğretmenleri, Sosyobilimsel Konular

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1. Introduction

In a changing and developing world, the permanence of changes in individuals' behaviors, keeping pace with advancements, meeting the era's demands, and fostering research, inquiry, self-awareness, and self-confidence is achievable only through education. Faced with these shifts, numerous countries scrutinize their education systems and strategies, and are inclined toward cultivating novel perspectives. Science strives to observe, elucidate, and forecast occurrences, facts, and circumstances across various domains. This same pursuit is evident in the realm of science education. Put differently, investigations can be conducted concerning natural phenomena and entities in the environment, principles can be formulated, and prognostications can be derived from these principles (Kaptan & Korkmaz, 1999). Individuals who embrace science adeptly can dissect the quandaries prevailing in their societal milieu and generate solutions with a discerning outlook. In a milieu where such individuals coexist with society, an individual secures a foothold within that society, propelling them toward the swift evolution into a contemporary community (Temizyürek, 2003).

Education and training received at schools, along with the content of educational programs, play a crucial role in personal development. In essence, the foundation of any educational system lies in its curriculum (Yüksel, 2003). The primary goal of the science curriculum is to cultivate individuals with scientific literacy. Such individuals can critically observe problems and situations that arise in their daily lives and swiftly generate practical solutions to address these issues. Science education programs have undergone numerous revisions to nurture scientifically literate individuals. Notably, in the context of the 2013 Science Curriculum, the inclusion of "Socioscientific Issues" within the "Science-Technology-Society and Environment" domain, as well as the incorporation of "Science-Engineering-Technology-Society and Environment" in the 2018 Science Curriculum, hold significant importance. SSI are complex ethical dilemmas that lack straightforward solutions (Sadler, 2004). They are complex and controversial topics that involve scientific concepts and have social, ethical, and moral implications (such as climate change, genetic engineering, vaccination, stem cell research, biotechnology, etc.). These issues often lack clear-cut solutions and involve multiple perspectives. They require individuals to consider scientific evidence, societal values, and ethical considerations when making decisions or forming opinions (Eastwood et al., 2012; Sadler, 2004). However, not all subjects can be categorized as SSI. Two critical criteria should

be fulfilled to be labeled as a socioscientific subject. The first criterion involves a connection to scientific content, while the second criterion necessitates having social significance and relevance (Sadler, 2004; Topçu et al., 2014). SSI has gained substantial economic attention on a global scale. Significant funds have been allocated, particularly for addressing these controversial issues. Nevertheless, the Fukushima Nuclear Power Plant disaster in Japan in 2011 highlights that the public's perspective on these allocated funds may not always be favorable. This example underscores the need to integrate SSI into the science curriculum (Özhan, 2018; Topçu et al., 2014). The studies in science education literature emphasize the importance of integrating SSI into the learning environment (e.g., Sadler, 2011; Sıbıç, 2017; Topçu, 2010; Tosunoğlu & İrez, 2017). Accordingly, Sıbıç (2017) revealed that pre-service teachers who have a good command of SSI can comprehend and convey examples related to the topics faster than pre-service teachers who do not have a good grasp of these topics. Furthermore, a study by Tekin and Aslan (2019) highlights that pre-service science teachers tend to view SSI as more valuable and significant than pre-service social studies teachers. Another study conducted with students investigated the contribution of socioscientific subjects to field knowledge through an experimental approach. The results of this experimental study indicated that classes receiving science education based on socioscientific topics exhibited higher levels of success compared to the other classes (Pehlivan, 2020). Besides et al. (2019) also emphasized the importance of integrating SSI within the Science|Environment|Health (S|E|H) perspective. Among these significant SSI is the topic of anti-vaccine sentiment.

Anti-vaccination can be defined as individuals decline or oppose vaccination services for themselves and their children, even when available. Recently, there has been a noticeable increase in vaccine hesitancy within our country (Dolu et al., 2021) and European countries as well (Wise, 2021). Within the studies, it has been determined that despite the significant reduction of vaccine-preventable diseases globally, particularly in developed countries due to routine vaccination programs, many parents' concerns regarding vaccination persist (Yüksel & Topuzoğlu, 2019). A similar study conducted by Türkay et al. (2017) revealed that the presence of 6.2% of the participants identifying themselves as anti-vaccine individuals may indicate a potential rise in vaccine rejection. A study investigating vaccine rejections and the underlying causes found that parents' distrust of vaccines and fears of potential side effects were prominent factors (Hasar et al., 2021). Consequently, to counter these biases and concerns, it has been

recommended that educational and healthcare institutions provide comprehensive training with accurate information (Yüksel & Topuzoğlu, 2019). Once again, in recent history, during the COVID-19 pandemic, the most pressing issue of our time, new types of vaccine have emerged. However, these vaccines have triggered similar hesitations and fears among individuals (Fazel et al., 2021; Yılmaz et al., 2021). According to a study, 41.2% of respondents expressed a willingness to receive the COVID-19 vaccine, while 20.9% indicated that they would reject it, and 37.9% remained undecided regarding their decision (Yılmaz et al., 2021). Furthermore, Sandler et al. (2020) emphasized that college students have mixed attitudes about vaccines and lack knowledge of information about vaccination.

It is impossible to overestimate the importance of vaccinations in modern culture as a public health intervention. Infectious illness prevention and management have undergone a radical transformation since the development of vaccinations, saving countless lives and significantly enhancing global health. Due to the COVID-19 pandemic, the significance of vaccines has come to light in public conversation, emphasizing the need for an informed populace. Nevertheless, there is a remarkable gap in the science education curriculum despite the vaccines' critical role. There is a noteworthy lack of information about vaccination in many educational systems, including science curricula in Türkiye. Although biology, chemistry, and physics concepts are frequently included in science curricula, the issue of vaccination is glaringly absent from the program. Science education plays a pivotal role in shaping individuals' understanding of the world and their capacity to engage with complex scientific and public health issues. The absence of vaccination-related issues from the curriculum deprives students of critical information that may enable them to make wise health decisions and participate in public health conversations. A comprehensive review of the science curriculum reveals a consistent gap in the coverage of vaccination-related content (MEB, 2018). The established curricula noticeably miss out on subjects like vaccine development and history, mechanisms of vaccine action, the value of herd immunity, and the function of vaccines in disease prevention. Absence of the vaccination-related content from the science curriculum is not solely an educational concern; it has also tangible consequences for public health. Making informed vaccination decisions is essential for overcoming vaccine reluctance and achieving high immunization uptake rates. As students mature into adults, their knowledge—or lack thereof—of vaccination directly affects their willingness to get immunized and their support for vaccination policy. In

order to encourage informed decision-making, overcome vaccine hesitancy, promote a population that actively engages with public health issues, and understand the nature of science, it is inevitable to address this shortcoming by incorporating thorough and accurate information regarding vaccination into science curricula. Accordingly, Dillon and Avraamidou (2020) discussed the role of science education in the context of COVID-19 pandemic and a vision of science education should be shaped in this post-pandemic era. Science education should provide answers to students who have concerns about vaccination and students should find their way in the light of scientific knowledge. To address the lack of information about vaccinations in the science curriculum, beforehand, it is critical to assess how prepared science teachers are to include this important topic in their lessons. A critical evaluation of the readiness of science teachers should be conducted to understand their perspectives and varying degrees of preparedness.

Therefore, the purpose of this study is to investigate insights into science teachers' perspectives on the topic of vaccination and its potential integration into the science curriculum. In this current study, science teachers' views will be understood by exploring their beliefs and knowledge regarding vaccination, including their opinions on its significance in the context of science education. Additionally, in case of integration of the vaccination topic into the science curriculum, their preparedness will be assessed in addressing questions and concerns related to vaccination when raised by their students. This includes evaluating their self-perceived competence in providing accurate information and fostering informed discussions. Then, the study will provide valuable insights and recommendations to curriculum developers, educational policymakers, and teacher training programs on the inclusion of vaccination-related content in the science curriculum based on science teachers' perspectives.

2. Method

This study employed a qualitative research method to elucidate teachers' perspectives regarding the utilization of vaccination and their opinions on integrating these topics into the science curriculum. In qualitative research, information can be directly obtained from individuals, allowing them to express their thoughts openly. In this study, a case study from a qualitative approach is used to explore the science teachers' views on vaccination that are not easily quantifiable, and a deeper understanding of science teachers' perspectives is needed

(Patton, 2202). The case study methodology remains closely aligned with its fundamental values and purposes (Merriam, 2009). The case of this study was in-service science teachers' perspectives about SSI, specifically vaccines, and the research question was designed based on this case; the social constructivist paradigm was situated to gather rich, context-specific data (Merriam, 2009).

2.1. Participants

The participants of this study were science teachers who were employed in different cities around Türkiye. Thus, the unit of analysis of this case study was in-service science teachers whose perspectives were investigated in terms of SSI, vaccination, and integration of the topic into the science curriculum. The participants were determined using a convenience sampling method involving 49 in-service science teachers (Fraenkel, & Wallen, 2009). All participants shared a common experience, teaching during the COVID-19 pandemic. The participants have a minimum of one and a maximum of twenty years of teaching experience in public schools in different cities. The demographic characteristics of the teachers are presented in Table 1.

Table 1.

Participants demographic characteristics

Gender	Frequency	Age Mean	Teaching Experience (years) Mean
Female	40	30.01	6.46
Male	9	35.56	12.22
Total	49	31.08	7.66

2.2. Data Collection

A question form was utilized as the primary data collection instrument in this research, designed by the authors. The beginning part of the question form encompassed inquiries concerning the demographic characteristics (such gender, teaching experience, school type that they teach, etc.) of the participating science teachers. Within the form, science teachers were consulted on their perspectives concerning the inclusion of SSI in their teaching/learning environment and the potential integration of topics like vaccination into the science curriculum. To formulate open-ended questions, an initial examination of the science curriculum was conducted to identify any existing content related to vaccination. No information regarding vaccination was identified within the curriculum. Subsequently, the questions were crafted in alignment with the research objectives. To ensure the appropriateness, clarity, and structure of

these questions, the questions were reviewed by two experts in the field of science education and two in-service science teachers. After making the suggested minor changes, the questionnaire was pilot tested with one in-service science teacher to ensure clarity, relevance, and coherence. Subsequently, the final version of the questionnaire was uploaded to Google Forms, and the questionnaire's link was distributed to in-service science teachers through social media channels. It typically takes participants approximately 30 to 45 minutes to complete all the questions.

The final question form consisted of two sections. The first section comprised the initial four questions, which gathered personal information, including school, age, gender, and years of teaching experience. Following these demographic questions, the questionnaire included six open-ended questions that explored the teachers' perspectives on SSI, with a specific focus on vaccination and its potential integration into the science curriculum. Some sample questions included: “Do you actively discuss topics commonly encountered in daily life with your students in the classroom?” or “When your students ask you a question about vaccination, do you feel confident in providing clear answers?”

2.3. Data Analysis

In this section, the data analysis is presented about the collected data from science teachers regarding their ideas and perspectives on vaccination. Science teachers wrote their ideas in the Google form and their responses were collected as qualitative data based on the open-ended questions. Therefore, the dataset included qualitative responses from the form. The data collected in the current research were analyzed using a qualitative approach which is a descriptive analysis method to provide a comprehensive understanding of science teachers' ideas and perspectives on vaccination, including calculations of percentages and frequencies. Before the analysis, the science teachers’ responses from the form were organized and anonymized to ensure confidentiality and facilitate the analysis process. Two researchers independently analyzed the data, first, the responses were reviewed to become familiar with the content and gain an initial understanding of the science teachers' perspectives on vaccination. Then, the codes, which were mainly inductive, were generated for segments of data that represented similar ideas or concepts. Additionally, some selected quotations from science teachers' responses were included to provide context for the findings. Then, the

relationships between codes and categories were investigated to identify patterns and insights within the data. The authors analyzed the data individually; afterward, the results were compared to resolve any discrepancies and ensure reliability and discussed to reach a consensus. Finally, the results were then recorded in the form of a frequency table.

3. Results

This section presents the teachers' views regarding vaccination based on the analysis of the collected data. The results are presented in the following section.

The science teachers were asked whether they were discussing the issues frequently encountered in daily life with students in the classroom environment. Their responses are given in Table 2. The table reveals that 41 science teachers incorporated everyday topics into their learning environment, while two frequently integrated them. Additionally, three science teachers occasionally included these topics, one science teacher did so infrequently, and two science teachers did not include them at all. One of the participant science teachers (Teacher 42) said, *"Yes, I address these topics using various approaches, particularly based on the grade levels. I also provide very instructive returns for myself."* Another participant (Teacher 39) expressed, *"Certainly. Keeping things up-to-date is crucial."*

Table 2.

Teachers' responses on discussing the issues frequently encountered in daily life with students in the classroom environment

Do you actively discuss topics commonly encountered in daily life with your students in the classroom?	f	%
Yes	41	83,67
Often	2	4,08
Sometimes	3	6,12
Rarely	1	2,04
No	2	4,08
Total	49	100

As a second question, teachers were asked their perspectives on incorporating science-related events/situations that fall outside the curriculum into the learning environment. Table 3 presents the teachers' perspectives regarding the incorporation of science-related events/situations into the learning environment, even if they are not part of the curriculum. Out of the total, 48 teachers indicated that they integrate these topics into the classroom, while one teacher stated otherwise. Here are some of the opinions expressed on this matter:

> **Teacher 9** "Yes, I do. Even if they are not part of the official curriculum, I make sure to discuss science-related topics from daily life in the classroom."
>
> **Teacher 10** "Absolutely, I do. By emphasizing that science is inherent to life itself, I consistently provide examples from everyday life, fostering a context-based learning environment."
>
> **Teacher 21** "Yes, I engage in this practice. Science is intricately connected to daily life, and if I only impart textbook knowledge to children, it becomes a mere lesson. By linking it to their everyday experiences, it becomes more engaging and memorable."
>
> **Teacher 29** "Indeed, I do. For instance, when explaining mutations, I discuss Covid-19, a topic frequently encountered in our daily lives. I also use the development of vaccines as an example of biotechnology."

Table 3.

Teachers' responses on incorporating science-related events/situations that fall outside the curriculum into the learning environment.

Do you introduce events/situations that are not covered by the curriculum but are related to science into the learning environment?	f	%
Yes	48	97,95
No	1	2,04
Total	49	100

The next question was about whether the teacher could confidently answer students' questions about vaccination. In Table 4, the teachers' capability to respond easily when their students inquire about vaccination is presented. The data indicates that 32 teachers responded positively, affirming they can readily address the queries. On the other hand, nine teachers acknowledged that they can sometimes answer easily, while eight teachers expressed that they cannot readily respond. Some individual perspectives on this matter are outlined below:

> **Teacher 38** "Yes, I can easily answer their questions about vaccination. I have a good understanding of the topic due to my interest and the extra reading and research I've done."
>
> **Teacher 42** "Yes, I can easily answer their questions. I believe that teachers should be knowledgeable about current issues and provide accurate information to students. If I am unsure about a specific detail, I tell them I will look it up and provide accurate information later. And added that they can investigate the issue in-depth with their parents."
>
> **Teacher 21** "I sometimes find it challenging because I'm not familiar with every vaccine. While I know what a vaccine is for and its intended purpose, I might struggle to answer questions about administering specific vaccines. I lack knowledge in this area."
>
> **Teacher 23** "I might face challenges in answering certain questions, as the details of vaccine contents, stages, trials, and launch are not always transparent or easily accessible."

Table 4.

Teachers' responses on responding to students' questions about vaccination.

When your students ask you a question about vaccination, do you feel confident in providing clear answers?	f	%
Yes	32	65,30
Sometimes	9	18,36
No	8	16,32
Total	49	100

The following question was about what prerequisite knowledge they think students should have in order to learn about vaccination. Table 5 presents teachers' perspectives regarding the prerequisite knowledge that students should possess to comprehend the significance of vaccination. The table reflects that among the participating teachers, three teachers emphasized the importance of understanding the health of systems, four teachers considered prior knowledge of biotechnology, 13 teachers pointed toward a comprehension of microscopic living organisms, and 17 teachers underscored awareness of the effects of vaccines. Furthermore, four teachers stated that understanding vaccination methods was essential, while one advocated for experiential knowledge. Similarly, one teacher stressed the necessity of vaccination only when required, and six teachers highlighted the importance of immunity. Additionally, two teachers elaborated on the role of white blood cells, one teacher discussed cells and microorganisms, one teacher addressed the circulatory system, and one teacher described the concept of the body's defense mechanisms. Three teachers suggested familiarity with infectious diseases as a prior knowledge requirement. Lastly, two teachers did not provide a response to this question. Below are a few sample responses to the question:

> **Teacher 2** "They should understand the benefits of vaccination."
>
> **Teacher 15** "They should have a strong grasp of biotechnology."
>
> **Teacher 29** "They should be aware of the technical methods used to create vaccines and understand that these methods have been employed against diseases for an extended period."
>
> **Teacher 32** "They should be familiar with body systems and their health. Additionally, having knowledge of technology and biotechnology would be supportive."
>
> **Teacher 41** "They should have a basic understanding of the immune system and how it works."

Table 5.

Teachers' responses on prerequisite knowledge that students should possess to comprehend the significance of vaccination.

What pre-knowledge do you think students should have in order to learn about vaccination?	f	%
The effects of vaccines	17	28,81
Microscopic living organisms	13	22,03
Importance of immunity	6	10,16
Biotechnology	4	6,77
Vaccination methods	4	6,77
Health of systems	3	5,08
Infectious diseases	3	5,08
White blood cells	2	3,38
Experiential knowledge	1	1,69
Necessity of vaccination	1	1,69
Cells and microorganisms	1	1,69
The circulatory system	1	1,69
The body's defense mechanisms	1	1,69
No response	2	3,38
Total	59*	100

**Some teachers gave multiple responses.*

The next question was about the opinions of teachers about the importance of informing students about vaccination and whether the subject of vaccination should be included in the curriculum. In Table 6, teachers' opinions regarding the importance of students' understanding of vaccination and its incorporation into the curriculum were collected. Upon examining the provided responses, 39 teachers expressed that the subject is significant and should be included in the curriculum, while seven teachers held the view that the subject is not important and shouldn't be part of the curriculum. Additionally, two teachers indicated that the subject is important but shouldn't be included, and one teacher remained undecided on this matter. Here are a few examples of the responses provided by the teachers on this subject:

> **Teacher 5** "It's important, and it should be included. Students should be aware of both the benefits and potential risks of vaccines."
>
> **Teacher 8** "Yes, especially given the increase in epidemics, understanding the importance of vaccines is crucial."
>
> **Teacher 21** "Certainly. When I was a child, we used to get vaccinations at school, but I never really understood why or why it was only during our early years. I would appreciate understanding the reasons at that time. While I believe experiential learning is valuable, I also think it's important to comprehend the rationale behind what we experience."
>
> **Teacher 29** "Parents should be the ones informed about this issue rather than students. Hence, I don't believe it should be integrated into the curriculum."

> **Teacher 35** "The topic of vaccination doesn't necessarily need to be included in the curriculum. It's more important for parents to receive information about whether to vaccinate or not."
>
> **Teacher 39** "Yes, it's definitely important. Yes, it could be incorporated into the curriculum. Throughout the coronavirus pandemic, I encountered numerous anti-vaccine arguments, often presented in a science fiction-like manner. I strongly believe this arises from a lack of understanding."
>
> **Teacher 40** "Certainly, it holds great importance. Diseases that have been eradicated through vaccination should be explained, along with the historical context. The impact of a pandemic, which these children have experienced, could be highlighted. Our transformed way of life, largely due to vaccination, stands as the closest and most relevant example."

Table 6.

Teachers' opinions regarding the importance of students' understanding of vaccination and its incorporation into the curriculum.

Do you think it is important for students to be informed about vaccination? Do you think the subject of vaccination should be included in the curriculum?	f	%
Yes, it should be included.	39	79,59
No, it shouldn't be included.	7	14,28
Yes, but shouldn't be included.	2	4,08
Undecided	1	2,04
Total	49	100

Followingly, the teachers were asked their opinions about the appropriate grade level and subjects for including vaccination in the science curriculum. In Table 7, teachers' views about the appropriate grade levels and subjects for including vaccination in the science curriculum are examined. From the responses, it is evident that five teachers suggested that vaccination should be taught at 'all levels of elementary school'. Additionally, five teachers believed it should be taught in 'Grade 8: Living Things and Life', ten teachers recommended 'Grade 6: The Health of Systems', and ten teachers favored 'Grade 8: DNA and Genetics'. Furthermore, two teachers indicated 'Grade 5: Let's Get to Know Living Things', while one teacher suggested it should be taught at the end of primary and secondary school. Another teacher mentioned 'Grades 4 or 5', and one teacher expressed 'Grade 5' as appropriate. There were suggestions for specific subjects, such as 'Grade 5: Technology and Health', 'Grade 6: Circulatory System', 'Grade 7: Cell', 'Grade 8: Nutrition and Health', and 'Grade 9: Biology'. It's important to note that 12 teachers (22.64%) did not respond to this question. Examples of teachers' responses are presented as follows:

> **Teacher 10** "It could be included in the 6th-grade curriculum as part of the "Our Body Systems and Health" unit."

> **Teacher 32** "The 6th and 8th grades are more suitable for discussing epidemics and diseases due to their subject distribution. However, 5th graders might show a heightened interest in the context of technology and health."
>
> **Teacher 33** "Biotechnology in the 8th grade DNA and Genetics unit can be given in more detail."
>
> **Teacher 41** "Previously, it was covered under the topic of the immune system. Although this subject was removed later, it could potentially be included in the 6th-grade curriculum."
>
> **Teacher 42** "It could be appropriate to include it under the topic of health in the 2nd unit of the 5th Grade curriculum, titled "Let's Get to Know Living Things."

Table 7.

Teachers' views on the appropriate grade level and subjects for including vaccination in the science curriculum.

If your answer to the previous question is yes, in which context do you think vaccination should be included in the program? What grade level and subjects do you think it is appropriate for?	f	%
Grade 6: The Health of Systems	10	18,86
Grade 8: DNA and Genetics	10	18,86
All levels of elementary school	5	9,43
Grade 8: Living Things and Life	5	9,43
Grade 5: Let's Know Living Things	2	3,77
At the end of primary and secondary school	1	1,88
Grades 4 or 5	1	1,88
Grade 5	1	1,88
Grade 5: Technology and Health	1	1,88
Grade 6	1	1,88
Grade 6: Circulatory System	1	1,88
Grade 7: Cell	1	1,88
Grade 8: Nutrition and Health	1	1,88
Grade 9: Biology – Viruses	1	1,88
No response	12	22,64
Total	53*	100

**Some teachers gave multi responses.*

The last question was whether they would face any challenges while teaching the topic of vaccination. Table 8 presents the teachers' responses regarding challenges in explaining topics related to vaccination. The results revealed that six teachers found the topic challenging, 32 teachers did not foresee any challenges, and eleven teachers mentioned potential challenges. Some examples of teachers' responses are provided below:

> **Teacher 10** "No, I won't have difficulties. I can provide information about vaccines using scientific journals in the classroom, and I can assist students in developing awareness by showing videos from experts in the field of medicine."
>
> **Teacher 29** "Maybe, I can face some difficulties, as I don't typically delve into technical articles on this topic."

Teacher 32 "Certainly not. We integrate real-life situations into our lessons, which often result in engaging and enjoyable moments. The concept of an epidemic can be divided into endemic and pandemic occurrences. The awareness of families will largely depend on children, especially if our country faces a problem or a global pandemic reemerges."

Teacher 33 "Yes, we can have difficulties. As Science Teachers, we should have received more comprehensive training on this subject during our university studies."

Teacher 38 "I don't believe so. However, I do make sure to caution my students about urban legends, which are false pieces of information, such as claims about microchipping."

Teacher 49 "Partial difficulties might be encountered, as not everyone is well-informed about vaccination, leading to potential biases or misconceptions against vaccination."

Table 8.

Teachers' responses regarding challenges in explaining topics related to vaccination.

Will you face any challenges while teaching the topic of vaccination?	f	%
Yes, I would.	6	12,24
No, I wouldn't.	32	65,30
Maybe, I would.	11	22,44
Total	49	100

4. Discussion and Conclusion

SSI are often regarded as fundamental aspects of science education. While it may not always be explicitly included in the formal curriculum, it is evident that these issues find their way into the classroom environment, where educators frequently incorporate them into their lessons. The results of this study revealed that science teachers give importance to events/situations not covered by the curriculum but related to science. Some science teachers mentioned that they took the initiative to explore some topics independently, incorporating these discussions into their lessons, even though it's not mandated by the curriculum. This highlights the practical importance of SSI in science education. The study by Yıldırım and Bakırcı (2020) underscores the significant role of SSI in enhancing students' comprehension of problems, events, and situations. They emphasize the importance of incorporating these issues more frequently into the curriculum, provided that necessary adjustments are made.

The topic of vaccination is indeed crucial and has gained even more significance in recent times, particularly in this COVID-19 pandemic era. Although this topic is not covered by the middle school science curriculum, it has been a hot topic in recent times, leading to many student questions about it. In addition, in the classroom environment, science teachers might come

across students who reject vaccines or are hesitant about vaccines, for sure. To answer students' questions or relieve them about their concerns, science teachers should have a basic understanding of vaccines and the ability to provide accurate answers to their students' questions or point them to trusted sources to get information to understand the nature of science. This not only promotes understanding but also helps address concerns and misconceptions related to vaccination, contributing to public health education. The science teachers in this current study expressed their perspectives on vaccination and integration of it into the science curriculum. Most of science teachers acknowledged the pressing need for comprehensive vaccination content within the science curriculum, especially in light of recent global health events like the COVID-19 pandemic. The study conducted by Girgin et al. (2023) reveals that teachers harbor a certain degree of mistrust regarding vaccines, and this mistrust is rooted in a lack of knowledge. This finding underscores the importance of providing teachers with accurate and comprehensive information about vaccines, as well as the significance of incorporating vaccination-related topics into science curricula to foster a better understanding of this critical public health issue among both teachers and students. In this study, teachers were asked two important questions: " When your students ask you a question about vaccination, do you feel confident in providing clear answers?" and " Will you face any challenges while teaching the topic of vaccination?" While a significant number of science teachers expressed their willingness to include vaccination-related content in their teaching, there are variances in their readiness levels. When analyzing the reasons behind their responses, it's notable that while a majority of teachers expressed confidence in their ability to address vaccination-related questions and teach the subject effectively, a significant portion of teachers acknowledged the possibility of encountering difficulties. In other words, not all science teachers felt equally equipped to address vaccination topics, some expressed their concerns about their own knowledge gaps regarding vaccines and may seek further training or resources to enhance their expertise.

The study highlights a crucial issue concerning the confusion and questions surrounding vaccines, primarily attributed to the lack of comprehensive education on this subject. The findings indicate that there is a need for students to possess some essential background knowledge about vaccines. According to the teachers surveyed, this preliminary knowledge should encompass information about the effects of vaccines, microscopic organisms, and

immunity. This observation aligns with the suggestion made by Yüksel and Topuzoğlu (2019), emphasizing the importance of incorporating detailed information about vaccines into accessible sources. Such information should cover the benefits, potential side effects, and the components of vaccines. This approach aims to equip individuals with accurate and reliable information, enabling them to make informed decisions regarding vaccination and counteracting the spread of misinformation often encountered on social media platforms.

The persistence of anti-vaccine views, even in an age of advanced technology, is indeed a concerning issue. This study underscores the critical role of education in addressing this problem. The reasons for hesitancy or vaccine rejection may vary. For instance, Sandler et al. (2020) emphasized the lack of knowledge of college students and Türkay et al. (2017) highlighted the major reasons for vaccine rejection were the spread of false news and political discourse in the media. This study (Türkay et al., 2017) also underscores the significance of education in struggling with vaccine misinformation and the importance of understanding the nature of science. In the current study, teachers were asked about the importance of students being informed about vaccination and whether vaccination should be included in the curriculum. The majority of teachers expressed that topics are important, and the topic of vaccination should be a part of the curriculum. Based on science teachers' responses, this study strongly recommended including the vaccination concept in the science curriculum. Similarly, as mentioned in Siani, Carter, and Moulton (2022), the results emphasize the need to guarantee that secondary school curricula comprehensively address crucial public health topics. Additionally, it is essential to equip both learners and educators with an adequate level of scientific and digital literacy to guide their decision-making regarding vaccinations (Siani et al., 2022). However, it's also necessary to mention that education alone might not be adequate, and it may need to be complemented by other strategies to address the complex issue of vaccine hesitancy or rejection. Zeyer and Dillon (2019) suggested that the science curriculum should be considered within the Science|Environment|Health (S|E|H) perspective. With the introduction of the S|E|H perspective, many researchers have used teaching approaches (e.g., Byrne et al., 2014; Cetin-Dindar, 2015), curriculum (e.g., Simon et al., 2016), and textbooks (e.g., Hoffer, Lex, & Simon, 2022) within the light of S|E|H perspective (Cetin-Dindar, 2022). Besides, based on the findings of this study, the vaccination concept can be included in the science curriculum, addressing the role of vaccination during pandemics. In order to achieve the goals

of science education and promote citizenship, teachers can leverage their expertise and past experiences to discern the aspects that merit discussion within particular contexts when working with specific groups of students (Justi et al., 2022). It is crucial that students not only grasp the importance of vaccination but also acquire basic knowledge about viruses, their transmission, and the science behind vaccines with an understanding of the nature of science (Reiss, 2022; Weisberg et al., 2021).

4.1. Implications of Research

This research on vaccination in the context of science education carries far-reaching implications for curriculum development, teacher training, public health, and community engagement. It emphasizes the importance of comprehensive vaccination education in shaping informed citizens and fostering a healthier society. The study underscores the need for an enriched science curriculum that incorporates socioscientific topics such as vaccination. By doing so, students can receive a more holistic education that equips them with the knowledge and critical thinking skills necessary to engage with real-world issues. The findings highlight the importance of providing science teachers with the necessary training and resources to confidently discuss vaccination topics in the classroom. Graduate student programs can empower teachers to effectively address students' inquiries and concerns about vaccination. Collaboration between science educators, health professionals, and policymakers is vital. This research emphasizes the need for interdisciplinary efforts to develop comprehensive educational programs and policies related to vaccination. Educational institutions should recognize the evolving nature of vaccination and public health challenges. The curriculum should remain adaptable to address emerging issues and new vaccines, fostering a lifelong commitment to informed decision-making.

Integrating vaccination topics into the science curriculum can contribute to better health literacy among students. This can empower them to make informed decisions about their health and vaccination, ultimately leading to improved public health outcomes. The study suggests that education about vaccination should extend beyond the classroom to engage parents and the broader community. This can help dispel myths and misconceptions, fostering a more supportive environment for vaccination.

The study highlights the potential for further research on the effectiveness of integrating vaccination topics into the science curriculum. This could involve longitudinal studies to assess the long-term impact on students' knowledge and attitudes toward vaccination. As discussions about vaccination can be sensitive and value-laden, educators should be prepared to address ethical aspects in the classroom. This research highlights the importance of including ethical discussions in vaccination education.

4.2. Suggestions

Addressing the following suggestions could contribute to a more comprehensive and nuanced understanding of the role of science teachers in vaccination education. The main suggestion of this study is the relatively small sample size of in-service science teachers involved. While efforts were made to reach a diverse group (such as more experienced, different locations, etc.), the findings may not be fully representative of all science teachers' perspectives on vaccination. Future research could involve a larger and more diverse sample of science teachers, potentially from different countries or regions. This would enhance the generalizability of findings. Combining quantitative data from questionnaires with qualitative data from interviews or focus groups could offer a more comprehensive understanding of science teachers' perspectives on vaccination. Long-term studies tracking changes in science teachers' perspectives and practices regarding vaccination could provide valuable insights into the impact of evolving scientific knowledge and educational policies.

Comparing the perspectives of science teachers with those from other disciplines or comparing teachers from different countries could reveal variations in attitudes and practices related to vaccination education. Designing and implementing educational interventions on vaccination within teacher training programs and assessing their impact on teachers' knowledge and practices would be beneficial for both research and practice. Also, investigating students' perceptions and understanding of vaccination and related topics could complement teacher-focused research, providing a more holistic view of science education's effectiveness in this area.

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