Modeling the Relations Among Argumentativeness, Epistemological Beliefs and Self-Regulation Skills

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Abstract

This study was conducted to examine the structural relationships among pre-service science teachers' scientific epistemological beliefs, self-regulation skills, and their disposition towards participating in argumentation. For this purpose, structural equation modeling (SEM) was applied in the study in which 229 pre-service science teachers participated. According to the results, development dimension of epistemological belief predicted argument approach positively, while source and certainty dimensions predicted argument avoidance negatively. All dimensions of epistemological beliefs, except for the certainty dimension, predicted self-regulation skills positively. When the relationship between self-regulation skills and argumentativeness was examined, it was revealed that pre-service science teachers' self-regulation skills such as asking questions and goal setting positively predicted participation in argumentation. According to the findings, it can be concluded that demonstrating the relationship between self-regulation and argumentativeness would make a significant contribution to the literature**.**

Keywords: Argumentativeness, Preservice Science Teachers, Scientific Epistemological Beliefs, Self-Regulation.

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INTRODUCTION

Argumentation is an indispensable part of learning and teaching science. The idea of integrating the process similar to the way scientists produce science into science learning and teaching environments has caused argumentation to have an important place in science education literature (Duschl & Osborne, 2002; Sandoval & Reiser, 2004). According to Osborne (2010), argumentation is a scientific practice in which students construct, critique, evaluate scientific arguments and reason scientifically. During this scientific practice, students ensure that scientific knowledge is constructed and critiqued by performing a social argumentation process (Ford, 2008). In this process, students generate scientific knowledge using written and spoken language, and this generated scientific knowledge is critiqued in a social group and it is resorted to defend and refute knowledge claims (van Eemeren & Grootendorst, 2004). Previous studies have consistently revealed that epistemic, social and linguistic practices embedded in argumentation-based science learning approach contribute positively to cognitive and motivational outcomes such as, conceptual learning (Kingir, Geban, & Gunel, 2013), higher-order thinking skills (Jimenez-Aleixandre & Erduran, 2007), self-evaluation and achievement goals (Asterhan, 2018; Kabataş Memiş & Seven, 2015), and linguistic skills (Demirbag & Gunel, 2014). Although the nature of the science learning approach has shifted from ordinary science practices to controversial and socio-scientific issues and engineering-based practices in recent years, argumentation has remained as an approach that is frequently used by researchers in the context of these issues. Indeed, in many studies, it was observed that argumentation improved effective decision making, argument development and conceptual learning processes in socio-scientific issues (Balgopal, Wallace, & Dahlberg, 2017; Venville & Dawson, 2010) and was used as a direct teaching method in STEM-based practices (Kuhn & McDermott, 2017).

However, despite the positive contributions mentioned above, some students do not participate in argumentation processes in classes where argumentation-based science learning takes place (Nussbaum, Hartley, Sinatra, Reynolds, & Bendixen, 2002). For instance, students do not express their opinions and avoid being part of the process in environments where arguments on socio-scientific issues such as nuclear power plants, genetically modified foods and cloning are conducted. Individuals tend to participate in or refuse argumentation for various reasons. Individuals' tendencies to participate in or to be far away from argumentation were explained by Infante and Rancer (1982) with the concept of argumentativeness.

When the studies on the concept of argumentativeness in science education are examined, it can be said that the number of studies related to this concept is limited. Researchers indicate that there is a need for the clarification of the concepts that are associated with this concept (Bahcivan, 2019; Nussbaum & Bendixen, 2003). Therefore, in this study, it was aimed to test the relationships among the concept of argumentativeness, epistemological beliefs and self-regulation. It was considered that epistemological beliefs, self-regulation and argumentativeness could be closely associated with each other. For instance, evidences showing that epistemological beliefs have an effect on the concept of argumentativeness are already available in the literature, although they are limited in number (Bahcivan, 2019; Nussbaum & Bendixen, 2003). Also, the structure of epistemological beliefs intertwined with self-regulation was frequently discussed in the literature (e.g., Barzilai & Zohar, 2014; Muis, 2007). Although the relationship between self-regulation and argumentativeness is not clearly stated in the literature, there are clues that these two concepts might be related. For this reason, it is important to investigate this possible relation. It can be said that the concept of self-regulation, which includes individuals' planning, monitoring and evaluation of their own learning processes, and whether they insist on an effective task, may be an effective parameter for participation in argumentation. Because individuals with high self-regulation skills exhibit an insistent and effort-oriented attitude in performing difficult tasks, however, individuals with low self-regulation skills avoid performing these tasks (Pintrich, 2004; Won, Wolters, & Mueller, 2018). Students' avoidance of the argumentation process, which is an important problem in the literature, might be related to considering argumentation as a challenging task. Demonstrating how the concept of argumentativeness is associated with epistemological beliefs and self-regulation skills may contribute

to the literature investigating which individual characteristics of students are far away from or close to argumentation.

- What are the relationships among preservice science teacher's epistemological beliefs, self-regulation and argumentativeness?

Background

Epistemological Beliefs

Epistemology means philosophy of knowledge (Cevizci, 2012). Epistemological beliefs can be defined as the beliefs about knowing and knowledge (Hofer & Pintrich, 1997). As frequently mentioned in the literature, there are four sub-dimensions of epistemological beliefs: justification and source dimensions in beliefs about knowing, and certainty and simplicity dimensions in beliefs about knowledge. When the perspectives on epistemological beliefs in the literature are reviewed, it appears that epistemological beliefs are divided into three main trends: developmental, multidimensional and domain-context specific. Developmental trend argues that the development in epistemological beliefs occurs in all dimensions (justification, certainty, simplicity and source) similar to cognitive development (Baxter & Magolda, 1992; King & Kitchener, 2004). In multidimensional trend, these four dimensions are considered to develop independently from each other (Schommer, 1990). For instance, while an individual has a sophisticated belief that knowledge is uncertain in the certainty dimension under the beliefs about knowledge, he/she may have an authority-dependent naive belief in the source dimension under the beliefs about knowing dimension. In domain-context specific trend, individuals' epistemological beliefs may differ from context to context or depending on the nature of the issue (Buehl, Alexander & Murphy, 2002; Elby & Hammer, 2001). For instance, a teacher who believes that the knowledge is constructed by multiple justification may adopt a traditional attitude by exhibiting a view of authority figure in an exam-oriented or success-oriented context. While knowledge with physics domain is certain for an individual, biology knowledge can be considered as more changeable knowledge.

When the studies on epistemological beliefs in the fields of educational psychology and science education are reviewed, there are evidences showing that epistemological beliefs are closely associated with cognitive and metacognitive components such as academic achievement (Lodewyk, 2007), goal orientation (Bråten, & Strømsø, 2004), argumentation processes (Wu & Tsai, 2011), self-construal (Bahcivan & Cobern, 2016), and higher-order thinking (Phan, 2008). Many studies have shown that epistemological beliefs are closely associated with self-regulation, which is one of the key concepts of this study (e.g., Greene, Muis, & Pieschl, 2010; Muis, 2007; Strømsø & Bråten, 2010). For instance, Pieschl, Stahl and Bromme (2008) revealed that epistemological beliefs strongly affected the biology students' self-regulation skills such as processing the more complex, deeper-level learning. In their study conducted with 84 physics undergraduates, Strømsø and Bråten (2010) reported that students with advanced epistemological beliefs about Internet-based information were more likely to use self-control strategies while using the Internet. In another study conducted with 439 post-secondary students, Muis et al. (2015) concluded that epistemological beliefs predicted the self-regulation skills, such as critical thinking, elaboration, rehearsal, and metacognitive control, through negative or positive epistemic emotions. These studies demonstrated that an advanced epistemological belief triggered the strategies that were closely related to self-regulation skills.

Self-Regulation

Self-regulated learning (SRL) is a key concept which includes cognitive and metacognitive skills. It can be defined as "an active, constructive process whereby learners set goals for their learning, and then attempt to monitor, regulate, and control their cognition, motivation and behavior, guided and constrained by their goals and the contextual features in the environment" (Pintrich, 2000, p.453). According to Winne and Hadwin's (1998) SRL model, SRL has four components, which are

task definition, goal setting and planning, studying tactics, and adaptation. When more innovative models are examined, it is observed that SRL continues to be conceptualized in accordance with its theoretical background. For instance, Muis (2007) defined self-regulated learning as 1) task definition, 2) planning and goal setting, 3) enactment, and 4) evaluation. Therefore, self-regulated individuals can be defined as individuals who choose any task, have planning and goals, and determine and implement their strategies in line with these goals, and then evaluate after the process. In the literature, many studies are showing that SRL is closely related to concepts such as epistemological beliefs (Pieschl, Stahl & Bromme, 2008) self-efficacy (Trautner & Schwinger, 2020) achievement (Muis, 2008) and problem-solving skill (van Gog, Hoogerheide, & van Harsel, 2020). There are many studies showing that self-regulation is closely related to argumentation. However, the relationship between self-regulation and argumentativeness (i.e., tendency to participate in or withdraw from argumentation process) has not been clearly stated.

Indeed, motivational factors such as self-regulation and self-efficacy are effective concepts for individuals to exhibit behaviors such as acting insistently, making efforts, and participating in or being far away from the action by demonstrating positive and negative emotions in challenging environments (Pintrich, 2004; Won et al., 2018; Zimmerman & Cleary, 2009). The relationship between motivational factors and such actions may provide clues that argumentativeness and the concept of self-regulation may be related. For instance, preservice teachers may consider argumentation as a challenging task, and having a high level of self-regulation during the challenging process may affect their participation in argument, in other words, adoption of an argument approach attitude. Or vice versa, students with low levels of self-regulation may not consider argumentation as a valuable task or they may be far away from argumentation without making any effort during argumentation. Individuals who cannot display their learning strategies effectively during the argument may be far away from argumentation by having negative feelings and thoughts through their own learning processes.

Argumentativeness

Individuals' tendencies to participate in or to be far away from argumentation were explained with the concept of argumentativeness by Infante and Rancer (1982). According to Infante and Rancer (1982, p.72), argumentativeness is conceptualized as a generally stable trait which predisposes the individual in communication situations to advocate positions on controversial issues and to attack verbally the positions which other people take on these issues. Argumentativeness is an individual trait and closely related to emotions, and there are two types of argumentativeness traits. They are *argumentativeness approach* and *argumentativeness avoidance* according to Infante and Rancer (1982). Individuals who are more prone to argumentation consider the argumentation as an exciting intellectual activity and tend to argumentation by having good feelings like invigorated, satisfied, and amusement in this environment where they defend their arguments. Individuals who avoid argument have unpleasant feelings before, during and after the argument, and individuals prefer to be far away from argumentation by being motivated and happy only when the argumentation is over (Infante & Rancer, 1982). When studies examining the relationship between the concept of argumentativeness and epistemological beliefs are examined, it is observed that there were mixed results. Nussbaum and Bendixen (2003) concluded that epistemological beliefs predicted the argument avoidance instead of argument approach. Unlike Nussbaum and Bendixen (2003), Bahcivan (2019) concluded that sophisticated epistemological beliefs in certainty and justification dimensions triggered the argument approach trait. Similarly, Demirbag and Bahcivan (2021) founded that sophisticated epistemological beliefs in source dimension positively predicted argument approach. In this context, it can be said that the literature needs further investigations.

The Proposed Model

When the relationships between epistemological beliefs, self-regulation skills and argumentativeness were examined based on the literature presented above, the model in Figure 1 was

proposed in this study. Preservice science teachers (PSTs) epistemological beliefs can be expected to positively predict metacognitive self-regulation under the concept of self-regulation (Hypothesis 1 – H1). If PSTs have sophisticated beliefs in the nature and knowing of scientific knowledge, they can use cognitive and metacognitive strategies such as questioning and goal setting effectively in the process of constructing and evaluating knowledge. Secondly (Hypothesis 2 – H2), PSTs with an advanced epistemological belief can be expected to display an argumentation approach. Although there are mixed results in studies showing this relationship (Bahcivan, 2019; Nussbaum & Bendixen, 2003); PSTs, who believe that scientific knowledge is tentative, relationally interconnected, and constructed by themselves through multiple justification processes, may consider argumentation or argument environment as an opportunity for learning. Therefore, it can be expected that an advanced epistemological belief will positively predict an argument approach. Finally, (Hypothesis 3 – H3), no study that directly showed the relationship between these two concepts as presented above was found, it can be said that self-regulation may be related to argument approach and argument avoidance. In this regard, it can be expected that PSTs claiming that they applied metacognitive strategies in their own learning processes will adopt a positive attitude in an argumentation environment that triggers this application process. Considering its close relationship with strategies such as making effort, insisting and task value, it can be thought that individuals having self-regulation skills may consider argument environment as an environment where they monitor and evaluate their own learning processes and their peers' learning processes, and therefore, they will make an effort to participate in this environment although such an environment may challenge them cognitively.

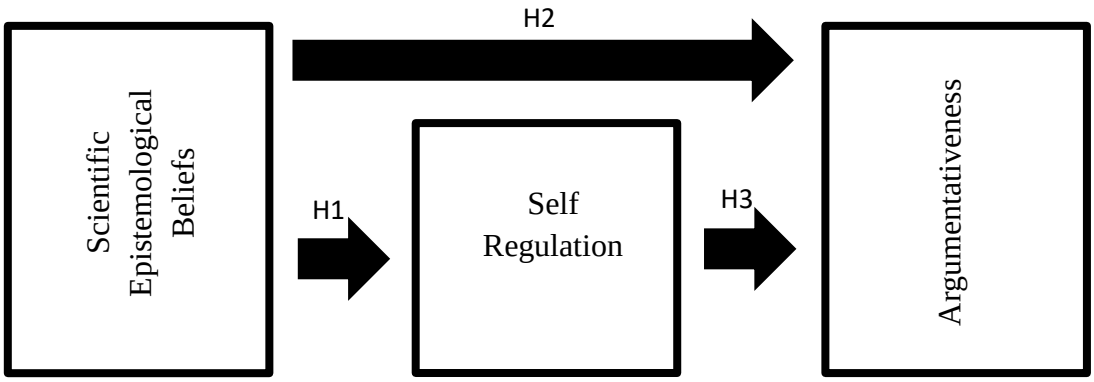

Figure 1. The Proposed Model

METHOD

In this study, the relationship between the variables presented in Figure 1 was investigated by SEM analysis. Therefore, correlational research design was applied in the study (Fraenkel & Wallen, 2009).

Participants

229 preservice science teachers who were selected from different public universities in Turkey by convenience sampling participated in the study. The participants were chosen among 2nd , 3rd and 4th graders because they had a stronger science teaching and learning experience than the 1st graders because of the number of courses taken.

The Instruments

Scientific Epistemological Beliefs Scale

The Scientific Epistemological Beliefs Scale was originally developed by Conley, Pintrich, Vekiri and Harrison (2004). The scale consists of 26 five-point Likert items with four dimensions: certainty (6 items; e.g., "Scientific knowledge is always true."), source (5 items; e.g., "Everybody has to believe what scientists say."), development (6 items; e.g., "Ideas in science sometimes change.") and justification (9 items; e.g., "Ideas in science can come from your own questions and experiments."). Participants' item scores in certainty and source dimensions were reversed because the items in this sub-dimension have negative question roots by their nature. The scale was adapted into Turkish in the study conducted with preservice science teachers by Bahcivan (2014). The fit indices of the scale were presented as (χ^2/df=1.44, CFI=.95, TLI=.93 and RMSEA=.04). The reliability scores of the sub-dimensions of the scale were between .66-.82. In this study, a confirmatory factor analysis (n=229) of the scale was conducted before performing the SEM analysis. According to the confirmatory factor analysis result, one item from certainty dimension, two items from development dimension and one item from justification dimension were excluded since their factor loading was lower than .40 (Shevlin & Miles, 1998).

According to the confirmatory factor analysis result, it was observed that measurement results had acceptable fit indices (χ2/df=1.36, CFI=.96, TLI=.95 and RMSEA=.04). Furthermore, factor loadings of the scale were between 0.45-0.79. Alpha reliability scores were calculated as .79, .84, .65 and .75 respectively, for certainty, source, development and justification dimensions.

The Motivated Strategies for Learning Questionnaire

The Motivated Strategies for Learning Questionnaire (MSLQ) in 7-point Likert form developed by Pintrich, Smith, García & McKeachie (1993) was used to measure self-regulation. The scale consisted of 81 items, including 31 items for motivation scale and 50 items for learning strategy. Since the concept of self-regulation was directly used in this study, 12 items constituting the metacognitive self-regulation sub-dimension under the learning strategy title of the MSLQ scale were used. This sub-dimension of the MSLQ scale (e.g., "If course readings are difficult to understand, I change the way I read the material") was used in previous studies, and the researchers (Akyol, Sungur, & Tekkaya, 2010) indicated that the scale had acceptable fit indices (CFI=.90, GFI=.92, RMSEA=.06) (Akyol et al., 2010). Prior to analysis, two of the scale items were recoded. Then, a confirmatory factor analysis was conducted for validation. According to the CFA result, 4 items with low factor loadings were excluded from the analysis. According to the result of this analysis (n=229), it can be said that acceptable fit indices were achieved. (χ^2/df=1.50, CFI=.99, TLI=.97 and RMSEA=.05) Furthermore, factor loading scores between .48-.86 and an alpha reliability score of .82 were achieved.

Argumentativeness Scale

The Argumentativeness Scale developed by Infante and Rancer (1982) was used to determine individuals' dispositions to participate in or getting far away from argumentation during argumentation. It is a 20-item scale in 5-point Likert format (1=almost never true for you to 5=almost always true for you) consisting of two sub-dimensions which are argument approach and argument avoidance. There are 10 items in both sub-dimensions. The items involve cognitive and emotional evaluations affecting individuals' participation in (e.g., "I enjoy defending my point of view on an issue.") or getting far away from (e.g., "I get an unpleasant feeling when I realize I'm about to get into an argument.") a conflict argumentation environment. The scale was first adapted into Turkish by (Demirbag & Bahcivan, 2021). In this study, according to the exploratory factor analysis result, 2 items were eliminated from the argument approach and avoidance sub-dimension because of factor loading scores lower than .40. For the adapted version consisting of 16 items, reliability coefficient of the sub-dimensions of the scale was found to be .79 for argument approach dimension and .80 for

argument avoidance dimension. In this study, confirmatory factor analysis (CFA) was applied to this adapted scale. According to CFA (n=229) result, one item was eliminated from argument avoidance dimension because factor loading was below .40. CFA analysis showed that scale results had good fit indices (χ^2/df=1.33, CFI=.98, TLI=.97 and RMSEA=.04). The factor loadings of the scale were between .44-.87. Furthermore, alpha reliability scores for the argument approach and argument avoidance dimensions of the scale were .80 and .85, respectively.

The Procedure

Due to the pandemic season, the instruments were electronically administered to the participants through Google forms. Prior to the administration of the instruments, necessary ethical permissions were obtained and participants were informed about the aim of the study. A control item in the form of "Please mark 5 in this question" was written among the question items in the scale in order to eliminate possible errors that may be reflected in the data collection process. 261 preservice science teachers enrolled in different public universities participated in the study. However, as a result of excluding 32 individuals who gave inappropriate response to the control item, 229 individuals were included in the study.

Data Analyses

Prior to performing the SEM analysis, confirmatory factor analysis (CFA) was conducted through AMOS program to validate the data obtained from the instruments. SPSS 25 program was used for the reliability scores of the scores obtained from the instruments. The values obtained as a result of the CFA are presented under the title of data collection tools. SEM analysis assumptions and SEM analysis results are presented below.

Multivariate Normality

It is necessary to examine the multivariate normality assumption in order to decide whether SEM analysis can be applied to the obtained data set. The Mardia's coefficient was used to examine this assumption (Khine, 2013). In the AMOS Program, the value at the bottom of the column that contains the Multivariate row and kurtosis value of the table showing the Results of Multivariate Normality Analysis is the Mardia's coefficient. If the value achieved as a result of the formula p*(p+2), where the number of observed variables used in the study is p, is greater than the Mardia kurtosis value, it is assumed that the data set meet the multivariate normality assumption (Raykov & Marcoulides, 2008). There were a total of 45 observed values (items) in the model in which the relationship between epistemological beliefs, self-regulation and argumentativeness were structurally tested. Since the value obtained according to the p*(p+2) formula (2115) was greater than the Mardia kurtosis value (236.89), it was determined that the data set met the multivariate normality assumption and the SEM analysis was performed.

RESULTS

SEM analysis was conducted to test the structural relations between the variables in the proposed model in Figure 1. According to SEM analysis (n=229) result, it can be said that the proposed model had acceptable fit indices (χ2/df=1.37, CFI=.91, TLI=.90 and RMSEA=.04). The significant relationships among the variables in the model are presented in Figure 2.

It was concluded that source, certainty and justification dimensions of the epistemological beliefs of PSTs significantly predicted self-regulation. While source and justification had a positive relationship with self-regulation, surprisingly, certainty dimension negatively predicted self-regulation. On the other hand, when the relationship between epistemological beliefs and argumentativeness was examined, the source and certainty dimensions of epistemological beliefs negatively predicted the argument avoidance. Furthermore, when Figure 2 was examined, it was

observed that only one dimension of epistemological beliefs was related to the argument approach dimension. Having a sophisticated belief in the development dimension of epistemological beliefs positively predicted the argument approach indicating the tendency to participate in argumentation. When the relationship between self-regulation and argumentativeness was examined, it was concluded that self-regulation had a positive relationship with the participation in argumentation.

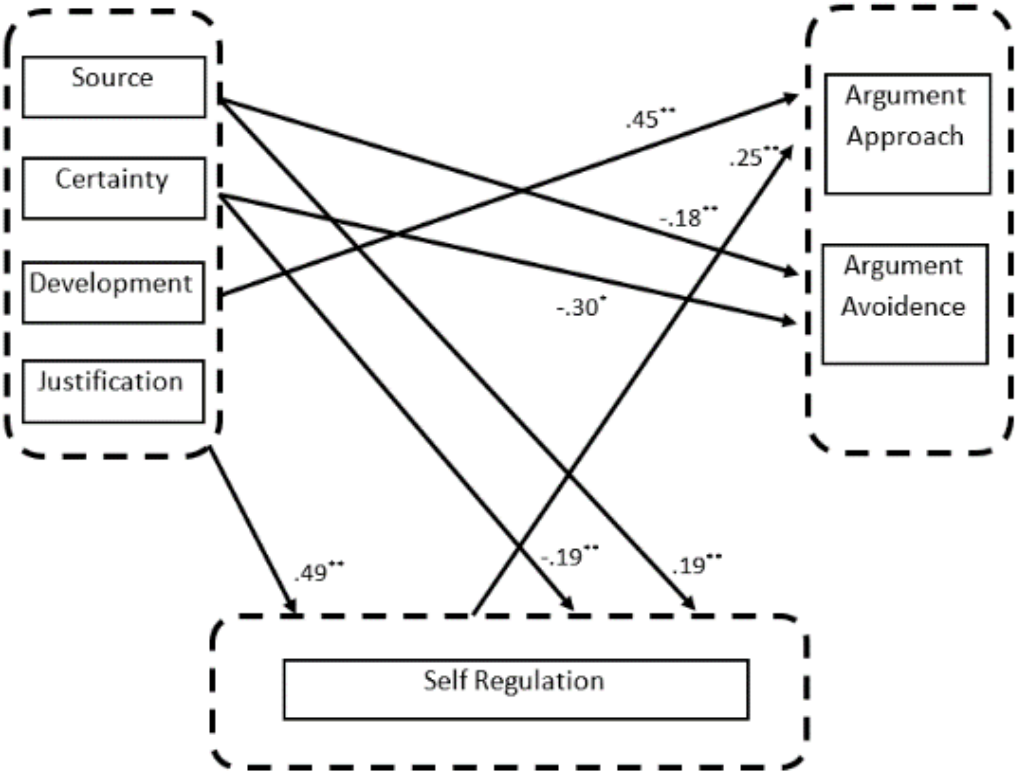

Figure 2. Statistical model (*p<.001, **p<.05)

DISCUSSION

According to the results of the study, it can be said that epistemological beliefs had an important role in determining higher-order thinking skills and dispositions to participate in argumentation processes. This result implies that epistemological beliefs are closely related to self-regulation, which is considered as a higher-order thinking skill and is a key concept regarding motivation in the literature. When the positive relationships between the source and justification dimensions of epistemological beliefs and self-regulation are considered, the development of preservice teachers' understanding of generating knowledge by justifying from multiple sources of evidence and beliefs in questioning the scientific authority may be regarded as the trigger of a metacognitive self-regulation (asking, goal setting, etc.) process. This result is similar to previous studies (e.g., Alpaslan, Yalvac, Loving & Willson, 2016; Muis & Franco, 2010). On the other hand, certainty dimension of epistemological beliefs showed a negative relationship with self-regulation, contrary to the expected hypothesis.

In the proposed model, we considered that preservice teachers' sophisticated beliefs that scientific knowledge is tentative and evolving would positively predict self-regulation. However, the

findings showed the opposite of this expectation. In other words, it was revealed that preservice teachers who believed that scientific knowledge is certain tended to have higher levels of metacognitive process. Preservice teachers may have considered the need for making more efforts and performing higher-order examinations in order to reach the principles and laws of science that are precise and unchanging for now (e.g., force of gravity). Preservice science teachers' learning and teaching concepts related to these pure science issues mentioned in learning practices may also have affected this situation. Their regulations and habits for the processes of learning precise and unchanging knowledge could be effective in the emergence of such a relationship between epistemological beliefs and self-regulation.

Nevertheless, it frequently appears that some dimensions of epistemological beliefs gave results contrary to expectations in different studies (e.g., Nussbaum & Bendixen, 2003). The reason for this unexpected result may result from cultural differences and contextual factors. The fact that the Scientific Epistemological Beliefs Scale consisted of domain general items may have been the reason for this situation. The relationship with PSTs' certainty dimension with self-regulation may give different and more consistent results in discipline-specific asked questions.

When the relationship between epistemological beliefs and argumentativeness is examined, it can be said that this relationship gave more consistent results with the hypotheses presented in the proposed model. The source and certainty dimensions of epistemological beliefs negatively predicted argument avoidance dimension. This result implied that preservice teachers averted from an argument avoidance as their perception of authority decreased regarding the source of knowledge and they thought that scientific knowledge is not precise. In brief, sophistication in certainty and source dimensions impede tendency to argument avoidance. Because there are evidences indicating that students with advanced epistemological beliefs exhibit an insistent attitude towards cognitively demanding tasks in challenging environments (Bråten, Anmarkrud, Brandmo & Strømsø, 2014). In addition, Demirbag & Bahcivan (2021) similarly found that the source dimension negatively predicted argument avoidance.

On the other hand, the development dimension of epistemological beliefs was the only epistemic dimension associated with the argument approach. This result differs from Bahcivan's (2019) study. In his study, Bahcivan (2019) indicated that there was no significant relationship with respect to the prediction of argumentativeness by development dimension. However, in this study, the development dimension positively predicted an argument approach. This result, which is compatible with the expected hypothesis, implies that as PSTs believe that scientific knowledge is tentative and evolving, they may have tended to have an argument approach. PSTs may have considered argumentation as an environment where evolving and tentative nature of science can be learned.

The results regarding the relationship between self-regulation and argumentativeness demonstrated that self-regulation was positively related with argument approach. However, self-regulation was not found to be related to the argument avoidance dimension. This result is compatible with the hypotheses in the proposed model and will make significant contributions to the literature. Because no evidence indicating the relationship between self-regulation and argumentativeness was found in the literature. When this relationship, which constitutes the original aspect of this study, is examined, it can be said that self-regulation is a significant predictor of participation in argumentation. In accordance with the proposed hypotheses, PSTs exhibited an argument approach as they were specialized in self-regulated strategies such as goal setting, asking questions, organizing, and making efforts. PSTs may also have considered argumentation as the practice of gaining these strategies. Because, in the studies, motivational factors such as self-regulation and self-efficacy were effective concepts for individuals to perform behaviors such as participating in or getting far away from challenging actions (Pintrich, 2004; Won et al., 2018; Zimmerman & Cleary, 2009). This result found in this study confirmed that self-regulation could be an important factor on the act of participating in argumentation.

Conclusions and Implications

According to the results of the study, it was concluded that PSTs' epistemological beliefs and self-regulation were related with the concept of argumentativeness. Especially considering that the studies on the reasons for some students' non-participation in argumentation processes, the positive contributions of which are presented in the literature, are limited, it can be considered that this result obtained from the study will contribute to the literature. This study, which was conducted to clarify the concept of argumentativeness in the context of science education, is an extension of the studies conducted by Nussbaum and Bendixen (2003), Bahcivan (2019) and Demirbag and Bahcivan (2021) . In this study, as well as in these studies mentioned, the conclusion indicating that especially epistemological beliefs are related to tendencies to participate in or getting far away from argumentation was once again revealed. On the other hand, the finding indicating that the concept of self-regulation, which contains cognitive and effective structures, is an important predictor in the act of participating in argumentation can be considered as the specific result of the study. In this regard, further studies may contribute to the field with regard to examining the causal relationship between the concept of argumentativeness and self-regulation in detail. The behaviors of participating in argumentation and getting far away from the argumentation environment of the students, who are divided into profiles within the context of self-regulation, can be clarified in depth by qualitative studies in which techniques such as observation and stimulated recall interview are used.

Nevertheless, educators who design professional development studies on argumentation-based learning in the science education literature may include studies aimed at the development of the argumentation act through the development of concepts such as epistemological beliefs and self-regulation skills that affect this process.

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