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The Evaluation of "Technological Pedagogical Content Knowledge based Argumentation Practices" Training for Science Teachers

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Abstract

In science education, creating learning environments supported with technology and students' use of theory-evidence coordination when expressing their ideas is emphasized regarding the development of students' scientific reasoning, critical thinking, decision making skills, and etc. In this process, great responsibilities are fallen to teachers as planner and designer of a learning environment. In this study, it is aimed to assess the training which aims the development of science teachers' *technological pedagogical content knowledge (TPACK) through argumentation practices.* In this context; this study evaluated the science teachers' argumentation skills, self-efficacy perceptions towards TPACK and the teachers' views about the training. 37 science teachers working at different cities in Turkey participated in the one group pre-test post-test experimental training study, which was lasted 54 hours during a week. The training is composed of both hand and minds on argumentation practices based on TPACK. The participants joined different activities such as collaborative group works, drama, modeling, thematic games, art activities, problem-based learning, field trips, observation and workshops. In the study, Argumentation Test, TPACK Self-Efficacy Belief Scale were used as data collection tools. At the end of the training written views of science teachers towards activities were taken. In the light of the findings, this training was effective on the participants' self-efficacy levels towards technological pedagogical content knowledge. Moreover, this training resulted in a positive change in the participants' views about how a

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statement could be accepted as an argument. However, the increase in scores of argumentation skills was not significant. Additionally almost all of the participants stated that they found the activities useful and can use in their classes. By considering these results, some suggestions were given.

Introduction

The main stay of an educational system is the teacher with his/her knowledge, skills and personal characteristics. In in-service training programs, due to its changeable feature "pedagogy, content knowledge, educational policy knowledge, use of technology in education, educational psychology etc." were frequently studied in knowledge and skill dimension. Projects for technology usage in addition to the teachers' content and pedagogical knowledge are being conducted with the purpose of increasing the teachers' quality. "Creating technological elements supported learning environments" phase, which was considered under the Project of Increasing Opportunities in Education Technology Improvements Movement (IOETI) of National Education Ministry, can be seen as a part of these changes. Although lack of technological resources was eliminated largely in schools through these improvements and the teachers use internet based technologies intensively in their daily lives (Turkish Statistical Institute [TÜİK], 2012; Baran & Ata, 2013), it is also known that the teachers had problems about using technology in their classroom (Kaya & Dağ, 2013; Çoklar, Kılıçer, & Odabaşı, 2007). Achievement of FATİH and similar projects which require technological infrastructure and knowledge is closely related to in-service trainings those aim to gain proficiency for the combination of technology, pedagogy and content knowledge and allow the transition from the theory to practice (Baran & Çağıltay, 2006) and the teachers' attitudes, perceptions and beliefs towards projects' contributions (Kaya & Yılayaz, 2013).

Technological Pedagogical Content Knowledge

In the early periods of educational technology studies, technology was defined as a medium but in the later stages it was began to be considered as a process with its transformer role. Defining technology as just an innovation and a tool that can draw students' attention in science education demands to define the role of technology again (Forsthuber, Motiejunaite, de Almeida Coutinho, Baidak, & Horvarth, 2011; National Research Council [NRC], 2012). Mishra and Koehler (2006) put forward that just as how the components of Pedagogical Content Knowledge (PCK) cannot be separated from each other, these components also cannot be separated from technology knowledge. They explained the new concept called as Technological Pedagogical Content Knowledge (TPACK) what requires for integrating of technology into pedagogy and content knowledge with. TPACK which is a part of the teachers' professional development is a model developed by the addition of technology knowledge to teaching knowledge defined as pedagogical content knowledge determined by Shulman (1986). The main components of this model are Content Knowledge (CK), Pedagogical Knowledge (PK), Pedagogical Content Knowledge (PCK) and Technology Knowledge (TK). TPACK which is the main component of this model corresponds to interactive relationship between content knowledge, pedagogical knowledge and technology, in other words it corresponds to how technology and content knowledge integrate and how the kind of instructional method and techniques can be used to help students construct the content knowledge better (Koehler & Mishra, 2005; Yanpar Yelken, Sancar Tokmak, Özgelen, & İncikabı, 2013). According to this theoretical framework, TPACK emerges from pedagogy, content and technology knowledge.

TPACK as a type of knowledge is modelled in different ways as situated, complex, sophisticated, transformer and combiner by different researchers (Angeli & Valanides, 2009; Harris, Mishra, & Koehler, 2009; Koehler & Mishra, 2009; Manfra & Hammond, 2008). For example, while Angeli and Valanides (2009) defined TPACK as a new and different knowledge type formed by the combination of content knowledge, technology knowledge and pedagogical knowledge according to transformer TPACK approach; they defined TPACK as process based knowledge combined together independently from each other during the instruction not a different knowledge type according to combiner TPACK approach. Whatever TPACK modelled, the common element of different approaches for TPACK is that it corresponds to a synthesize knowledge type which aims the inclusion of information and communication technologies and educational technologies into classroom teaching and learning processes.

TPACK has managed to become the focus of researchers' attention in a short time thanks to its structure consisted of critical multiple components which affect the teachers' teaching behaviors and identity such as content knowledge, technology knowledge, pedagogical content knowledge. In the context of TPACK, besides determination the needs of technology integration to education and theoretical studies about improvements of practices (Bull et al., 2007; Toth, 2009; Brush & Saye, 2009; de Olviera, 2010; Guerrero, 2010), it is also encountered with research studies carried out by qualitative, quantitative and mix methods (Khan, 2011; Wilson & Wright, 2010; Özmantar, Akkoç, Bingölbalı, Demir, & Ergene, 2010; Wu, Chen, Wang, & Su, 2008; Tee & Lee, 2011; Banas, 2010; Polly, Mims, Shepherd, & İnan, 2010; Özgün Koca, 2009) and studies about assessing the teachers' and the participants' products (Valtonen, Kukkonen, & Wulff, 2006; Oster Levinz & Klieger, 2010).

It is seen that practices based on TPACK contribute to the teachers' use of technology in their lessons successfully when examined studies in this fields. For example, Kaya & Dağ (2013) aimed to develop preservice science teachers' TPACK and its elements and classroom teaching skills. In this context, preservice science teachers trained in a learning environment created by blending face to face learning environment and four main and 18 sub online components consisted of Moodle CMS, Web-ODS, ITONA and E-portfolio. At the end of the study, it was determined that preservice teachers were inadequate in the determination of middle school students' learning difficulties which is a sub-component of PCK and in TCK and TPK. It was also found that while preservice teachers were found to be inadequate in four components except for technology supported strategy and method knowledge components and at the end of training there was a significant difference between control and experimental groups' middle and post test scores related to TPACK and its components and classroom teaching skills in favor of the experimental group. Guzey and Roehrig (2009) carried out a study which aims to integrate technology into high school teachers' inquiry-based science teaching lessons. In their study, after introducing various technological tools (probeware, mind mapping tools (CMaps), internet applications (computer simulations, digital images and films) to the teachers they had them make practices. At the end of the training, it was seen that the teachers' use of technology level in classroom increased and all of the teachers integrated technology into their science courses. Chikasanda, Otrel Cass, Williams, and Jones (2013) designed lessons that aim to expand teachers' nature of technology knowledge and increase classroom practices based on technologic-pedagogic and in the end, they determined that the teachers' knowledge about technology and technology education increased. Chai, Koh, and Tsai (2010) also put forward that preservice and in-service teachers' active experiences of technology are effective on TPACK components. They implemented a series of practical works and before their implementation they observed the participants' TPACK scores were highly correlated only with pedagogical knowledge. After the practical works, they found that their TPACK scores correlated highly with all other fields forming technological pedagogical content knowledge. Akkoç, Özmantar, Bingölbalı, Baştürk, and Yavuz (2011) developed a program that aims to gain technological pedagogical content knowledge to preservice mathematics teachers in their completed project. At the end of the study, they reported that the program, which consisted multiple representations of technology and concepts, students' difficulties and misconceptions about technology, method and strategy for teaching the technology and concept, measurement and evaluation about technology and concept and teaching concept with technology in the context of curriculum, was successful to develop the participants' technological pedagogical content knowledge.

Besides knowledge levels about TPACK components, affective factors such as how individuals perceive themselves and their self- efficacy beliefs which are effective on instructional decision making process and practices were also examined by the researchers. Saudelli and Ciampa (2016), in their ethnographic study, indicated that the teachers' professional experiences and pedagogical knowledge levels were effective on their decisions about the integration of mobile technology into instructional process used in classroom and their attitudes towards mobile technology they used in the study (iPad) affected their pedagogy directly and strongly. Lin, Tsai, Chai, and Lee (2013) also found that the science teachers technological pedagogical content perceptions correlated significantly positive with all other technological pedagogical content knowledge factors, female teachers trusted themselves more about pedagogical knowledge than male teachers but they felt themselves inadequate about technological knowledge and female in-service teachers' perceptions about technological knowledge, technological pedagogical knowledge, technological content knowledge and technological pedagogical content knowledge correlated significantly negative with their ages. Similarly, Öztürk (2013) found in his study -aiming to identify variables connected to classroom teachers' technological pedagogical content knowledge- that whether preservice teachers felt themselves adequate in the use of technology or not affected their technological pedagogical content knowledge. Canbazoğlu Bilici (2013, 2014, 2015) carried out trainings that aim to gain technological pedagogical content knowledge to the science teachers in the context of 4005 projects supported by TUBİTAK Science and Society Department. In this context, TPACK Self-Efficacy Beliefs Scale was implemented as pre-test in the first day of training, post-test in the last day of training and follow-up tests after 6 weeks and 1-year from training. According to results, training, which aims to gain TPACK, led to significant changes in the teachers' TPACK self-efficacy beliefs and it is determined that training affected their TPACK self-efficacy beliefs positively. On the other hand, Çoklar et al. (2007) assessed training given about educational technology in Education Faculties in terms of standards via preservice teachers' views and examined how self-efficacy perception towards educational technology differ. As a result, they found that preservice teachers showed high level self-efficacy in terms of educational technology standards, they felt themselves more inadequate in terms of performance based measurement and evaluation and they were the most adequate in internet use dimension. In Sancar Tokmak, Sürmeli, and Özgelen's study (2014) in which they examined preservice science teachers' perceptions towards the development of technological pedagogical content knowledge via preparing digital story, they determined that preservice science teachers' perceptions towards technology knowledge were weak due to their limited technology knowledge and they felt themselves inadequate before starting digital story studies but their technological pedagogical content knowledge and their perceptions about it developed as soon as they progressed in practices. Keser, Karaoğlan Yılmaz, and Yılmaz (2015) showed in their studies with preservice teachers that their TPACK proficiency level and self-efficacy perceptions towards technology integration did not differ according to gender and an increase in their TPACK proficiency level positively affects their self-efficacy perceptions towards technology integration. Moreover, researchers discussed that looking technology integration process from only TPACK framework was insufficient because integration process was associated with elements related to systems such as political system, economical system etc. and elements related to individuals such as beliefs, self-regulation, motivation etc. (Usluel, Özmen, & Çelen, 2015) and their interaction with each other. Chai, Koh, and Tsai (2013) indicated that another effective factor that influence the teachers' TPACK use and TPACK development was contextual factors and examined these factors in four dimensions including personal, interpersonal, cultural/institutional and physical/technological. They tackled epistemological and pedagogical beliefs which are effective on instructional decision making and creating a design in personal dimension; the teachers' cooperation with their colleagues in interpersonal dimension; schools' as places of cultural reproduction support for the teachers in cultural/institutional dimension and finally having technology in terms of school's opportunities and the teacher support in physical/technological dimension.

On the other hand Kay (2006) investigated 42 studies about computer use found that in more than 51 percent of those 41 studies male participants used more computers than female participants. In another study, Jamieson-Proctor, Burnett, Finger, and Watson (2006) put forward that female teachers have lower level self confidence about use of information communication technologies. Similarly, in their studies with 1185 prospective teachers Koh, Chai, and Tsai (2010) indicated that gender is an effective factor regarding technological knowledge, content knowledge and technological pedagogical knowldege as components of TPACK. Moreover, Jordan (2013) emphasized that in studies related with TPACK most of the researchers focused on either scale development or components of TPACK so studying on -as an imprortant and effective varible- gender is insufficient. He concluded that investigating gender in TPACK studies provides a clear definition of its role. Yaghi (2001) in his study with teachers showed that older teachers felt themselves less confident on use of computer. In a similar way, Lee and Tsai (2010) reported that older teachers had less self confidence regardimg their perception of TPACK. Besides Koh et al. (2010) found that there is a negative corelation between age and technological knowledge and more studies should be conducted in order to have detailed knowledge. Moving from the findings of these studies, gender, age are evaluated as effective variables in TPACK studies and in the scope of this study.

Science Teaching and Argumentation

The science teachers reflect their TPACK in terms of science courses to classroom environment in the direction of Science Curriculum (Ministry of National Education [MNE], 2013). In the vision of curriculum, it is emphasized that the teachers play facilitator and guider roles in teaching and learning process and students play investigator of knowledge source, querier, explainer and arguer individual roles (MNE, 2013, p. III). Furthermore, in the same curriculum, it is mentioned prominently that it is a necessity to take classroom and outdoor learning environment as "explain and making argument" process not only "explore and experiment" in order to provide students to learn knowledge in science field significantly and permanently. The general feature of these environments opposed to traditional instructional methods and techniques is considered as stimulating students from different aspects, establishing theory-evidence coordination when students express their ideas and especially developing students' scientific reasoning skills, critical thinking, problem-solving skills, collaborative work and decision making abilities.

Both abroad and within the country, many studies about advantages of argumentation use especially in science courses in terms of students and the teachers are encountered. For example, Uluçınar Sağır and Kılıç (2012) showed in their studies, in which they investigated the effect of argumentation based science activities on students' academic achievement and retention of knowledge, that academic achievement of the group whom activities based on this method were applied was higher than other students whom this method was not applied and this method was effective on retention-continuity of knowledge and conceptual understanding. Dawson and Venville (2010) investigated the instructional methods which develop high school students' argumentation skills towards socio-scientific issues in genetic course in their study. In this context, they used whole class group discussions and written arguments for socio-scientific issues in lessons. Findings obtained from classroom observation, video records and students' written arguments showed that the teachers could increase the quality of argumentation by promoting discussion and listening, defining argument and supporting justification for evidence. Kaya, Doğan, and Kılıç (2005) indicated that argumentative discourse via concept mapping had positive effects on college students' attitudes toward general chemistry laboratory. Walker (2011) examined the effect of general chemistry laboratory practices conducted with argumentation activities through inquiry on students in the context of doctoral thesis. At the end of the study, it was seen that argumentation through inquiry instruction model facilitated students' personal development in making argument, there was an improvement in students' performance task scores and a positive increase in students' written argument scores. Ogunniyi and Hewson (2008) found in their study in which they investigated the effect of argumentation based courses on the teachers' disposition of indigenous science knowledge that the teachers could differentiate scientific and indigenous science knowledge and their awareness about appropriate contexts where they could use scientific world view or indigenous science knowledge developed after they participated in a training about nature of science and indigenous science knowledge for 6 months. Günel, Özer Keskin and Akkuş (2013) found in their study in which they aimed to help students learn science concepts and help them strengthen their scientific literacy, moreover a change in the teachers' who will implement the method, perceptions about learning, pedagogical practices and epistemological beliefs via argumentation based science learning approach that applied in-service training seminars changed most of the teachers' classroom practices skills based on argumentation based science education approach positively.

Although argumentation based learning has been studied in international field since 1990 (Lemke, 1990; Kuhn, 1991, 1993; Siegel, 1995); it was seen that in our country the first study about argumentation was conducted by Kaya in 2005 and most of argumentation based studies in our country again was conducted without using educational technology actively (Günel, Kıngır, & Geban, 2012; Kıngır, Geban, & Günel, 2011; Günel, Akkuş, & Özer Keskin, 2010; Gümrah & Kabapınar, 2010; Kaya & Kılıç, 2008; Erduran, Ardaç, & Yakmacı Güzel, 2006). Making instructional methods independent from time and space in nowadays when technology-riched learning environments have been used common and widely in all over the world gains importance to become dominant in the production of knowledge and technology. Educational technology supported argumentation based teaching practices are increasing gradually in Finland (Kiili, 2012), Norway (Ludvingsen, 2012), Australia (Butchart et al., 2009; Davies, 2009), America (Hoffman, 2008) and England (Okada, 2008) in recent years and its positive effects on students' cognitive, affective and psychomotor skills have been reported. Although studies about educational technology supported argumentation based science learning become widespread gradually in abroad, it is seen that computer or educational technology supported argumentation based educational practices have just started in our country. From these studies, teaching science and technology topics via online argumentation method in elementary level conducted by Keçeci, Kırılmazkaya, and Kırbağ Zengin (2011) and Kırbağ Zengin, Keçeci, Kırılmazkaya, and Şener (2011) can be considered as first and pioneer studies. Both studies were conducted by Moodle (a software used for creating an internet based lesson or web site) commonly used in distance education software and in the end, it was concluded that online argumentation method developed students' critical thinking in both concept learning in science courses and especially socio-scientific issues in their daily lives. On the other hand, Akpınar, Ardaç, and Er-Amuce (2012) developed a computer based system called Argumantarium in order to help students learn some science units by making arguments based on virtual experiments, multiple and visual rich representation of knowledge, video and vitalization. Argumantarium learning environment developed by researchers was completely structured and news feed consisted of virtual experiments and activities flowing from material to student.

In sum, when the literature is examined about both TPACK and argumentation it is seen that both concepts are not new. However, it is known that the science teachers did not feel confident about using, developing argumentation in classroom and they had negative attitudes (Akpınar et al., 2012), they had problems about integration of technology and education especially in classroom practices (Kaya & Dağ, 2013; Çoklar et al., 2007) and their self-efficacy about technology use affected their TPACK directly (Öztürk, 2013). But it is required for the teachers to adapt and become aware of new instructional methods and develop practices in order to educate students who will meet the today requirements. Harris et al. (2009) discussed the activity types that help the teachers develop TPACK in their studies. At the end of the study, researchers advocated that TPACK based professional development trainings designed for teachers must include various instructional philosophy, instructional pattern and approaches because the teachers' TPACK is not restricted with specific teaching methods. The studies reviewed here indicate that there are separate studies about TPACK and argumentation practices but it is also seen that no single study combined TPACK and argumentation for teacher training and there is need to study the effects of gender and age. . As mentioned above, when used effectively, TPACK frame is especially important for the teachers in order to help their students comprehend the interaction between science, technology, society, environment and individual. In this context, the findings of a training, which aims to develop science teachers' TPACK through argumentation practices is presented in this study.

This research focuses on problems of "*what is the effect of "TPACK based argumentation practices" training on the teachers' argumentation skills and TPACK self-efficacy beliefs?*" and "*what are the views of the teachers about the training?*". Based on these questions, sub-problems of the study are expressed below:

1. Is "TPACK based argumentation practices" training effective on the science teachers' argumentation skills?
2. What is the effect of "TPACK based argumentation practices" training on the science teachers' TPACK self-efficacy beliefs?
    a. Do the science teachers' TPACK self-efficacy beliefs differ significantly after the training?
    b. Do the science teachers' TPACK self-efficacy beliefs differ according to gender before and after the training?
    c. Do the science teachers' TPACK self-efficacy beliefs differ according to age before and after the training?
    d. Do TPACK self-efficacy scale sub-factors differ significantly before and after the training?
3. What do science teachers think about "TPACK based argumentation practices"?

Method

Both quantitative and qualitative research methods are utilized in the study. "One group pretest posttest experimental model" was used to answer the 1st and 2nd research problems. Qualitative research methods were utilized to answer the 3rd question. In one group pretest posttest model, measurements belonged to one group were carried out before and after the implementation. The model explains that if post-test scores are higher than pre-test scores, this is because of the implementation effectiveness (Fraenkel & Wallen, 2003). Although it is a weak experimental model, it is preferred to study with one group because this study aims to determine the effectiveness of a training program.

The Participants

37 science teachers from different cities in Turkey participated in this study. The determination of teachers was based on their volunteerism. In this context, announcements about the training were made through web site (www.tpab.org) and social media groups.

When examined teachers' demographic data, it was seen that there were 3 teachers between ages of 20-25 (%8.3), 20 teachers between ages of 26-30 (%55.6), 8 teachers between ages of 31-35 (%19.4), 3 teachers between ages of 36-40 (%8.3) and 3 teachers older than age of 41 (%8.3). While 22 of the participants (%59.5) are female, 15 of them (%40.5) are male. When examined their professional experience, there were 15 teachers between years of 1-5 (%41.7), 11 teachers between years of 6-10 (%30.6), 11 teachers between years of 11-15 (%27.8). 8 of 37 the participants from Marmara Region (İstanbul-6, Bursa-1, Yalova-1); 10 of them from Aegean Region (Izmir-9, Manisa-1); 5 of them from Mediterranean region (Antalya-3, Burdur-1, Isparta-1); 6 of them from Eastern Anatolia Region (Ağrı-2, Adıyaman-1, Erzincan-1, Kars-1, Van-1); 4 of them from Southeastern Anatolia Region (Gaziantep-3, Mardin-1); 2 of them from Central Anatolia Region (Konya-1, Ankara-1) and 2 of them from Black Sea Region (Samsun-1, Sinop-1) participated in the training.

Data Collection Tools

Argumentation Test", "*Technological Pedagogical Content Knowledge Self-Efficacy Beliefs Scale*" and "*Question Form*" were used as data collection tools in the study.

Argumentation Test (AT): Originally, the test was developed towards the teachers by Sampson and Clark (2006) and adapted to Turkish by Kaya, Çetin, and Erduran (2014). Cronbach alpha reliability coefficient of test was found as .70. AT includes totally 6 questions with two parts. The first part has three questions about how a statement accepted as an argument and the second part also has three questions about how a statement accepted as a challenge to an argument. Moreover, the questions in both parts include a claim and six arguments related to this claim. In the first part, the teachers were expected to rank these six arguments according to their convincingness from 1 (the most convincing argument) to 6 (the least convincing argument). Here, argument characterized by 1 should include "*data, explanation and rebuttal*"; argument characterized by 2 should include "*explanation and evidence*"; argument characterized by 3 should include "*evidence only*"; argument characterized by 4 should include "*warrant only*"; argument characterized by 5 should include "*appeal to authority*" and argument characterized by 6 should include "*contradictory*". In the second part of AT, questions were designed to determine what the teachers thought as a good challenge to a scientific argument. In each question, the teachers were given a claim supported by an argument. Following, a challenge and six arguments related to this were given. The teachers were asked to rank these arguments in terms of their strength from 1 (the strongest argument) to 6 (the weakest argument). Here, the score 1 was categorized as "*argument with backing*"; 2 was categorized as "*argument with warrant*"; 3 was categorized as "*argument with data*"; 4 was categorized as "*argument with claim*"; 5 was categorized as "*counter claim*" and 6 was categorized as "*emotive argument*". The Argumentation Test was given in Appendix 1. In the context of the research, AT was applied as pretest in the first day and as posttest in the last day of training.

Technological Pedagogical Content Knowledge Self-Efficacy Belief Scale (TPACK SEBS): This scale was developed by Canbazoğlu Bilici, Yamak, Kavak, and Guzey (2013). The scale consists of totally 8 factors and 52 items which 8 items for pedagogical knowledge (PK), 6 items for content knowledge (CK), 10 items for pedagogical content knowledge (PCK), 6 items for technology knowledge (TK), 4 items for technological content knowledge (TCK), 7 items for technological pedagogical knowledge (TPK), 5 items for contextual knowledge (CK) and 6 items for technological pedagogical content knowledge (TPACK). The scale is 10-point Likert type whose choices ranging between "*10: believe to do definitely*" and "*0: believe not to do definitely*". Cronbach alpha reliability coefficient was found as .98 for the scale and .92; .90; .86; .89; .89; .93; .92 and .82 for sub factors respectively in the original study. In the context of the study, the scale was applied as TPACK SEBS pretest in the first day and as TPACK SEBS posttest in the last day of training and Cronbach alpha reliability coefficient was found .89 for pretest and .86 for posttest.

Opinion Form (OF): OF was developed by the researchers in order to evaluate the views of participants about training consist of questions such as "*Do you think that activities in the training are useful for you? Why?*"; "*Do you think to practice the points in the activities with your students in classroom?*" and "*How do you think about implementation of TPACK based argumentation practices in the class?*". Three expert researchers from science education and one science teacher evaluated the face and content validities of the questions.

Implementation

"*TPACK based argumentation practices*" training lasted for seven days and included 54 hours and 33 activities. In the training, besides helping the teachers develop their proficiencies about argumentation and technology practices through doing-living and hands-on activities, it was also aimed to create the teachers' awareness towards TPACK based argumentation practices. Activities and program were prepared in accordance with integrative TPACK approach (Angeli & Valanides, 2009) which views TPACK not a separate and different knowledge type but a process based knowledge brought together during teaching.

The participants were experienced the content of training program via seven experimental studies, 23 technological practices, five cooperative group works, two modelling activities, three thematic games, two artistic activities, two problem based learning activities, one day long field trip and four observation activities with six workshops and two drama activities. The participants were trained by 14 teaching staff who are leading experts in developing activity and the teacher training and working at the universities in İstanbul, Ankara, İzmir, Eskisehir and Uşak. Moreover, six teaching assistants who are expert in the fields of content knowledge, activity development and implementation and assessment also took part during the implementation. Worksheets were prepared to provide the participants to follow the instructions and to process knowledge about the purpose of activity easily. In worksheets, besides the activity name, purpose, duration etc., stimulus such as questions, reminders and technology access ways and etc., that will help the participants learn knowledge in the context of exploratory teaching approach and in collaboration in some activities.

In the first day of the study, the teachers were given TPACK SEBS and AT as pretest after a brief introduction was made. In the first day of the implementation, a presentation expressing the link between the topic of training and curriculum were made to the teachers. After that, the teachers were involved in hands on practices which they could explore the argument elements such as data, claim, rebuttal, qualifier etc. in introductory phase of argumentation. During the next two days, the teachers experienced experimental and art activities based on Toulmin Argument Model via various activities which they could constitute argument schemas. In Toulmin Argument Model, claims put forward for a specific problem are constructed with data, warrant, backing, rebuttal and qualifiers. At that point the participants initially studied the problems given through work sheets individually. Afterwards they participated in whole class discussion which lead to small group discussions those are held in group of five. Each group reviewed the basic concepts in guidance of the trainer in accordance with the research question they formulated corresponding the problem given at the beginning. The groups designed and conducted experiments, collected data and formed their claims, justifications and other argument components through the guidance and appropriate questioning techniques of the trainer. Every group presented their question, claim and justifications to the other groups and they discussed their arguments. The discussion sessions were supported by the trainer. During the whole processes the trainer was in the role of evaluating the participants' thoughts, keeping discussions in the problem line and distinguishing misconceptions in a participant centered pedagogical frame. At the end of completing group work, every participant reflected on their learning process, role of both student and teacher and the relationship between argument and learning through their experiences. By this way, the participants' obtainment of experiences related with argumentation based learning processes and pedagogical qualifications were aimed. Starting from the third day of training program, both theoretical information about various technological applications was given to the teachers and allowed them to experience these applications actively. For this reason, the participants had their own laptops. In addition to this, they were also able to participate in mobile applications with their own mobile phones as all of them had smart phones. Hands on learning environments where they could integrate both technology and argumentation were created for the teachers with the inclusion of technological applications. In this context, they carried out some works such as preparing e-journal with Word program, sharing this journal on social media environment (Facebook), making a video and adding photo, setting the duration of the photo on the screen, adding audio to video, cropping the audio, splitting the audio, setting the audio level in Movie Maker program, using social media networks effectively, web 2.0 applications, introduction of web 3.0, use of Edmodo, creating animation with Powtoon, introduction and use of various simulation programs, use of smart board and tablet etc. In these activities, the participants were asked to formulate research questions, put forward their claims and reach related evidences and other argument components based on the worksheet just they had experienced in the first two days of the training but this time through technological applications. In the fifth day of the study, the teachers participated in a geology field trip with an instructor who is the expert in the field. During the field trip where the fundamental principles of geology were experienced, the teachers collected data with both technological tools and information given by instructor. In the last day of study, the teachers designed a learning environment based on technological pedagogical content knowledge based argumentation by using data collected in field trip within the frame of problems/scenarios given to them and they presented them to a jury consisted of instructors and other colleagues. Reflective discussions were made after each presentation. At the end of the implementation, TPACK SEBS, AT and OF were applied as posttest.

Data Analysis

After data was collected through AT and TPACK SEBS, test of normality was conducted in order to decide the statistical test to be used. Among the normality tests Shapiro-Wilks test was carried out because the group size was less than 50 (Büyüköztürk, 2009).

Analysis results obtained from Shapiro-Wilks for AT consisted of two parts were accepted as appropriate for normal distribution because p value is greater than 0.05 for both pretest and posttest distribution of first part (p= .07 and p=.08 respectively) and pretest and posttest distribution of second part (p= .06 and p=.07 respectively). Based on these results, paired sample t-test was used to compare the mean scores obtained from AT.

For TPACK SEBS, it was seen that normality assumption was met by only CK sub-factor in all sub-factors and total score for both pretest and posttest (p value for pretest= .055 and p value for post-test=.692). P values obtained from pretest and posttest distribution were less than .05 for remaining PK, PCK, TK, TPK and CK factors. When examined whether the total score of scale distributed normal or not, it was seen that pretest and posttest scores were normally distributed (p value for pretest=.205 and p value for posttest= .532). For this reason, paired samples t test, which is a parametric test, was used in total scores analysis. Nonparametric statistical methods were utilized in scale sub-factors analysis.

The data obtained from OF were posted on computer from papers. Then, the categories were formed by starting from the sample expressions in the data. Two researchers worked in the process of category formation. Firstly, the participants' expressions were categorized by the first researcher. After then, other researcher categorized the participants' expressions similarly. At the end of the categorization process, correspondence percentage (number of common codes/ number of all codes) between two researchers was found as .87 (Miles & Huberman, 1994). The categorization process was accepted as reliable because correspondence percentage was found greater than .70 (Büyüköztürk, 2009. In the presenting of the data as findings, expressions belonged to non-agreement categories were categorized by examining again. The teachers' views were cited to provide internal validity and reliability. While making analysis, a descriptive code was written for each teacher instead of the name (K1, K2, K3…etc.).

Findings

The findings obtained from the study were presented in the following according to the order of sub-problems.

The First sub-problem: Is "TPACK based argumentation practices" training effective on the science teachers' argumentation skills?

Paired samples t-test results conducted with the aim of determining whether the difference between the teachers' pre-test and post-test scores was significant were presented in Table 1.

Table 1. Mean Scores of the Teachers' Answers Related to AT

	n	$\overline{x}$	SD	*t*	*P*
I. part scores					
Pre-test	37	6.08	2.27	-1.90	.06
Post-test	37	6.97	2.42		
II. part scores					
Pre-test	37	9.39	2.70	.49	.63
Post-test	37	9.11	2.30		
Total Score					
Pre-test	37	15.47	3.53	-.84	.41
Post-test	37	16.08	3.63		

*p<.05

Table 1 indicated that while pre-test scores are 6.08, post-test scores are 6.97 related to first part which aims to determine how a statement is accepted as a good argument by the teachers. Although it was seen that there was an increase in the teachers' post-test scores, t-test results showed that this increase was not significant (t (36)= -1.90; p>.05). Similarly, although it was seen that the teachers' post-test scores were higher than pre-test scores related to total score, this difference also was not significant statistically (t (36)=.84; p>.05). Moreover, although data in the table showed that the teachers' post-test scores were lower than pre-test scores related to second part which aims to determine how a statement was accepted as a good challenge to a scientific argument by the teachers, this difference was not significant (t (36)=.49; p>.05).

Besides statistical comparison, frequency values for each question were also presented to determine the rate of the teachers' correct answers and what they choose as alternative answers. The data were presented in the tables at the following.

Table 2. Percentage of the Teachers' Answers Related to First of Part of AT Pre-Test

Item no	Correct answer (order)	Percentage of correct answer	1st most chosen wrong answer	Percentage of 1st most chosen wrong answer	2nd most chosen wrong answer	Percentage of 2nd most chosen wrong answer	3rd most chosen wrong answer	Percentage of 3rd most chosen wrong answer
1.1	3	13.8	5	36.1	6	32.2	1	16.6
1.2	4	27.7	3	25	2	22.2	5	16.6
1.3	2	36.1	1	36.1	3	13.8	4	8.33
1.4	6	2.7	3	47.2	3	27.7	1, 5*	11.1
1.5	5	22.2	6	63.8	4	8.3	1, 2*	2.7

Table 2. Continue

Item no	Correct answer (order)	Percentage of correct answer	1st most chosen wrong answer	Percentage of 1st most chosen wrong answer	2nd most chosen wrong answer	Percentage of 2nd most chosen wrong answer	3rd most chosen wrong answer	Percentage of 3rd most chosen wrong answer
1.6	1	30.5	2	30.5	3	19.4	5	11.1
2.1	4	30.5	3	38.8	5	32.2	2	8.33
2.2	2	75	3	13.8	1	8.3	5	2.7
2.3	6	19.4	5	50	4	25	3	5.5
2.4	3	33.3	4	38.8	2,4*	11.1	1	5.5
2.5	5	11.1	6	11.1	3, 4*	5.55	-	-
2.6	1	88.8	2, 3, 5, 6*	2.7	-	-	-	-
3.1	6	83.3	5	11.1	3, 4*	2.7	-	-
3.2	1	22.2	2	27.7	3, 4*	19.4	5	11.1
3.3	5	55.5	4	22.2	3, 6*	11.1	-	-
3.4	2	16.6	1	41.6	3, 4*	16.6	5	8.3
3.5	4	19.4	2	33.3	3	30.5	1	11.1
3.6	3	19.4	1	25	2	22.2	4	19.4

* selected questions are preferred at the same rate.

Table 2 showed the values of correct answers and frequency percentage of selected alternative answers to this correct answer related to what the teachers accept as a good argument before training. According to this, only %30.5 of the teachers could determine the most convincing argument for the claim given in the first question. The remaining %69.5 preferred the arguments including "*explanation and evidence*" (%30.5), "*evidence only*" (%19.4) and "*appeal to authority*" (%11.1) as the most convincing argument in the descending order. Similarly, only %22.2 of the teachers could determine the most convincing argument in the third question. The remaining %77.8 preferred the arguments including "*explanation and evidence*" (%27.7), "*evidence only*" and "*warrant only*" (%19.4) and "*appeal to authority*" (%11.1) as the most convincing argument in the descending order. However, the teachers showed %88.8 success rate in determining the most convincing argument.

When examined the data generally, it was seen that the teachers confused the most convincing argument including "*data, explanation and rebuttal*" (1) with the arguments including "*explanation and evidence*" (2) mostly and in addition to this they also preferred the arguments including "*evidence only*" (3), "*appeal to authority*" (5) and "*contradictory*" (6) as an alternative to the most convincing argument in the second question. Similarly, most of the teachers preferred the argument including "*explanation, data and rebuttal*" (1) as an alternative to the argument including "*explanation and evidence*" (2) in the first and third questions but they selected the argument including "*evidence only*" (3) in the second question. The teachers selected "*appeal to authority*" (5) in the first question, "*warrant only*" (4) in the second question, "*explanation, data and rebuttal*" (1) in the third question as alternative answers to the statements related to "*evidence only*" (3) argument. For the arguments including "*warrant only*" (4), while most of the teachers selected the argument including "*evidence only*" (3), in the third question some of the teachers selected the argument including "*explanation and evidence*" (2) as alternative answer. For the arguments including "*appeal to authority*" (5), while the teachers leaned towards the argument including "*contradictory*" (6) in the first and second questions, they preferred the argument including "*warrant only*" (4) in the third question. While the teachers classified the statements related to "*contradictory*" (6) as the argument including "*appeal to authority*" (5) in the second and third questions, they also selected the argument including "*warrant only*" (4) in the first question.

Table 3. Percentage of the Teachers' Answers Related to Second Part Pre-Test of AT

Item no	Correct answer (order)	Percentage of correct answer	1st most chosen wrong answer	Percentage of 1st most chosen wrong answer	2nd most chosen wrong answer	Percentage of 2nd most chosen wrong answer	3rd most chosen wrong answer	Percentage of 3rd most chosen wrong answer
4.1	2	36.1	3	25	1	19.4	4	16.6
4.2	5	66.6	4	16.6	6	11.1	3	5.5
4.3	1	58.3	2	22.2	3	13.8	4	5.5
4.4	3	25	2	27.7	4	25	1	19.4
4.5	6	86.1	5	11.1	4	2.7	-	-
4.6	4	33.3	3	30.5	5	16.6	2	13.8
5.1	6	97.2	5	2.7	-	-	-	-
5.2	2	11.1	5	52.7	3	19.4	4	11.1
5.3	4	33.3	3	44.4	2	16.6	1, 5*	2.7
5.4	3	16.6	2	38.8	1	25	4	19.4
5.5	1	69.4	2	25	3	5.5	-	-
5.6	5	41.6	4	36.1	3	13.8	2	8.3
6.1	3	33.3	2	36.1	4	22.2	1, 5, 6*	2.7
6.2	5	58.3	6	27.7	4	8.3	3	5.5
6.3	2	50	3	38.8	1, 4*	5.5	-	-
6.4	6	69.4	5	25	3, 4*	2.7	-	-
6.5	1	91.6	2	5.5	3	2.7	-	-
6.6	4	61.1	3	16.6	5	13.8	2	8.3

* selected questions are preferred at the same rate.

Table 3 showed the values of correct answers and frequency percentage of selected alternative answers related to how a statement was accepted as a good challenge to a scientific argument by the teachers before training. According to this, the teachers could determine the strongest argument properly in the rate of %58.3 in the fourth question, %69.4 in the fifth question and %91.6 in the sixth question. However, they leaned towards "*argument with warrant*" alternative answer (2) mostly instead of selecting "*argument with backing*" (1) as the strongest argument in all of each three questions.

The teachers were able to show success in the ratio of %36.1 in the fourth question, %11.1 in the fifth question and %50 in the sixth question in determining the "*argument with warrant*" as the second strongest argument. However, they categorized the second strongest argument as "*argument with data*" (3) in the fourth and sixth questions and "*counter claim*" (5) in the fifth question alternatively.

The teachers' determination ratio of the third strongest argument properly was %25 in the fourth question, %16.6 in the fifth question and %33.3 in the sixth questions. However, the teachers preferred "*argument with warrant*" (2) mostly instead of selecting "*argument with data*" (3) as the third strongest argument in all of the questions.

The teachers were able to determine the fourth strongest argument properly in the rate of %33.3 in the fourth question, %33.3 in the fifth question and %61.1 in the sixth question. However, they learned towards "*argument with data*" (3) alternative answer mostly instead of selecting "*argument with claim*" as the fourth strongest argument in all of each three questions.

Similarly, the teachers showed success in the ratio of %66.6 in the fourth question, %41.6 in the fifth question and %58.3 in the sixth question in determination of the fifth strongest argument. When examined the alternative categorizations, it was seen that the teachers confused *"counter claims"* (5) with *"argument with claim"* (4) in the fourth and fifth questions and "*emotive argument*" (6) in the sixth question.

Finally, it was seen that the teachers were more successful in fourth (%86.1) and fifth (%97.2) questions than sixth question (%69.4) in determination of the weakest argument. However, when examined the selected alternative answers, it attracted the attention that the teachers had difficulties mostly in distinction of "*emotive argument*" (6) as the weakest argument from "*counter claims*" (5) in all of the questions.

Table 4. The Teachers' Answer Percentage of AT First Part Post-Test

Item no	Correct answer (order)	Percentage of correct answer	1st most chosen wrong answer	Percentage of 1st most chosen wrong answer	2nd most chosen wrong answer	Percentage of 2nd most chosen wrong answer	3rd most chosen wrong answer	Percentage of 3rd most chosen wrong answer
1.1	3	36.1	1	19.4	4, 5*	13.8	6	11.1
1.2	4	47.2	5	27.7	6	11.1	3	8.3
1.3	2	44.4	1	27.7	3	16.6	5, 6*	5.5
1.4	6	0	5	38.8	3	27.7	4	22.2
1.5	5	11.1	6	66.6	4	13.8	3	5.5
1.6	1	44.4	2	41.6	3	5.5	4, 5, 6*	2.7
2.1	4	30.5	3	36.1	5	13.8	2	11.1
2.2	2	77.7	3	11.1	4	5.5	1, 5*	2.7
2.3	6	22.2	5	36.1	4	25	3	11.1
2.4	3	41.6	4	30.5	5	19.4	2	5.5
2.5	5	22.2	6	63.8	4	8.3	1, 2*	2.7
2.6	1	91.6	5	5.5	6	2.7	-	-
3.1	6	86.1	5	8.3	1, 4*	2.7	-	-
3.2	1	19.4	3	38.8	2	30.5	4	5.5
3.3	5	50	4	25	2	11.1	3	8.33
3.4	2	27.7	1	38.8	3, 4*	13.8	-	-
3.5	4	30.5	3	27.7	5	19.4	2	16.6
3.6	3	11.1	1	33.3	4	22.2	2, 5*	13.8

* Indicated items are chosen in same frequency.

Table 4 indicates the percentage of the teachers correct and alternative answers about their choice of good arguments after instruction. According to this, the teachers could determine the most convincing argument correctly by %44.4 percentage. However, rest of the teachers with %55.6 percentage have preferred alternative answers shown with decreasing order "*explanation and evidence*" (%41.6), "*only evidence*" (%5.5) and "*warrant only*", "*appeal to authority*", and "*contradictory*". Similarly, in third question, in which most convincing argument is determined, the teachers made correct decisions with %19.4 percentage, while their alternative answers shown with decreasing order "*evidence only*" (%38.8), "*explanation and evidence*" (%30.5) and "*warrant only*" (%5.5). However, in second question, the teachers determined the most convincing argument with %91.6 percent success.

Table 4 indicated that the teachers had difficulties in making distinction between the most convincing argument which includes "*data, explanation and rebuttal*" (1) and alternative arguments including "*explanation and evidence*" (2) in first question, "*appeal to authority*" (5) in second question and "*evidence only*" (3) in third question. Most of the teachers classified their arguments with answer "*explanation and evidence*" (2) in first and third questions while also classifying "*evidence only*" in second question. Similarly, the teachers have chosen "*data, explanation and rebuttal*" (1) answer for arguments in which correct answer is "*evidence only*" (3), however in second question they also preferred "*warrant only*" (4) alternative answer. The teachers confused classifications in which correct answer is "*warrant only*" (4) with options "*appeal to authority*" (5) in first question and "*evidence only*" (3) in second and third questions. Some of the teachers who preferred "*contradictory*" (6) option in first and second questions which has "*appeal to authority*" (5) correct answer also preferred "*warrant only*" (4) classification in third question. Moreover, the teachers preferred alternative answer "*appeal to authority*" (5) in arguments with correct answer "*contradictory*" (6) in all questions.

Table 5. The Teachers' Answer Percentage of AT Second Part Post-Test Test

Item no	Correct answer (order)	Percentage of correct answer	1st most chosen wrong answer	Percentage of 1st most chosen wrong answer	2nd most chosen wrong answer	Percentage of 2nd most chosen wrong answer	3rd most chosen wrong answer	Percentage of 3rd most chosen wrong answer
4.1	2	30.5	3	33.3	1	30.5	4	5.5
4.2	5	47.2	4	15.1	6	11.1	3	8.3
4.3	1	50	2	30.5	3, 4*	8.3	6	2.7
4.4	3	36.1	2	25	4	19.4	1	13.8
4.5	6	83.3	5	16.6	-	-	-	-
4.6	4	38.8	5	30.5	3	16.6	2	8.3
5.1	6	100	-	-	-	-	-	-
5.2	2	5.5	5	36.1	4	33.3	3	22.2
5.3	4	16.6	3	69.4	2	11.1	1	2.7
5.4	3	2.7	2	52.7	1	22.2	4	13.8
5.5	1	72.2	4	13.8	2	11.1	3	2.7
5.6	5	55.5	4	22.2	2	19.4	3	2.7
6.1	3	36.1	2	41.6	4	13.8	1	5.5
6.2	5	55.5	6	19.4	4	13.8	3	8.3
6.3	2	44.4	3	44.4	5	8.3	4	2.7
6.4	6	80.5	5	19.4	-	-	-	-
6.5	1	94.4	2, 4*	2.7	-	-	-	-
6.6	4	63.8	2, 3, 5*	11.1	6	2.7	-	-

* Indicated items are chosen in same frequency.

Table 5 shows percentage frequency values of the teachers' correct and alternative answers about which statement they prefer as rejection to a scientific argument. According to this, the teachers could spot the strongest argument %50 correct in fourth question, %72.2 correct in fifth question and %94.4 correct in sixth question. On the other hand, in statements they should choose "*argument with backing*" (1) as the strongest argument, they chose "*argument with warrant*" (2) in fourth question, "*argument with claim*" in fifth question and both alternative answers in sixth question.

The teachers could determine "*argument with warrant*" as the second strongest argument %30 correct in fourth question, %5.5 correct in fifth question and %44.4 correct in sixth question. However, they have classified alternative arguments "*argument with data*" (3) in fourth and sixth questions and "*counter claim*" (5) in fifth question as second strongest argument.

The teachers' rates of determining third strongest argument are %36.1 in fourth question, %2.7 in fifth question and %36.1 in sixth question. However, in all questions the teachers mostly preferred "*argument with warrant*" (2) alternative answer instead of "*argument with data*" (3) answer which they should have preferred.

The teachers could determine fourth strongest argument at rates of %38.8 in fourth question, %16.6 in fifth question and %63.8 in sixth question. However, the teachers mostly preferred "*argument with data*" (3) and "*counter claim*" (5) alternative answers instead of "*argument with claim*" answer which they should have preferred in three questions. In sixth question, they also have preferred "*argument with warrant*" (2) in addition to these alternative answers.

Similarly, the teachers could determine fifth strongest argument at rates of %47.2 in fourth question, %55.5 in fifth question and %55.5 in sixth question. Alternative classifications examination Show that the teachers confused "*counter claim*" (5) with "*argument with claim*" in fourth and fifth questions and "*emotive argument*" in sixth question.

Lastly, the teachers were successful in determining the weakest argument in fourth (%83.3), fifth (%100) and sixth (%80.5) questions. However, in fourth and sixth questions the teachers confused weakest argument "*emotive argument*" (6) with alternative answer "*counter claim*" (5)

Second sub-question: **What is the effect of "TPACK based argumentation practices" training on the science teachers' technological pedagogical content knowledge self-efficacy beliefs?**

In order to answer "Do the science teachers' TPACK self-efficacy beliefs differ significantly after the training?" sub-question, results of paired sample t-test, which conducted to determine difference in the teachers' TPACK SEBS pre-test and post-test scores, are presented below.

Table 6. The Teachers' TPACK SEBS Answer Score Means

	n	$\overline{x}$	SD	*t*	*P*
Pre-test	37	78.55	9.53	-3.72	.001*
Post-test	37	83.90	7.82		

* p<.05

According to Table 6, the mean of post-test score ($\overline{x}$ = 83.90; SD = 7.82), was higher than the mean of pre-test scores ($\overline{x}$ = 78.55, SD = 9.53) and the difference was statistically significant (t(36) = -3.72; p = .001)).

In order to answer the sub-question "Do the science teachers' TPACK self-efficacy beliefs differ according to gender before and after the training?" independent sample t-test results are presented below. Levene homogeneity of variance test was conducted for pre-test, post-test and homogeneity of variance hypothesis was accepted. The post-test findings indicated women's score means ($\overline{x}$ = 82.89; SD = 7.20) were not significantly different from men's score means ($\overline{x}$ = 85.32; SD = 8.67) (t (35) = .91; p = .37). Pre-test results also indicated women's score means ($\overline{x}$ = 77.27; SD = 9.66) were not significantly different from men's score means ($\overline{x}$ = 80.33; SD = 9.37) (t (35) = .95; p = .35).

Table 7. Descriptive Values of TPACK SEBS Pre-Test Post-Test Scores According to Gender

	Gender	n	$\overline{x}$	SD	SEM
Post-test	Female	22	82.89	7.20	1.57
	Male	15	85.32	8.67	2.23
Pre-test	Female	22	77.27	9.66	2.11
	Male	15	80.33	9.37	2.41

In order to answer sub-question "Do the science teachers' TPACK self-efficacy beliefs differ according to age before and after the training?" independent sample t-test results are presented below. Levene homogeneity of variance test was conducted for pre-test, post-test and homogeneity of variance hypothesis was accepted. The post-test findings indicated no significance difference between age 20-30 the participants' score means ($\overline{x}$ = 82.54; SD = 7.94) and age 30 and higher the participants' score means ($\overline{x}$ = 86.32; SD = 7.26) (t (35) = 1.41; p = .16). However, pre-test TPACK findings indicated age 20-30 the participants' score means ($\overline{x}$ = 75.47; SD = 8.52) were significantly lower than age 30 and higher the participants' score means ($\overline{x}$ = 84.00; SD = 9.03) (t (35) = 2.82; p = .008).

Table 8. Descriptive Values of TPACK SEBS Pre-Test Post-Test Scores According to Age

	Age	n	$\overline{x}$	SD	SEM
Post-test	20-30	23	75.47	8.52	1.77
	31>	14	84.00	9.03	2.50
Pre-test	20-30	23	82.54	7.94	1.65
	31>	14	86.32	7.26	2.01

In order to answer "Do TPACK self-efficacy scale sub factors differ significantly before and after the training?" sub-question, Wilcoxon test was used. Table 9 shows average score means of the participants according to factors.

Table 9. Row Means and Row Sums

		n	Row mean	Row sum
SPK – PK	Negative rows	10[a]	13.56	122.00
	Positive rows	25[b]	18.92	473.00
	Equal	2[c]		
	Total	37		
SCK – CK	Negative rows	12[d]	15.41	169.50
	Positive rows	21[e]	17.07	358.50
	Equal	4[f]		
	Total	37		
SPCK – PCK	Negative rows	11[g]	13.20	132.00
	Positive rows	26[h]	20.54	534.00
	Equal	0[i]		
	Total	37		

Table 9. Continue

		n	Row mean	Row sum
STK – TK	Negative rows	13[j]	14.33	172.00
	Positive rows	24[k]	20.58	494.00
	Equal	0[l]		
	Total	37		
STCK – TCK	Negative rows	9[m]	9.88	79.00
	Positive rows	26[n]	19.85	516.00
	Equal	2[o]		
	Total	37		
STPK – TPK	Negative rows	11[p]	11.55	115.50
	Positive rows	24[q]	19.98	479.50
	Equal	2[r]		
	Total	37		
STPACK – TPACK	Negative rows	9[s]	11.88	95.00
	Positive rows	25[t]	18.64	466.00
	Equal	3[u]		
	Total	37		
SCK – CK	Negative rows	12[v]	14.86	163.50
	Positive rows	23[w]	18.76	431.50
	Equal	2[x]		
	Total	37		

a. SPK < PK, b. SPK > PK, c. SPK = PK, d. SCK < CK, e. SCK > CK, f. SCK = CK, g. SPCK < PCK, h. SPCK > PCK, i. SPCK = PCK j. STK < TK, k. STK > TK, l. STK = TK, m. STCK < TCK, n. STCK > TCK,, o. STCK = TCK, p. STPK < TPK , q. STPK > TPK, r. STPK = TPK, s. STPACK < TPACK, t. STPACK > TPACK, u. STPACK = TPACK , v. SCK < CK, w. SCK > CK, x. SCK = CK

According to the results, from 37 participants, 25 participants' PK, 21 participants' CK, 26 participants' PCK, 24 participants' TPK, 25 participants' TPACK and 23 participants' BK post-test scores were higher than being in pre-test. Table 10 shows PK, PCK, TK, TCK, TPK, TPACK and CK pre-test post-test scores indicates an important difference.

Table 10. Wilcoxon Pre-Test Post-Test Significance Test

	SPK - PK	SCK - CK	SPCK - PCK	STK - TK	STCK - TCK	STPK - TPK	STPACK - TPACK	SBK - CK
Z	-3.00	-1.77	-3.16	-2.53	-3.74	-3.16	-3.39	-2.29
p	.003	.077	.002	.011	.000	.002	.001	.022

***Third sub-question:* "What do science teachers think about TPACK based argumentation practices"?**

Answers given to questions are given below. The participants' answers to question "*Do you think technological pedagogical content knowledge based argumentation practice would be useful for you? Why?*" are given below with categories and examples in Table 11.

Table 11. The Participants' Views About Benefit of Practice

Categories	f	Example Quotations
Yes	37	*It was definitely beneficial. We learned what argumentation is and how do we integrate it to our courses. What is more, we tried to cover our lack of information in field of technology. P14* *I definitely think of using it. I started to think argumentation based learning may be more useful for elaborating inquiry and applying what you learn to a new field, revealing new products when using 5E based learning and STEM applications. P15* *I think it's pretty beneficial. Especially helped me to see my lack in content knowledge. P20* *I found argumentation concept, which is newly introduced to me, very useful by means of learning some technological programs. P22* *I have learned many things I didn't know. Both from my colleagues and personally. Much work in short time, cheers to the team… P23* *Yes, especially I think I'm now more competent in integrating argumentation to courses. P27* *I was already practicing argumentation as a technique in 5E method. Now I learned how to structure it for a whole course. I got ideas about latest developments and directions in education. I learned by living. P31* *I think so. Now I'm thinking of preparing a plan according to knowledge I learned and conduct a course with it. Before I was thinking that I couldn't apply. But after I learn something about technology, argumentation gave me courage all week. P32*

According to Table 11, all participants indicated that practices were beneficial from different angle of views (technology, content knowledge, argumentation, content teaching etc.). The participants' answers to question "*Do you think about practicing points indicated in activities to your students in classroom?*" are given below with categories and examples in Table 12.

Table 12. The Participants' Views About Using TPACK Based Argumentation Activities in Classroom

Categories	f	Example Quotations
Yes	30	*Yes. I will use because our science education program encourages students to think and drives them to present justified results. P14* *Yes I think so. Because actually argumentation and technology have place in our life. With knowledge I have learned from this training, I can provide argumentation skills to my students. P18*
Partially yes	6	*I can use in 5th and 6th grades but I don't think I can use in 7th and 8th grade because they are more exam focused and they will demand tests from me instead. P5* *We may not be able to use every point given in activity. Because secondary school students' lack of abstract thinking is the biggest obstacle in this subject. But it can be used with more basic questions which direct students. P9*
No	1	*No, school' condition is not appropriate. P12*

Table 12 indicates that the most of the teachers were willing to use practices they experienced in classroom, six of them were partially willing and one was not willing because of improper school conditions thought. Samples from the teachers' answers to question "How do you intend to TPACK based argumentation practice in classroom?" which was asked them in order to elaborate their answers, are presented below. The examination of the teachers' answers indicated they would use practices planned, encourage students to think and some of them used practices next unit available after they learned.

"I will use asking question, encouraging curiosity, writing thoughts with much more attention." P1

"I saw that argumentation is important by making connection between reason-result for encouraging students to in think. Students will spend effort to find evidence for their claims. That encourages them to think." P4

"For example, I will use it with 7th and 8th grades' pressure topic next week." P6

"While planning subjects, I may add technology to course actively in measure and evaluation part by promoting readiness after getting their attention. I comprehended why my students sometimes couldn't understand. I can make my plans more effectively." P7

"For example, I have chosen obesity as context in 5th grade nutrition and learning our body unit. Students came after making research about what is the issue and how to solve it and they were producing solutions. I think I can move this work forward with argumentation based learning." P15

Discussion

Discussion and interpretations about findings gathered in scope of this study are taken in terms of sub-question questions. Analysis made in order to answer sub-question question of study "Is TPACK based argumentation practices training effective on the science teachers' argumentation skills?" showed that there is an increase in the teachers' argumentation skills scores after training, even though it is not statistically significant (Table 1). This situation might be occurred due to the schedule of training. Because in the training firstly Toulmin Argument Pattern's components are introduced with hands on activities, then the teachers experienced several argumentations based active learning practices. Also in literature there are studies reporting that argumentation based learning environments which the teachers/pre-service teachers experience actively affects their cognitive and affective factors about method (Sadler, 2006; Ogunniyi & Hewson, 2008; Tümay & Köseoğlu, 2011; Aydın & Kaptan, 2014; Demircioğlu & Uçar, 2015). However, descriptive analyses which conducted in order to gain better understanding about the teachers' argumentation skills showed that the teachers are not very successful at determining the most convincing argument in both pre-test and post-test (Table 2, Table 4). According to this, the teachers mostly preferred "explanation and evidence" included argument as alternative instead of the most convincing argument which included "data, explanation and rebuttal". This situation indicates that teachers were inadequate to internalize practice achievements and had difficulties about understanding and using argument components because of short practice duration. Osborne, Erduran, and Simon (2004) indicated that short duration education practices are inadequate to increase argument quality and promote quality argument according to findings of their study. This finding might found because of the participants' assessment of "data" and "rebuttal" under name of "evidence" instead of emphasize one by one. Similarly, Kaya, Erduran, and Çetin (2012) found that pre-service teachers have difficulties in making distinction of justification types, especially they use "data, explanation and rebuttal", "explanation and evidence" and only "evidence" instead of each other. Researchers indicated this situation might have occurred because of their lack of understanding about epistemic measures which correspond different justification types. What is more, conducted analyses revealed that the teachers are better in determining the strongest argument than determining the most convincing argument, however they confuse backing and warrant with evidence and warrant both in pre-test and post-test while classifying the strongest argument (Table 3, Table 5). This situation might have occurred because of short practice duration and thus the teachers could not develop an understanding about epistemological criteria of argument components. At this point when it's considered that educational practice argument structure heavily depended of Toulmin Argument Pattern (TAP), as Sampson and Clark (2006) indicated TAP uses general, common categories and this situation might have occurred because "data, warrant, evidence, backing, qualifier and rebuttal" components adding and removal depends on only the participants' interpretation.

Analysis conducted in order to answer sub-question question "Do the science teachers' TPACK self-efficacy beliefs differ significantly after the training?" indicated that the teachers' TPACK SEBS scores increased significantly after educational practice (Table 6). This result might be obtained because of teachers' participation in technological applications via hands on activities, learning meaningfully by doing and living. This result is in line with other studies reporting that including teachers in hands on technology education contributes their development of technological pedagogical content knowledge, forming classroom environment based on technology etc. (Guzey & Roehrig, 2009; Chai et al., 2010; Akkoç et al., 2011; Harris & Hofer, 2011; Chikasanda et al., 2013; Sancar Tokmak et al., 2014; Canbazoğlu Bilici & Baran, 2015).

Findings of sub-question question "Do the science teachers' TPACK self-efficacy beliefs differ according to gender before and after the training?" revealed that there is no significant difference between teachers' pre-test and post-test TPACK SEBS scores, however descriptively women's self-efficacy beliefs were lower than men both before and after educational practice (Table 7). When studies in literature are examined, obtained finding is in line with Keser et al. (2015) study conducted with pre-service teachers in which it's found that TPACK adequacy levels and self-efficacy perceptions towards technology integration do not show significant difference according to gender. On the other hand, Lin et al. (2013) examined the teachers' self-efficacy beliefs towards TPACK sub-factors and found that woman teachers have confidence in themselves about pedagogical knowledge more than man teachers but they feel inadequate about technology knowledge.

According to findings of sub-question question "Do the science teachers' TPACK self-efficacy beliefs differ according to age before and after the training?" age 20-30 the participants' scores were significantly lower than age 31 and higher the participants' scores in pre-test (Table 8). Low TPACK self-efficacy beliefs of age 30 and under the participants might be explained with vocational experience variable. Vocational experiences of this age group are generally 0-5 years and 5-10 years. Age 31 and higher group has more experienced than other group which includes the teachers with 10 years or less experience. When examined from this angle of view, it may seem TPACK self-efficacy beliefs improves as vocational experience increases. In addition, no significant difference found between age groups after educational practice. Therefore, we might say TPACK based argumentation practice is effective on both groups' TPACK self-efficacy beliefs. However, we might also say TPACK based argumentation practice is more effective on age 20-30 the participant group than age 31 and higher the participant group. From this angle of view, obtained finding is in line with Lin et al. (2013) study which found that especially woman teachers' technological knowledge, pedagogical knowledge, technological content knowledge and pedagogical content knowledge adequacy perceptions are related significantly in opposite direction. Similarly, Saudelli and Ciampa (2016) indicated that when integrating mobile technologies to instructional processes, the teachers' vocational experiences are important in their decisions and their attitudes towards mobile technologies they use (iPad) affects their pedagogy directly and in a strong way.

In analysis of sub-question question "Do TPACK self-efficacy scale sub factors differ significantly before and after the training?" obtained findings indicate the participants feel more competent in PK, PCK, TK, TCK, TPK, TPACK and CK (contextual knowledge) than CK (Table 9, Table 10). This might indicate that TPACK based argumentation practice does not directly contribute CK (content knowledge) component but emphasizes on technology and pedagogy knowledge components in practices towards the teachers. This situation is in line with other findings which researchers in similar field indicated.

Ansyari (2012) could not found a significant difference between English teachers' CK pre-test post-test scores after TPACK based in-service educational practice. In addition, resaearchers justified the improvement of participants self efficacy beliefs except CK component (TK, PK, PCK, TCK, TPK, TPACK) via educators' focus on technological knowledge and pedagogical knowledge rather than content knowledge. (Ansyari, 2012)Similar results might be seen in other experimental studies. For example, Graham et al. (2009) found significant increase in TCK, Kafyulilo, Fisser, and Voogt (2014); Canbazoğlu Bilici and Baran (2015) in TCK, TPACK, TPK and TK self-efficacy beliefs in their experimental studies. In CK (contextual knowledge) component, it might see both experimental practice contexts and the teachers' inner contexts shown increase after TPACK based argumentation practice. At this point, as Chai et al. (2013) indicated, TPACK based argumentation might support the teachers from personal/interpersonal, culturel/corporal, physical/technological point of view which is effective on use and development of TPACK. This finding is in line with findings of Doering, Veletsianos, Scharber, and Miller (2009); Koh, Chai, and Tay (2014) and Canbazoğlu Bilici (2015).

In this study when qualitative data which obtained in order to answer "What do science teachers think about "TPACK based argumentation practices"? about teaching practices?" were examined, it's seen that all of the participants indicate TPACK based argumentation practices are beneficial to them. Statements in Table 11 shows that there is an increase in the participant teachers' awareness about argumentation topic which emphasized on science education program (MNE, 2013), the teachers understood the importance of using argumentation and TPACK practices in innovative approaches such as Science-Technology-Engineering-Mathematics (STEM) and inquiry, the teachers benefit from TPACK based argumentation practices' cooperative nature and they will use their experiences in courses. These statements indicate TPACK based argumentation practices are planned for needs of the participants, fills in the gap of field and increases the participants' TPACK self-efficacy beliefs after educational practice.

The findings indicate that most of the participants (n=30) were thinking about using what they learned in their own classes by using their experiences. On the other hand, a group of teachers indicated that course run in class is exam based and they might use TPACK based argumentation practice partially. Only one the participant indicated it will not be possible to use TPACK based argumentation experience because of school condition. The post-test results show that the participants CK (contextual knowledge) increased in scope of TPACK self-efficacy, indicating a resistance to limitations arising from environmental conditions. From this point of view, it is possible to state for one more time that applicability of TPACK argumentation practice and similar innovative method and approaches are closely related to system conditions (political economical bureaucratically, personal beliefs etc.) (Usluel et al., 2015).

When the teachers who are willing to use TPACK based argumentation practices in their own class were asked how they will conduct the practice, they replied curiously focusing on argumentation and have not indicated about technological component. This situation might be resulted from the fact that the teachers are familiar with technological practices at a certain and limited level and they might focus on argumentation in active knowledge process as emphasized in the new science curriculum. They may concern argumentation practices more than its integration with technology.

Conclusion

In this study participant teachers from different cities and age groups experienced TPACK based argumentation practices where initially argumentation practices were followed by technology integrated activities in a holistic manner for a week period. It was showed that this implementation although insignificantly increased participants' argumentation skills regarding statistics it did not contribute to the solution of the problems participants encountered in differentiation of the types of justification (evidence, rebuttal, explain and etc.) and in defining the most and least convincing arguments in a sufficient level.

On the other hand, it was seen that TPACK based argumentation practices helped participant teachers improve their TPACK self-efficacy beliefs in a statistically significant manner. Despite the lower level of TPACK self-efficacy beliefs of female participants before training it was seen that the training affected the participants TPCAK self-efficacy in the same ratio. Besides, in spite of the fact that participants' TPACK based self-efficacy beliefs did not differ during the training depending on their age their performances at the end of training when compared to the results at the beginning revealed that the participants aged between 21 and 30 (in a negative correlation with their year of experience) were affected more positively from the training than the participants older than 31 years old. It was also identified that TPACK based argumentation practices directly improved the technological and pedagogical self-efficacy beliefs in corroboration with the practices towards teaching profession whereas it helped to improve their content knowledge self-efficacy beliefs indirectly.

According to the views of the participants about TPACK based argumentation practices at the end of the training it may be stated that the training was planned according to the need of the participant group, has dimensions that can be implied in their classes in a very large extent and tries to fill a gap in the field.

Suggestions

The results reached during TPACK based argumentation practices on the teachers' argumentation skills and technological pedagogical content knowledge self-efficacy beliefs were affected by some limited factors. The duration of the training may be evaluated to be first of these limitations. Data collection tool also helped spotting the teachers' misunderstandings about argument components. Finding also have shown the teachers could not even have a strong understanding about argument components and could not make epistemological distinction towards evidence-warrant-backing. Therefore, repeating this study in a larger time interval and with different argument models would be important to detail practices and might be effective on removing misunderstandings towards argument components as well as increasing its reliability.

Another limitation factor may be seen as the argumentation model held in the study. At that point it may be suggested that besides Toulmin's argument model which is mentioned in methods and discussion sections, other argument models should take place in the training. This is also required in order for determining levels of both argument components and quality. On the other hand, the argument structure of the activities did not directly indicate the relationship between argument and formation of scientific knowledge. Therefore, it is believed that studying argumentation on epistemological bases and linking both conceptually and explicitly through activities would be helpful.

In scope of educational practice, it's found that the teachers' technological pedagogical content knowledge self-efficacy beliefs were improved. In this manner, how and in what degree this increase in the teachers' self-efficacies affects their classroom experiences and monitoring those might be subject of the future studies.

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Appendix 1. Argumentation Test

Part I. Making a Scientific Argument

Introduction: Once a scientist develops an explanation for why something happens, he or she must support their claim with some type of reason. The explanation and the supporting reason is called an argument. Scientists use arguments to convince others that their claim is indeed true. How do you think scientists create a convincing argument?

Directions: The first three questions are designed to determine what you think counts as a good scientific argument. In each question you will be given a claim. Following the claim are 6 different arguments. Your job is to rank the arguments in order using the following scale:

1 = This is the most convincing argument

2 = This is the 2nd most convincing argument

3 = This is the 3rd most convincing argument

4 = This is the 4th most convincing argument

5 = This is the 5th most convincing argument

6 = This is the least convincing argument

Your task is to rank the 6 different arguments in terms of how convincing you think they are.

Remember that you can only rank one argument as 1, one argument as 2, one argument as 3, and so on.

Question #1. Objects sitting in the same room often feel like they are different temperatures. Suppose someone makes the following claim about the temperature of various objects sitting in the same room, which reason makes the most convincing argument?

Claim: Objects that are in the same room are the same temperature even though they feel different because…	**Your Ranking**
…when we measured the temperature of the table, it was 23.4^{0}C, the metal chair leg was 23.1^{0}C, and the computer keyboard was 23.6^{0}C.	______
…good conductors feel different than poor conductors even though they are the same temperature.	______
…objects that are in the same environment gain or lose heat energy until everything is the same temperature. Our data form the lab proves that point: the mouse pad and plastic desk were both 23^{0}C.	______
…objects will release and hold different amounts of heat energy depending on how good of an insulator or conductor it is.	______
…the textbook says that all objects in the same room will eventually reach the same temperature.	______
…we measured the temperature of the wooden table and the chair leg and they were both 23^{0}C even though the metal chair leg feels colder. If the metal chair leg was actually colder it would have been a lower temperature when we compared it to the temperature of the table.	______

Question #2. A pendulum is a string with a weight attached to one end of it. Suppose someone makes the following claim about pendulums, which reason makes the most convincing argument?

Claim: The length of the string determines how fast a pendulum swings back and forth regardless of the weight on the end of the string because…	**Your Ranking**
…the weight on the end of a long string has a longer distance to travel when compared to a weight on a short string. As a result, pendulums with shorter swings make more swings per second than pendulum with longer strings.	
…pendulums with different string length have different swing rates. We measured the swing rate of a pendulum with a 10 cm string and a pendulum with a 20 cm string, The 10 cm pendulum had swing rate of 2 swings per second and the 20 cm pendulum has a swing rate of 1 swing per second.	
…a pendulum with a 14 cm string had a swing rate of 1 swing per second and a pendulum with a 15 cm string had a swing rate of 1 swing per second.	
…a pendulum with a 10 cm string had a swing rate of 2 swings per second and a pendulum with a 15 cm string had a swing rate of 1 swing per second.	
…our textbook says that the weight on the end of the string has nothing to do with how fast a pendulum swings.	
…we tested the swing rate of three pendulums, one with a 10 gram weight and 10 cm string, one with a 10 gram weight and 20 cm string, and one with 20 gram weight and a 20 cm string. The two pendulums with the 20 cm string had the same swing rate (1 swing per second) and were slower the pendulum with the shorter string (2 swings per second). If the weight on the end of the string mattered these two pendulums would have had different swing rates but they were the same.	

Question #3. Scientists often use animals in their research. Suppose someone makes the following claim about the use of animals in scientific research, which reason makes the most convincing argument?

Claim: Scientists should be allowed to use animals for research because…	**Your Ranking**
…a computer or other non animal model can be used instead.	
…animals are susceptible to many of the same bacteria and viruses as people, such as anthrax, smallpox, and malaria. Even though animals differ from people in many ways, they also are very similar to people in many ways. An animal is chosen for research only if it shares characteristics with people that are relevant to the research.	
…public opinion polls have consistently shown that a majority of people approve of the use of animals in biomedical research that does not cause pain to the animal and leads to new treatments and cures.	
…animal research was essential in developing many life-saving surgical procedures once thought impossible. For example the technique of sewing blood vessels together was developed through surgeries on dogs and cats by Alexis Carrel, for which he was awarded a Nobel Prize in 1912.	
…infecting animals with certain microbes allows researchers to identify the germs that cause different types of diseases. Once discovered scientists can develop vaccines to test the effectiveness of these vaccines without harming any people in the process.	
…humans have 65 infectious diseases in common with dogs, 50 with cattle, 46 with sheep and goats, 42 with pigs, 35 with horses, and 26 with fowl.	

Part II. Challenging an Argument

Introduction: Once a scientist develops an explanation for why something happens, he or she must support the explanation with there reasons for why they think their explanation is correct. The explanation along with its supporting reasons is called an argument. Sometimes other scientists agree with the argument; sometimes they do not. When they disagree, they challenge the accuracy of the argument. How do you think scientists challenge the arguments of other scientists? The last three questions on this test are designed to determine what you think counts as a good challenge to a *scientific* argument

Directions: In each question you will be given an argument. Following the argument are 6 different challenges. Your job is to rank the challenges using the following scale:

1 = This comment is the strongest challenge to this argument

2 = This comment is the 2nd strongest challenge to this argument

3 = This comment is the 3rd strongest challenge to this argument

4 = This comment is the 4th strongest challenge to this argument

5 = This comment is the 5th strongest challenge to this argument

6 = This comment is the weakest challenge to this argument

Question #4. Jason, Angela, Sarah, and Tim are in physics class together. Their teacher asked them to design an experiment to determine if all objects in the same room are the same temperature even though they feel different. After they designed and carried out an experiment to answer this question on their own, they met in a small group to discuss what they have found out. Suppose Jason suggests that:

> *"I think that all objects in the same room are always different temperatures because they feel different and when we measured the temperature of the table, it was 23.4^{0}C, the metal chair leg was 23.1^{0}C, and the computer keyboard was 23.6^{0}C."*

Angela disagrees with Jason. Your task is to rank the 6 different challenges given by Angela in terms of how strong you think they are.

Angela: **I disagree…**	**Your Ranking**
…because your evidence does not support your claim. All of the objects that you measured were within one degree of each other. That small of difference is just measurement error.	________
…I think that all objects in the same room are the same temperature even though they feel different.	________
…if those objects were really different temperatures their temperature would have been much different. For example, when I measured the temperature of my arm it was 37^{0}C while the temperature of the table was 23^{0}C that is a difference of 14 degrees. Everything else was right around 23^{0}C.	________
…I think all objects become the same temperature even though they feel different because objects that are good conductors feel colder than objects that are poor conductors because heat transfers through good conductors faster.	________
…because I know you always rush through labs and never get the right answer.	________
…I think all objects become the same temperature because the temperatures of all those objects you measured were within 1 degree.	________

Question #5. Tiffany, Steven, and Yelena are in the same science class. Their teacher asked them to design an experiment to determine what makes some objects floats and some objects sink. After they designed and carried out an experiment to answer this question on their own, they met in a small group to discuss what they have found out. Suppose Steven suggests that:

"I think heavy objects sink and light objects float. This is true because when I put the 10 gram plastic block in the tub of water it floated while the 40 gram metal block sank."

Tiffany disagrees with Steven. Your task is to rank these 6 different challenges given by Tiffany in terms of how strong you think they are.

***Tiffany:* I disagree…**	**Your Ranking**
…because Yelena is always right and she disagrees with you.	______
…because you did not test enough objects. How can you be sure that it is the weight of an object that makes it sink or float if you only tested two things?	______
…the metal block sank because it is very dense not because it is heavy and the plastic block floated because it has density that is less than water not because it is light.	______
…because light objects can sink too. A paper clip only weighs one gram and it sinks. According to you claim all light objects should float. How can a paper clip that is lighter than a piece of plastic sink while the heavier piece of plastic floats?	______
…The plastic block may have been lighter than the metal block but that is not why it floated. The metal block has a density of 2,5 g/cm^3, which is more than water so it sinks. The plastic block has a volume 16 cm^3 which means its density is. 6 g/cm^3 which is less than water so it floats.	______
…I think objects that have a density greater than water sink and objects that have a density less than water float.	______

Question #6. Elana, Shauna, and Sam are in a science class together. At the beginning of class, their teacher poses the following question: "Should scientists be able to use animals in medical research?" The teacher then asked Elana, Shauna, and Sam to discuss what they think about the issue in a small group. Suppose Shauna begins the conversation by saying:

"I think using animals in medical is a bad idea because people and animals suffer from different disease and the bodies of animals and humans are completely different. So how can scientists justify performing painful experiments on animals if they are so different?'

Sam disagrees with Shauna. Your task is to rank these 6 different challenges given by Sam in terms of how strong you think they are.

***Sam:* I disagree…**	**Your Ranking**
…even though animal and human bodies are completely different like you say, I think using animals in medical research is a good idea because it would be impossible to prove that a specific germ is responsible for a disease without the use of laboratory animals.	______
…I think using animals in medical research is good idea and very useful.	______
…animals are not that different from humans. Animals and humans have similar organs and animals suffer from many of the same diseases that we do.	______
…because you don"t know what you are talking about. You just care more about animals then you do about people.	______
…an animal is only chosen for research if it shares characteristics with people that are relevant to the research. For example; animals share many of the same organs as people so they can be used to develop new surgical techniques. Organ transplants, open heart surgery, and many other procedures that are common today were developed by experimenting with animals.	______
…how can using animals in research be a bad idea if it allows scientists to do research without having to conduct painful experiments on people?	______