Discussing Socio-Scientific Issues on Twitter: The Quality of Pre-Service Science Teachers' Arguments

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Article Info	Abstract
	The purpose of this study is to determine pre-service science teachers' (PSTs') argument qualities in the process of discussing some SSIs on Twitter. In this respect, firstly, sources that PSTs use to reach information and ranking of these sources as they access information were taken. The study is designed as a case study and the participants were 13 PSTs (11 females, 2 males). Data were collected through arguments written on Twitter and after classroom discussions, and field notes taken by the researchers. The findings showed that PSTs use Internet, books and social media tools as they try to reach information and spend at least 1 to 5 hours in social media during the day. The findings also showed that online discussions on Twitter developed their argumentation qualities. This may indicate that as PSTs become familiar with writing arguments and realize that they need to consider the elements of arguments, they produce better arguments. It is therefore recommended to the researchers and teachers to provide students with environments where they can be active and conduct informal discussions about SSIs. Social media tools (Facebook, Instagram, YouTube, etc.), at this point, may provide with a useful option.

Introduction

Socio-scientific issues (SSIs), are scientific issues that require decision making by leaving individuals in dilemmas (Zeidler & Nichols, 2009) and have potentially large impacts on societies and individuals' lives (Sadler, 2004). SSIs have some special features: they do not have absolute solutions, they are usually ill structured, and people are likely to confront them in their daily lives (Kolstø, 2001). These issues require consideration of many dimensions such as ethical/moral, economic, political, social/cultural or environmental issues (Chang Rundgren & Rundgren, 2010; Holbrook & Rannikmae 2009; Nuangchalerm 2010). Integration of scientific issues and scientific processes is needed for inquiry and decision making about these issues (Sadler et al., 2007). According to Zeidler and Nichols (2009), the use of SSI in education is addressed as contemporary social-related issues that not only require scientific knowledge to make informed decisions but also promote students' active participation and develop students' argumentation skills. Combining scientific concepts with the challenging problems of SSI has been shown to be an effective way of engaging students in discussions and developing students' skills in decision-making and critical thinking (e.g., Chang Rundgren & Rundgren 2010; Klosterman & Sadler, 2010). The reasoning process of SSIs is consistent with argumentation method. In other words, SSIs constitute an important context for the argumentation method (Dawson & Venville, 2013; Ekborg et al., 2013). Argumentation is a process in which scientific claims are justified based on experimental or theoretical evidence (Erduran & Jiménez-Aleixandre, 2007). While discussing their opinions about a SSI that is open to debate, individuals employ the process of reasoning that requires consideration of elements such as, claims, evidence and reason (Sadler et al., 2007). Carrying the argumentation process out of formal learning environments is important for scientific literacy. Scientific literacy requires students to understand complex scientific issues and make decisions based on their own knowledge. The inevitability of individuals to be exposed to SSIs in informal learning environments shows that addressing these issues is important for scientific literacy (Zeidler, 2007). As being issues concerning the society, carrying SSIs into the classroom environment is thought to be effective in making interpretations about these issues in informal environments and improving scientific literacy. For such reasons, it is important that science teachers, as well as science teacher candidates, should have the related training for carrying SSIs into their classes.

It is known that SSIs frequently take place in media and create dilemmas because of their relation to society. In this respect, individuals refer to media elements as they want to learn, reason or make decisions about SSIs. (Boyd & Ellison, 2007; Dimopoulos & Koulaidis, 2003; Kachan et al., 2006; Klosterman et al., 2012). In the

21st century, individuals often use social media tools like Twitter, Facebook, Instagram and WhatsApp (Klosterman et al., 2012). Sharing SSIs in social media environments and reflecting the argumentation process on these sharing will contribute to the development of scientific literacy and the quality of arguments. In this context, in the current study, a number of socio-scientific issues (farm chicken consumption, influenza vaccines, sugar intake during pregnancy, raw/processed milk consumption, vaccination of children and homeotherapy) were discussed through Twitter – a popular social media platform. The study was structured on the basis of the opinions expressed by the PSTs during their discussions about the SSIs on Twitter and their written and verbal arguments stated throughout the process. In the related literature, there are studies on the discussion of SSIs in the classroom (Cansız, 2014; Öztürk & Yenilmez Türkoğlu, 2018), however, it is hoped that, the current study will contribute to the literature in terms of providing an alternative informal environment that makes PSTs feel comfortable and express their arguments freely.

Socio-Scientific Issues and Argumentation

An argument is an assertion with supporting information or, alternatively, a claim with reasons to support the claim (Dawson & Carson, 2017). Argumentation, on the other hand, is expressed as a complex process defined as an artefact with the statements that individuals use to support their claims or refute the counterclaims as they put forward their arguments about an issue (Sampson & Clark, 2008). Argumentation was first introduced by Toulmin (1958) with its elements. The Toulmin's Argument Model contains the elements of claim, grounds, warrant, backing, qualifier and rebuttal (Toulmin, 1958). Based on Toulmin's Argument Model, several researchers have expanded or changed the argument elements to determine argument levels /qualities (Erduran et al., 2004; Lin & Mintzes, 2010; Sadler & Fowler, 2006).

Argumentation in science education is an effective process in which scientific claims are based on beliefs and experimental evidence (Driver et al., 2000; Erduran, & Jiménez-Aleixandre, 2007). The use of argumentation process is considered as an important method in addressing the SSIs that require students to produce arguments, reason and make decisions (Acar et al., 2010; Dawson & Venville, 2013; Ekborg et al., 2013; Kolstø, 2001). A number of studies in the literature also indicate that SSIs are suitable for determining teacher candidates' argument qualities and their developmental processes (Dawson & Venville 2010; Osborne et al., 2004; Wu & Tsai, 2007; Zohar & Nemet, 2002).

It is obvious that the skills acquired during the argumentation process are important for evaluating the views about the SSIs that are open to discussion and arriving at a final decision (Sadler et al., 2007). Argumentation skills are seen as important skills that people should have in modern societies when they need to make decisions on SSIs they face (Chang, 2007; Chang & Chiu, 2008; Osborne et al., 2004; Chang Rundgren & Rundgren, 2010; Chang Rundgren, 2011; Sadler, 2004). Argumentation on a SSI, together with argument writing skills, can provide important contributions to scientific thinking skills and decision-making skills of individuals (Chang & Chiu, 2008; Sadler & Zeidler, 2005b; Zohar & Nemet, 2002). In the related literature, it is seen that the number of studies examining students' argument qualities of SSIs is limited (e.g. Topçu et al., 2010; Sadler & Zeidler, 2005a; Sadler & Donnelly, 2006; Isbilir et al., 2014).

Argumentation can be carried out in the classroom, as well as in informal spaces like online environments. Online argumentation is the process where the discussion takes place in computer and internet environment and teachers and students interact with each other online (Çelik et al., 2017). In informal learning environments opportunities should be provided to students for experiencing SSIs (Zeidler, 2007). By this way, students will be able to understand complex scientific issues in the society, interpret the information and make decisions about the issues by using their own knowledge (Zeidler, 2007). There are studies in the related literature that point out an increase in argumentation levels/quality of students as a result of online discussions (Lin et al., 2012; Isbilir et al., 2014). Lin et al. (2012) reported that there was a positive development in physics students' quality of arguments after online discussions and that the students performed better in the online discussion environment. In another study, Isbilir et al. (2014) investigated PSTs' argument qualities on four different SSIs and concluded that PSTs produced high level arguments in online discussion environments.

Socio-Scientific Issues and Media

Teachers and students most likely use media as the source of information about popular SSIs that are discussed in the society (Kachan et al., 2006). The popular media, or the mass media in other words, remain as an important source of communication in modern societies. While newspapers and radios gained an important

place as news and entertainment sources of individuals in the nineteenth century, internet-based technologies such as Facebook, Twitter, etc. have frequently taken place in the community agenda in the 21st century (Klosterman et al., 2012). Media/social media tools that occupy a significant part of daily life in recent years, can be used as an important source in science education. Media, with various areas of use, is an important source of choice especially in teaching practices of SSIs (Dimopoulos & Koulaidis, 2003; Kachan et al., 2006; Öztürk, Eş, & Turgut, 2017; Türköz & Öztürk, 2019). Klosterman et al. (2012) concluded that media was effective in teaching SSIs and that teacher and students reached the information about SSIs through media. Dimopoulos and Koulaidis (2003) pointed out in their study that media is frequently used to form opinions about the contemporary SSIs and the social impacts of science and technology. Öztürk et al. (2017) in their study with talented students, used YouTube videos about a SSI, and took students' claims and grounds about the issue.

Use of Twitter in Education and SSIs

The widespread use of mobile phones and internet increases the demand for social media to provide easy access to social media from mobile phones. According to the most up-to-date Internet usage statistics report published by We Are Social and Hootsuite (2018), 3.81 billion people (51% of the world's population) were internet users, while 3.02 billion (37% of the world's population) were social media users in 2017. In 2018, on the other hand, 53% of the world's population, which consists of 4.02 billion, were internet users, while 42% of the world's population (3.19 billion) is said to be a social media user. Even in the last two years, the increase in the use of social media makes it important to use these environments for educational purposes. In several studies, it is seen that social media tools such as Facebook and Twitter are used for students to communicate with each other and for learning activities (Junco et al., 2010; McArthur & Bostedo-Conway, 2012; Veletsianos, 2012).

Moreover, there are also studies indicating that educators also use social media for communicating with each other and making sharing to support their professional development (Ebner et al., 2010; Mills, 2014; Rankin, 2009; Schroeder et al., 2010). People use Twitter for several purposes like communicating, asking questions, making recommendations, putting their opinions on agenda-related issues, commenting and discussing. Carpenter and Krutka (2014), in their extensive research on how Twitter is used by educators, draws attention to the fact that it is mostly used for professional development and communication, but less for classroom applications; and they recommend to do extensive research on the use of Twitter for educational purposes. The current study focuses on the sharing of arguments on SSIs in Twitter as a popular social media tool.

The purpose of this study

The purpose of this study is to determine PSTs' argument qualities in the process of discussing SSIs on Twitter.

Method

This study is designed as a case study. The case study is a qualitative approach in which detailed and in-depth information is gathered by using a variety of sources such as observation, audio-visual materials, interviews, documents and reports within a certain period of time (Creswell, 2013). In this context, in accordance with the study group and the scope of the study, it was decided to conduct the study in an elective course named "Media Literacy".

Participants

The participants of the study were 13 PSTs (11 females, 2 males) attending the Science Education Program at state university in Turkey. They were selected conveniently from the university where the researchers were working, for the purpose of being easily accessible to them. The participants were questioned for their use of social media tools and it was found that they are using Instagram (f=11), Facebook (f=10), WhatsApp (f=8), Twitter (f=5), Snapchat (f=2), Tumblr (f=2), YouTube (f=2) and Swarm (f=1). Moreover, it was determined that they are either spending 5 or more hours (f=5), 3 to 5 hours (f=3), 1 to 3 hours (f=4) or less than 1 hour (f=2) on social media. All PSTs participated in this study used social media tools and typically allocated a certain period to social media usage during the day.

Procedure

The "Media Literacy" course is a 2-hour-per-week elective course. At the end of this course, students are expected to recognize the mass media, and discuss the relationships between media, society and culture, media and economy, media and ethics, and science-society-media and socio-scientific issues. The current study was carried out at 10 weeks. It consists of two stages. Detailed information about the process is presented in Figure 1.
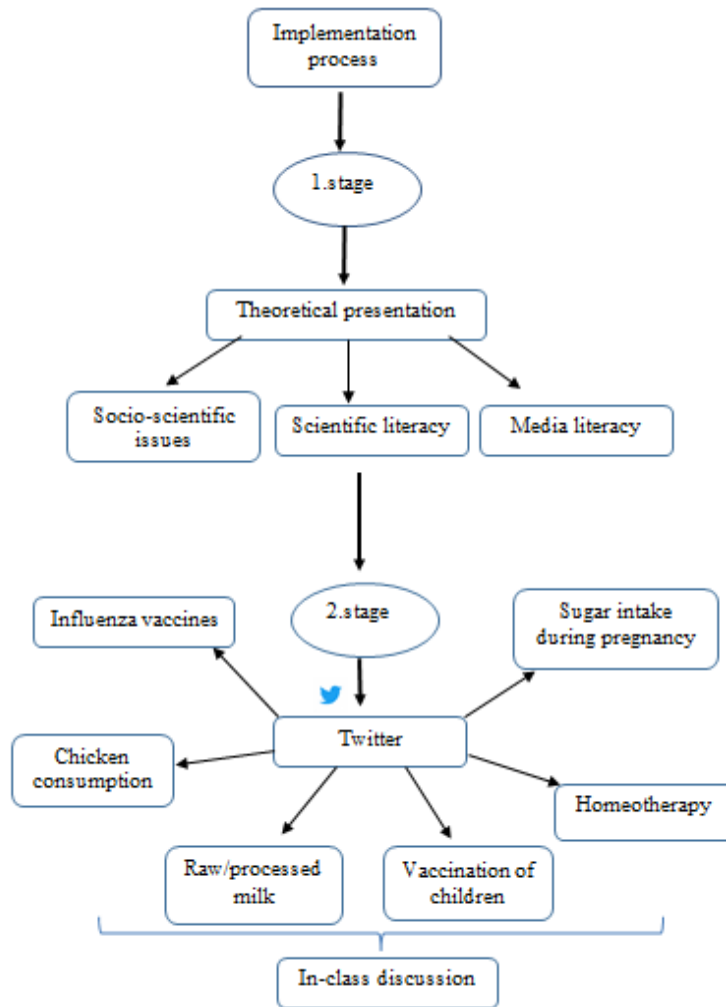

Figure 1. The procedure of the study

In the first 3 weeks of the 10-week period, theoretical presentations were done by the researchers of this study. The presentations were about scientific literacy and its relationship with SSIs, science curriculum and SSIs, argumentation and its elements, media literacy, and SSIs in the context of scientific literacy and media literacy. The PSTs have already taken theoretical and practical courses on argumentation and argumentation elements during their past education. The issues of chicken consumption, flu shot, sugar intake during pregnancy, raw/processed milk consumption, vaccination of children and homeotherapy were discussed respectively during the study. Online discussions were carried out on Twitter together with the researchers and the participants of the study, once a week (Sundays) between 20:00 and 23:00. The selected SSIs were brought up for discussion by the researchers based on some scientific research findings, news from newspapers, supportive/non-supportive blog shares, YouTube videos, pictures, etc. For example, some YouTube videos covering two different opinions about farm chicken consumption were shared by the researchers and left for discussion by the PSTs. Videos taking 1-5 minutes were specifically selected in order to take the remaining time for the discussion of the issues.

After watching the videos, the PSTs initially stated their claims about the issue (as supporting / not supporting / undecided) under the sharing. Each PST, then, tried to support his/her claim through information from different sources (such as, newspapers, YouTube videos, research findings). The PSTs searched the sources during twitter

writings. The periods of 3-hour discussions were thought to be sufficient for searching and screening the issues since access to information through internet is very fast. Students were also directed to search on the issues before coming to the class discussions.

The points that they paid attention to in accordance with the instructions given by the researchers were the (i) claims, (ii) data, (iii) warrants and (iv) backings and the rebuttals used to disprove the counter ideas. The researchers participated in the discussion process occasionally through probing questions. For example, upon a statement like "I don't support farm chicken consumption, I find it harmful", the researchers responded as "So, why don't you support and find it harmful?" and oriented the PSTs to create more detailed and qualified arguments. No limitation has been imposed on the use of resources by researchers, however, they directed questions like "Do you think this source is reliable? Can you reference it? How would you know that this is correct?" etc. After a few weeks, resources were questioned by the PSTs before making a decision. Since there is a character limitation on Twitter (140 characters), the entries of PSTs were listed as +, ++, +++, or 1,2,3...

After discussing the SSIs on Twitter, each week, the related issue was discussed in the classroom, as well. Since there are six SSIs covered in this study, the discussion process took a total of 6 weeks. After completing the discussions, PSTs were asked to write their arguments about each SSI. The arguments written on Twitter and at the end of the discussions were taken and examined in respect to the purpose of this study.

Data Collection and Analysis

Data were collected through arguments written on Twitter and at the end of the classroom discussions, and the field notes taken by the researchers of the study during the classroom discussions. The written arguments on Twitter were transcribed and compared with the classroom discussion-end-of-written arguments for the purpose of determining whether there are any differences in the argument elements.

Together with the written arguments and filed notes, demographic data about participants' habits of social media use and access to information were also taken for the purpose of defining the participants. A sample coding list for the sources that PSTs use as they try to access information is given in Table 1.

Table 1. A sample coding list for the sources that PSTs use as they try to access information

Theme	Code	Sample expression
Media	Social media	*"The easiest way to access information nowadays is the social media. I mostly use Instagram…"* (PST-5)
	TV	*"I like TV shows most. Especially the talk shows…"* (PST-11)
	Newspapers	*"… I mean, I hang out more on the internet, but I also check the newspapers. The same news may be given differently in different newspapers…"* (PST-7)
	Magazines	*"I love scientific- technical magazines. There are more accurate and up-to-date information in them; so I'm trying to get them occasionally… "* (PST-8)

Written arguments were analyzed based on content and continuous comparative analysis techniques. According to Patton (2002), content analysis is defined as scanning the text for repeated words or themes. The analysis was done according to the criteria proposed by Erduran et al. (2004) based on Toulmin's Argument Model. Erduran et al. (2004) proposed 5 argumentation levels. If the argument consists of a simple claim or a counter-claim, this is defined as Level 1 argumentation. Level 2 argumentation, on the other hand, has arguments consisting of a claim versus a claim with either data, warrants, or backings but do not contain any rebuttals. In Level 3 argumentation, there are arguments with a series of claims or counter-claims with either data, warrants, or backings with the occasional weak rebuttal. Level 4 argumentation shows arguments with a claim with a clearly identifiable rebuttal and these arguments may have several claims and counter-claims. Finally, Level 5 argumentation displays an extended argument with more than one rebuttals.

PSTs' qualities of arguments were evaluated based on the criteria given above. In order to increase the reliability, data analyses were triangulated by three researchers. Two researchers analyzed the transcripts independently and the results were presented to the third researcher for consideration. Through this triple evaluation process, the reliability of the data was tried to be provided. The analyses provided by the two researchers and the consideration of the third researcher was compared until a consensus was reached between the researchers and the argument levels of the PSTs were then finalized. For the purpose of clarifying the analysis process, one of the PSTs' (PST-12) argument evaluation is presented in Table 2.

Table 2. Sample argument analyzing scheme for PST-12

Level	Explanation	Sample excerpt
1	Argument consists of a simple claim or a counter-claim	"I support the use of village chicken, do not support the store chicken."
2	Argument consists of a claim versus a claim with either data, warrants, or backings but do not contain any rebuttals	"…I was against the flu vaccine, but I changed my mind upon the discourse of experts shared in Twitter. I support it because of the health benefits for people, as written in the news named 'You should be vaccinated'."
3	Argument consists of a series of claims or counter-claims with either data, warrants, or backings with an occasional weak rebuttal	"I'm against sugar loading. Because, giving 50 g sugar to a pregnant woman can result in dangerous outcomes. The speech of the expert impressed me. I can say that the data she showed affected my decision. If I experience such a situation, I can think about it if only there is data supporting that it is not harmful, otherwise I am determined…"
4	Argument consists of a claim with a clearly identifiable rebuttal or may have several claims and counter-claims	"I think that raw milk is more useful. Because I agree with the ideas of the expert (shared in Twitter) and the opinions of the experts who make such sharing. Processed milk is undergoing many treatments and many useful things within the milk are killed. Just think! It doesn't go bad for long, and this makes me think. I think, the data defending processed milk is insufficient. Maybe if the data were clear and sufficient, I may be confused.…"
5	An extended argument with more than one rebuttals	"I don't agree with my friends. Children should be vaccinated. Because they may have diseases like measles, chicken pox, and vaccines protect them. Many experts also have made supporting explanations; even the Ministry of Health. Babies may die if the vaccine is not given. So if the baby could only be protected by breast milk without vaccination, there would be no need for vaccination, would it? Vaccination is an important invention that affects children's health…"

As seen in Table 2, PST-12 presented a claim with the statement:

> I support the consumption of village chicken.

She presented a claim and a warrant by saying:

> I support it because of the health benefits for people, as written in the news named "You should be vaccinated"

PST-12 stated a claim by saying:

> I'm against sugar loading

and data by

> …giving 50 g sugar to a pregnant woman…

and a warrant by

> …can result in dangerous outcomes.

Regarding raw/processed milk consumption, she presented a claim by saying:

> I think that raw milk is more useful

data and a warrant by

> Processed milk is undergoing many treatments and many useful things within the milk are killed,

backings by

> Because I agree with the ideas of the expert (shared in Twitter) and the opinions of the experts who make such sharing

and rebuttals by

> …if the data were clear and sufficient….

Finally, regarding the vaccination of children, PST-12 stated a claim by saying:

> Children should be vaccine,

data and a warrant by

> Because they may have diseases like measles, chicken pox, and vaccines protect them,

backings by

> Many experts also have made supporting explanations; even the Ministry of Health,

and clear rebuttals by

> Babies may die if the vaccine is not given. So if the baby could only be protected by breast milk without vaccination, there would be no need for vaccination, would it?

Results

One of the purposes of the current study was to examine the kinds of sources that PSTs use as they try to reach information. For this purpose, the sources they use to reach information, the ranking of these sources as they access information, the reliability of the information and their opinions about the decision making process were taken before the SSIs were discussed. In this respect, the findings related to the sources they use in reaching the information are presented in Table 3.

Table 3. PSTs' views on the sources they use to reach information

Category	Code	f
Internet	Internet	13
Media	Social media (Facebook, Instagram, etc.)	5
	TV	3
	Newspapers	2
Library	Books	8
	Magazines	2
	Articles	1
	Theses	1
	Encyclopedia	1

As seen in Table 3, all of the PSTs (f = 13) mentioned that they use Internet as they try to reach information, while most of them (f = 8) also reach information from books and some (f = 5) from social media tools such as, Facebook, Instagram and Twitter. When they are asked to rank the sources with respect to their use in reaching information, seven of them stated that Internet was the first one that they use to reach information, while five stated that books led them more, and one PST gave the first place to the theses done in the field. PSTs showed different attitudes as they were asked about the reliability of the knowledge and the criteria by which they decide on the reliable information. Sample responses are as follows:

> I do research from other sources. I ask people around me and get ideas. I act according to the majority (PST1).

> Of course, I do not stick to a single web page or book. I try to confirm information by looking at different web pages or books, and I decide by majority (PST3).

If I have seen or heard the same information from many sources, I can trust and decide (PST8).

First of all I do research from different sources and examine the opinions and ideas on the issue. If there are common news everywhere, I consult experts. Of course, people may have been influenced elsewhere in the media. It is therefore best to find the primary source (PST9).

I reach information through my own experiences. I consult my family, my friends, my social environment, and sometimes internet (PST5).

It can be observed that many of the PSTs commonly reached knowledge by searching from different sources. While PST1 is concerned with different sources of information, PST9 emphasized the expert factor and PST5 considered the environmental factor.

Besides examining the kinds of sources that PSTs use as they try to reach information, in the current study, a number of socio-scientific issues (farm chicken consumption, influenza vaccines, sugar intake during pregnancy, raw/processed milk consumption, vaccination of children and homeotherapy) were discussed through Twitter and PSTs' argument qualities related to these issues were also examined in this study. PSTs argumentation levels about the SSIs before and after discussions are given in Table 4.

Table 4. PSTs' argumentation levels with respect to SSIs

Pre-service science teachers	Chicken C.		Influenza vaccines		Sugar Intake		Raw/Proc. M.		Vacc. of Children		Homeother.	
	Pre-	Post-	Pre-	Post-	Pre-	Post-	Pre-	Post-	Pre-	Post-	Pre-	Post-
PST1	1	2	1	2	2	2	2	3	3	3	3	3
PST2	1	1	2	3	2	3	3	3	3	3	3	4
PST3	2	2	3	3	3	3	3	3	3	3	3	3
PST4	1	2	2	3	3	3	3	3	4	4	4	4
PST5	1	2	1	2	2	3	2	3	2	3	3	3
PST6	3	3	3	3	4	4	4	4	3	3	1	3
PST7	2	2	2	2	2	3	3	3	3	3	3	3
PST8	1	2	2	2	2	3	3	3	3	3	3	4
PST9	2	3	2	3	3	3	3	3	3	3	4	4
PST10	3	3	3	3	4	4	4	4	3	4	4	4
PST11	1	2	2	3	2	3	4	4	4	4	5	5
PST12	1	2	2	3	3	3	4	4	5	5	5	5
PST13	1	2	2	3	2	3	3	4	4	4	4	4

Table 4 shows 13 PSTs' argumentation levels for each SSI determined before discussions (-pre) and during-and-after (-post) discussions. The first SSI discussed on Twitter was Farm Chicken Consumption. Before this issue was discussed, it was observed that most of the PSTs (n=8) stated simply a claim (level 1), three of them stated a claim, data, warrant or backing, and two stated a claim, data, warrant, backing and a weak rebuttal. In response to researchers' questions like:

Why do you (or, don't you) support the consumption of farm chicken?

they said:

That's just what I think. I think so (PST1).

or

I think, we should consume village chicken (PST8),

and did not present any data or warrant. In the second week, on the other hand, most of the PSTs (f = 8) wrote their arguments at level 2 and presented their claims with data, warrants or backings. Three PSTs wrote arguments at level 3 and two PSTs at level 1. In response to the questions like:

Why would (or, would not) you prefer to have Influenza vaccine?

they replied like:

> Influenza vaccine should not be given because in the article written by the expert it was noted that there is aluminum and mercury in the vaccine (PST3).

Another PST replied this response as:

> So, you decide only based on the opinion of the expert? Then, another expert mentioned that it (vaccine) was important for health! (PST5).

The researchers had been actively involved in the discussion and triggered the discussion with questions like:

> What are your arguments to refute the counter-argument on this issue? What are your data?

In the third week, it was found that most of the PSTs (f=7) still wrote their arguments at level 2, while four at level 3 and two at level 4. In the fourth and fifth weeks, however, most PSTs (f=7, f=8, respectively) improved to level 3. As Table 4 suggests, there is no PST at level 1, that is proposing just a claim or counter-claim, starting from the third SSI - sugar loading during pregnancy. In the last week of the study, it is observed that many of the PSTs (f = 6) were at level 3, while four were at level 4 and two at level 5. One of the PSTs (that is, PST6) had an unstable attitude towards the issue (homeotherapy) and considered to be at level 1.

In general, in the written arguments taken at the end of the discussions, it was determined that the argumentation levels of the PSTs were similar and also the levels were developed towards the end when compared to the arguments discussed in Twitter in the first weeks. For example, nine PSTs' (PST1, PST2, PST4, PST5, PST8, PST9, PST11, PST12, PST13) low levels of argument qualities in the first and second weeks significantly developed at the end of the discussions (see Table 4). It was determined that the six PSTs in the third week, three PSTs in the fourth week, two PSTs in the fifth week and three PSTs in the sixth week were observed to develop. This development can be interpreted as the reflection of knowledge and experience acquired during the discussions on Twitter on PSTs' written arguments taken at the end of the process. For example, PST4 stated his/her idea about the consumption of raw/processed milk on Twitter as:

> I prefer to consume raw milk.

Through probing questions like:

> Why do you prefer so?

the PST was asked to think about the issue and encouraged to state data and justifications for his/her arguments; and through directing questions like:

> There are opposing ideas; PST10 for example, how would you refute this argument?

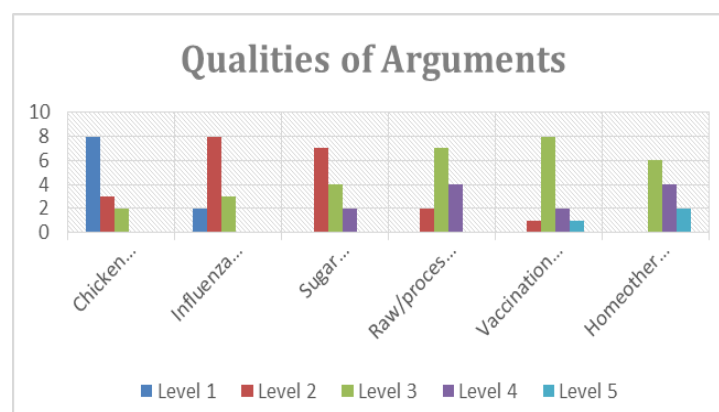s/he was encouraged to use backings and rebuttals, as well.

Figure 2. Frequencies of argument qualities for the SSIs

As seen in Table 4, the quality of arguments improved as the SSIs were discussed on Twitter. The field notes taken by the researchers also show that PSTs possessing level 1 argumentation in the prior SSIs showed higher levels of argumentation at the end of the process. For example, it was observed that while PST13 put only claims forward about the first SSI in the discussion process on Twitter (level 1), s/he included the elements of argument like data and justification at the end. It can be said that this improvement indicates a positive development in PSTs' argument qualities. The improvement of the qualities of arguments related to the issues discussed in this study are presented in Figure 2.

When Figure 1 is examined, it is seen that most of the PSTs' arguments were at level 1 about farm chicken consumption (f=8), level 2 about influenza vaccines (f=8) and sugar intake during pregnancy (f=7), and level 3 about raw/processed milk consumption (f=7), vaccination of children (f=8) and homeotherapy (f=6). It is observed that PSTs are able to produce arguments at level 3 in all SSIs, that is, they produce arguments consisting of a series of claims or counter-claims with either data, warrants, or backings with an occasional weak rebuttal. From the third SSI (sugar intake during pregnancy) level 1 arguments disappear while level 4 arguments start to appear. In the last SSI, there are no arguments at level 1 and level 2 but PSTs were able to write arguments at level 5, that is, they could produce extended arguments with more than one rebuttals.

Data obtained from researchers' field notes showed that PSTs were satisfied with the discussions on Twitter; they were usually motivated to the argumentation process every week, and tried to make the best decision by searching different resources about the issues and use the argument elements in forming their decisions. For example, PST6 stated his/her satisfaction as:

> That was a very useful application for us.

PST7, on the other hand, showed his/her willingness by saying:

> …every Sunday I willingly participated in the discussion. I realized that it was both fun and instructive for us to discuss the issue together on Twitter.

Some PSTs referred to the contributions of the discussions. For example, PST9 said:

> There is information pollution on the internet. I noticed that we never questioned this case. Now I am more careful.

Similarly, PST12 said:

> The discussion on Twitter continued at school. We argued about everything. I enjoyed it very much. And, that contributed us a lot.

and PST6 said:

> I learned that I should not decide on a single source. We're going to be teachers, how we decide is very important. Some sharing of our friends, for example, with supportive arguments inevitably motivated me.

Besides the discussion process itself, researchers'' probing questions like:

> Why did you refer to that source? Why didn't you join your friend's words? How would you convince your friend who has an opposing idea?

students were asked to question their decisions and re-evaluate the arguments they wrote. In addition, during the class discussions, PSTs were encouraged to feel the development in their own decisions. For example, in response to PST12's word:

> …that contributed us a lot,

the researchers asked:

> How did the process contribute to you? What skills do you think you have developed?

Finally, observing their willingness to present their ideas about the issues and providing arguments to defend their decisions, it is possible to say that the implementation conducted in this study would result in a continuous behavior of PSTs.

Results, Discussion and Recommendations

The purpose of this study is to determine PSTs' argument qualities in the process of discussing a number of SSIs on Twitter. In this respect, firstly, the sources that PSTs use to reach information, the ranking of these sources as they access information, the reliability of the information and their opinions about the decision making process were taken before the SSIs were discussed. It was found that all of the PSTs use the Internet as they try to reach information, many of them use books and some of them reach information from social media tools such as Facebook, Instagram and Twitter. Considering the findings of 'We Are Social and Hootsuite' in 2017 and 2018 about the dissemination of social media usage, it is expected that teacher candidates would use social media widely. According to Muntinga et al. (2011), social media tools such as Facebook, YouTube and Twitter provide Internet users with opportunities to interact, share, and create content on an unlimited range of imaginative sharing networks. The general profiles of PSTs on media use also support this situation. It is found in this study that PSTs spend time in social media for at least 1 hour and a maximum of 5 hours during the day. Seven PSTs mentioned that the Internet is the first source they use as they rank the sources they use to access information. While five of the PSTs stated that books led themselves more in the first place, one PST gave the first place to the theses made in the field. It was also determined that PSTs decided according to criteria such as family, environment, internet, media sources, book and expert opinion.

For the purpose of this study, PSTs' argument qualities on the issues of farm chicken consumption, influenza vaccines, sugar intake during pregnancy, raw/processed milk consumption, vaccination of children and homeotherapy were evaluated as level 1 to level 5 based on Toulmin's Argument Model. It was found that PSTs possess differing argument qualities for different SSIs even at the lowest level. It was determined that PSTs who produce arguments at the levels of 4 and 5 consider scientific sources, expert opinions on the issue and refer to these elements in particular as they provide backings or warrants for their claims. It was also found that most PSTs, who possess levels of 1, 2 or 3, had limited elements in their arguments and referred mostly to their personal experiences and knowledge. Christenson et al. (2014) stated that supporting arguments with scientific knowledge and data influence the quality of the argument. In line with the findings of the current study, Karışan et al. (2017) stated that prospective teachers cannot provide sufficient scientific evidence in presenting their arguments, rather they usually refer to their personal opinions. Similarly, Albe (2008) determined that prospective teachers could produce arguments with personal opinions rather than scientific data. The findings of this study, in general, showed that starting from the third SSI discussed on Twitter (that is, sugar intake in pregnancy), PSTs were able to reveal the argument elements based on scientific data and resources rather than their personal experiences.

During the discussions on Twitter, it was observed that most of the PSTs possessed level 1 arguments in the first week's SSI (that is, farm chicken consumption) by simply claiming, while they possessed level 2 arguments on the second week (influenza vaccines) and presented their claims with data, warrants or backings. In the third week (sugar intake during pregnancy), it was determined that most PSTs wrote their arguments in level 2, and in the fourth week (raw/processed milk consumption) in level 3. According to the findings of the study, in short, the argumentation levels tended to improve. This finding may indicate that as PSTs become familiar with writing arguments and realize that they need to consider the elements of arguments, they produce better arguments. PSTs gained awareness about the SSIs and were able to present different arguments about these issues. The findings of this study, in which the argumentation process itself improved the quality of the arguments, are consistent with the related research findings (Akbaş & Çetin, 2018; Isbilir et al., 2014; Karışan et al. 2017; Sadler & Donnelly, 2006; Topcu et al., 2010). However, in this study, it is thought that the realization of the argumentation process in an online informal environment motivated the PSTs to the process and ensured effective discussion within the boundlessness of sharing. Similar to this research, Isbilir, et al. (2014) conducted a research in an online environment and took PSTs' written arguments on climate change, nuclear energy, genetically modified foods and the human genome project. They determined that PSTs' produced high level arguments about the SSIs and the online discussion environment where the SSIs were discussed was effective in producing arguments. Lin et al. (2012) stated that there was a positive development in the quality of arguments after online discussions with students of physics department and they showed better performance in online discussion environment.

The findings of this study showed that online discussions on Twitter developed PSTs' argumentation qualities. Several researchers point out that social media tools such as Facebook and Twitter provide students with environments for communicating with others or for learning activities (Junco et al., 2010; McArthur & Bostedo-Conway, 2012; Veletsianos, 2012). In addition, educators also use social media in order to communicate with each other and to make sharing that support their professional development (Ebner et al., 2010; Mills, 2014; Rankin, 2009; Schroeder et al., 2010). Considering that social media is widely used for several purposes and users feel comfortable to express their ideas in such environments, together with the results of this research, it can be concluded that Twitter is a suitable environment where SSIs can be discussed.

Considering the findings of this research, it is recommended to the researchers and teachers to provide students with environments where they can be active and can conduct informal discussions about SSIs. To do this, they can use different social media tools (Facebook, Instagram, YouTube, etc.) that occupy most of a day's time period, in the teaching process, so that they can use the time for learning. Considering that the popular media play an important role in the teaching of SSIs, it is thought that pre-service teachers will experience with such practices or activities before they begin their work and develop their knowledge, and gain different perspectives in local, regional or social decision-making processes.

Scientific Ethics Declaration

The authors declare that the scientific ethical and legal responsibility of this article published in JESEH journal belongs to the authors.

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