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Studying Argumentation Writing Skills of Science Teacher Candidates on Covid-19 Pandemic and Their Opinions Regarding the Vaccine as a Socio-Scientific Issue

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Abstract

To see the reflections of scientific literacy in individuals' daily life manners is one of the most significant objectives of science education. In this context, it is thought that science teacher candidates are required to have the skills of socio-scientific issues and writing arguments on those subjects. Thus, the purpose of this study was to assess science teacher candidates' skills of writing argumentation on Covid-19 pandemic, which is a socio-scientific issue, and discuss their opinions on Covid-19 vaccine. The research was designed by using mixed method case study. The study group of the research consisted of 33 teacher candidates who were second grade students enrolled in the department of science teaching in a state university in Istanbul. The data in this study were gathered via "Written Argumentation Form" in accordance with argumentation writing components of Cope et al. (2013). For the opinions of teacher candidates on Covid-19 vaccine, "Interview Form" including two open-end questions was used. In data analysis, Argumentation Assessment Rubric (AAR) was used for argumentation and for opinions related to the vaccine, content analysis was applied. At the end of the research, it was found out that the teachers were successful in terms of creating "argument" and "result argument" while writing argumentation of which subject is socio-scientific, however they could not refute the counter claims adequately. Even though the teacher candidates approached Covid-19 pandemic scientifically in the arguments, it was found out that they had hesitations about how to behave in Covid-19 pandemic considering their opinions on vaccines. Although the teacher candidates thought that it was a real pandemic and follow vaccine studies closely, vast majority stated that they did not want to be vaccinated or they were undecided about it. It is recommended to examine thoroughly the fact that even though the vast majority of the teacher candidates thought pandemic was real, they had different opinions on vaccines.

Keywords: Science education, socio-scientific issues, argumentation, Covid-19 pandemic.

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Introduction

While the beginning of the 21st century marked various advancements in science and technology, the reflections of science in technology also has improved the life quality of human beings. Then, how much have people appreciated science for that or questioned the improvements? Science always has a significant impact on societies. But to what extend have human beings discussed the significance of science? Generally this impact has been of interest to a few intellectual people engaged in science or interested in scientific developments. Novel coronavirus which was declared a pandemic in the beginnings of 2020 has altered some certain habits of societies such as following and questioning scientific developments and doing an act in the light of those developments.

Covid-19 pandemic has clearly manifested that science was a part of our daily lives. People put some subjects of scientific fields on their agendas while having conversations with their inner circles asking questions such as "How a mask can protect me and people in my surrounding?", "Why does testing matter so much to re-open a country?", "How can we protect ourselves from a second or even a third wave?". The pandemic has underlined that along with the problems which made us face the virus, some socio-scientific issues such as climate change, pollution and hunger in the world would be getting closer to our homes in the past decades (Hoisington, 2020). Socio-scientific issues (SSI) are generally subjects of notable social interest, with controversial scientific basis (Jafari and Meisert, 2019). While scientific subjects with social consequences create a dilemma, they are called socio-scientific issues (SSI) due to the central roles of both social and scientific factors. As each implementation of science cannot be considered independent of society, interest to and consequences of socio-scientific issues regarding the society has a unique influence (Sadler, 2004). Fundamental reference in SSI originates from society and citizens rather than academic communities where scientific information is created and approved (Jimenes-Aleixandre and Erduran, 2007).

SSI are also controversial issues where contradicting opinions of different parties are present in one or more of the fields of biology, sociology, ethics, politics, economics and environment (Simonneaux, 2007; Ceyhan, Muğaloğlu and Tillotson, 2019). In this sense, the following are some of ISS: cloning, global warming (Sadler, 2004; Atasoy, 2018; Tekin and Aslan, 2019), stem cells genome projects, alternative fuels (Sadler, 2004), nuclear power plants (Atasoy, 2018; Tekin and Aslan, 2019), genetically modified organisms (Atasoy, 2018) and in vitro fertilization (test-tube baby) implementations (Tekin and Aslan, 2019). SSI might be international as well as national. On one hand, the ideology dominant in a society and on the other hand the values and beliefs of that particular society are the determinants for what is controversial or not (Tatar and Adıgüzel, 2019).

In teaching SSI, it is seen that particularly science education programs of countries take responsibility considerably. One of the major objectives of science education is to support students via science classes not only in their school achievement and performances but also in their decision-making processes related to the events the encounter in their daily lives (Simonneaux, 2007). For science

education to achieve its objectives, socio-scientific issues has an important role (Sadler, 2004). SSI are included in France's curriculum in order to enable students to develop conscious standpoints upon SSI, to make choices about preventive measures, to make use of new techniques wisely and to discuss all those in the perspective of citizenship. For that purpose, along with the other necessities, students are required to understand and discuss scientific content including its epistemology, decide on the issues, and analyze social consequences in economic, political and ethical terms (Simonneaux, 2007). Along with being studied in the recent past in Turkey (Tatar and Adıgüzel, 2019), it is seen that SSI are included in the objectives of science education in the current science program. The purpose of science education is defined as: to make students do research, question, establish a connection between their daily lives and science subjects, solve problem, be cooperative, and develop discernment, scientific thinking and decision-making skills by using socio-scientific issues (Ministry of National Education [MONE], 2018).

Being experienced in SSI through science education, students would be able to increase their capacities to use the required skills in future while making decisions as citizens (Yapıcıoğlu and Kaptan, 2018). SSI provides individuals with cognitive, emotional and social progress and focus on not only intellectual advancement of students but also on their emotional and social improvements (Topçu, 2010). SSI may assist students to put science into practice while studying difficulties they encounter, their communities and the world around them (Sutter, Dauer, Kreuziger, Schubert and Forbes, 2019). Furthermore, SSI is used to provide context for teaching as a means of enhancing the quality of teaching implementations (Karahan and Roehrig, 2019). Through stating different opinions, SSI allows to use skills such as researching-questioning current condition, analyzing options to reach a solution.

While making a decision on SSI, individuals need informal reasoning through thinking processes which include assessing evidence on various disciplines with political, economic, moral and ecological justification and taking different points of view into consideration (Özden, 2020). The opportunity to express oneself for students via informal reasoning is provided by argumentation (Sadler, 2004).

Even though argumentation essentially depends on discussions in scientific areas in the past, the basis of argumentation that is known today was first formed in the book titled "The Uses of Argument" written by Toulmin in 1958 and revised in 2003 (Toulmin, 2003). Toulming (2003) made a diagram of argumentation model as a pattern consisting of six components. These components were comprised of data, qualifier, claim, reasoning, supporter and confuter. Various argumentation models were developed with reference to Toulmin model and one of them is the model developed by Cope, Kalantzis, Abd-El-Khalick and Bagley (2013). The argumentation components in this model are as follows (Cope et al., 2013): 1) Opening argument: the part where argument and the question or problem the argument handles, the solution tried to be found are introduced. In this part, the argument is expected to attract readers and establish a relationship between the writer and the reader of the argument. 2)

Claim 1: a statement that answers the original question or problem followed by evidence and reasoning. *Evidences* are appropriate and sufficient scientific data that supports the claim. *Reasoning* is a justification that connects the evidence to the claim and shows why the data counts as evidence by applying scientific principles (often labeled 'warrant'). 3) Claim 2: the next claim planned as the previous claim. 4) Counter-claim(s): an awareness of the existence of alternate or opposing claims, and a critically evaluation of the evidence offered to support these claims, and the reasoning provided. 5) Conclusions: overall judgment considering all discussions.

Arguments are constructed by participants in a way involving the ideas suggested in the process of argumentation (Okumuş, 2020). While Kuhn (2018) states that the process of constructing an argument can be defined as a social implementation rather than a completely individual competence, Boğar (2019) identifies argumentation process both as an individual and social activity based on the definitions in literature. The individual creates certain arguments, designs them, and evaluate them in mind. In social processes, two or more people construct different arguments on a particular subject and they have a discussion on validity of those arguments for evaluation (Boğar, 2019). When it comes to science classes, argumentation facilitates a surrounding to improve both social discourse and communication skills by emphasizing reciprocal discussion, criticizing and justifying ideas (Allchin and Zemplén, 2020). As argumentation can be used through almost every subject and approach in science education, it has become important to determine the criteria to reveal the quality of argumentation. It is possible to have different focuses while assessing argumentations; evaluation and assessment can be conducted from different perspectives such as students' using argumentation components, argument writing skills, understanding of the nature of science, decision-making skills and understanding of democratic implementations. This may change based on teacher's purpose of using and assessing argumentation and learning outcomes. In literature, the skill of argumentation writing is generally studied with reference to its components. In this regard, Bowel and Kemp (2018) state that some argumentations may not contain a good argument, and they recommend to pay attention to the following three points in analysis for that: 1) Determining the subject discussed, to find whether persuasion is provided or not via an argument 2) if an argument is offered, determining the argument and claims, re-constructing the argument in order to express it clearly and present reasoning steps and style in the argument explicitly 3) Re-assessing the argument, questioning its advantages and disadvantages. When we suggest and argument, we either offer an opinion or recommend a certain action. In both situations, we have several claims to support the argument. The quality of claims used here is significant. For instance, instead of saying "The world is on the verge of an environmental disaster", stating "Climate scientists predict that the world is on the verge of an environmental disaster" would be a more qualified claim. Erduran (2007) addresses the assessment of the nature of evidence used as data, reasoning (justification) and support as follows: Can theoretical statements be accepted as evidence or must evidence depend on experiments? Can opinions, beliefs, thoughts and values be counted as evidence? Is there a difference among those accepted as evidence in scientific and socio-

scientific contexts? More questions similar to those above may be raised. The source of argument components, whether be experimental or theoretical, offers another problem to code arguments. At this point, considering the usage of evidences, the validity of arguments is required to be examined. From different perspectives, the usage of experimental evidences may be more appropriate than of theoretical evidences. For the others, theoretical statements may be the only source of evidence. Simonneaux (2007) advocates that the best criteria to designate the quality of an argumentation are students' having counter-claims. If counter-claims are constructed in a way to be supported by different disciplines and points of view, an advantage might be given to opponent over oneself and argument can be weakened or sometimes, it can strengthen the argument although its rhetorical usages are not scientific.

Taking an important place in the programs of countries, activating thinking skills and also being included essentially in SSI, argumentation has had a considerable significance in today's science education and related fields (Allchin and Zemplén, 2020).

Thus, in the study of Tezel and Günister (2018), it is indicated that one of the methods mostly used in teaching SSI is argumentation; Ceyhan, Muğaloğlu and Tillotson (2019) assert that argumentation implementations in which evidence-based thinking is applied while teaching SSI have a crucial importance for students to make decisions as conscious citizens. Decision-making skills of individuals on SSI personally, vocationally and as citizens would depend on their understanding of what science is, how science works and also on their thinking, speaking and applying skills on scientific thoughts in their daily lives (Hoisington, 2020). Most scientific developments facilitate our lives, and most of those changes have a positive impact on our life quality, however sometimes there may be new risks, discussions and ethical dilemmas and there may not be always a success regarding a solution to problems to be handled. Hence, science education has an important role for students to develop required skills to perceive controversial SSI like genetically modified food or nanotech goods and make conscious, evidence-based and responsible decisions (Hadjichambis, Georgiou, Hadjichambi, Kyza, Agesilaou ve Mappouras, 2019).

It is likely to have some difficulties in argumentation implementations carried out on SSI in class. Difficulties teachers may have are directing discussion in complex and uncertain subjects and objectivity, taking social consequences of discussions into consideration and mastery on interdisciplinary problems. Gathering interdisciplinary subjects together may be challenging for students, too. Besides, arguments of students may be influenced by personal and social factors related to discussion topic. The greatest factor here is the problem that some public discussions on media might constrain students from creating their own arguments. The solution to this problem would be keeping students away from discussions embraced by media, and promoting them to think for themselves by analyzing present knowledge and then expressing their own opinions. Since knowledge is gradually improved via discussions, argumentation is an inner part of learning. Because argumentations on SSI

include various disciplines by definition, it would be appropriate to evaluate them objectively by teachers of different fields (Simonneaux, 2007).

In recent years, there have been quite a lot studies both SSI and argumentation in science education. Some studies conducted on SSI in the last four years discuss the following: opinions and attitudes of science teachers and teacher candidates (Ayvacı, Bülbül and Türker, 2019; Erkol and Gül, 2020; Gürbüzkol and Bakırcı, 2020; Karahan and Roehrig, 2019; Sibic and Topçu, 2020; Tekin and Aslan, 2019;); dissertations and/or article analysis (Atabey, Topçu and Çiftçi, 2018; Aydın and Kılıç Mocan, 2019; Genç and Genç, 2017; Özcan and Kaptan, 2020; Tatar and Adıgüzel, 2019; Tezel and Günister, 2018); developing a model related to its teaching (Alred and Dauer, 2020; Sadler, Foulk and Friedrichsen, 2017); impact of different methods (Yıldırım and Bakırcı, 2020) and pedagogical background knowledge qualities of science teacher candidates in the context of SSI (Varal and Belge Can, 2020). Similarly when studies on argumentation are considered; these were examined: theoretical proposals on the appliance of argumentation and its significance in science education (Allchin and Zemplén, 2020; Boğar, 2019; Lazarou, Sutherland and Erduran, 2016); influence of argumentation on different variables as a method (Akkaş and Kabataş Memiş, 2020; Arık and Akçay, 2018; Bilir, Tatlı, Yıldız, Emiroğlu, Ertuğrul and Sakmen, 2020; Çakan Eroğlu and Yıldırım, 2020; Çalışkan and Kapucu, 2021; Demir and Gönen, 2019; Er and Kirindi, 2020; Kara, Yılmaz and Kıngır, 2020; Tüzün and Köseoğlu, 2018; Yaman, 2019); analysis of studies in literature (Erduran, Özdem and Park, 2015; Hafızoğlu and Bahar, 2020; İnam and Güven, 2019; Memiş, 2017; Yıldırım, 2020); thoughts on argumentation (Balcı and Benzer, 2020; Özcan, Aktamış and Hiğde, 2018; Yılmaz and Benzer, 2020); ascertaining level of argumentation (Çorbacı and Yakışan, 2018; Seçkin Kapucu and Türk, 2019; Torun and Açıkgül Fırat, 2020; Uluçınar Sağır, Soylu and Bolat, 2021); adapting the scale of factors affecting the teaching of argumentation into Turkish (Atabey, Topçu and Çiftçi, 2020). There have been studies in which those two major subjects of science education were discussed together. Those studies include experimental studies where argumentation implementations are used in teaching socio-scientific issues (Ceyhan, Muğaloğlu and Tillotson, 2019; Karakaş, 2020; Okumuş, 2020; Zengin, Keçeci and Kırılmazkaya, 2012;) and the impact of implementations conducted in socio-scientific context upon argumentation writing skills is examined (Anwar and Ali, 2020; Arslan and Atabey, 2018; Dawson and Venville, 2010; Evren Yapıcıoğlu and Kaptan, 2018; Karakaş and Sarıkaya, 2020; Özcan and Balım, 2018; Öztürk and Doğanay, 2019; Topçu and Atabey, 2017).

As it is the primary purpose of science education to improve science literacy and also socio-scientific decision-making is a crucial part of science literacy, it is essential to discover how students structure their decisions about SSI and how they discuss and solve SSI (Özden, 2020). Any attempt to be made without considering the current condition of teachers who would provide the in-class integration of any learning and teaching initiatives related to SSI will increase the possibility of encountering problems in intra-class implementations (Han Tosunoğlu and İrez, 2017). Furthermore, it

is proposed to implement learning process in current science curriculum by the means of surroundings enabling the construction of argumentation (MONE, 2018). Argumentation levels of various partners consisting of students, teachers and teacher candidates in the context of SSI are indicated in the studies carried out in the field of science education. Such studies were mostly conducted together with science teacher candidates, and argumentations were evaluated by the aspect of their socio-economic-ecological-technological focus areas (Demircioğlu and Uçar, 2014; Ural, Öztaş and Ercan, 2020) and contexts they were written in (Atasoy, 2018; Kutluca and Aydın, 2017). In some studies, argumentation levels were interpreted based on different variables. The argumentation levels of science teacher candidates were evaluated depending on critical thinking skills and background knowledge by Demiral and Çepni (2018); argumentations of theology students by Eş and Varol (2019); taking decision-making and reasoning into consideration by Türköz and Öztürk (2020). Kutluca, Çetin and Akbaş (2020) examined argumentation writing skills of secondary school students considering their grade and knowledge level. When general inclination of studies in literature are considered, it is possible to find studies examining argumentation writing skills of science teacher candidates in the context of socio-scientific issues by the means of various criteria.

What makes this study different from other studies is that it discusses argumentations of teacher candidates written in the context of Covid-19 pandemic remaining on the agenda as a socio-scientific issue. There is no other study on this particular subject in literature. Covid-19 is a socio-scientific issue which highly affects society, sparks a debate in society, and on which scientists might have different thoughts (Evren Yapıcıoğlu, 2020). Coronavirus pandemic has made its impact in Turkey as well as the whole world, on March 11, 2020, WHO (World Health Organization) declared Covid-19 a worldwide pandemic (Er and Ünal, 2020). Pandemic simply can be defined as a major epidemic. Its significant characteristic: spreading a wide geographical area, being transferred from one place to another easily, having high infection speed, no immunity for most of the population, its being new, threatening human health seriously (Morens, Folkers and Fauci, 2009). In Covid-19 pandemic which is a socio-scientific issue, people have faced many complex moral and ethical problems such as “Is the virus causing Covid-19 natural? Or artificial?” and “Is one supposed to be vaccinated or not?” (Evren Yapıcıoğlu, 2020). There are studies on Covid-19 in the field of education (Abdillah, Setyosari, Lasan and Muslihati, 2020; Aktan-Acar et al., 2021; Bahruddin and Ramadhanti Febriani, 2020; Bozkurt, 2020; Çakın and Külekçi Akyavuz, 2020; Er and Ünal, 2020; Erbaş, 2021; Evren Yapıcıoğlu, 2020; Genç, Engin and Yardım, 2020; Haşıloğlu, Durak and Arslan, 2020; Karakaya, Adıgüzel, Üçüncü, Çimen and Yılmaz, 2021; Şensin and Rubat Du Mérac, 2020; Üstün and Özçiftçi, 2020; Ziegler, Bedenlier, Gläser-Zikuda, Kopp and Händel, 2020). (Common inclination in studies were based on distant education process and learning opinions of different partners related to this process. And in this study, argumentation writing skills of teacher candidates on Covid-19 were evaluated, and their opinions on pandemic and vaccine were examined. Being different from other studies, assessment on argumentation writing was carried out through the argumentation writing rubric developed by Coped et al. (2013). It was thought that the

consequences of this study would contribute to the understanding of argumentation writing skills in the context of socio-scientific issue which science teacher candidates are already in. Hence, it was aimed in this study to evaluate argumentation writing skills of science teacher candidates on Covid-19 pandemic as an important SSI, which they were in and experience and discuss their opinions on the pandemic and Covid-19 vaccine with reference to argumentation. Regarding the purpose mentioned, answers were sought to these questions: "How are argumentation writing skills of science teacher candidates on Covid-19 pandemic as a socio-scientific issue?" and "What do science teacher candidates think of Covid-19 and its vaccine?.

Method

Research Design

In this study, case study was conducted. Primary purpose of case study was to reveal outcomes of one or more cases and study those cases thoroughly (Yıldırım and Şimşek, 2013, p.83). Two cases related to science teacher candidates were covered here. First case was to study argumentation writing skills of teacher candidates on Covid-19 pandemic as a socio-scientific issue. And the second case was about learning teacher candidates' opinions of Covid-19 pandemic and vaccination studies. Moreover, the cases in this study were presented with the frequencies of teacher candidates' codes. Hence, it would be more accurate to state that the pattern of the study was mixed method case study involving quantitative data (Christensen, Johnson and Turner, 2020, s. 417-418).

Study Group

Study group was consisted of teacher candidates who were second graders enrolled in the department of science teaching of a university in Istanbul. There were totally 33 students in this group, 31 of them women (%93, 9) and 2 of them men (%6,1). Study group was conducted with volunteered teacher candidates who had Critical and Analytical Thinking class. Since students were taught all components of argumentation method in that class, it was considered appropriate to include those students taking that particular class in the study group. As it would be hard to carry out an implementation during the pandemic, teacher candidates in the study were chosen from the university where one of the researchers works. Accordingly convenience sampling was used in the study.

Data Gathering Process

Before beginning the argumentation to be written within the scope of the study or asking teachers to write any argumentation, one of the researchers gave a four-hour seminar on how to write an argumentation as a part of the class. Because of the pandemic, seminar was conducted through distance learning system. First, a short introduction on argument and argumentation was made and then an argumentation was carried out through a daily life subject that could be understood easily (What is the best pet?). Here the purpose was to enable teacher candidates to implement argument components

by the means of a subject they were familiar with. For instance, while some students supported the argument "dogs are the best pets", they claimed that "they could walk around with dogs", "dogs were loyal to their owners" and "they could play fetch with dogs". While doing so, they used their experience and observations as evidence in the classroom environment. The statements made by other students as counter-claims such as "toilet needs of dogs being a problem" and "dogs being too noisy" were tried to be refuted by statements such as "toilet problem can be fixed by taking dogs for walk and this would be an excuse for human beings to walk around, which would have a positive effect on human health both physically and psychologically", and "The noise made by dogs would be less compared to cats since dogs do not jump and kick over things". After this brief implementation, using the book of Bowel and Kemp (2018), following subjects were exemplified: "What is an argument and argumentation?", "What are the components of argumentation?", "What are the features of components?", "What are argumentations, and what are not?" (e.g. Rhetoric)?". Then, teacher candidates were informed of the news not supported by scientific knowledge (for instance, 5G's being the reason of the pandemic, corona parties organized and the pandemic's being not real etc.) and asked: "Do you think Covid-19 is a real pandemic?", and then they were asked to write an argumentation text about it.

Data Gathering Tools

Two data gathering tools were used in the study. One of them was "the written argumentation form" which included the argumentations written by teacher candidates and the other one was "the interview form" consisting of two open ended questions teacher candidates were asked about their opinions on Covid-19 vaccine.

The Written Argumentation Form

Teacher candidates were asked to construct their argumentation on Covid-19 pandemic on a word document, using the components described by Cope et al. (2013) namely argument, claim, evidence, counter-claim, rebuttal and conclusion argument, and hand it over in a pdf form. Here, teacher candidates were assigned to write their argumentation within a week, using different resources, news with scientific or non-scientific points of view, explanations made by scientists and discussions related to the subject. This one-week time was given to allow teachers not to write what they had in their minds directly, to enable them to discern scientific knowledge and construct their own argumentations.

The argumentation writing form was also used to get data to reveal their thoughts on whether "Covid-19 was a real pandemic" and "Covid-19 was manufactured in a lab" or not.

The Interview Form

To learn about teacher candidates' thoughts on Covid-19 vaccine, two questions were asked: "Do you follow the vaccination studies?" and "Do you consider to be vaccinated if you have the opportunity to get Covid-19 vaccine? Why or why not?" The first question was used to designate whether the second question was answered based on certain knowledge. Moreover, by the means of

interview questions, it was aimed to discuss the arguments and opinions of teacher candidates on the vaccine comparatively. The interview questions were examined by two academicians who were experts of science education and had publications on SSI, and evaluated whether they were appropriate or not, so their internal validity was sustained. After the suitability of questions was ascertained, the questions written on Google forms were sent to teacher candidates.

Data Analysis

The Analysis of the Written Argumentation Form: Argumentation Assessment Rubric (AAR)

The argumentations written by teacher candidates in this study were assessed via Argumentation Assessment Rubric (AAR) developed by Cope et al. (2013). Rubric was in English originally and translated into Turkish by the researchers of the study. In this process, first, corresponding writer of the article was contacted and approval to use Turkish version within the context of the subject in question (Covid-19) was received. Following the approval, the rubric was translated into Turkish by two science education experts and a language expert. During the translation process, first, experts studied individually and then cooperatively to complete the translation, finally the rubric translated was sent to the language expert for spellcheck and proofreading. The Turkish rubric translated and the original English one was used by two science education expert to evaluate the same argumentation text and the same evaluation outcomes were reached. Later, content validity of the rubric was examined by an academician in science education. In this context, as the last matter of the rubric was mostly on writing style and was irrelevant to the purpose of the study, it was removed. By the means of 16 argumentations written on Covid-19 but not used in the study, the reliability of the rubric was examined. At this point, two independent experts evaluated those argumentations individually. And then, a third expert evaluated the argumentations for the mismatched grades of the former two experts and shared the new evaluation with the other experts. In this process where evaluations were shared interactively, it was concluded that evaluating counter-claims and rebuttals based on the criteria under the same matter had raised difficulties in grading. Regarding this issue, an arrangement was made related to counter-claims and rebuttals and two argumentation components which were studied under a single matter in the original one were re-evaluated as separate matters. Finally, in the calculation based on the formula of Miles and Huberman (2015), a high level of consistence at the ratio of %92 was confirmed among the evaluators.

Chart 1. Argumentation Assessment Rubric

Steps	Questions	Criteria	
Introduction	Is the argument introduced explicitly?	0	The argument is not introduced.
		1	The argument is introduced poorly.
		2	The argument is introduced but it is not clear enough.
		3	The argument is introduced clearly.
Claims	Does the writer provide relevant claims to support the argument?	0	There is no claim.
		1	There is a claim but does not support the argument.
		2	There are claims and they mostly support the argument.
		3	There are enough claims and all support the argument.
Evidences	Does the writer provide strong evidences to support each claim?	0	There is no evidence to support the claim.
		1	There are some evidences stated; however not all the evidences support the claim.
		2	Evidences are included to support the claim; however the argument could be stronger via more evidences.
		3	Strong evidences are included to support each claim.
Counter-claims	Does the writer accept/is the writer aware of the counter-claims made in the texts written by other people?	0	Counter-claims are not accepted.
		1	Poor counter-claims are made.
		2	Only one strong claim and poor claims are accepted.
		3	Main counter-claims are accepted.
Rebuttals	Can the writer refute the counter-claims accepted?	0	Counter-claims are not refuted.
		1	The opportunity to refute some important counter-claims is missed.
		2	Counter-claims are refuted, but it is not done profoundly.
		3	Counter-claims are refuted completely.
Conclusions	How well does the writer conclude the argument?	0	There is no conclusion or the conclusion is not relevant to the argument.
		1	It is hard to follow the consequence or the consequence is not relevant to the argument.
		2	The conclusion is stated clearly, however more than one subject are covered or inconvenient and emotional phrases are used.
		3	The conclusion is stated clearly, one subject is covered and inconvenient and emotional statements are avoided.

AAR (Argumentation Assessment Rubric) finalized and consisting of six sections was used to evaluate the argumentations written by 33 teacher candidates. At this point, since the argumentation texts of those teachers who had not provided a certain argument had no argumentation stated, even

though the claims they made in their argumentation directed the argumentation text to an argument, it was thought that it would pose a problem in creating profound data to include the claims of those students and other argumentation components into the evaluation. Hence, the argumentations of those two teachers were not taken into consideration for the other steps of AAR. Similarly, the evidences of the students with no claims and the rebuttals of students with no counter-claims were also excluded and n value indication total number of people varied in the argumentation components. Those numbers were shown on the chart. Furthermore, even though there was a claim but it did not support the argument, evidences were taken under consideration and their support to the claim was examined.

As a result of evaluation conducted by researchers separately to designate the reliability of data in the study, it was recorded that data were reliable at a ratio of %88 based on the calculation by the formula of Miles and Huberman (2015). Accordingly, for each component, minimum 0 point, maximum 3 points and 18 points in total for six components could be acquired from AAR. The analyses carried out were presented in the findings section separately for both general argumentation assessment and argumentation components. At those presentations, grading criteria in the rubric, frequency (f) and percentages (%) were indicated in charts by quotations from the statements of teacher candidates who could represent the criteria best. Especially, in order to show the relation between claim and evidence/ argument and claim/ counter-claim and rebuttal pairs, examples from the statements of the same teachers were given in different charts. This also allowed saving the content density of the charts.

The Analysis of the Interview Form

For the analysis of interview questions, content analysis was used. The main purpose of content analysis was “to reach concepts and relations to explain data. What to do for that purpose was: to gather similar data together within the context of certain concepts and themes and interpret them in a way to enable readers to understand.” (Yıldırım and Şimşek, p.259). The opinions of teacher candidates forming the data in the study were examined thoroughly by the researchers and another science education expert outside the research; themes and codes were created. At this point, the researchers analyzed the opinions independently, and then came together and reached a consensus. Codes were presented in the charts through direct quotations from the answers of teacher candidates to exemplify frequency, percentage and codes. To the presentation of interview questions, general opinions related to Covid-19 determined based on argumentation were included and examined together with two socio-scientific issues.

Findings

At the findings section of the study, first, the findings about the evaluation of argumentation writing skills of teacher candidates on Covid-19 and then findings about the evaluation of their opinions on Covid-19 and the vaccine were covered.

Findings on the evaluation of argumentation writings of teacher candidates upon Covid-19

In this section, findings related to the research question "How are the argumentation writing skills of science teacher candidates on Covid-19 pandemic as a socio-scientific issue?" were included. First, findings acquired by the evaluation of teacher candidates' argumentations via AAR were generally indicated in Figure 1, and then argumentation components were examined one by one.

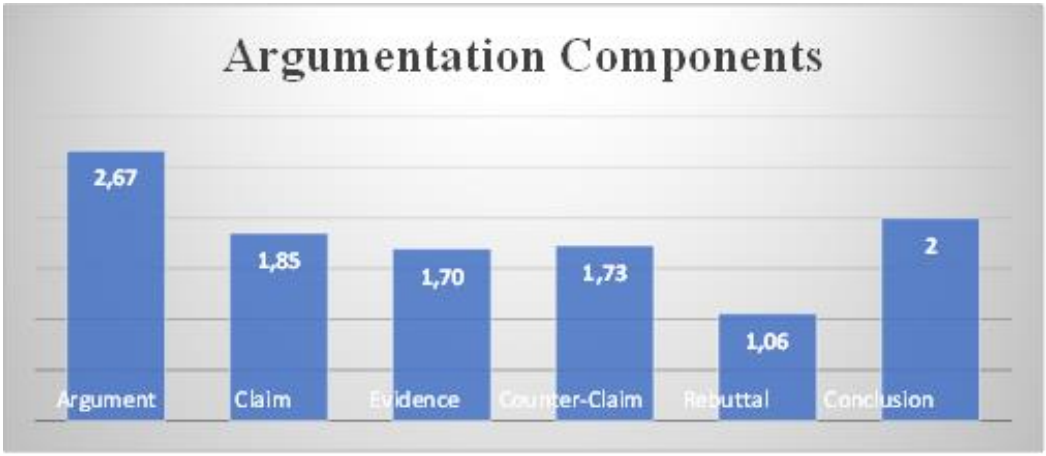

Figure 1. General findings acquired by the evaluation of teacher candidates' argumentations via AAR.

When grades teacher candidates got from the argumentation assessment rubric in Figure 1, it was seen that they were more successful in the step of expressing and identifying the arguments related to whether Covid-19 was a real pandemic or not compared to the other steps ($\bar{X}_{argument}$=2,67). That step was followed by conclusion argument written after all discussion steps ($\bar{X}_{conclusion\ argument}$=2). As the success of teacher candidates in construction claim, evidence and counter-claims was similar to each other, the part teachers were challenged most was when counter-claims were to be refuted ($\bar{X}_{counter\ claim}$=1,06). The highest score that one could get from the rubric was 18, the total average score of teachers was 11.

Argument

As a result of the examination whether teacher candidates stated their arguments clearly or not, the findings at Chart 2 were reached.

Chart 2. Introducing the Argument (n=33)

	f	%	The example of the best representing teacher
The argument is not introduced (0)	2	6,1	*"...In December, 2019, the virus appeared in Wuhan city of China, of which certain symptoms were seen in March, 2020 in Turkey, created an atmosphere of pandemic, but whether it was caused because of "a bat" or a biological weapon manufactured in a lab is not known yet..." TC [Teacher Candidate]29* *"...Covid-19 challenged all continents and habits to change directly. This paper will be upon the reality of the pandemic crisis we have been through... "TC2*
The argument is introduced poorly (1)	0	0,0	-
The argument is introduced but is not clear enough. (2)	5	15,2	*"...I do believe that Covid-19 is real..." TC22* *"...I believe the reality of Covid-19 virus in our lives..." TC26*
The argument is introduced efficiently(3)	26	78,8	*"Pandemic is a general definition of outbreaks or epidemics spreading to a large area in and having an impact on more than one country-continent in the world. And Covid-19 is a pandemic which appeared in Wuhan, on December 2019 for the first time. Following Wuhan, it started appeared respectively in Japan, South Korea, The USA and other countries. Since it spread in the whole world, it is a real pandemic." TC20* *"I believe Covid-19 pandemic is real because there are Covid-19 virus infections across the world and it causes people to die..."*

For the question "Do you think Covid-19 is a real pandemic?", it can be in Chart 2 that the vast majority of teacher candidates (%78,8) stated their arguments clearly and explicitly as an argument statement. 5 teacher candidates asserted that they believed Covid-19 was real, but did not clarify whether it was a pandemic or not. When the answers of 2 teacher candidates were examined, it was seen that TC28 mentioned that pandemic atmosphere was created but did not mention whether that atmosphere was real or not, so that teacher candidate did not construct an argument, and TC2 did not write an argument statement, only made an introductory explanation about the issue. The arguments made by teacher candidates suggest Covid-19 created a real pandemic.

Claim

At the end of the research conducted whether claims of teacher candidates support their arguments or not, if yes, how strongly they support those claims, the findings at Chart 3 were attained.

Chart 3. Introducing the claims supporting the argument (n=31)

	f	%	The example of best representing teacher
There is no claim (0)	2	6,5	*"…Based on the current number, we have lost 1.252.807 people in our country and in the world because of the virus. Patients more than 10 million hope to be recovered. Recently, International Council of Nurses (ICN) declared that exactly the same number of nurses died in the World War I was lost because of novel corona virus…After a short while the virus appeared in our country, the limitations started…" TC25*
There is a claim but it does not support the argument. (1)	7	22,6	*"…There have been many epidemics from past to present. The difference from other diseases is that they spread very fast and since transportation between countries was not as easy as it is today, of course it is an important factor for epidemic to spread…." TC1* *"…Covid-19 is a type of coronavirus infected from animals to human beings…" TC33*
There are claims and they mostly support the argument. (2)	12	38,7	*"…The reason why Covid-19 pandemic is real is that it spreads fast…If the pandemic is not real, why can we not have face-to-face education right now?...The fact that there are many deaths and sick people and so countries take precautions despite of the economic losses indicates that it is a real pandemic indeed." TC14* *"… Because Covid-19 virus is contagious across the world and cause people to die. And countries around the world order a curfew because of Covid-19 pandemic. Considering this incident, some sectors allow their employees to work at home due to the pandemic…" TC13*
There are enough claims and they all support the argument. (3)	10	32,3	*"People in contact with a corona virus-infected person are also infected. There are certain symptoms of Covid-19. The most common of those are headache, fever, dry cough and loss of smell and taste… Covid-19 is a pandemic with a lethal effect, spreading to the world just like the other diseases and studies for its treatment are still on going." TC20* *"…because many people passed away due to that virus. In a short while, it spread to the whole world, all countries imposed several bans as a precaution…" TC10*

As seen in Chart 3, the claims made by teacher candidates within the context of their arguments mostly support the argument (%38,7) and all of the claims presented in a sufficient number support the argument (%32,3). When claims of those teacher candidates were examined, the fact that all of the factors to declare a pandemic (fast spreading, spreading across the world, causing deaths, similar symptoms etc.) and both WHO and countries tried to take precautions like lockdowns in spite of the economic losses seemed to support that Covid-19 is a real pandemic. For %22,6 of teacher candidates, it was seen that there were claims supporting other arguments but not their own arguments. For instance, TC1 tried to state not his/her own argument related to the reality of the pandemic but the argument related to the idea that Covid-19 was different than the pandemics in the past, claiming "it spreads faster", and this situation was explained through transportation's being easier now. TC33 only mentioned it infected human beings through animals, did not support its being a pandemic. There were only 2 teacher candidates who did not involve any claims in their argumentations. When answers of

those teacher candidates were studied, it was seen that they did not write any claims; instead, they included explanations with some data.

Evidence

The findings examining the situations to support the claims of teacher candidates with strong evidences are indicated in Chart 4.

Chart 4. Presenting strong evidences to support the claim (n=29)

	f	%	The example of the best representing teacher.
There is no claim to support the argument. (0)	2	6,9	*"In an epidemic like that, it is expected all the countries seek for solutions cooperatively. That was what happened. From our countries, there were aids from our country to the others." TC1*
There are some evidences but not all the evidences support the argument. (1)	7	24,1	*"A 39 year-old athlete called…who is normally fit and healthy is having a treatment in ICU because of coronavirus disease. The young woman struggling to breathe called out to people from her sickbed:…who is warning about the dangers of coronavirus said that she felt like there was glass in her lungs in every breath she inhales and warned people that coronavirus was a serious disease. The decreasing number of cases thanks to the bans imposed is evidence." TC10*
There is evidence to support the claim but the claim could be stronger with more evidences. (2)		37,9	*"For instance, a person who was infected with corona virus in a wedding held in Ankara and hence including bride and groom, 100 people were infected with Covid-19. Another example is that a person who participated in a funeral in Şanlıurfa, Siverek were infected with corona virus, so 12 people more in the funeral got infected. People who are tested Covid-19 positive have those symptoms in common…The number of people died of coronavirus reached up to 1.235.335. Lots of firms continue vaccine studies. If a current example is to be given, the very well-known American pharmaceutical company Pfizer and its German partner BioNTech announced that they started vaccine studies on 20 October, 2020…"TC20.*
here are strong evidences to support each claim. (3)	9	31,0	Claim 1: *"…The risk spreading from human to another human is too much…" Evidence 1: "…How fast and easily this virus spreads can be found via R0 value. According to a study published in NEJM journal on 29 January, that value for corona virus is 2,2. This means that each person infected spreads this virus to 2, 2 people on average. As a result of the researches conducted, that value reached to 3,3, too. To end a pandemic, R0 value must be lower than 1…" TC6.*

As Chart 4 illustrates, evidences enabling teacher candidates to support their claims via data and explanations mostly supported the claims but they could be stronger (%37,9) and each claim was supported by strong evidences. It was thought that TC20 could present stronger evidences to support his/her claims. (The claims made by TC20 are shown at Chart 3). For instance, when the statements of that particular teacher candidate were examined, the statement "the symptoms of Covid-19 are common

in those who tested positive" constituted a strong evidence. One of the claims and evidences of TC6 who got the highest score possible was included. This example indicates that TC6 presented sufficient evidences to support the claim what was important in pandemic was that the risk of contagion was high. %24,1 of teacher candidates presented evidences that did not support the claim much. When the statements made by TC10 were examined, it can be seen that poor evidences not supporting the claims were presented. (The claims of TC10 are shown in Chart 3). 2 teacher candidates did not present any evidence to support their claims. TC1, one of those teacher candidates mentioned just now, did not present any evidence, and only mentioned some suggestions. (The claim of TC1 is included in Chart 3).

Counter-Claim

The findings examining the counter-claims of teacher candidates are shown on Chart 5.

Chart 5. Accepting counter-claims (n=31)

	f	%	The example of the best representing teacher
Counter-claims are not accepted. (0)	2	6,5	*"…Covid-19 can infect any person, but it is not fatal for everyone. Curfew applied by countries across the world has a negative impact on economy and prevents people from socializing. Employees' working at home decreases productivity of works…" TC13* *"… Covid-19 may not be fatal for everyone..." TC8.*
Poor counter-claims are made. (1)	8	25,8	*"…People are dying because of other diseases and the reason is told to be coronavirus. Masks are sold commercially…" TC1.* *"…There are people who think that some people use Covid-19 to create panic in the country and collapse economy, and it is a deception…" TC4.*
Only one strong counter-claim and poor counter claims are accepted. (2)	14	45,2	*"…It is suggested that it is used to depopulate the world…" TC14.* *"There are people who advocate that it is a conspiracy theory, there are other purposes, and even no such virus ever existed…" TC32.* *"…A claim suggests that virus is only a game related to flu or 5G..." TC31*
Main counter-claims are accepted. (3)	7	22,6	*"…The claim suggesting that Corona virus is not real states that it is produced in a lab in Wuhan…. There are people thinking that such a pandemic was made up in order to change the economic system completely, to establish a different economic system, and it is not real…" TC5*

Chart 5 shows that %45,2 of teacher candidates constituted only one strong counter-claim, other counter-claims were poor. The strong counter-claims stated here were related to the argument claiming Covid-19 was not a real pandemic; the most mentioned arguments about virus was that it was only used to decrease the population, related to 5G, realizes a conspiracy theory. While %25,8 of teacher

candidates presented poor evidences like pandemic was declared because of mask trade, %22,6 of them mentioned main counter-claims suggesting that virus was produced in a lab, created to change the economic systems. 2 students did not construct a counter-claim. Of those, TC13, explained the negative consequences of Covid-19, TC8 stated it was not fatal for everyone, which had no counter-claims.

Rebuttal

Findings examining whether teacher candidates refuted counter-claims completely or not are shown on Chart 6.

Chart 6. Refuting counter-claims (n=29)

	f	%	The example of the best representing teacher
Counter-claims are not refuted. (0)	8	27,6	*"...How can the death of 1,24 million people because of the same reason until 06.12.2020 and continuity of vaccination studies on such scale be explained... TC1* *"...And I am asking you, would you want to cause the death of some many people?.." TC14.*
The opportunity to refute some important counter-claims is missed. (1)	9	31,0	*"**Counter-Claim:** ...So many people mention that virus is wanted to be spread in a planned way....It is claimed that coronavirus is seemed to be not different from the common flu and its effects are not too significant to take seriously.... **Rebuttal::**...According to the official researches, it is shown that virus spread from a fish market in China... Its symptoms developed like high fever, dry cough and shortness of breath when it became more serious indicate the significance and seriousness since it might result in death." TC18.*
Counter-claims are refuted but not very strongly. (2)	10	34,5	*"...This virus now spreads with the same symptoms and same spreading style across the whole world swiftly. Deaths are generally seen for those who have a certain health condition and at a certain age. Deaths of billions of people with the same symptoms, in the same way expose the reality of this virus. When generally examined, the fact that all countries suffer from economic difficulties at certain times, deaths cannot be controlled, people ruling a country also get that illness refute the theories that this virus is planned..." TC32*
Counter-claims are completely refuted. (3)	2	6,9	*"...Secretary of State Mike Pompeo often brought forward the claim that " pandemic was created in a lab in Wuhan city.". Hua Chunying, Advocate general of Minister of Foreign Affairs of China, answered those claims were suggested, however no evidence were presented. Chinese virologist Dr. Li-Meng Yan, who had to ran away to the USA suggested that Beijing government whitewashed the corona virus and it was human-made and stated he would prove those claims scientifically. However, he could not present any evidence...But, an analysis titled "Proximal Origin of SARS Cov-2 (Covid-19) was published in Nature Journal on March 17; regarding the genetic sequencing of noval corona virus, it was concluded that DNA sequences providing the attachment of virus to human body had traces of natural selection, hence virus could not be produced in a lab artificially. Furthermore, Takeshi Kasai, Pacific Regional Director of World Health Organization made an explanation stating: "All evidences indicate that*

			Covid-19 was infected via bats in China at the end of the previous year and it was not produced in a lab or manipulated…" TC5.

Chart 6 shows the vast majority of teacher candidates (34,5) cannot refute the counter arguments thoroughly. Even though %31 of teacher candidates had rebuttals, they could not refute some of the strong counter-claims. For instance, it is seen that TC18 of whose counter-claim was include on the chart refuted other counter-claims suggested, but in this example, important counter-claims related to the virus, even though they were presented, could not be refuted. While refuting, it was not mentioned what the official researches were or ratios of resulting in death. %27,6 of teacher candidates did not refute counter-claims. When statements of those teacher candidates are examined, it is seen that they handled the counter-claim emotionally, but did not use data or explanations stated by official or scientific authorities. 2 teacher candidates refuted counter-claims completely.

Conclusion Argument

As a result of examination on concluding the arguments of teacher candidates clearly and explicitly, findings on Chart 7 were reached.

Chart 7. Writer's concluding the argument (n=31)

	f	%	The example of the best representing teacher candidate
There is no conclusion or it is not relevant to the argument (0)	2	6,5	*"…In this situation in which we shape the conditions of our lives based on the virus, it is up to us whether to believe or not to believe in science."* *"…the virus is real and spreading." ÖA27*
There is a poor relation with the argument and it is hard to follow the conclusion. (1)	5	16,1	*"…We have to obey the rules imposed against the virus which has infected and killed so many people in the world. It would be wrong not to care about the pandemic and to think it is a setup, and this would accelerate the spread of the virus, increasing its threat. As long as we continue not to care, we would hurt not only ourselves but all around us." TC18* *"…As I stated above, this virus really exists and hurt many people a lot. People who recovered have permanent damage in their lungs. This disease damaged the economy in the countries which have been through it. It caused social restriction still ongoing. " TC15*
The conclusion is stated clearly, but more than one subject are mentioned or inconvenient and emotional statements are used. (2)	11	35,5	*"…If there are people who do not really believe this situation, they should visit hospitals and see the effects of this disease on people closely so that they can understand its severity. As a result, Covid-19 pandemic is real and since there is no treatment to stop the spread of the virus yet, it continues to cause so many people to die." TC14* *"It should be taken into consideration that Covid-19 pandemic affects psychology of people as well as their health. People who stayed at home, could not go out, was absent of socializing have encountered major psychological breakdowns. The death ratio because of Covid-19 is %3 according to current data. This ratio indicates that the pandemic is not fatal. Since most of the*

			infected people consist of old people, death rate is higher in old ages. Young people are carriers but it does not mean that they do not get infected and die. Hence, if the rules of social distancing and hygiene are cared enough, we can diminish the effects of the pandemic or even end the pandemic." TC16
The conclusion is stated clearly, one subject is mentioned, and emotional and inconvenient subjects are avoided. (3)	13	41,9	*"…Covid-19 is a contagious, fatal disease to which the world was not exposed before. Because of the reason I stated and because it fits the conditions of a pandemic designated by World Health Organization, Covid-19 is a real pandemic." TC6.* *"…Based on all these data, I still support the arguments and think that Covid-19 is real. Not to be infected by that disease is up to us. We shall obey the rules set for us. We should pay attention to using mask and social distancing" TC28*

It is clear in Chart 7 that %41,9 of teacher candidates stated their arguments clearly being free from inconvenient subjects and emotional statements. These teacher candidates explicitly stated that they reached the conclusion argument (they could change the initial arguments of theirs) based on their argumentation. %35,5 of teacher candidates stated the conclusion argument along with emotional statements or they could not manage to focus on the main argument distracting by different subjects. It was possible to see emotional statements in the conclusion argument of TC14. In the conclusion argument of TC16, the main argument was digressed through very different subjects. Furthermore, it was found that 5 teacher candidates established poor relations with the argument in the conclusion, included statements related to the virus rather than the pandemic. 2 teacher candidates did not construct an argument in the conclusion.

Findings related to the evaluation of teacher candidates' opinions on Covid-19 and the vaccine.

In this section, findings related to the question "How are the opinions of science teacher candidates on Covid-19 and the vaccine?" were covered. First, in the framework of teacher candidates' argumentations, their general opinions on Covid-19 were discussed and then findings obtained from their opinions on the vaccine were included.

When the opinions of teacher candidates reaching at the conclusion within the context of their argumentations whether Covid-19 created a real atmosphere of the pandemic were examined, the findings were reached shown on Chart 8.

Chart 8. Opinions of teacher candidates on whether Covid-19 is a real pandemic or not.

Codes	f	Sample answer
It is a real pandemic.	32	"As a result, Covid-19 pandemic is real. There is no chance for a pandemic that shatters the world not to be real. While we can keep track of daily spreading of the disease and there are Covid-positive cases in our close surrounding, we cannot ignore it by turning a blind eye to the suffering end efforts of those people." TC1 *"Eventually, there is a virus which keeps spreading ever day non-stop, and as it can be understood, it is real. One should not believe false and fabricated statements about Covid-19 which causes millions to die, instead precautions must be taken. This must be perceived as soon as possible, and for treatment, vaccination studies must be pursued TC2* *"Covid-19 pandemic is real and it causes serious problems and results that cannot be underestimated. Infected people should isolate themselves and avoid contact with other people." TC31*
It is not a real pandemic.	1	*"The objective of all these pandemic ambiance is so different. For more progress of technological age emerging and presenting itself sharply in recent years, there are purposes that are not realized before our eyes. These purposes may be: to establish new network areas to shape the world, a new economic system, biological chip to be inserted in human body via vaccination, to decrease the world population which increases beyond control and is close to start the global end." TC29*

According to Chart 8, 32 teacher candidates stated that pandemic was real, 1 teacher candidate stated that pandemic was not real. While 31 teacher candidates who thought pandemic was real asserted that pandemic was serious, it must be taken seriously due to all those experienced, otherwise more serious problems might arise. Teacher candidates coded TC11 stated that he/she was not certain about to take the pandemic seriously even though he/she believed its being real: "That's why; we can say that Covid-19 affected the economy but we cannot say too bad or very good." It was evident that a teacher candidate thought Covid-19 was not a real pandemic and countries tried to create an atmosphere like that to fulfill various purposes.

The findings related to the answers of the question "Do you follow the latest news related to the Covid-19 vaccine?" are shown on Chart 9.

Chart 9. Findings related to the fact of teacher candidates' following Covid-19 vaccine.

Codes		f	%	Sample answer
Studies on Covid-19 vaccine are followed.	Yes	23	69,7	"I try to follow the studies since I consider it the only chance to get rid of the virus. I believe that our country also should give a particular importance to vaccination studies." TC5 *"I certainly follow them. Every improvement is crucial." TC14.* *"Yes, I closely follow them." TC30*
	Relatively	6	18,2	*"Not really, but I hope an efficient vaccine shall be invented." TC16.* *"I can say that I follow the studies on Covid-19 vaccine through the news in some measure." TC4* *"I was following more often in the very beginning, but I do not follow that often as I was in the past." TC24*
	Rarely	1	3	"*I rarely follow them. I get to know through the information shared on social media." TC18*
Studies on Covid-19 vaccine are not followed.	No	3	9,1	*"I do not follow because it makes me too anxious since a lot of wrong and right information are mingled." TC17* *"No, I do not follow them." ÖA23*

When Chart 9 is examined, it is clear that most of the teacher candidates, with a ratio of %69,7, followed the vaccination studies whereas %18,2 relatively followed them, and %1 rarely followed them. 3 of teacher candidates (%9,1) stated they did not follow the vaccination studies. While the teacher candidates following the vaccination studies asserted that the vaccine was very important and so studies about it must be followed absolutely, the teacher candidates following relatively or rarely stated they followed through social media or similar news sources. When it comes to the teacher candidates who did not follow the studies on the Covid-19 vaccine, they only mentioned that they did not follow them, only one teacher candidate stated that he/she did not follow because he/she felt anxious because of too much information confusion.

The findings considering the answers of the teacher candidates to the question "Do you consider getting Covid-19 vaccine?" are shown on Chart 10.

Chart 10. Findings on the situation whether teacher candidates consider getting a Covid-19 vaccine

Codes	f	%	Sample answer
He/she does not consider getting a Covid-19 vaccine.	12	36,4	*"I do not consider being vaccinated because there are many side effects of even any pain killers. I believe a medicine to vanish such a strong disease would definitely have lots of side effects." TC3* *"No because in the simplest term I have no idea what is inside the vaccine. How can I be sure that its side effect would not harm me or anyone dearest tome. Moreover, we will develop immunity even though it takes long. Additionally, I do not think this disease will be gone only via vaccine. Whoever invents the vaccine, it is not known whether the vaccine will harm people or not. There is no evidence. While I am even against getting a flu shot, why shall I get a Covid-19 vaccine? I pay attention to my health and have a balanced and sufficient diet and save my immunity. In other words, I think there is no need for a vaccine if I take the precautions. As it is seen on the news, there are professors talking and warning like we should be vaccinated. I do not think they are originally true. For instance, I have an aunt who is a medical doctor; even she says she will not be vaccinated even though she is much acknowledged. TC7* *"No, I do not because I do not have positive thoughts on that the vaccine would work. I think there is a need for minimum 2 or 3 year-studies in today's conditions to develop a beneficial vaccine." TC18*
He/she considers getting a Covid-19 vaccine.	11	33,3	*"Yes, I do. After all, this vaccine was developed through various experiments, and since the solution to this disease is vaccination and I am afraid of taking more risks, at least I want to have the antibody against it in my body even though it is mutated." TC1* *"I consider being vaccinated because I believe the vaccine will immunize people. I think we can prevent coronavirus to spread fast in this way. Furthermore, I have heard of experts claiming that the vaccine will not lose its effect although the virus might mutate. So, I consider getting a Covid-19 vaccine. TC4* *"I consider being vaccinated because I think this virus will not vanish without vaccination. I feel a prejudice against the Chinese vaccine in my surrounding. However, the Chinese vaccine would be presented to us after a phase of examination. Regarding the opinions of our minister of health, I and my family considering being vaccinated." TC14*
Hesitant	7	2 1,2	*"I am hesitant because I think a healthy person can recover from Covid-19 without any problems." TC6* *"I am not sure yet. 3rd phase is said not to be completed yet. I am confused about the complications developed following the vaccine. I think I do not consider being vaccinated for a while. If I am sure of its being safe after a while, I may consider being vaccinated." TC15* *"On one hand, I want to be vaccinated, but I do not on the other hand because I do not know its consequences. What if people become worse because of this vaccine? But I want this virus to vanish, if the vaccine becomes influential, it*

			will go away and finish. I do not know why but I cannot be sure. There is no decent explanation. There may be side effects. So, I am uncertain about it." TC19
Depends on the type of the vaccine	3	9,1	*"I consider being vaccinated unless the vaccine is China-origin. Since there is no other solution for getting rid of the virus, of course I want to be vaccinated. However, since the virus first appeared in China, I personally do not want to contribute China to get a commercial income via the vaccine." TC5* *"Yes, if the vaccine is produced in Turkey and its benefits are proved and of course it has no huge side effects, I may be vaccinated." TC9* *"I consider being vaccinated but I prefer having the domestic one. News on the media is very effective on decisions. I got nervous when a Chinese person said they would not vaccinate Chinese people with the Chinese vaccine. So, I prefer the domestic vaccine." TC28*

Chart 10 indicates that %36,4 of teacher candidates did not want to be vaccinated. They stated the reason was they did not know the content of the vaccine and they thought it might harm their health. The ratio of teacher candidates who considered getting Covid-19 vaccine is %33,3. It is clear on the Chart that teacher candidates who considered getting vaccinated said yes because they did not think the pandemic would be over otherwise. The ratio of teacher candidates who were hesitant about being vaccinated is %21,2. It may be said based on their answers that those teacher candidates were hesitant because they shared the opinions of both sides equally, namely the teacher candidates who considered being vaccinated and those who did not. Some teacher candidates (%9,1) stated that they would have different opinions related to the subject based on the type of the vaccine to be implemented. Even though teacher candidates asserted in their argumentations that Covid-19 was a real pandemic, most of them did not want to be vaccinated.

Discussion and Conclusion

Covid-19 pandemic which has influenced the world since the end of 2019 is on the agenda of the world for a couple years as a current socio-scientific issue. In this study, as a field undertaking to teach socio-scientific issues, science teacher candidates' "argumentation writing skills about Covid-19 pandemic" and "their opinions related to Covid-19 pandemic and vaccination studies" was discussed. Conclusions regarding those two issues examined were covered in this section and discussed.

In this study, the argumentation writing skills of teacher candidates on Covid-19 pandemic were examined within the context of six components. These components were as follows: introduction of argument, writing a claim, presenting evidences, writing counter-claims, rebuttals and construction conclusion argument. It was observed that while writing argumentations, the maximum success achieved by the teacher candidates was in constructing argument, and the lowest success was in writing rebuttals. The first part of the argumentation components was constructing the argument. When the

arguments of teacher candidates were examined, it was seen that most of them introduced the argument sufficiently. It was thought that the efficiency of teacher candidates to introduce their arguments enough might stem from Covid-19 pandemic's being a current and socio-scientific issue. In the studies conducted by Sadler and Zeidler (2005) with university students and Özcan and Balım (2018) with middle school students, it was stated that using socio-scientific issues had positive impacts on constructing an argument. Apart from those studies, Sandoval and Millwood(2005) found out in their study with high school students that students have had difficulties in constructing arguments. The reason of this conflict might be that science teacher candidates have more field experience and are more acknowledged in socio-scientific issues.

When the claim component of the research was examined, it was stated that the claims made by teacher candidates mostly supported the arguments. When the fact that claims did not support the argument completely was examined, it was seen based on the statements of the teachers while presenting their claims that they constructed those claims mostly depending on the news sources, or interpreting what they heard about Covid-19 in their surroundings, and sometimes based on estimations.

The study conducted by Soysal (2012), asserting that individuals tried to implicate their claims indirectly rather than stating them directly was similar to this study in terms of the consequences. Moreover, the study carried by Torun and Açıkgül Fırat (2019), it was remarked that teacher candidates made a mistake of not being able to state or make a clear claim about the claim component. Yet, since Covid-19 has been a current issue, it may be said that the teacher candidates took advantage of excessive amounts of claims mentioned on media every day and so tried to support their arguments.

Establishing a strong relation between claim and argument is important in argumentation process. It is ascertained that most of the teacher candidates in the research did not have difficulty in finding evidences, but some of those evidences made claims stronger as some claims were in need of more evidences. Evidences that can be used in the socio-scientific argumentation can evidences with social, ethical and moral dimensions as well as scientific knowledge (Sadler and Fawler, 2006). Since Covid-19 pandemic is a socio-scientific issue, the fact that most of the teacher candidates had no difficulty in finding evidence can be explained through this interpretation above. However, it is clear that teacher candidates must reinforce their claims by data or experts. It is seen that the teacher candidates using strong evidences to reinforce their claims have included what was mentioned above. So, it can be said that the reasons why most of the teacher candidates could not support their claims or could support them poorly was that they did not include more data. In their study, Maloney and Simon (2006) stated that the skills of using evidences of individuals were connected with their argumentation skills, and that statement corresponded to the results of this study. However, to the contrary of this study, there are other studies which reveal that students had difficulties in finding evidences to support their claims on a particular subject (Evagorou and Osborne, 2013) and they often failed in presenting enough evidences (Sandoval and Millwood, 2005). Those studies coincide with the finding here

indicating that some of the teacher candidates have had difficulties in finding evidences to support their claims. Some teacher candidates failed in writing claims to support their claims, and this was caused by not being capable of making strong claims. When a wrong relation between claim and evidence is established, this may cause individuals to fail in the subject they defend (Torun, 2019). Again, when similar studies were examined, the study by Jimenes-Alexandre, Rodriguez and Duschl (2000) with high school students indicated that only few arguments made by students included data component. Sandoval (2003) found out that high school students generally had difficulties in stating the data explicitly which was used to support their claims. These consequences may be interpreted as the teacher candidates had similar problems in using the evidences even though the study by Çapkınoğlu and Yılmaz (20118) was conducted with different age groups. In the argumentation process, using the components accurately and appropriately is important for the quality of the argumentation constructed. The teacher candidates who could support their arguments with strong claims and establish the relation between the claim and evidence well have completed the process successfully.

When the use of counter-claims and rebuttal components in the study was examined, it was observed that a great number of teacher candidates could not confute counter-claims. Using rebuttals increased the quality of argumentation (Erduran, Simon and Osborne, 2004). However, when the results of other studies just like this study were examined, the study by Topcu, Yılmaz Tüzün and Sadler (2011) with science teacher candidates indicated that only a limited number of counter-claims and rebuttals were used. Freeley and Skinberg (2013) concluded that individuals had failures in using rebuttals during argumentation process and could not produce alternatives to their claims.

In this research, argumentation writing skills of the teacher candidates based on the Argumentation Assessment Rubric (AAR) developed by Cope et al.(2013) were examined and it was seen that most of them stated the conclusion clearly within the context of their arguments, mentioned an issue and did not include emotional or inconvenient statements. These results may be explained by the fact that Covid-19 pandemic is connected with daily life and science teacher candidates have higher field (background) knowledge and expertise in socio-scientific issues. A similar conclusion was mentioned by Demiralp and Çepni (2018) in their studies asserting that field (background) knowledge had a positive impact upon argumentation skill. In addition, Soysal (2012) stated that background knowledge was not influential on socio-scientific argumentations.

When all those components were examined, it was seen that teacher candidates constructed the argument and conclusion argument in the argumentation process, had difficulties in constructing claims, evidences or counter-claims, but yet they managed to achieve them, however they had difficulties in refuting counter-claims. These results can indicate that most of the teacher candidates have good argumentation skills.

When the second title of the research was examined, opinions of the teacher candidates on Covid-19 pandemic and the vaccine were covered. This title was examined in the framework of three

questions. Those questions are as follows: Is Covid-19 a real pandemic?; Do you follow the latest news about Covid-19 vaccine?; Do you consider getting a Covid-19 vaccine? When opinions of the teacher candidates on whether Covid-19 pandemic was real or not, it was seen that 32 teacher candidates believed pandemic was real, 1 teacher did not think it was real. It was observed that among 32 teacher candidates who thought it was a real pandemic, 31 of them took it seriously, but 1 teacher candidate was hesitant about whether it was serious or not even though he/she believed it was a real pandemic. When the answers of the teacher candidates were examined within the context of those conclusions, it was inferred that they knew about Covid-19 pandemic, were aware of its effects and the severity of loss of lives it caused. A similar conclusion was made in the study of Görgülü Arı and Hayır Kanat (2020) with teacher candidates, where Covid-19 was defined as a fatal pandemic and they stated that it was a serious pandemic. It was seen that the teacher candidates participated in the study mentioned above thought pandemic was real because it caused many deaths, showed similar symptoms for everyone, and spread fast. Those opinions coincided with the studies conducted on the symptoms and effects of Covid-19 pandemic (Uğraş Dikmen, Kına, Özkan ve İlhan, 2020). It is clear that a teacher candidate participated in the research did not believe pandemic was real because that teacher candidate thought it was a planned act initiated by powerful countries to change the social order. The study by Budak and Korkmaz (2020) stated that some people believed pandemic was a conspiracy theory, such a situation could not be true in the century we live in; this statement supports the conclusion that there are other individuals sharing the same opinion with that particular teacher candidate.

In fact, a teacher candidate stated that virus was created in a lab. The fact that teacher candidates thought Covid-19 pandemic emerged naturally stems from pandemic's being influential across the world, having similar symptoms in everyone, its fatal consequences and being an infectious disease transmitted from human to human. In the study of Çiftçi and Çoksüer (2020), considering wild animals to be the first source of the infection and defining it as a virus transmitting humans through natural causes bear a resemblance to the conclusion mentioned here. When the answers of those teacher candidates thinking the virus was created in a lab are examined, it is evident that they considered virus to be a distraction of the great powers in the background to achieve their purposes and to destroy the current social order. Görgülü Arı and Hayır Kanat (2020) mentioned in their study that they evaluated information on different accounts regarding the fact that the teacher candidates thought virus did not emerge naturally. Again similarly, there are studies on whether Covid-19 is a biological weapon or not (Dehghani and Masoumi, 2020); however to the contrary of those studies, it was explained through hypotheses that it was unlikely for Covid-19 to be created in a lab (Çiftçi and Çoksüer, 2020).

When the answers of the teacher candidates on whether they followed the improvements related to Covid-19 vaccine were examined, it was found out that there were 23 teacher candidates following the latest news, 6 teacher candidates relatively following them, 1 teacher candidate rarely following and 3 teacher candidates never following. The teacher candidates following the latest news about it stated that

they considered the vaccine to be the only way of being free from the virus and so they followed every single improvements or news about it closely. Likewise, Erkekoğlu, Erdemli Köse, Balcı and Yirün (2020) asserted in their studies that producing Covid-19 vaccine would be the only way to be saved from the pandemic. Similarly, the study of Okyay (2021) advocated the most influential way to prevent contagious diseases was the vaccine. The fact that WHO described the target of vaccination as the protection general state of health by preventing from death, disability, severe illness, and diseases supported the conclusion above. Depending on those results, it may be inferred that society is generally sensitive to the pandemic in terms of protection (Bostan, Erdem, Öztürk, Kılıç and Yılmaz, 2020). It is clear that teacher candidates either followed or never followed the improvements related to the vaccine because they were not sure of the accuracy of the news or hesitant about it. Some teacher candidates stopped following the improvements later. Why three teacher candidates did not follow the improvements related to the vaccine was because of their anxiety, not being sure of the accuracy of the news they heard on media. Likewise, Mora (2008) asserted that media had a great impact upon influencing and directing every aspect of human lives. In the Reuters Report, it was mentioned that the way how news were broadcasted effects unreliability of media. During SARS virus spreading in 2003, trying to reach the news via media was similar to trying to acquire information on Covid-19 virus via media today.

When the answers of the teacher candidates raised the question “Do you consider getting Covid-19 vaccine?” were examined, it was seen that there were 11 teacher candidates who considered getting the vaccine, 7 teacher candidates who were hesitant, 3 teacher candidates who considered getting the vaccine based on the origin/type of the vaccine and 12 teacher candidates who did not consider getting the vaccine at all. The teacher candidates who considered getting the vaccine said that the spreading of the virus could be prevented by that way and the vaccine was necessary in order to be freed from the virus and be immunized. Among those teacher candidates, when the hesitant ones were examined, it was found out that they would decide based on the reasons such as the side effects of the vaccine, complications that may be developed following the vaccine, commercial earning the vaccine would provide to countries and the country that would manufacture the vaccine. Even though the same teacher candidates thought pandemic was real and serious, they did not consider getting vaccinated. This conclusion is noteworthy since those two results conflict with each other and science teacher candidates are expected to approach such incidents scientifically. When literature was examined, all the studies conducted so far have indicated that vaccination was the most influential and safe way to protect public health. Memiş Doğan and Düzel (2020) stated in their study that the virus posed a risk by the aspect of being contagious and fatal, so participants considered the vaccine a savior and the ratio of those who approached the vaccine positively was higher than those who were against the vaccine. Again the same study asserted that since Covid-19 was a novel type and what was known about it was limited, it caused uncertainty for participants. When the opinions of the anti-vaxxer teacher candidates were examined in the research, the reasons were as follows: they did not know the side effects of the vaccine or its content.

Implementing the vaccine before the appearance of the disease, suspicions related to the profit-oriented activities of big pharmaceutical firms were also the reasons for being anti-vaxxers (Memiş Doğan and Düzel, 2020). Again similarly, not trusting the content of the vaccine, being under the influence of anti-vaxxers' explanations, religious motives and news on the media were among the reasons of anti-vaccine movements (Erkekoğlu, Erdemli Köse, Balcı and Yirün, 2020). To the contrary of the study in question, Sarı, Temoçin and Köse (2017) mentioned in their studies with healthcare professionals that the ratio of anti-vaxxers was higher than those who believed the necessity of the vaccine. However, this study was conducted in 2017. It is thought that there may be differences between the vaccines implemented during the natural process and the process of the pandemic in terms of necessity and attitudes of people. Moreover, it can be said that prejudices of the teacher candidates and their concerns about something unknown or new played an effective role on decision-making processes. Apart from this, a student explained the reason of not being vaccinated scientifically by mentioning normally vaccination test periods lasted 2 or 3 years. However, there is a process here advancing fast and on which technology has a remarkable impact, it may be said that the nature of scientific developments is missed.

This study was limited to the opinions of the teacher candidates about the Covid-19 pandemic and the Covid-19 vaccine as a socio-scientific issue. When all of those results were examined, the significance of socio-scientific issues particularly in science teaching was found out. It is a fact that science teacher candidates are in a central position to increase this skill, since decision-making skills of the society on scientific issues concerning the society are largely provided by science education. The following situations had a positive impact on argumentation writing skills: The teacher candidates in the research were highly knowledgeable, Covid-19 was an issue on the agenda and socio-scientific issues were included in science teaching program. However, teacher candidates still have concerns about how to approach Covid-19 pandemic. Furthermore, the fact that most of the teacher candidates had different points of view related to the vaccine, even though they thought the pandemic was real, must be examined thoroughly.

Suggestions

- As a socio-scientific issue of the Covid-19 pandemic period, environments providing opportunities to find solutions for these and similar problems should be created both during the undergraduate education and with in-service training programs for teacher candidates and teachers.
- The inclusion of implementations related to teaching socio-scientific issues by argumentation method in undergraduate education of teacher candidates should be increased.
- The argumentation skills of teacher candidates on different socio- scientific issues should also be evaluated.
- The vaccine is produced with mRNA technology, which is a new technology. Detailed opinions of science teacher candidates should be sought on vaccines produced with new technologies.

- In this study, argumentation skills were evaluated with Cope et al.'s (2018) measurement tool. The measurement tool can be differentiated by considering that other tools which measure argumentation skills will also consider argumentation skills from different perspectives.

Policy Implications

Rapid and striking developments in the age of technology we live in, the obligations they impose, and epidemics that deeply affect human life bring different educational environments and training programs to the agenda. Educational programs also focus on some skills of students so that they can succeed in a rapidly changing, digital society. Many of those skills are associated with critical thinking and problem solving. Using those skills, individuals can analyze a new situation, a problem, express their thoughts, and produce solutions. The most important task in gaining the mentioned skills belongs to educational institutions and educators. Different opinions have been put forward about the Covid-19 pandemic, which is the subject of this study, regarding the cause of its emergence and prevention and treatment process. At this point, the fact that the teacher candidates discussed their views on the Covid-19 pandemic via the method of argumentation indicates the authenticity of this study. Due to this research, it is thought that individuals will realize the importance of using the argumentation method in education and they will be able to examine problems from different perspectives. In this context, it is thought that this research is influential in terms of closing the gap in the above-mentioned subject and guiding future studies, as well as providing diversity in the literature.

Conflict of Interest

No potential conflict of interest was declared by the authors.

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Ethical Statement

We declare that we act in accordance with scientific ethical principles and rules in the preparation of the study, collection of data, analysis, presentation of information and all stages, that we do not make any changes in the data used, that we fully refer to all sources used in the study, and that we comply with all our ethical duties and responsibilities. We undertake and declare that we will assume all legal responsibilities if a situation contrary to this statement we have made regarding the study is detected.

Credit Author Statement

Author 1: Research, Conceptualization, Data analysis, review, Writing – editing and drafting

Author 2: Data collection, Data analysis, Formal Analysis, Methodology, Writing - Review and Editing, Supervision, Project Administration,

Author 3: Research, Data analysis, Review, Writing-Editing

References

Abdillah, H., Setyosari, P., Lasan, B., & Muslihati, M. (2020). The acceptance of school counselor in the use of ICT during school from home in the Covid-19 era. *Journal for the Education of Gifted Young Scientists*, *8*(4), 1569-1582. https://doi.org/10.17478/jegys.804939

Aktan Acar, E., Erbaş, Y. H., & Eryaman, M. Y. (2021). Okul öncesi öğretmenlerinin Covid-19 pandemi sürecinde uzaktan eğitime ilişkin görüşlerinin incelenmesi. *Açıköğretim Uygulamaları Ve Araştırmaları Dergisi, 7*(4), 31-54. https://doi.org/10.51948/auad.979726

Allchin, D., & Zemplén, G.Á. (2020). Finding the place of argumentation in science education: Epistemics and whole science. *Science Education*, *104*(5), 907-933. https://doi.org/10.1002/sce.21589

Alred, A. R., & Dauer, J. M. (2020). Understanding factors related to undergraduate student decision-making about a complex socio-scientific issue: Mountain Lion Management. *EURASIA Journal of Mathematics, Science and Technology Education*, *16*(2), 1-21. https://doi.org/10.29333/ejmste/113757

Anwar, N. P., & Ali, M. A. (2020). The effect of socio-scientific issue (SSI) based discussion: A student-centred approach to the teaching of argumentation. *SOTL in the South*, *4*(2), 35-62. https://doi.org/10.36615/sotls.v4i2.76

Arık, M., & Akçay, B. (2018). An effectiveness of engaging in argumentation on students' ability to demarcate science from pseudoscience. *Sakarya University Journal of Education*, *8*(1), 41-60. https://doi.org/10.19126/suje.338919

Arslan, A., & Atabey, N. (2018). Biyoteknoloji ve klonlama konusunun işbirlikli öğrenme modeli ile öğretiminin sınıf öğretmeni adaylarının argümantasyon nitelikleri üzerine etkisi. *Anemon Muş Alparslan Üniversitesi, Sosyal Bilimler Dergisi*, *6*(18), 35-45. https://doi.org/10.18506/anemon.464820

Atabey, N., Topçu, M., & Çiftçi, A. (2020). Adaptation of the scale of the factors affecting argumentation instruction into Turkish. *Journal of Theoretical Educational Science, 13*(2), 352-368. https://doi.org/10.30831/akukeg.582454

Atabey, N., Topçu, M.S., & Çiftçi, A. (2018). Sosyobilimsel konu senaryolarının incelenmesi: bir içerik analizi çalışması. *OPUS Uluslararası Toplum Araştırmaları Dergisi*, *9*(16), 1968-1991. https://doi.org/10.26466/opus.474224

Atasoy, Ş. (2018). Öğretmen adaylarının yaşam alanlarına göre yerel sosyobilimsel konularla ilgili informal muhakemeleri. *Fen Bilimleri Öğretimi Dergisi, 6*(1), 60-72.

Aydın, E., & Kılıç Mocan, D. (2019). Türkiye'de dünden bugüne sosyobilimsel konular: Bir doküman analizi. *Anadolu Öğretmen Dergisi, 3*(2), 184-197. https://doi.org/10.35346/aod.638332

Ayvacı, H.Ş., Bülbül, S., & Türker, K. (2019). Fen bilgisi öğretmen adaylarının sosyobilimsel konular hakkındaki tutumlarının sınıf düzeyine göre incelenmesi. *Ondokuz Mayıs Üniversitesi Eğitim Fakültesi Dergisi, 38*(2), 17-30. https://doi.org/10.7822/omuefd.525453.

Bahruddin, U., & Ramadhanti Febriani, S. (2020). Student's perceptions of Arabic online learning during Covid-19 emergency. *Journal for the Education of Gifted Young Scientists, 8*(4), 1483-1492. https://doi.org/10.17478/jegys.763705

Balcı, E., & Benzer, S. (2020). Lisansüstü öğrencilerin argümantasyon konusundaki görüşleri. *Online Science Education Journal, 5*(1), 9-20.

Bilir, V., Tatlı, A., Yıldız, C., Emiroğlu, B., Ertuğrul, D., & Sakmen, G. (2020). Argümantasyon tabanlı öğrenme yaklaşımında kullanılan argümantasyon tekniklerinin ortaokul sekizinci sınıf öğrencilerinin bilim insanı imajları üzerine etkisi. *Gazi Üniversitesi Gazi Eğitim Fakültesi Dergisi, 40*(2), 481-510.

Boğar, Y. (2019). Synthesis study on argumentation in science education. *International Education Studies, 12*(9), 1-14. https://doi.org/10.5539/ies.v12n9p1

Bostan, S., Erdem, R., Öztürk, Y. E., Kılıç, T., & Yılmaz, A. The Effect of Covid-19 pandemic on the Turkish society. *Electron J Gen Med., 17*(6), em237. https://doi.org/10.29333/ejgm/7944

Bowell, T., & Kemp, G. (2018). *Eleştirel düşünme kılavuzu*. TÜBİTAK Popüler Bilim Kitapları.

Bozkurt, A. (2020). Koronavirüs (Covid-19) pandemi süreci ve pandemi sonrası dünyada eğitime yönelik değerlendirmeler: Yeni normal ve yeni eğitim paradigması. *Açıköğretim Uygulamaları ve Araştırmaları Dergisi, 6*(3), 112-142.

Budak, F., & Korkmaz, Ş. (2020). Covid-19 pandemi sürecine yönelik genel bir değerlendirme: Türkiye örneği. *Sosyal Araştırmalar ve Yönetim Dergisi*, (1), 62-79. https://doi.org/10.35375/sayod.738657

Ceyhan, G. D., Muğaloğlu, E. Z., & Tillotson, J. W. (2019). Sosyo-bilimsel konuların kanıta dayalı düşünme uygulamaları ile öğretilmesi: Öğretim iskelesi kullanmanın uygunluğu, yararları ve zorlukları. *Elementary Education Online*, 18(4), 1405-1417. https://doi.org/ 10.17051/ilkonline.2019.630305

Christensen, L. B., Johnson R. B., & Turner, L. A. (2020). *Araştırma Yöntemleri: Desen ve Analiz*. Pearson Education Ins.

Cope, B., Kalantzis, M., Abd-El-Khalick, F., & Bagley, E. (2013). Science in writing: Learning scientific argument in principle and practice. *E-Learning and Digital Media, 10*(4), 420-441. https://doi.org/10.2304/elea.2013.10.4.420

Çakan Akkaş, B., & Kabataş Memiş, E. (2020). Argümantasyon uygulamalarının 5. sınıf öğrencilerinin madde ve değişim ünitesi başarılarına ve bireysel değişimlerine yansıması. *Kastamonu Eğitim Dergisi, 28*(3), 1407-1417. https://doi.org/10.24106/kefdergi.4043

Çakın, M., & Külekçi Akyavuz, E. (2020). Covid-19 süreci ve eğitime yansıması: Öğretmen görüşlerinin incelenmesi. *International Journal of Social Sciences and Education Research, 6*(2), 165-186. https://doi.org/10.24289/ijsser.747901

Çalışkan, T., & Kapucu, S. (2021). Astronomi konusunda argümantasyon tabanlı bilim öğrenme yaklaşımının öğrencilerin fen öğrenme anlayışlarına ve fen öğrenme yaklaşımlarına etkisi. *Yüzüncü Yıl Üniversitesi Eğitim Fakültesi Dergisi, 18*(1), 316-353. https://doi.org/10.33711/yyuefd.863217

Çapkınoğlu, E., & Yılmaz, S. (2018). Yedinci sınıf öğrencilerinin yerel sosyobilimsel konulardaki argümanlarında kullandıkları veri bileşeninin incelenmesi. *Eğitim ve Bilim, 43*(196), 125-149. http://dx.doi.org/10.15390/EB.2018.7205

Çiftçi, E., & Çoksüer, F. (2020). Yeni koronavirüs infeksiyonu: Covid-19. *Flora İnfeksiyon Hastalıkları ve Klinik Mikrobiyoloji Dergisi, 25*(1), 9-18. https://doi.org/10.5578/flora.202002

Çorbacı, N., & Yakışan, M. (2018). Fen bilimleri dersi duyu organları konusu ile ilgili 7. sınıf öğrencilerinin geliştirdikleri argümanların analizi. *Ondokuz Mayıs Üniversitesi Eğitim Fakültesi Dergisi, 37*(1), 249-263. https://doi.org/10.7822/omuefd.408922

Dawson, V. M., & Venville, G. (2010). Teaching strategies for developing students' argumentation skills about socioscientific ıssues in high school genetics. *Research in Science Education, 40*(2), 133-148. https://doi.org/10.1007/s11165-008-9104-y

Dehghani, A., & Masoumi, G. (2020). Could Sars-Cov-2 or Covıd-19 be a biological weapon? *Iran Jornal of Public Health, 49*(1), 143-144. https://doi.org/10.18502/ijph.v49iS1.3691

Demir, T., & Gönen, S. (2019). Argümantasyona dayalı öğretimin 7.sınıf öğrencilerinin kuvvet, iş ve enerji ilişkisini anlamalarına etkisi. *Electronic Journal of Education Sciences, 8*(15), 23-38.

Demiral, Ü., & Çepni, S. (2018). Fen bilgisi öğretmen adaylarının sosyobilimsel bir konudaki argümantasyon becerilerinin incelenmesi. *Ahi Evran Üniversitesi Kırşehir Eğitim Fakültesi Dergisi (KEFAD)*, *19*(1), 734-760.

Demircioğlu, T., & Uçar, S. (2014). Akkuyu nükleer santrali konusunda üretilen yazılı argümanların incelenmesi. *İlköğretim Online*, 13(4), 1373-1386. https://doi.org/10.17051/io.2014.31390

Er, A. G., & Ünal, S. (2020). Dünyada ve Türkiye'de 2019 koronavirüs pandemisi. *Flora dergisi*, *25*(1), 1-8. https://doi.org/10.5578/flora.202001

Er, S., & Kirindi, T. (2020). Argümantasyon tabanlı fen öğretiminin öğrencilerin bilimsel süreç becerileri ve akademik başarılarına etkisi. *Gazi Eğitim Bilimleri Dergisi*, *6*(3), 317-343. https://doi.org/10.30855/gjes.2020.06.03.004

Erbaş, Y. H. (2021). Covid-19 salgını döneminde eğitim: İlkokuma yazma öğretiminde karşılaşılan sorunlar ve çözüm önerileri. *Ana Dili Eğitimi Dergisi, 9*(2), 360-380.

Erduran, S. (2007). Methodological foundations in the study of argumentation in science classrooms. S. Erduran ve P. Jimenez-Aleixandre (Eds.), in *Argumentation in Science Education* (s.47-70). Springer.

Erduran, S., Özdem, Y., & Park, J. Y. (2015). Research trends on argumentation in science education: A journal content analysis from 1998–2014. *International Journal of STEM Education*, *2*(5), https://doi.org/10.1186/s40594-015-0020-1

Erduran, S., Simon, S., & Osborne, J. (2004). TAPping into argumentation: Developments in the application of Toulmin's Argument Pattern for studying science discourse. *Science Education, 88,* 915-933. https://doi.org/10.1002/sce.20012

Erkekoğlu, P., Erdemli Köse, S. B., Balcı, A., & Yirün, A. (2020). Aşı kararsızlığı ve Covid-19'un etkileri. *Eczacılık Bilimleri Dergisi*, *9*(2), 208-220. https://doi.org/10.5336/pharmsci.2020-76102

Erkol, M., & Gül, Ş. (2020). Fen bilgisi öğretmen adaylarının sosyobilimsel konulara yönelik tutumları. *Pesa International Journal of Social Studies*, *6*(1), 9-21. https://doi.org/10.25272/j.2149-8385.2020.6.1.02

Eroğlu, E., & Yıldırım, H. (2020). Argümantasyon tabanlı öğrenme yaklaşımının ortaokul 6. sınıf öğrencilerinin çevreye yönelik tutum, davranış ve başarılarına etkisi. *Gazi Eğitim Bilimleri Dergisi*, *6*(1), 42-68. https://doi.org/10.30855/gjes.2020.06.01.003

Eş, H., & Varol, V. (2019). Fen bilgisi öğretmenliği ve ilahiyat öğrencilerinin nükleer santral sosyo-bilimsel konusuyla ilgili informal argümanları. *Mersin Üniversitesi Eğitim Fakültesi Dergisi*, *15*(2), 437-454. https://doi.org/10.17860/mersinefd.533013

Evagorou, M., & Osborne, J. (2013). Exploring young students' collaborative argumentation within a socioscientific issue. *Journal of Research in Science Teaching*, 50(2), 209-237. https://doi.org/10.1002/tea.21076

Evren Yapıcıoğlu, A., & Kaptan, F. (2018). Sosyobilimsel durum temelli öğretim yaklaşımının argümantasyon becerilerinin gelişimine katkısı: Bir karma yöntem araştırması. *OMÜ Eğitim Fakültesi Dergisi*, *37*(1), 39-61. https://doi.org/10.7822/omuefd.278052

Freeley, A. J., & Steinberg, D. L. (2013). *Argumentation and debate, critical thinking for reasoned decision making*. Cengage Learning.

Genç, M., & Genç, T. (2017). Türkiye'de sosyo-bilimsel konular üzerine yapılmış araştırmaların içerik analizi. *e-Kafkas Journal of Educational Research*, *4*(2), 27-42. https://doi.org/10.30900/kafkasegt.291772

Genç, S., Engin, G., & Yardım, T. (2020). Pandemi (Covid-19) sürecindeki uzaktan eğitim uygulamalarına ilişkin lisansüstü öğrenci görüşleri. *Atatürk Üniversitesi Kazım Karabekir Eğitim Fakültesi Dergisi*, (41), 134-158. https://doi.org/10.33418/ataunikkefd.782142

Görgülü Arı, A., & Hayır Kanat, M. (2020). Covid-19 (Koronavirüs) üzerine öğretmen adaylarının görüşleri. *Yüzüncü Yıl Üniversitesi Sosyal Bilimler Enstitüsü Dergisi Salgın, Hastalıklar Özel Sayısı*, 459-492.

Gürbüzkol, R., & Bakırcı, H. (2020). Fen bilimleri öğretmenlerinin sosyobilimsel konular hakkındaki tutum ve görüşlerinin belirlenmesi. *YYÜ Eğitim Fakültesi Dergisi*, *17*(1), 870-893. https://doi.org/10.33711/yyuefd.751857

Hadjichambis, A., Georgiou, Y., Hadjichambi, D. P., Kyza, E.A., Agesilaou, A., & Mappouras, D. (2019). Promoting RRI and active citizenship in an inquiry-based controversial socio-scientific issue: the case of cholesterol regulation with statins, *Journal of Biological Education*, *53*(5), 548-560. https://doi.org/10.1080/00219266.2018.1530277

Hafızoğlu, A., & Bahar, M. (2020). Türkiye'de 2009-2019 yılları arasında yayımlanan ilkokul ve ortaokul düzeyinde fen eğitiminde argümantasyon konulu lisansüstü tezlerin değerlendirilmesi. *Ihlara Eğitim Araştırmaları Dergisi*, *5*(1), 155-175.

Han Tosunoğlu, Ç., & İrez, S. (2017). Biyoloji öğretmenlerinin sosyobilimsel konularla ile ilgili anlayışları. *Uludağ Üniversitesi Eğitim Fakültesi Dergisi*, *30*(2), 833-860.

Haşıloğlu, M., Durak, S., & Arslan, A. (2020). Covid-19 uzaktan eğitim sürecinde fen bilimleri şube rehber öğretmenlerinin gözünden öğretmen, öğrenci ve velilerin değerlendirilmesi. *Uluslararası Eğitim Bilim ve Teknoloji Dergisi*, *6*(3), 214-239. https://doi.org/10.47714/uebt.811306

Hoisington, C. (2020). A Scientific age. *Educational Leadership*, *78*(3), 59-64.

İnam, A., & Güven, S. (2019). Argümantasyon yönteminin kullanıldığı deneysel çalışmaların analizi: Bir meta-sentez çalışması. The *Journal of International Lingual Social and Educational Sciences*, *5*(1), 155-173. https://doi.org/10.34137/jilses.584642

Jafari, M., & Meisert, A. (2019). Activating students' argumentative resources on socioscientific issues by indirectly instructed reasoning and negotiation processes. *Research in Science Education*, *51*, 913–934. https://doi.org/10.1007/s11165-019-09869-x

Maloney, J., & Simon, S. (2006). Mapping children's discussions of evidence in science to assess collaboration and argumentation, *International Journal of Science Education*, *28*(15), 1817-1841. https://doi.org/10.1080/09500690600855419

Jiménez-Aleixandre, M. P., Bugallo Rodriguez, A., & Duschl, R. A. (2000). "Doing the lesson" or "Doing science": Argument in high school genetics. *Science Education*, *84*(6), 757-792. https://doi.org/10.1002/1098-237X(200011)84:6<757::AID-SCE5>3.0.CO;2-F

Jimenez-Aleixandre, P., & Erduran, S. (2007). Argumentation in science education: An overview. S. Erduran, P. Jimenez-Aleixandre (eds.). in *Argumentation in Science Education* (s.3-28). Springer.

Kara, S., Yılmaz, S., & Kıngır, S. (2020). Argümantasyon tabanlı bilim öğrenme yaklaşımının ilkokul öğrencilerinin akademik başarılarına ve argümantasyon kalite düzeylerine etkisi. *Kastamonu Eğitim Dergisi*, *28*(3), 1253-1267. https://doi.org/10.24106/kefdergi.3785

Karahan, E., & Roehrig, G. H. (2019). Case studies of science teachers designing socioscientific issues based instruction. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi*, *34*(1), 71-89. https://doi.org/10.16986/HUJE.2018044772

Karakaş, H., & Sarıkaya, R. (2020). Çevre-Enerji konularına yönelik gerçekleştirilen argümantasyon temelli öğretimin sınıf öğretmeni adaylarının argüman oluşturabilmelerine etkisi. *Pamukkale Üniversitesi Eğitim Fakültesi Dergisi*, *48*, 346-373. https://doi.org/10.9779/pauefd.524850

Karakaş, H. (2020). Presentation of socio-scientific issues to students by using argumentation process. *Avrasya Uluslararası Araştırmalar Dergisi*, *8*(23), 409-427. https://doi.org/10.33692/avrasyad.794827

Karakaya, F., Adıgüzel, M., Üçüncü, G., Çimen, O., & Yılmaz, M. (2021). Teachers' views towards the effects of Covid-19 pandemic in the education process in Turkey. *Participatory Educational Research, 8*(2), 17-30. https://doi.org/10.17275/per.21.27.8.2

Kuhn, D. (2018). A role for reasoning in a dialogic approach to critical thinking. *Topoi, 37*, 121–128. https://doi.org/10.1007/s11245-016-9373-4

Kutluca, A. Y., Çetin, P. S., & Akbaş, M. (2020). An examination of the evidences used by the secondary school students in the process of socio-scientific argumentation: Global climate change sample. *Bartın University Journal of Faculty of Education, 9*(1), 36-48. https://doi.org/10.14686/buefad.617933

Kutluca, A.Y., & Aydın, A. (2017). Fen bilimleri öğretmen adaylarının sosyobilimsel argümantasyon kalitelerinin incelenmesi: Konu bağlamının etkisi. *Necatibey Eğitim Fakültesi Elektronik Fen ve Matematik Eğitimi Dergisi (EFMED), 11*(1), 458-480. https://doi.org/10.17522/balikesirnef.356575

Lazarou, D., Sutherland, R., & Erduran, S. (2016). Argumentation in science education as a systemic activity: An activity-theoretical perspective. *International Journal of Educational Research, 79*, 150–166. https://doi.org/10.1016/j.ijer.2016.07.008

MEB (2018). Fen Bilimleri Dersi Öğretim Programı (İlkokul ve Ortaokul 3, 4, 5, 6, 7 ve 8. Sınıflar). Ankara.

Memiş Doğan, M., & Düzel, B. (2020). Covid-19 özelinde korku-kaygı düzeyleri. *Turkish Studies, 15*(4), 739-752. https://dx.doi.org/10.7827/TurkishStudies.44678

Memiş, E. (2017). Türkiye'de argümantasyon konusunda gerçekleştirilen tezlerin analizi: Bir meta-sentez çalışması. *Cumhuriyet Uluslararası Eğitim Dergisi, 6*(1), 47-65. https://doi.org/10.30703/cije.321436

Miles, M. B., & Huberman, A. M. (2015). Nitel veri analizi (Çev. Eds. S. Akbaba Altun & A. Ersoy). Pegem Akademi.

Mora, N. (2008). Medya ve kültürel kimlik. *Uluslararası İnsan Bilimleri Dergisi, 5*(1). Erişim: http://www.insanbilimleri.com

Morens, D. M., Folkers, G. K., & Fauci, A. S. (2009). What is a pandemic? *The Journal of Infectious Diseases, 200*(7), 1018-1021. https://doi.org/10.1086/644537

Okumuş, S. (2020). Argümantasyon destekli işbirlikli öğrenme modelinin akademik başarıya, eleştirel düşünme eğilimine ve sosyobilimsel konulara yönelik tutuma etkisi. *OMÜ Eğitim Fakültesi Dergisi*, *39*(2), 269-293. https://doi.org/10.7822/omuefd.570419

Okyay, P. (2021). Covid-19 pandemisinin mevcut durumu ve gelecek öngörüleri. *Sağlık Bilimlerinde İleri Araştırmalar Dergisi*, *4*, 97-103. https://doi.org/10.26650/JARHS2021-986141

Özcan, C., & Kaptan, F. (2020). 2008-2017 yılları arasında sosyobilimsel konulara ilişkin yapılan çalışmaların incelenmesi. *Muallim Rıfat Eğitim Fakültesi Dergisi*, *2*(1), 16-36.

Özcan, E., & Balım, A. G. (2018). Sosyo-bilimsel argümantasyon yönteminin fen bilimleri dersinde kullanımına ilişkin bir etkinlik örneği. *Fen, Matematik, Girişimcilik ve Teknoloji Eğitimi Dergisi*, *1*(1), 48-65.

Özcan, R., Aktamış, H., & Hiğde, E. (2018). Fen bilimleri derslerinde kullanılan argümantasyon düzeyinin belirlenmesi. *Pamukkale Üniversitesi Eğitim Fakültesi Dergisi*, *43*(43), 93-106. https://dx.doi.org/10.9779/PUJE800

Özden, M. (2020). Elementary school students' informal reasoning and its' quality regarding socio-scientific issues. *Eurasian Journal of Educational Research*, *86*, 61-84. https://doi.org/10.14689/ejer.2020.86.4

Öztürk, A., & Doğanay, A. (2019). Development of argumentation skills through socioscientific issues in science course: A collaborative action research. *Turkish Online Journal of Qualitative Inquiry*, *10*(1), 52-89. https://doi.org/10.17569/tojqi.453426

Sadler, T. D., & Fowler, S. R. (2006). A threshold model of content knowledge transfer for socioscientific argumentation. *Science Education*, *90*, 986-1004. https://doi.org/10.1002/sce.20165

Sadler, T. D., & Zeidler, D. L. (2005). Patterns of informal reasoning in the context of socioscientific decision making. *Journal of Research in Science Teaching*, *42*, 112-138. http://dx.doi.org/10.1002/tea.20042

Sadler, T.D., Foulk, J.A, & Friedrichsen, P.J. (2017). Evolution of a model for socioscientific issue teaching and learning. *International Journal of Education in Mathematics, Science and Technology*, *5*(2), 75-87. https://doi.org/10.18404/ijemst.55999

Sadler, T.M. (2004). Informal reasoning regarding socioscientific issues: A critical review of research. *Journal of Research in Science Teaching*, *41*(5), 513–536. https://doi.org/10.1002/tea.20009

Sarı T., Temoçin F., & Köse, H. (2017). Sağlık Çalışanlarının influenza aşısına yaklaşımları. *Klinik Dergisi, 30*(2), 59–63. https://doi.org/10.5152/kd.2017.15

Seçkin Kapucu, M., & Türk, H. (2019). Güncel bilimsel haberlerin Toulmin argüman modeline göre incelenmesi ve öğrencilerin argüman düzeylerinin belirlenmesi. *Eğitimde Nitel Araştırmalar Dergisi*, *7*(3), 1119-1144. doi:10.14689/issn.2148-624.1.7c.3s.10m

Sibic, O., & Topcu, M.S. (2020). Pre-service science teachers' views towards socio-scientific issues and socio-scientific issue-based instruction. *Journal of Education in Science, Environment and Health (JESEH), 6*(4), 268-281. https://doi.org/10.21891/jeseh.749847

Simonneaux, L. (2007). Argumentation in socio-scientific contexts. S. Erduran ve P. Jimenez-Aleixandre (eds.), in *Argumentation in science education* (s.179-199). Springer.

Soysal, Y. (2012). *Sosyobilimsel argümantasyon kalitesine alan bilgisi düzeyinin etkisi: Genetiği değiştirilmiş organizmalar*. Master thesis, Abant İzzet Baysal Üniversitesi.

Sutter, A.M., Dauer, J.M., Kreuziger, T., Schubert, J., & Forbes, C.T. (2019). Sixth grade students' problematization of and decisionmaking about a wind energy socio-scientific issue. *International Research in Geographical and Environmental Education*, *28*(3), 242–256. https://doi.org/10.1080/10382046.2019.1613586

Şensin, C., & Rubat Du Mérac, E. (2020). A good scare is worth more than good advice: Educational regulations in Italy and Turkey after CoVid-19. *International Journal of Social Sciences and Education Research, 6*(3), 429-442. https://doi.org/10.24289/ijsser.785757

Tatar, Ş., & Adıgüzel, O. C. (2019). Türkiye'de tartışmalı ve sosyobilimsel konular üzerine yazılan lisansüstü tezlerin eğitim bilimleri perspektifinden incelenmesi. *Eskişehir Osmangazi Üniversitesi Sosyal Bilimler Dergisi*, *20*(Özel sayı), 35-325. https://doi.org/10.17494/ogusbd.548368

Tekin, N., & Aslan, O. (2019). Öğretmen adaylarının sosyobilimsel konulara yönelik tutumlarının çeşitli değişkenler bakımından incelenmesi. *Fırat Üniversitesi Sosyal Bilimler Dergisi*, *29*(1), 133-141. https://doi.org/10.18069/firatsbed.538660

Tezel, Ö., & Günister, B. (2018). Sosyobilimsel konu temelli fen öğretimi üzerine Türkiye'de yapılan çalışmalardan bir derleme. *Eskişehir Osmangazi Üniversitesi Türk Dünyası Uygulama ve Araştırma Merkezi (ESTÜDAM) Eğitim Dergisi*, *3*(1), 42-60.

Topçu, M., & Atabey, N. (2017). The effect of socioscientific issues based field trips on elementary school students' argumentation quality. *Bartın University Journal of Faculty of Education*, *6*(1), 68-84. https://doi.org/10.14686/buefad.263541

Topçu, M. S., Yılmaz-Tüzün, Ö., & Sadler, T. D. (2011). Turkish preservice science teachers' informal reasoning regarding socioscientific issues and the factors influencing their informal reasoning. *Journal of Science Teacher Education, 22*(4), 313-332. https://doi.org/10.1007/s10972-010-9221-0

Topçu, M.S. (2010). Development of attitudes towards socioscientific issues scale for undergraduate students. *Evaluation & Research in Education, 23*(1), 51-67. http://dx.doi.org/10.1080/09500791003628187

Torun, F., & Açıkgül Fırat, E. (2020). Öğretmen adaylarının argümantasyon düzeylerinin ve argüman oluşturma sürecinde yaptıkları hataların belirlenmesi. *Fırat Üniversitesi Sosyal Bilimler Dergisi, 30*(1), 119-135. https://doi.org/10.18069/firatsbed.644631

Torun, F. (2019). Argümantasyon yöntemi ile kanıt kullanma becerisinin geliştirilmesi. Y. Kabapınar (Ed.), *Kimlik belirleyen derslerde kanıt temelli öğrenme* (s. 241-258). Pegem Akademi.

Toulmin, S. E. (2003). *The uses of argument: Updated edition*. Cambridge University Press.

Türköz, G., & Öztürk, N. (2020). Fen bilgisi öğretmen adaylarının bazı sosyo-bilimsel konularla ilgili kararlarının çok boyutlu bakış açısı ile incelenmesi. *Cumhuriyet Uluslararası Eğitim Dergisi, 9*(1), 175-197. http://dx.doi.org/10.30703/cije.550533

Tüzün, Ü. N., & Köseoğlu, F. (2018). Bilim eğitiminde düşünce deneyleri temelli online argümantasyonla lise öğrencilerinin eleştirel düşünme becerilerinin geliştirilmesi. *JOTCSC, 3*(2), 77-98.

Uğraş Dikmen A., Kına M., Özkan S., & İlhan M. N. (2020). Covid-19 epidemiyolojisi: Pandemiden ne öğrendik? *J Biotechinol & Strategic Health Res., 4*, 29-36. https://doi.org/10.34084/bshr.715153

Uluçınar Sağır, Ş., Soylu, Ü., & Bolat, A. (2021). 7. Sınıf öğrencilerinin kuvvet ve enerji ünitesindeki argümantasyon seviyelerinin belirlenmesi. *Anadolu Journal of Educational Sciences International, 11*(1), 184-203. https://doi.org/10.18039/ajesi.726305

Ural, E., Öztaş, F., & Ercan, O. (2020). Sınıf öğretmeni adaylarının sosyo-bilimsel bir konuda akıl yürütme tarzlarının ve argüman seviyelerinin incelenmesi. *EKEV Akademi Dergisi, 24*(82), 97-118.

Üstün, Ç. & Özçiftçi, S. (2020). Covid-19 pandemisinin sosyal yaşam ve etik düzlem üzerine etkileri: Bir değerlendirme çalışması. *Anadolu Kliniği Tıp Bilimleri Dergisi, 25*(Özel Sayı), 142-153. https://doi.org/10.21673/anadoluklin.721864

Varal, E., & Belge Can, H. (2020). Fen bilgisi öğretmen adaylarının sosyobilimsel konular bağlamında pedagojik alan bilgilerinin incelenmesi. *Mehmet Akif Ersoy Üniversitesi Eğitim Bilimleri Enstitüsü Dergisi*, *8*(10), 21-42.

Sandoval, W. A. (2003). Conceptual and epistemic aspects of students' scientific explanations, *Journal of the Learning Sciences*, *12*(1), 5-51. https://doi.org/10.1207/S15327809JLS1201_2

Sandoval, W. A. & Millwood, K. A. (2005). The quality of students' use of evidence in written scientific explanations. *Cognition and Instruction*, *23*(1), 23-55. https://doi.org/10.1207/s1532690xci2301_2

Yaman, F. (2019). Argümantasyon tabanlı bilim öğrenme yaklaşımının ortaokul öğrencilerinin kavramsal anlamalarına ve fendeki gösterimleri kullanmayla ilgili görüşlerine etkisi. *Abant İzzet Baysal Üniversitesi Eğitim Fakültesi Dergisi*, *19*(1), 399-413. https://doi.org/10.17240/aibuefd.2019.19.43815-451118

Evren Yapıcıoğlu, (2020). Fen eğitiminde sosyobilimsel konu olarak Covid 19 pandemisi ve örnek uygulama önerileri. *Milli Eğitim Dergisi*, *49*(1), 1121-1141. https://doi.org/10.37669/milliegitim.787170

Yıldırım, A., & Şimşek, H. (2013). *Sosyal bilimlerde nitel araştırma yöntemleri*. Seçkin Yayıncılık.

Yıldırım, F. (2020). Argümantasyon odaklı öğrenme yaklaşımıyla ilgili bilimsel çalışmaların incelenmesi. *Kastamonu Eğitim Dergisi*, *28*(5), 2058-2070. https://doi.org/10.24106/kefdergi.770439

Yıldırım, İ., & Bakırcı, H. (2020). Ortak bilgi yapılandırma modeline dayalı fen öğretiminin sekizinci sınıf öğrencilerinin sosyobilimsel konular hakkındaki görüşlerine yansımasının incelenmesi. *İnönü Üniversitesi Eğitim Fakültesi Dergisi*, *21*(2), 1051-1070. https://doi.org/10.17679/inuefd.735702

Yılmaz, K., & Benzer, S. (2020). Öğretmenlerin argümantasyona yönelik görüşleri. *Anadolu Öğretmen Dergisi*, *4*(1), 44-60. https://doi.org/10.35346/aod.613914

Zengin, F., Keçeci, G., & Kırılmazkaya, G. (2012). İlköğretim öğrencilerinin nükleer enerji sosyo-bilimsel konusunu online argümantasyon yöntemi ile öğrenmesi. *NWSA Education Sciences*, *7*(2), 647-654.

Ziegler, A., Bedenlier, S., Gläser Zikuda, M., Kopp, B., & Händel, M. (2020). Female top performers in higher education STEM and humanities: Socio-emotional perceptions and digital learning-related characteristics during Covid-19. *Journal for the Education of Gifted Young Scientists*, *8*(4), 1373-1385. https://doi.org/10.17478/jegys.811344.