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Self-Efficacy Perceptions Of Science Teachers Regarding Content Knowledge

Berna Sari and Seyit Ahmet Kiray

This study aims to determine the self-efficacy of science teachers regarding their content knowledge. The research was conducted using a multiple case study design. Three science teachers working in public schools were selected through purposive sampling. Personal interviews were used to collect the data for the study. The results showed that science teachers' self-efficacy in physics, chemistry, biology, astronomy, earth sciences, scientific process skills and science-technology-society-environment (STSE) are different. The area where science teachers are weakest in terms of their content knowledge self-efficacy is STSE. Although sustainable development, socio-scientific issues, science and career awareness sub-dimensions in the STSE have taken place in the curriculum, the teachers were not aware of these dimensions. Based on the results, the researchers recommend that in-service training courses be organised to increase the self-efficacy of science teachers on content knowledge.

KEYWORDS: Science Content Knowledge, Case Study, Self Efficacy

Introduction

When considered the historical development of the teaching profession, it is seen that having the content knowledge regarding a certain field is very important. The whole educational system in the past was based on knowing, which was memorizing or grasping the existing knowledge, from the teachings in schools of Plato and Aristotle to religious educational institutions. The task of the teacher was to know the current knowledge in the field and to convey this information. Until Shulman (1986), the teaching profession continued to be seen as knowing the knowledge of a field (Kiray, Celik & Colakoglu,

Berna Sari
Institute of Education Sciences, Necmettin Erbakan University, Turkey.
Email: bernasari42@gmail.com

Seyit Ahmet Kiray ✉
Ahmet Kelesoglu Education Faculty, Science Education Department, Necmettin Erbakan University, Turkey.
Email: ahmetkiray@gmail.com

2018). With Shulman, the teaching profession has begun to move beyond the conventional understanding of having knowledge of the field for centuries. Teachers now had to have pedagogical knowledge about how to teach in addition to their content knowledge (Ladachart, 2019). With Mishra and Koehler's (2006) study, the technology knowledge along with the pedagogy knowledge has been added to the characteristics that teachers should have. In the 21st century, it is accepted that successful science teachers are teachers who can present science knowledge by using appropriate instructional strategies and technologies (Lin, Tsai, Chai, & Lee, 2013).

When the pedagogy and technology knowledge added to the teaching profession as closely new as compared to the content knowledge, the importance of content knowledge began to decrease compared to the past. In Turkey, questions about general culture, general skills and educational sciences in the Civil Servant Selection Examination (CSSE) that teachers had to take before starting the profession were asked until 2013 (Tasan & Bektas, 2016). This led to almost total ignorance of content knowledge in teacher training institutions. So much so that in some branches the content knowledge is ignored extremely, pedagogy knowledge and technology knowledge in some fields started to be highlighted. Due to the fact that studies in the field of technological, pedagogical, and content knowledge (TPACK) and science, technology, engineering, and mathematics (STEM) education are considered as technology and pedagogy-based trends by many researchers, science content knowledge has started to leave its place at the centre of the teaching profession to pedagogy and technology knowledge.

Content Knowledge

Content knowledge is the rigorous knowledge of teachers about the disciplines they will teach (Koehler & Mishra, 2009). In order for the teacher to start the teaching process, a sufficient knowledge of the subject area of his/her branch is required (Gencosman, 2015; Mutluoglu & Erdogan, 2012). Teaching is a multifaceted and complex process that requires rigorous knowledge of the content and adapting it to different situations (Hollins, 2011). On the basis of the efficiency of teaching, the equipment acquired by the teachers during their university years is effective (Erdem & Soylu, 2017). The main backbone of science content knowledge is physics, chemistry, biology, astronomy and earth sciences. Pre-service science teachers and in-service science teachers should have the knowledge of the concepts, principles, generalizations, theories and laws of science. Today, the knowledge related to scientific process skills, science-technology-society-environment relationship, nature of science and common misconceptions in science are seen in science content knowledge (MoNE, 2006, 2013).

The impact of the lack of science content knowledge in Turkey is manifested in the science classes given by most primary school teachers. In Turkey, science classes are given beginning from the third grade in elementary school. These classes are given by the primary school teachers in the third and fourth grades. Although the grade level is low, primary school teachers feel that their science content knowledge is inadequate (Çepni, Kucuk, & Ayvaci, 2003). Also, this inadequacy is not limited to physics, chemistry, biology, astronomy or earth sciences. Primary school teachers who teach these science classes do not have the necessary knowledge and skills about the scientific process skills that have come to the fore in science teaching since the 1990s (Turkmen & Kandemir, 2011).

The most important deficiencies in the content knowledge of science teachers and teacher candidates are the misconceptions in science. The deficiencies and misconceptions of teachers in science content knowledge can lead to misconceptions and learning deficiencies of students (Kiray, Aktan, Kaynar, Kilinc, & Gorkemli, 2015; Mataka & Taibu, 2020). In the studies conducted on science teacher candidates, it is seen that science teacher candidates have serious learning deficiencies and misconceptions about many basic science concepts. However, it is of great importance that teachers have rigorous knowledge about a particular field (Nakiboglu & Karakoc, 2005).

Review Of Literature

Studies conducted on elementary school teachers have shown that these teachers do not have a lack of confidence in teaching science because of their incomplete knowledge of science (Akerson, 2005; Akerson & Flanigan, 2000). Weak content knowledge leads to low self-efficacy as well as anxiety. This prevents the realization of an effective science teaching (McConnell, Parker, & Eberhardt, 2013).

McConnell et al. (2013) designed a tool to measure teachers' science content knowledge and applied this measurement tool to 78 volunteer teachers. Researchers provided the professional development programme for the teachers. Before and after the programme, content knowledge measurement they developed was given to the teachers. In their findings, they discussed their assessment methods and the effectiveness of the programme they provided. As a result, researchers pointed out the importance of teachers' content knowledge and emphasized the importance of evaluating and developing content knowledge in their study.

Diamond, Maerten-Rivera, Rohrer, and Lee (2014) revealed that teachers' content knowledge, which was measured by a test, had a significant effect on students' science achievement. However, no relationship was found between

the science self-efficacy expressed by the teachers themselves and student achievement.

Martinez-Torregrosa, Liminana, Menargues, and Colomer (2018)found that pre-service elementary school teachers had a negative attitude towards science teaching and learning due to their limited science content knowledge, and these teachers claimed that this caused them to feel a failure in teaching science and lack of self-confidence when they began to teach in schools. In order to overcome this situation, researchers designed a professional development programme for pre-service elementary school teachers in order to develop their content knowledge on astronomy. At the end of this programme, researchers positively changed the pre-service teachers' content knowledge and their attitude towards science.

Catalano, Asselta, and Durkin (2019)found a negative relationship between science teaching self-efficacy and science content knowledge. In other words, although their knowledge of science content is very low, teachers have the perception that they will teach science effectively. On the contrary of this study, Menon and Sadler (2016) argued that there was a positive relationship between science self-efficacy and science conceptual understanding. Another important finding in the study of Catalano, Asselta and Durkin (2019) is that self-efficacy perceptions differ slightly in different fields of science. Sultan, Henson, and Fadde (2018) also revealed a similar finding showing that among the sub-fields of science, pre-service science teachers have the highest self-efficacy in biology teaching and the lowest self-efficacy in physics teaching.

As a result, it is seen that the importance given to the content knowledge in teacher training programmes has gradually decreased from the past to the present. The fact that pedagogy and technology knowledge come to the forefront in teacher training institutions causes the importance of content knowledge to be ignored. This results in low self-efficacy perceptions of teachers' science content knowledge. Interestingly, there are very few studies investigating teachers' science content knowledge (Diamond et al., 2014). Studies show that teachers' science content knowledge and science content knowledge self-efficacy perceptions are problematic. Therefore, in this study, it was aimed to draw attention to the importance of science teachers' content knowledge self-efficacy and answers to the following question was sought.

How are the self-efficacy perceptions of science teachers regarding content knowledge?

Research Methodology

This study is a case study from the qualitative research methods. The purpose of the case study is to obtain detailed information about a case. In this process,

data collection, orientation and analysis are very important. Each case should be carefully selected for the purpose of the study. The case study facilitates deep understanding of the cases studied (Patton, 2002). Multiple case study design refers to case study research in which several instrumental limited cases are selected to develop a more in-depth understanding of the phenomenon than a single case can provide. Therefore, in this study, multiple case studies were preferred among the types of case studies. In this study, science teachers' self-efficacy perceptions about science content knowledge were determined as multiple cases.

The Study Group

In this study, the study group consisted of three science teachers who were working in public schools in the 2017-2018 academic years. The participants were first given TPACK-Science Self-Efficacy Scale that was developed for science teachers and its validity and reliability was calculated by Kiray, Celik, and Colakoglu (2018) . In the study, participants' responses to the TPACK Science Self-Efficacy Scale and its sub-dimensions were analysed in detail. TPACK scale was applied to a total of 11 science teachers. Considering the answers of these teachers to the content knowledge (CK) dimension, one science teacher from each upper score, medium score and lower score groups and in the range of 1-5 years of teaching experience were called to interview. All three of the teachers have a master's degree in science education. The classification of teachers is given in Table 1.

Table 1

Classification of Teachers Based on their Content Knowledge Dimension.

Dimension	Upper Score (31-45)	Medium Score (16-30)	Lower Score (0-15)
CK	Efnan Teacher (44 points)	Busra Teacher (30 points)	Melisa Teacher (15 points)

In order to keep the identity of the teachers participating in the interview as confidential, the teachers took place with different names. The demographic characteristics of the science teachers participating in the interview are as follows:

Efnan Teacher had a score of 44 in the content knowledge dimension of the TPACK Self-Efficacy Scale and was placed in the upper score group. She graduated from science teaching department in the faculty of education. She was a graduate student at the time of the interview. She has a master's degree

in science education. She also works in a village school. Her professional experience is in the range of 1-5 years. She is teaching science to the 5th, 6th, 7th and 8th graders. There is an average of 20 students in each class that she is teaching this year.

Busra Teacher had a score of 30 in the content knowledge dimension of the TPACK Self-Efficacy Scale and was placed in the medium score group. She graduated from science teaching department in the faculty of education. She is continuing her graduate education at the university she graduated from. She is currently working as a science teacher in a central district. Her professional experience is in the range of 1-5 years. She is teaching science to the 5th, 6th, 7th and 8th graders. There is an average of 30 students in each class that she is teaching this year.

Melisa Teacher had a score of 15 in the content knowledge dimension of the TPACK Self-Efficacy Scale and was placed in the lower score group. She graduated from science teaching department in the faculty of education. She is continuing her graduate education at the university she graduated from. She is currently working in a district. Her professional experience is in the range of 1-5 years. She is teaching science to the 5th and 6th graders. There is an average of 30 students in each class that she is teaching this year.

Tools Used

The interview form was used as a data collection tool. Questions in the interview form were based on the CK dimension of the TPACK scale developed by Kiray et al. (2018). Seven different expressions in this dimension of the scale were transformed into the form of interview question. These questions were included in the interview form as the main questions. At the same time, probe questions were prepared to support these main questions in order to prevent interruptions during the interview and to obtain more in-depth information. In order to decide on the appropriateness, the validity and comprehensibility of the questions, expert opinions were asked, and pilot interviews were conducted. Following the expert opinions and the pilot interviews, the main questions and probe questions to be included in the Interview Form were finalized.

Findings Of The Study

In line with the aim of the study, a multiple case study design was carried out with the three science teachers and qualitative data were collected. In this section, the findings obtained by interpreting and analysing the collected qualitative data and comments on these findings are presented.

Science Teachers' Content Knowledge

In this section, teachers' content knowledge was examined as in the headings of science sub-content knowledge (physics, chemistry, biology, astronomy, and earth sciences), misconceptions/lack of knowledge, scientific process skills, Science-Technology-Society-Environment (STSE).

Self-Efficacy Perception of Science Sub-Content Knowledge (Physics, Chemistry, Biology, Astronomy, and Earth Sciences)

Teachers stated that they perceived content knowledge at a medium level. Teachers' self-efficacy perceptions regarding the science class in Turkey consisting of five different disciplines including physics, chemistry, biology, astronomy, and earth sciences vary. Two of the teachers consider themselves more adequate in physics than other disciplines, while the other teacher considers herself more adequate in chemistry than other disciplines. Teachers have never mentioned earth sciences or stated that they have fewer competencies than other disciplines. Teachers stated that they had difficulty in teaching the content that they feel less self-efficient. Teachers' opinions are as follows:

Efnan Teacher: When I was studying at the university, my content knowledge was not so good… I was tutoring middle and high school students before I could get a job (at the public schools). So, I've improved myself at the middle school level… If I rank (at the middle school level), first physics, then astronomy, biology, and chemistry. I feel closer to the content of physics. My physics professor at the university was very good theoretically and was so equipped, that might be the one reason… Chemistry is more troublesome than others for me. I don't like chemistry very much. I had a hard time studying (chemistry) at the university... Because I was not interested in chemistry, I had to do a lot of preliminary preparation. That's why I'm having some trouble with those parts.

Busra Teacher: I think I am good at knowledge… Actually, I feel close to all the disciplines (that make up the sciences). Frankly, I cannot say I am better at just one of them. Physics is a branch that I like very much. Actually, I like physics very much, but it is hard to teach for me. Biology is easier to teach, it is easier to understand than physics. Sometimes when we come to the astronomy, things I don't know can come up or children can have many different questions. I'm lacking knowledge in that discipline. Honestly, I would be a bit scared of the subjects if I taught to the 12th graders. I like physics very much, but… I like biology less than physics because there is so much to memorize. But I'm so comfortable when I'm teaching biology... (Students) are interested in biology, they're more or less familiar with their environment. When it comes to physics, there is a bias due to mathematical calculations and we are breaking

this bias so hard.

Melisa Teacher: I see my content knowledge at medium level. I might be good at some of them, but I think I have some deficiencies at the others… I think this is (due to) the inadequate education in the university in some subjects… (To be assigned as a teacher in public schools) even though we take the content knowledge exam and participate in trainings later, I still cannot say I am good… I think I'm a little better at chemistry. I am at the medium level in physics, biology, astronomy and earth science. If I had to rank, I would rank first chemistry and physics, then biology and others. While I was preparing for the content knowledge exam (to be assigned as a teacher in public schools in Turkey), I could easily understand and quickly solve the chemistry questions. When I learn the subject in general, I don't have any problems in solving the questions. But I was making more mistakes in physics or biology. This shows that I have a lack of content knowledge. That is how I know that (the process of preparing for the content knowledge exam) ... For example, I think you care more because you feel that you are missing knowledge in biology… I do teach chemistry better…

Misconceptions

Teachers have knowledge about misconceptions. Especially they are aware that lack of knowledge is not a misconception. However, they do not know how to identify or correct misconceptions. They state that the only source in which the misconceptions are presented to them is the old science curriculum. Teachers think that they have more misconceptions in the fields of chemistry and physics in elementary school science curriculum.

Efnan Teacher: Misconception means that the concepts that are related to each other are used instead of the actual concept, without being aware because the content knowledge is inadequate… I had a hard time in teaching heat and temperature concepts to the 8th graders. In the last year, I have also had trouble explaining the Mass-Weight relationship to the 7th graders... I have difficulty in explaining misconceptions and children have difficulty in understanding... In the university education, the misconceptions were not given much importance... I had no knowledge of misconceptions before. As I face them by myself, I realized them… I do not have a very clear content knowledge of misconceptions about science ... (Excess of misconceptions) I think in Chemistry… There is heat-temperature at middle school level… many of them are about lack of knowledge.

Busra Teacher: Misconception is misunderstanding of the concepts. Mixing the concept even though student saw it. I am aware of the concepts melting and dissolution, heat and temperature… I do like to elaborate many miscon-

ceptions because when I cannot clarify things in my mind, I am having trouble to explain them to the students. I know many of them. When we were at the university doing microteaching, we had criticized some of our friends about it. I remember that a friend of mine used the role-playing technique to describe the atomic charge… Although he had to move the electrons, he moved the protons… There is not much of a misconception in the curriculum… Actually they (learning disciplines) all have more or less… For example, melting and dissolution concepts. When we throw sugar into tea, we say it is dissolved not melted. Sometimes I see that they write neutron is uncharged, and I fix it and say that neutron is neutral. Positive and negative charges are equal to each other. Also, when students see the models, they think that these are bigger in the reality. When explaining the atriums and ventricles of the heart as well, they think it's so big. In order to correct it, I bring the human body and show them the parts. In the phases of the moon, for example, I explain the reason why some parts of the moon are dark, and light is the rotation of the Moon. For those who think that the shape of the Moon changed, I explain that the shape is same and that it looks dark when it cannot receive light from the Sun because it is not a light source. Misconception is the mix of meaning in the concepts. Lack of knowledge means that the person either did not understand or did not receive that information… Everything is not a misconception. Maybe it is because of the lack of knowledge. But if the person is mixing things in spite of receiving the information, then it is a misconception.

Melisa Teacher: Misconception is that you think wrong and insist on that, accepting that as absolute truth, not being aware of the wrong. I am aware of misconceptions but when I look at them, I don't all the misconceptions. You notice some of them and check yourself; and you pay special attention while explaining to the students. However, there are times when you don't notice it, or you fall into the misconception yourself… Sometimes misconceptions are also included in the curriculum… There is no website that I look at for misconceptions… There are a lot of academic studies about misconceptions, so it might be better to benefit from them… Because I do not have very detailed information about all of them (misconceptions), I cannot say it is all under my control… For example, I think there is more misconception in physics and chemistry when you consider the sub-branches, biology has misconceptions too but I think there will be more misconceptions in these two… There is a misconception about heat and temperature. I mean the concepts of heat and temperature are different. There are students who think that the gas released as a result of a chemical reaction is destroyed. They don't think it exists because they don't see the gas. It's the same for the air. Melting and dissolution concepts are also very confusing. There are more, but these are the things I think now.

Scientific Process Skills

All three teachers think that the development of scientific process skills in science is very important. Teachers stated that they had the most difficulty in teaching dependent and independent variables among scientific process skills at 5-8 grade levels.

Efnan Teacher: Yes, it is certainly important. Today, I explained the subject of electricity to the 5th graders in the classroom. I had to explain how the bulb brightness is affected as the number of batteries increases or how the life of battery is affected as the number of bulbs increases. It is one of the musts for science… I mean dependent and independent variables… I explained them by simulating a cake. I told them if I increase the number of grapes, the consistency of the cake changes. However, there are students who gave this cake example in the exam. They could not really adopt it to the science. It is a little abstract about science.

Busra Teacher: I think Scientific Process Skills (SPS) are very important. It improves the child's oratory or point of view. It improves child's prediction and what s/he needs to look at while observing… I use SPS in my lessons as much as I can. Most students make predictions and observations. There are students who can design an experiment, but they cannot do it all… I place predictions in the lesson, and I support this with the book. There are prediction boxes in the book, and I think about them. I also place observations and inferences in the lesson, but I'm not doing anything extra to improve the SPS… I care about variables, but they find it hard to understand. I'm having trouble in explaining the dependent and the independent variables. They learn in the 5th grade, but most of them forget it. In the 6th grade, we explain it again and even teach them in the 7th and 8th grades.

Melisa Teacher: I think it is quite important for science. A student should be able to perform observations, predictions, comparisons, classifications, and experiments, so that s/he can learn science… I try to make each one of them participate. I also try to make them do experiment... Unfortunately, students are having trouble in understanding mostly dependent and independent variables. They learn them in the 5th grade, but even in 7th grade, they are still having a lot of trouble. For example, they learn the dependent, independent, and control variables when doing a simple electrical circuit. I don't know if this is because the 5th grade, but somehow students cannot transfer their learning to the further grades when they continue to the next grades without completely understanding it. I have to remind them in every single experiment. Right now, my 6th graders did not completely understand it. I realize this is a shortcoming. They know the name of the dependent and independent variables, but they don't know what they mean. After learning in 5th grade, it is necessary

to remind, especially in our experiments, that this is our dependent variable, and this is our independent variable.

Science-Technology-Society-Environment

The knowledge of the teachers about the field of STSE is very superficial. Teachers' STSE understanding was limited to trying to explain the relationship between these four concepts. It is seen that teachers are not quite aware of socio-scientific issues, sustainable development, science and career awareness, nature of science, the contribution of science to the society and the relationship between science and technology sub-fields within the scope of STSE in 2013 science education curriculum in Turkey. Teachers talked about the relationship between science and technology as these concepts are in the title itself. All three teachers have an opinion, though limited, about the nature of science. Only one teacher has once used the concept of sustainable development in a sentence. Teachers' knowledge about the nature of science is limited to the knowledge that scientific knowledge is subjective, can change because it is not absolute truth, and is not a method of science. However, it is seen that teachers just memorized that scientific knowledge is subjective and is not the method of science. Their explanations showed that the teachers did not fully understand these two characteristics of scientific knowledge.

Efnan Teacher: Science and technology are intertwined, so is the community and the environment. They are influenced by each other. All the developments in technology are tied to the science… It is easy to classify living things because I am in a village school. It is also easy to explain global warming and biodiversity by just going out of the school. I make them look around… I also take advantage of the environment when I am explaining the kinetic and potential energy and simple machines. Chemistry subjects mostly remain in the classroom. I give examples of daily life, but frankly I do not think that I am very adequate… (Science). It is in a certain order… It can be changed; can be tried so it can be repeated. There is also a margin of error… I started to have grasp of it a little more after I started my master's degree. In the lessons, we have seen theoretical issues related to the nature of science. Interchangeability of scientific knowledge… We are already asked to reflect on the science curriculum. Children are asked to work as scientists. There are expressions like "does" and "research" at objectives (in the curriculum). I explain them we first need to determine a problem situation, make hypotheses, and try to find solutions by experimenting. I'm not very successful at 5th and 6th grades. Grade 8 students are getting better through the end of this semester.

Busra Teacher: There is expansion is Science-Technology-Society-Environment. The importance of science for the society, its importance and impact for the environment. In our lessons, we talk about air, water, environmental pollution

and recycling. Its importance on the society, frankly I think so… I am sensitive about the environment… We warn (students) about recycling. We have recycling bins in our school. Although we have difficulties in collection, these things stay in the school for sometimes. We are always telling that we should keep our environment clean, and trees should not be harmed. But if the students do these at school and not do at home, then it doesn't have a meaning. If you want to publish an article, you have a method based on where you publish it. But if you want to discover something yourself, I don't think it is so much necessary. One searches the encyclopaedias, one searches on the Internet, one searches by asking someone else, and the other one searches on his own. I don't think there's a single method. There's no right or wrong... It varies from person to person. But of course, there are some truths that everyone accepts. But they are not immutable… Frankly, I know they can change and be changed. For instance, it is thought that the atom cannot be broken down but now it can be. The thing that is different at the beginning can gradually get a different shape.

Melisa Teacher: It is the relationship of science with technology, society, and environment. It makes the connection with each other and makes a whole. I think these are objectives for transferring science, not just theoretically, to the technology, to the society, and to the environment. Science develops as technology develops. I think these should be explained (to the students) because as many subjects of science are related to what we see around us. Many of the phenomena we've already observed are the subject of science. In particular, you're teaching to the students at a simpler level compared to physics, chemistry, and biology; students are already encountering many phenomena in society, they are already in touch with the environment, and they are already using the technology. That's why I think it should be taught. I am trying to mention these as much as I can. These are already in the book as well. For example, there are things like being a conscious consumer, or what can be done for sustainable development. I also mention these in the classroom when it is time. I'm trying to relate to technology. First of all, science starts with a problem around people, or with the solution to this problem. You can look at the past studies. Maybe you can ask the ones around, you can do an observation and an experiment. You search for sources in the past. You can consult the people you see as scientists. You can come to the conclusion by trial and error. I think it has come this way from past to present. For example, this is always mentioned in the sources whether it is subjective. We have seen it is more subjective in the nature of science class at the university… that the knowledge may change, or may change based on the person's interpretation, or may be different according to me and different according to you. We know that it has occurred with accumulation and is continuing its accumulation from past to present. Other methods that rely on experiment and observation can

be used. It is necessary to emphasize that scientific knowledge can be changed because students can think that knowledge is immutable.

Discussion

Science teachers participated in the research have felt themselves strong in some of the areas that make up the science, while they are struggling in other areas. This finding obtained in the research is in line with the findings of Catalano et al. (2019)and Sultan et al. (2018). Physics, chemistry, biology, astronomy and earth sciences classes are included in the 5-8 science classes which is designed according to widefield design which is one of the curriculum designs approaches. This situation causes science teachers to feel strong in some areas and to feel weak in some areas. The widefield design is designed to prevent students to learn the knowledge disconnected from each other by gathering the classes that are accepted as look-alike each other (such as physics, chemistry, biology) under one roof (Henson, 2006). However, although there are some commonalities, there are differences in the nature of physics, chemistry, biology, astronomy, and earth sciences. These differences are more evident at the undergraduate and graduate level. Teachers' perceptions of self-efficacy against these classes during their undergraduate education may also be effective in their teaching career.

The importance given to the misconceptions in science education is increasing day by day. This situation led the misconceptions identified in the literature get into the curriculum (MoNE, 2005). The reason why the new teachers who did not yet spend five years in the profession is not unfamiliar with the misconceptions may be that they encounter the misconceptions in the curriculum during their undergraduate years. At the same time, the science and technology curriculum in Turkey developed in 2005 and gave importance to the misconceptions remained in force until 2013. Considering that this curriculum completely removed from the system in 2016, even if they did not see these misconceptions in the undergraduate years, it is highly probable that they encountered these misconceptions in the textbooks and curriculum in the first years of their teaching career. However, it is seen that the misconceptions of teachers are limited to the misconceptions indicated in the curriculum. In order to detect misconceptions, many instruments such as three-tier tests, four-tier tests, etc. were developed by researchers (Kaltakci-Gurel, Eryilmaz, & McDermott, 2017). Teachers, however, do not have an idea of the methods by which these misconceptions are identified. Similarly, in order to eliminate misconceptions, many methods such as conceptual change texts, conceptual refutation texts etc. have been developed. Teachers also have no opinion on methods of eliminating misconceptions. They apply the methods that they think will eliminate the misconceptions. This may be due to the fact that the

misconceptions were not mentioned in the undergraduate years.

In today's science education approach, it is adopted to develop scientific process skills in students and to plan courses to develop these skills (Aydin-Ceran & Ates, 2020; Tosun, 2020). All of the teachers participating in this research were aware of the importance of scientific process skills and gave importance to these skills in their courses in a consistent manner with the understanding of today's science education. This finding of the research contradicts the findings of Turkmen and Kandemir (2011) that teachers teach without being aware of SPSs and they do not have an idea about SPSs. This may be due to the fact that the teachers in this study have graduated from science teaching, they are new teachers who have not completed five years in their career, and they are doing a master's degree in science education. However, they find it difficult to teach dependent and independent variables at the 5-8 grade levels. According to the research conducted by Bahtiyar and Can (2016) on the pre-service teachers, although the SPS that the teachers are most successful at teaching is the ability to recognize the variables related to determining dependent and independent variables, the teachers who participated in this research have difficulty in teaching this skill in primary education. The reasoning process to determine the variables may be above the level of mental development of primary school students. Therefore, this skill, which can be easily learned in advanced ages, may not be learned in the age range of 10-15 years.

It has been revealed that the area where teachers had the least grasp of is STSE. When teachers heard this statement, they directly tended to reason with four words. The lack of awareness of the teachers about the sub-topics in the curriculum is in line with the results of the research of Erdogan (2004), Dogan (2005) , Aslan, Yalcin, and Tasar (2009) and Mihladiz and Dogan (2016). In order for the STSE education to be applied in real terms, the teachers who give science education should have knowledge about the scientific process skills and the nature of science. In addition to science, learning the nature of technology is an important objective for the STSE education (Yalaki, 2014). However, teachers in this study did not have enough knowledge about the nature of technology and its relation to science. Although there are some expressions of teachers that may be included in socio-scientific subjects, they have never mentioned the concept of socio-scientific issues. The concept of sustainable development was mentioned only once. It is also seen that teachers did not state an idea about science and career awareness.

Conclusions

Because science course is designed with widefield design approach, science teachers' self-efficacy perceptions toward physics, chemistry, biology, astron-

omy and earth sciences that constitute the science course vary. Teachers feel strong in some of these areas while feel weak in others. Teachers are having difficulties to teach areas where they feel inadequate. One of the biggest difficulties in teaching content knowledge is to overcome misconceptions. Since teachers are new in the profession and the concept of misconception is included in the curriculum, teachers are knowledgeable about what the concept of misconception is even if this knowledge is limited. However, they do not have any opinions on how to identify or eliminate misconceptions.

Science teachers have high self-efficacy perceptions about scientific process skills. Although the teachers have enough knowledge of scientific process skills, it has been found that they have difficulty in teaching some of these skills. It has been found that 5-8 grade students had difficulty in grasping especially dependent and independent variables. It is thought that this situation is not related to teachers' knowledge or skills but rather to students' level of development. About the content knowledge, STSE is the weakest area of science teachers. Teachers' knowledge of STSE is limited to the fact that they related the concepts in the acronym to each other by using the general cultural knowledge. Although sustainable development, socio-scientific issues, science and career awareness sub-dimensions in the STSE have taken place in the curriculum that the teachers used at the time this study was conducted, it was found that the teachers were not very aware of these dimensions. Although the teachers had knowledge about the nature of science in the STSE, it has been revealed that their knowledge was consisted of memorized statements and they did not completely comprehend the nature of science. Based on the results of this study, it may be recommended to organize in-service training courses in order to increase the self-efficacy of science teachers on content knowledge.

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