

Boğaziçi University SCED Graduate Student Research Symposium

Date: May 25, 2023

13.00 - 16.30

ABSTRACT BOOK

The Department of Mathematics and Science Education (SCED) are pleased to announce Boğaziçi University SCED Graduate Student Research Symposium. Our goal is to showcase the quality and diversity of graduate-level research at our department. Participants are expected to present their studies orally during the Symposium.

Presenters' List (according to author names)

1 - Design of a Mathematics Learning Environment: Contribution of Metacognitive and Argumentation Practices on Problem Solving

Alev Güneş Uzun, Engin Ander

2 - Describing Secondary School Mentor Teachers' Mentoring Conceptions in Preservice Teacher Education

Arife Şahin, Fatma Aslan Tutak

3 - Preservice Mathematics Teachers' Cue Utilization and Accuracy in Judging Students' Understanding of Rational Numbers

Aybüke Karagözler, Engin Ader

4 - Investigation of Factors Related to Immigrant Students' Mathematics Performance in PISA 2018

Ayşe Akkır, Serkan Arıkan

5 - Developing a Scale on Examinees' Attitudes Toward Computerized Adaptive Test: Applying Technology Acceptance Model

Beyza Arpacıoğlu, Serkan Arıkan

6 - Teaching Nature of Science: A Science Teacher's Autoethnographical Reflections

Büşra Aksöz, Ebru Kaya, Ayşegül Çilekrenkli

7 - Exploring Middle School Students' Computational Practices in a Stem-Integrated Instruction on Climate Change

Dilara Kara Zorluoğlu, Gaye Defne Ceyhan

8 - Informal Science Communication Meetings Shaped by Student Questions: Exploring Middle School Students' Questions

Dilara Kara Zorluoğlu, Ülkü Seher Budak,Erenay Atay, Gaye Defne Ceyhan

9 - A Causal Comparative Study: Students' Confidence Scores Through Environmental Problems

Elif Sude Aydın, Gizem Özyazıcı

10 - Science Teachers' Views on Nature of Science and Its Inclusion in the Science Curriculum

Gözde Kurt, Ebru Kaya

11 - Exploring Middle School Students' Perceived Value of Science Communication Meetings

İpek Paksoy, Melike Hanedar, Gaye Defne Ceyhan

12 - Pre-service Teachers' Plausibility Perceptions of Global Climate Change: Results of the Updated Plausibility Perception Measure Scale

Melike Hanedar, Gizem Özyazıcı, Gaye Defne Ceyhan

13 - Investigating the Differential Relationship Between the Big Five Domains of Social and Emotional Skills and Mathematics Achievement Using OECD's SSES

Mihriban Altıner Sert, Serkan Arıkan

14 - Understanding Nature of Science Among Students with Different Metacognitive Awareness Levels

Nazmiye Ertuğrul

15 - Pre-Service Science Teachers' Experiences in Computer Simulation and Virtual Reality Application: Atom and Molecule Concepts

Öznur Erkoca, Sevil Akaygün

16 - Preservice Mathematics Teachers' Knowledge of and Attitudes Toward Probability and its Teaching

Selen Çaylı, Kemal Akoğlu

17 - Pre-service Mathematics and Science teachers' Views on Designing Interdisciplinary Mathematical Modelling Tasks

Sevil Sezer, Fatma Aslan Tutak

18 - Analyses of Mathematics Performance, Immigration Status and Well-being of Students in Turkey Using PISA 2018

Simge Akbal, Sevda Yerdelen Damar

19 - Research Trends on Systems Thinking Approach in Science Education

Ülkü Seher Budak, Gaye Defne Ceyhan

20 - STEM Stereotypes: Scale development and validation

Zeynep Aydin, Kübra Kaya, Sevda Yerdelen Damar, Felicity McLure

Design of A Mathematics Learning Environment: Contribution Of Metacognitive And Argumentation Practices On Problem Solving

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Developments in the educational area unveiled some issues about the educational system like the significance of students' critical thinking and reasoning skills, and the learning environment. This study problematizes the learning environments and it tries to investigate whether specific features of a learning environment promote students' problem-solving skills or not. Hence in this study, an enriched mathematics learning environment is aimed to be designed.

Learning and teaching mathematics, and particularly problem solving which is one of the main components of mathematics classrooms can be developed through including argumentation and metacognition to the classroom discourse (Cho & Jonassen, 2002; Jimenez-Aleixandre, Rodriguez & Duschl, 2000; Lucangeli, Tressoldi & Cendron, 1998; Mevarech & Amrany, 2008; Shin, Jonassen & Mcgee, 2003) Having effective and participatory classroom discussions and providing opportunities to students to increase their metacognitive skills is expected to support students in analyzing the problem and creating productive solutions for it. This study is a design based research and a mathematics learning environment is aimed to be designed in which argumentation and metacognitive skills of students, that are expected to develop problem solving skills of students, will be promoted. Main research question of the research is: How can a learning environment enhancing students' argumentation and metacognitive skills support problem solving skills of students?

The sub-questions regarding the main research question are:

1) How can an intervention program focusing on argumentation and metacognition enriched with proper tasks and adequate scaffolding of the teacher can support the classroom argumentation practices?

2) How can an intervention program focusing on argumentation and metacognition enriched with proper tasks and adequate scaffolding of the teacher can support the classroom metacognition practices?

3) How are argumentation and metacognition related to each other during solving mathematics problems?

4) How do students' problem-solving skills change throughout the school year with the development of argumentation and metacognition?

In this study design based research is being carried out. A mathematics learning environment is designed in which argumentation and metacognitive skills of students are aimed to be promoted. Participants of the study are two 5^{th} grade classrooms and their mathematics teachers. This design will endure nearly one and half school year and there will be 3 phases. (McKenney & Reeves, 2012). Phase 1 is the analysis and exploration phase. In this phase the aim was to analyze the problem and explore the ways to solve it. This study problematizes the mathematics learning

environments and the ways mathematics questions are solved. Phase 2 is the design and construction phase in which the focus will be on the solution of the problem. Solution will be designed and constructed on the real learning environment. The design process need to be "systematic and intentional" for precision, and also "creative" to respond the emerging situations on the field (McKenney & Reeves, 2012, p. 109). Interventions guided by theory and the needs of the field are planned and actually implemented. In this study, the aim is to investigate whether specific features of a learning environment promote students' problem-solving skills or not and some interventions have been made to promote those features. Phase 3 is the evaluation and reflection phase in which a comprehensive retrospective analysis, beside the formative evaluations will be carried out. The study is in Phase 2 now.

During the school year, teacher-researcher workshops and classroom observations have been carried out with the aim of promoting students' argumentation and metacognitive skills. In the workshops, teacher and researcher have been working on how to promote students' argumentation and metacognitive skills of students. Observations of each classroom have been carried out biweekly for nearly 7 months from October 2022 to May 2023. Meetings with teacher have been held one week after the observation since it is wanted that teachers can also have the chance to reflect on his/her practices before meeting. Meetings are not structured, they have been designed according to the needs of the teachers and formative evaluations of existing condition. In addition, classroom talk is transcribed, categorized, analyzed and the talk analysis have been used to understand the change in the argumentation and metacognitive skills of students. Pre and posttests will be used to reveal the change in problem solving skills of students.

This study is currently ongoing and has not been completed yet. Therefore, in this part both the results gathered until now and the expected results will be mentioned. During the first weeks of the field work pre-test was implemented. Descriptive statistics about the test is shown in Table 1. The questions asked in the test was consisted of 5 skill based questions chosen from recommended questions of MEB. (For the test See Appendix A) The test was assessed according to the Holistic Scoring Rubric (Aschbacher, Koency, & Schacter, 1995) (For the rubric See Appendix B). 4 is the highest and 0 is the lowest point that students can get. Therefore, 20 is the maximum value that can be attained from the test. It is expected that there will be statistically significant difference between pre and posttests.

TABLE 1 ***Descriptive Statistics for pre-test results of two classrooms***

Variable	*N*	*Mean*	*SD*	*Range*	*Min*	*Max*	*Skewness*	*Kurtosis*
5A	23	5.13	3.27	13	0	13	.25	- .01
5B	21	4.48	2.84	10	0	10	.29	- .77

Ayalon and Even (2016) look for argumentation moves in the classrooms they observe and they create a schema of all argumentation moves in the classroom. Argumentation schema proposed by these researchers will be used to create an effective argumentation route. To create argumentation schemas of the classrooms, classroom talk is coded (See Appendix C) and classified according to the type of dialogue. Figure 1 and 2 shows argumentation schemas of two classrooms.

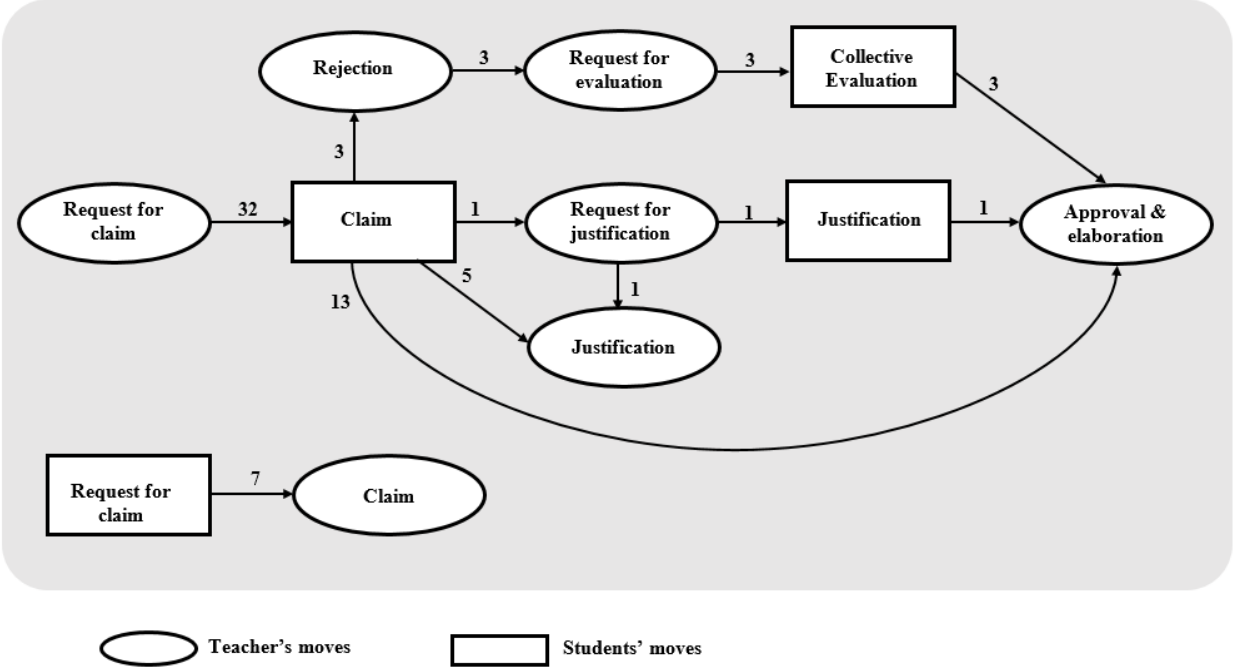


Figure 1. Argumentation schema of 5A

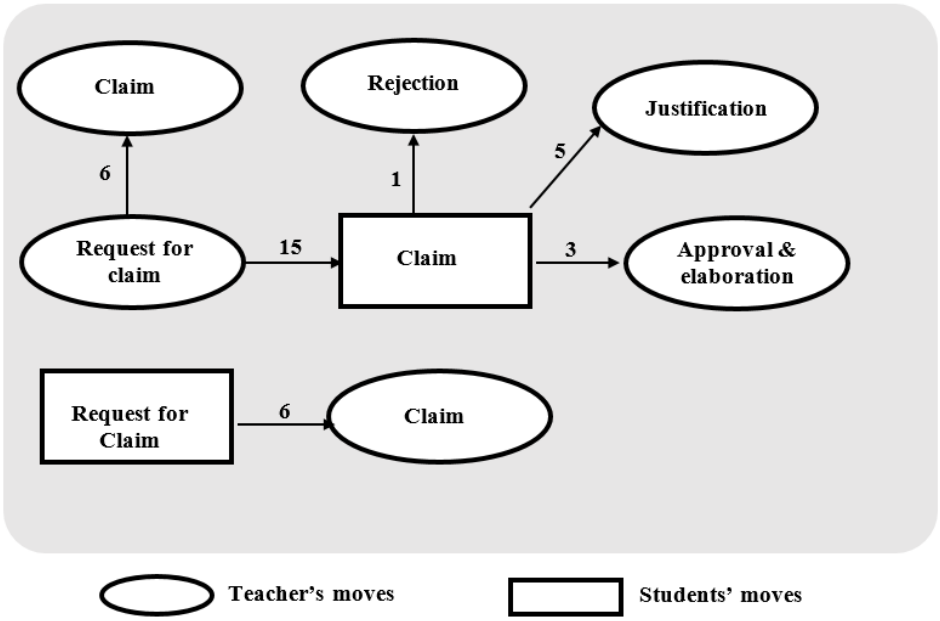


Figure 2. Argumentation schema of 5B

During the school year three argumentation schemas will be constructed and the change will be traced. In these figures it is expected that student participation and justification, and collective evaluation of whole classroom will increase.

The classroom talk is used also for the metacognitive talk analysis. The talk is first categorized as teacher (T) and student (S) talk, then as metacognitive (M), cognitive (C) and social (S). In addition, SM refers to student expression including metacognitive knowledge or skill. TM is used for teacher's metacognitive expressions and A is used for the whole classroom talk. After

categorization, proportion of metacognitive talk is calculated. First metacognitive analysis of classroom talk is shown in Table 2. During the school year metacognitive talk analysis will be carried out three times and the change in types of talk will be traced. It is expected that metacognitive talk especially student metacognitive talk will increase.

TABLE 2 ***Metacognitive talk analysis of two classrooms***

Variable	*T*	*S*	*M*	*C*	*S*	*TM*	*SM*	*TM/T*	*TM/A*	*SM/A*	*M/A*
5A	112	112	45	138	41	33	12	0.29	0.15	0.05	0.2
5B	79	83	21	92	50	9	12	0.11	0.06	0.07	0.13

Keywords: Metacognition, Argumentation, Problem solving

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Describing Secondary School Mentor Teachers' Mentoring Conceptions in Preservice Teacher Education

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Mentoring has a complex structure; understanding this process is crucial to increase the effectiveness of teaching practicum in preservice teacher education (PSTE). The mentoring process is generally evaluated in terms of mentor teachers' (MTs) practices, and MTs' practices are defined in terms of preservice teachers (PSTs) needs, which are expected to shape MTs' practices. Even if there are expected MTs' practices, each MT shapes practices according to her beliefs about what mentoring is. These beliefs are the bases for MTs' mentoring conceptions. Mentoring conceptions are defined as "a set of beliefs about the goals, sources, and nature of mentored learning to teach" (van Ginkel et al., 2016, p.104). There are two types of mentoring conceptions: developmental (DMC) and instrumental (IMC). The distinction between IMC and DMC parallels the distinction between teacher-centered and student-centered conceptions of teaching (Donche & Van Petegem, 2011). MTs who hold DMC see themselves as a creative person who establishes a collaborative and reciprocal relationship with PSTs to discuss the reasons behind the teaching principles (Hall & Davis, 1995). MTs who hold IMC see themselves as a maestro who develops proficiency for PSTs, and they think the mentoring relationship is asymmetrical (Hall & Davis, 1995).

Mentoring conceptions are crucial for identifying how MTs perceive mentoring (van Ginkel et al., 2016); therefore, describing MTs' conceptions would be beneficial to understand MTs' practices and how practices shape the whole process. This abstract, part of my thesis, just focuses on mentoring conceptions. It aims to describe MTs' mentoring conceptions in PSTE and also aims to examine whether MTs' mentoring conceptions are differentiated in their subject and years of mentoring experience.

1. What are secondary school MTs' mentoring conceptions in PSTE?
2. Is there any statistically significant difference in secondary school MTs' mentoring conceptions regarding their subject and years of mentoring experience?

The study sample comprised 141 secondary school mathematics, science, physics, chemistry, biology, Turkish, English, history, geography, and social science MTs in Istanbul. The participant mentor teachers' (PMTs) years of mentoring experience ranged from 1 to 25 (M=7.23, SD=5.89), and years of mentoring experience were separated into four groups (1-3, 4-7, 8-11, and more than 12). The branches of PTMs were separated into three groups: Mathematics (middle and high school), Science (physics, biology, chemistry, and science), and Language and Social Science (Turkish, English, history, geography, and social science). The data were collected using the Mentoring Conception Scale (MCS) in the 2021 fall term at a single point in time. The MCS was developed by van Ginkel et al. (2016) through literature and the pilot study to assess mentor teachers' conceptions. The MCS consists of 48 seven-point Likert-type items based on two conception factors, DMC and IMC. Within the scope of this study, the MCS was translated from Dutch to Turkish using the backward translation design. After translating into Turkish, the scale was applied to eight MTs, and interviews were conducted to strengthen the linguistic equivalence of the scale. Considering the opinions of the MTs, lastly, the field experts checked the scale, and the translation was completed. For the reliability analysis of the scale, the Cronbach alpha coefficient was calculated and found to be 0.96. The Confirmatory Factor Analysis was performed to check the construct validity of the MCS. Due to the small sample size, CFA was performed by considering the means and variance-adjusted weighted least squares (WLSMV) estimation for variance (Beauducel & Herzberg, 2006). CFA results were evaluated based on fit indices, factor loadings, and

discriminant validity was also considered. Except for the RMSEA index, all fit indices were within the acceptable range (X^2=2841.01, X^2/df=2.63, RMSEA=.10, CFI=.90, TLI=.90). When the sample size is small, RMSEA is likely to be biased and tends to give a worse model fit than the population values (Shi et al., 2018). In addition, all items' factor loadings were statistically significant and higher than 0.5. Finally, Average Variance Extracted (AVE) was calculated, showing that discriminant validity was achieved. Since data were not normally distributed, the non-parametric alternatives of statistical tests were used in the analysis part. A Wilcoxon Signed Rank Test was used to compare conception factors. A Kruskal Wallis Test was used to decide whether conception factors are differentiated regarding subject and years of mentoring experience groups.

The descriptive results showed that PTMs tended to give high scores for both DMC (M=150.9, SD=15.9) and IMC (M=136.1, SD=21.9). However, comparison analysis showed that there is a statistically significant difference among conception factors (z=-9.02, p<0.001, r=.54). Due to MTs' approaches to PSTs generally showing similarities with approaches to students (Chan & Elliott, 2004), the PMTs could have reported stronger agreement with DMC (Md=156) than IMC (Md=138). As a result of education reform in 2004 (Ünder, 2010), teachers started adopting constructivist teaching and learning conceptions (Aypay, 2011). The changes brought about by the new approach to education might have affected PMTs' conception choices; therefore, they might have indicated their dominant conception factors as DMC.

Even if education reforms in Turkey have caused changes in teachers' conceptions of teaching, teachers in all branches have not been affected by new approaches in the same way. This study showed that there is a statistically significant difference in PMTs' DMC (χ2(2, n=141) =11.41, p=.003, r=.26) and IMC (χ2(2, n=141) =9.97, p=.007, r=.24) scores across subject groups. While PMTs in Mathematics and Science groups did not differentiate, the Language and Social Science (LSS) group differentiated from Mathematics and Science groups. The LSS group tended to give high scores for each conception factor. LSS teachers tend to have the constructivist approach more than Mathematics and Science teachers because these subjects provide more opportunities to adopt the constructivist approach (Tezci et al., 2017).

According to the study, there is no statistically significant difference in PMTs' DMC (χ2(3, n=141) =1.07, p=.78) and IMC (χ2(3, n=141) =4.52, p=.21) scores across years of mentoring experience groups. MTs might be preserving their initial mentoring conceptions because of the limited reform movements in mentoring programs and no further mentor-teacher training program besides a three-day training program in Turkey.

Keywords: Mentoring, Mentoring Conception, Preservice Teacher Education

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Preservice Mathematics Teachers' Cue Utilization and Accuracy in Judging Students' Understanding of Rational Numbers

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A teacher can generate activities to improve students' performances, design lessons according to their students' needs and evaluate students' performances to see their students' level of understanding. At this point, teachers' judgments of their students' performances play an important role. How teachers judge their students' performances and whether teachers' judgments are accurate or not have been investigated in many studies. Artelt and Rausch, (2014) asserted that accurate judgments of teachers aid in their way of teaching by affecting their actions in the class, their types of measurements of achievement, and giving grades. Thiede, Oswalt, Brendefur, Carney, & Osguthorpe, (2019) explained that if teachers are able to make accurate judgments about their students' learning process, it would be possible for them to assess the instruction quality by making reasonable improvements. This study will be about preservice mathematics teachers' judgments of students' performances in a rational number domain. Oudman, van de Pol, Bakker, Moerbeek, & van Gog (2018) looked at teachers' judgments about students' performances of decimal numbers. They concluded that the reason behind teachers' making inaccurate judgments is their insufficient knowledge of possible misconceptions of students. This study will check the preservice teachers' knowledge of students' misconceptions about rational numbers to see their relationship with their judgment accuracy.

This study will have significance in terms of its different properties than other studies which are: selecting preservice teachers as participants who will make judgments for unfamiliar students, choosing a specific domain to be judged rather than the general mathematical ability, checking preservice mathematics teachers' level of knowledge for misconceptions of students about rational numbers to relate it to their judgment accuracy and cue utilization.

Research questions:

- How does preservice mathematics teachers' judgment accuracy differ under different cue-availability conditions?
- Is there a significant difference between cues that preservice mathematics teachers use while they are making judgments of students' understanding of rational numbers in different cue-availability conditions?
- How preservice teachers' cue utilization and their judgment accuracy is related?
- How preservice mathematics teachers' knowledge about students' misconceptions about rational numbers is related to their judgment accuracy of students' understanding of rational numbers?
- How is preservice mathematics teachers' knowledge about students' misconceptions about rational numbers related to their cue utilization?

Approximately 30 preservice mathematics teachers from Boğaziçi University participate in the study. They are senior students, doing their internship in middle schools in İstanbul. There will be two parts of this study. The first one is conducted with middle school students for the purpose of collecting materials to be used in the study with preservice teachers. Middle-grade students were instructed to complete two mathematical assignments. 9 students and all the collected data from them under the name of student and answer cues, were chosen for further data collection. These 9 students correspond to three categories according to their mathematics performance which are low, medium, and high. 3 students from each performing level are judged by teachers in every 3 conditions: student-only, answer-only, and student+answer.

The main study starts with preservice teachers. They complete a PCK test designed by Depeape et al., (2015) and make their judgments about nine students in three conditions. In the first phase of the main study, preservice mathematics teachers work on the PCK test which is about students' understanding of rational numbers.

In the second phase of the main study, they will make their judgments about students' performances for rational numbers. Preservice mathematics teachers will judge students' performances in different cue-availability conditions. They will judge items in the second assignment by indicating whether students had given answers to these items correctly or incorrectly. In student only condition, teachers are only knowledgeable about the information about the student; in answer only condition, teachers can access the answers that students have given on the first assignment to make a judgment on the second assignment; in the student+answer condition, teachers know both the information about students and their answers for the first assignment.

While preservice teachers make judgments about students' performances, they will be asked to select the cues from the cue list which is presented to them.

Each preservice teacher will have 3 judgment accuracy score for each condition and these scores will be compared. Thus, ANOVA will be used to see how teachers' judgment accuracy differ under different cue-availability conditions. Again, ANOVA will be used to see the difference between cues that preservice mathematics teachers use since each teacher has one cue score for each cue in all cue-availability conditions. Multiple regression will be used to see the relation between teachers' cue utilization and judgment accuracy. Correlation will be calculated to check the relationship between preservice teachers' knowledge and their judgment accuracy. Again, correlation will be calculated to check the relationship between preservice teachers' knowledge about students' misconceptions and their cue utilization.

As a result of this study, it is expected that if preservice teachers use more diagnostic cues while they are doing their judgments, they are able to accurately judge students' performances. Oudman et al., (2018) found that when teachers could access students' answers rather than knowledge about students' general characteristics, they did more accurate judgments about students' performances. However, they found that when teachers have both information about students' answers and general characteristics, teachers did not overlook information about students' general characteristics while they were doing judgments. Since teachers have judged their own students in the study of Oudman et al., (2018), the present study may reveal different outcomes because of preservice mathematics teachers' judging unfamiliar students for them. For example, preservice teachers may prefer to use answer cues more than student cues, when they can access both since middle-grade students who are judged are not their own students. Also, it is expected that a preservice mathematics teacher who is more knowledgeable about students' misconceptions will make more accurate judgments in answer-only and student+answer conditions. This is because, if teachers can detect students' misconceptions from their answers, they may be more capable of interpreting students' performances.

Keywords

Judgment Accuracy, Cue Utilization, Misconception Knowledge of Preservice Teachers

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Investigation of Factors Related to Immigrant Students' MathematicsPerformance in Pisa 2018

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There has been a large number of studies on the performance gap between immigrant and native students (Pivovarova and Powers, 2019; Martin, Liem, Mok, & Xu, 2012; Arikan, Van de Vijver, & Yagmur, 2017; Rodriguez, Valle, Gironelli, Guerrero, Regueiro, & Estévez, 2020). Numerous studies have been conducted on student-level and contry-level variables that are related to immigrant students' performance. Student-level variables are chosen based on Walberg's theory.According to Walberg's theory, a student's success is impacted by their characteristics and environment. The main psychological factors influencing academic achievement were categorized as student ability, instruction, and psychological environment. Student aptitude is the student's capacity or predisposition for perseverance in academic work. The quantity and the quality of the instructional time refers to instruction. Psychological environments refers to students' views of their peers in the classroom and the home environment (Walberg, 2004). On the other hand, country level variables are chosen based on research. Some research suggests that migrant integration policy index (MIPEX) is associated with achievement (He et al., 2017; Arıkan et al, 2017). Furthermore, the human-development index (HDI) was found associated with achievement (Arikan et al., 2020).

The research questions are based on the objectives of determining whether there is a performancegap between immigrant and native students and determining factors of immigrant students' performance;

RQ1: Which student level (motivation to master tasks, resilience, and cognitive flexibility/adaptivity, exposure to bullying, sense of belonging, discriminating school climate, students' attitudes toward immigrants) and country level (MIPEX and HDI, educational expenditure) variables could predict mathematics performance of immigrant students and native students across European countries in PISA 2018?

RQ2: Is there a statistically significant difference between the mathematics performance of first-generation immigrant students, second-generation immigrant students and native students across European countries in PISA 2018?

RQ3: Is there a statistically significant difference between the mathematics performance of first-generation immigrant students, second-generation immigrant students and native students after controlling socio-economicstatus?

Participants are immigrant students (first and second generation) and native students who take the PISA assessment in 2018. Students who were born in another country and whose parents were born in another country are considered first-generation. Second generation students are those who were born in the country ofassessment but whose parents were born elsewhere. Native students are those whose parents (at least one of them) were born in the assessment country (OECD, 2019a). The data from 17 European countries such as Austria, Croatia, Estonia, Germany, Greece, Finland, Iceland, Ireland, Italy, Latvia, Luxembourg, Malta, Portugal, Serbia, Slovenia, Spain, Switzerland were included.

PISA do not only measure the performance of students but also gather data about students' backgrounds by applying questionnaires. Student level variables are chosen from the student questionnaires. Student level variables are motivation to master tasks, resilience, and cognitive flexibility/adaptivity, exposure to bullying, sense of belonging, discriminating school climate, students' attitudes toward immigrants. At the country level, migrant integration policy index and human development index was used. As a control variable socio economicstatus (ESCS) was used.

In order to answer the first research question, multilevel regression analysis will be used to investigate which student level and country level variables could predict the mathematics performance of immigrant and native student. For the multilevel regression analyses, MPLUS 7.4 will be used. For the second research question, independent samples t-test will be used to compare the performance of immigrant

students and native students.The sample weights and plausible values will be included in the analyses to have unbiased results (IEA, 2022). IDB Analyzer will be used. In order to answer the third research question, propensity score matching will be used first and then related comparisons will be performed to examine the performance gap between immigrant students and native students after controlling socio-economic status. The MatchIt R package (Ho, Imai, King, & Stuart, 2011) will be used for propensity score matching.

The intraclass correlation will be used to indicate the variation in immigrant students' math performance explained by country-level and student-level differences. In addition to this, R-square will be used to show thepercentage of variances in mathematics performance explained by student level variables and country level variables. First, explained variance by student level and country level variable will be presented.Then,student and country level variables that are significantly related to mathematics performance will be reported.

In this study, multiple independent samples t-test will be used to test if statistically significant difference exists between the mathematics performance of first-generation immigrant students, second-generation immigrant students and native students. The mathematics performance of first-generation immigrant students and native students will be compared. Then, second generation immigrant students' and native students' mathematics performance will be compared. After that, first generation and second-generation immigrant students' mathematics performance will be compared. Confidence intervals, t-scores and effect sizes will be presented. Propensity score matching will be used in the current study to investigate the performance difference between immigrant students and native students after ESCS has been controlled. The scores of economic and social status will be matched for immigrant and native groups so that the groups will be similar regarding ESCS. Then, the performance of immigrant students and native students will be compared by applying the t-test. IDB Analyzer will be used for the t-test. Effect size of performance difference before and after matching will calculated.

Keywords: immigrant students, mathematics performance, PISA 2018, multi-level regression

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Developing a Scale on Examinees' Attitudes Toward Computerized Adaptive Test: Applying Technology Acceptance Model

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Implementations in measurement, a key component of education system, are greatly affected by and quickly adapt to recent advances in the field of education and communication technology (ICT) (Bennett, 2002; Linn, 1993). Particularly, noticeable growth in computer usage has demonstrated its impact on computer-based administrations in measurement and evaluation (McDonald, 2002). Correspondingly, the usage of Computerized Adaptive Test (CAT) has increased significantly and more examinees experience CAT. Thus, understanding examinees' attitudes toward CAT is essential for CAT implementations to be more successful and to be used widely in educational systems (Lilley, Pyper & Wernick, 2011; Özbaşı, 2016). However, there are few studies that investigating examinees' attitudes toward CAT in the literature (Daphine, Sivakumar & Selvakumar, 2020; Lilley, Pyper & Wernick, 2011; Nikolaus, Bode, Taal, Vonkeman, Glas, van de Laar, 2014; Özbaşı, 2016; Schmidt, Urry & Gugel, 1978; Tonidanel & Quiñones, 2000) and there is lack of instrument that measures examinees' attitudes toward CAT. The purpose of this study is to develop a scale to measure examinees' attitudes toward computerized adaptive test (CAT).

The findings of current study are expected to contribute to literature especially in two aspects. Firstly, scales measuring examinees' attitudes toward CAT frequently used after CAT experiences in health sector, recruitment processes and employee evaluation procedures. Scales measuring examinees' attitudes toward CAT in the field of education are limited. Therefore, investigating attitudes toward CAT in the field of education is valuable to improve CAT for future educational testing. Secondly, the scale developed in the current study is significant because it will be developed by collecting data from examinees after an actual CAT experience. Developing a scale measuring attitudes toward CAT by collecting data from examinees just after they have real experience on CAT is expected to make contribution to the literature.

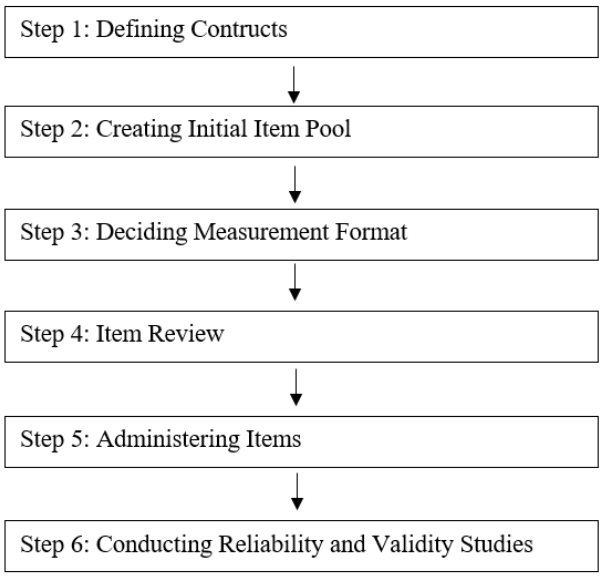
The research questions of the study:

1. Is the scale scores for measuring examinees' attitude towards CAT internally consistent?
2. Is the scale scores for measuring examinees' attitude towards CAT valid?
3. Does the proposed measurement model examining test-takers' attitude towards CAT exhibit measurement invariance with respect to gender?

Sample will consist of 300-350 students because there will be approximately 15 items. Convenience sampling will be used. Participants of this study will be fourth grade primary school students. Schools that permit the application will be selected from both public and private ones.

Test construction steps suggested by Devellis (2017) and Crocker & Algina (2008) are integrated into the current study to develop scale measuring examinees' attitudes toward CAT.

Figure 1
Scale Development Steps



TAM presented by Davis (1993) provides a major conceptual framework for the current study. There are three dimensions in the current study: Perceived Usefulness (PU), Perceived Ease of Use (PEU) and Perceived Enjoyment (PE). PU and PEU are rooted in TAM whereas PE has its foundation in literature. These three are indicators of Attitude Toward Using CAT.

- PU is defined as the degree to which an examinee believes that he or she is capable of using CAT advantageously while especially comparing it to traditional paper-pencil test.
- PEU is defined as the degree of an examinees' beliefs of using CAT being free of difficulty or effort.
- PE is defined as the participants' overall satisfaction with the CAT system is examined.
- Attitude Toward Using CAT is defined as examinees' evaluative judgments of using CAT.

Items were generated according to definitions. Measurement format is 4-Point Likert Scale from "Strongly Disagree", "Disagree", "Agree" to "Strongly Agree."

Cronbach's Alpha will be used to provide evidence for reliability of the test scores in the current study. Cronbach's Alpha Coefficient will be analyzed by using SPSS 25.0. Table of specification and expert opinion were done to provide evidence for content validation.Within construct-related validation, Mplus will be used to test factor structure of the scale via confirmatory factor analysis. Fit indices in confirmatory factor analysis will be checked.

IRT framework will be used for item analysis. Model fits will be compared. Unidimensionality will be investigated by parallel analysis scree plot. Item parameter estimations and item fit indices will be provided. Items will be evaluated, and problematic items will be listed by item characteristics curves.

It was aimed to test the gender-related measurement invariance to understand whether the item characteristics are different for the two groups of respondents and whether these scale-level analyses reflect or ignore the differences in item threshold characteristics. Configural, metric and scalar steps will be documented . Change in the fit values will be evaluated.

It is expected that the scale scores for measuring examinees' attitude towards CAT will be internally consistent. According to Cichetti (1994) criteria, coefficient of Cronbach's Alpha value should be bigger than 0.7 for acceptable internal consistency. It is also expected that the scale scores for measuring examinees' attitude towards CAT will be valid. TLI, CFI and RMSEA values should be acceptable. Factor loadings should be higher than 0.40. (Salkind, 2010). Then, the findings revealed that the configural, metric and scalar invariances will be achieved with respect to gender, having the same meaning to two groups. Change in the fit values will be acceptable.

Keywords**:** Computerized Adaptive Test (CAT), Scale Development, Technology Acceptance Model (TAM), Perceived Usefulness, Perceived Ease of Use, Perceived Enjoyment, Model Testing, Confirmatory Factor Analysis

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Teaching Nature of Science: A Science Teacher's Autoethnographical Reflections

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Nature of science (NOS) in science education has become one of the fundamental requirements for science lesson. There are different approaches to explain NOS for science education (e.g., Abd-El-Khalick & Lederman 2000; Allchin 2011; Erduran & Dagher 2014; Matthews 2012). One of the influential approaches was developed by Erduran and Dagher (2014) who described science as epistemic-cognitive and social-institutional system. Kaya and Erduran (2016) used the phrase "RFN" for "Reconceptualized Family Resemblance Approach (FRA) to Nature of Science (NOS)" to distinguish its educational aspects from Erduran and Dagher's FRA to NOS. In the current study, RFN was used as the theoretical framework.

There are also different approaches about whether NOS teaching strategies should be explicit/reflective (Bell et al. 2011; McDonald 2010) or implicit way (Abd-El- Khalick & Lederman, 2000; Khishfe & Abd-El-Khalick, 2002). The empirical studies support that teaching NOS explicitly is more effective in developing learners' NOS perceptions (Akerson et al., 2000; McDonald, 2010). According to Loughran (2002), reflection can increase educators' knowledge of practice by reflecting on what they learn in practice. Journal writing is one of the best ways for reflective practice. In the current study, the researcher (teacher) keeps weekly journal which enabled her to make critical examination of her experiences on diverse aspects about teaching NOS.

There are some studies based on RFN framework including educational intervention with diverse learning groups (Akbayrak & Kaya, 2020; Cilekrenkli & Kaya, 2022; Cullinane & Erduran, 2022). However, there are limited studies that refers how instructors experience these processes and what their expectations, concerns, difficulties, and suggestions of a teacher for an effective NOS teaching, etc. are (Sarıbas & Ceyhan, 2015). Hence, in this study, we aim to report the reflections of a science teacher through her experiences about teaching all RFN categories in a systematic way.

Autoethnography provides researchers to draw on their own experiences to understand a particular phenomenon or culture (Mendez, 2013). The first author as the science teacher reflected on her teaching knowledge and practice and the learning processes of her students through journals. The school she worked at during the study was a religious middle school in an underdeveloped region of a metropolitan city in Turkey. The teacher taught an instructional sequence to two of her classes. One class was the experiment and the other was the control group. We developed the instructional sequence including activities and materials based on the Turkish science education curriculum and the textbook supplied by the Ministry of National Education to all students. During the intervention both groups conducted same activities. But the activity sheets of the experimental group included extra questions that would give students opportunities to think and discuss about predetermined aspects of NOS. The teacher took journal entries for each week of the implementation. She totally answered 15 questions for each week which 6 of them before the instruction and 9 of them after the instruction. The questions she answered before the instruction had generally aims to increase (1) teacher's awareness about whether the Turkish science education program or the textbook are explicitly connected to NOS issues, and her awareness about teaching of the current theme on the related week. The questions she answered after the instruction had generally three focuses which are (1) the evaluation of teaching RFN, (2) students' progress in learning RFN, and (3) teacher's developmental progress through the intervention. For example, "Do you think the lesson was meaningful for them? Why do you think so?" are some of the questions she answered after the

implementation for the evaluation of teaching RFN. Thematic and content analysis was conducted through open, axial, and selective codings (Corbin & Strauss, 1990). Related codes and categories, and the relationship between the categories were identified. Finally, the teachers' reflections for the inclusion of RFN into their lessons were determined based on diverse themes.

The results are presented under the themes considering the journal questions which some of themes were summarized as,

The inclusion of NOS in the Turkish science education program and science textbook

The teacher thinks that the curriculum and science textbook have limited explicit connections to NOS. Even the objectives provided by the MoNE refer to some scientific practices, they were so limited to provide holistic understanding of NOS. The teacher suggests that developing specific objectives to teach NOS and developing textbooks considering these objectives may enable teachers systematic teaching of NOS.

Teaching RFN categories to fifth grade students

The teacher believes that fifth-grade students can be taught to all RFN categories to some extent, but social-institutional categories are easier than others. Scientific methods and methodological rules, and scientific knowledge categories involve more theoretical concepts such as manipulation, changing variables, theory, law, etc but they can still be taught. Specific suggestions for teaching each RFN category will be provided during the presentation.

The students' progresses in learning RFN

The teacher notes that although students initially perceived group activities as a chance to talk with friends, they eventually learned the nature of group work and reporting findings. The instructional strategies used were helpful for students to express their ideas, work together, and understand the nature of science. In the experimental group, the teacher observed that students made explicit connections to NOS concepts in their studies and answered NOS-based questions using visuals.

Teacher's developmental progress thorough the intervention

Keeping journals enabled the teacher to systematically study the development of her RFN perception, teaching methods, and teaching skills, leading to high levels of professional satisfaction at the end of the semester. Future studies can focus on teaching RFN with different grade levels and contexts, both vertically and horizontally.

Keywords: Auto-ethnography; Nature of Science; Fifth Grade Students

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Exploring Middle School Students' Computational Practices in A Stem-Integrated Instructıon On Climate Change

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The problems of the twenty-first century require the skills, expertise, and perspectives of many different fields. Individuals in various professional categories need to have the skills necessary to quickly find solutions to difficulties encountered in daily life (Ring et al., 2017). Peters-Burton et al. (2022) highlighted the importance of engaging computational thinking (CT) principles like abstraction and pattern-recognition through classroom activities to gain the interdisciplinary skills. The problem-solving process using CT has certain elements including logical sequencing, data analysis, and the generation of solutions (Barr & Stephenson, 2011). The current study investigated how CT could be incorporated into eighth grade science classrooms using an integrated STEM teaching strategy. The research question was "Which computational thinking skills do eighth grade students use throughout the intervention?".

Although computational thinking (CT) is not a new concept, its use became widespread after Wing (2006) identified the importance of CT as a critical skill for everyone, not just computer scientists, and defined it as a thinking process. Weintrop and colleagues (2016) created a framework for CT in interdisciplinary contexts, including data practices as a useful addition to scientific investigations. According to Peters-Burton et al. (2022), integrating CT techniques and skills into science education would improve both science content and computational thinking. CT practices allow students to understand the relationship between concepts in complicated topics such as climate change (Park & Green, 2019). Most studies in the literature examine how science contexts enhance CT skills (e.g., Sengupta et al., 2013), while a few studies, including the current study, focus on CT and science subjects being studied together (e.g., Arık & Topçu, 2022). The STEM Integrated Teaching Framework, developed by Corlu (2017), was used as a roadmap to design the lesson plans. Questions were designed to assess how students use CT practices.

This study was conducted in a public school with academically successful students and technological facilities. The participants were thirty eighth-grade middle school students (15 females, 15 males). The students were divided into 5 groups and their worksheets were analyzed using qualitative techniques to highlight the level of CT practices used during the intervention. As part of the study, the lesson plans included activities to teach middle school students about climate change using CT practices, specifically abstraction, pattern recognition, algorithms, and decomposition. The activities in the worksheets were designed to enable students to use CT practices to produce a report. The CT concepts related to data science were used considering Weintrop et al.'s (2016) framework, which included data practices of creating data, collecting data, manipulating data, visualizing data, and analyzing data.

Given the framework, the open-ended questions guided students to think about the process. Each instructional step (i.e., fact-finding, product development) was linked to CT practices to assess the process. For example, at the beginning of the lesson, students were asked to identify the steps for conducting research or the equipment needed to conduct research. The problem was also presented as a general problem. They should divide this problem into manageable parts. Therefore, when they answer the questions in APoKS, they are actually using the decomposition practice. The lesson design and the questions were organised considering the data practices and the analysis was done considering the CT practices (i.e. decomposition, abstraction). According to the framework, each data practice includes different CT practices, which shows that both practices are paired in the framework. For each part of the lesson plan

analysis, the Peters-Burton et al. (2022) rubric and the Ceyhan et al. (2021) rubric were used to create a new rubric. Responses were scored from 0 to 4 according to the overlapping codes from the definitions. If there were no relevant answers, the score was 0. 4 points were given if the relevant information, explanation and examples were included as well as the necessary connections from previous parts. After calculating the average scores, each practice was categorised with levels from 1 to 4.

Considering the definitions in the framework of Weintrop et al. (2016), as well as the definitions and sample questions related to CT and data practices shaped by Burton et al. (2020), the students' worksheets were qualitatively analyzed. The responses to each question were considered as part of the report produced by the groups at the end of the study. The CT practices that were the focus of this study were abstraction, pattern recognition, algorithms, and decomposition. Average scores for each part of the worksheet were found for all five groups. The results showed that 4 out of 5 groups were at level 4 for decomposition. On the other hand, 3 groups were at level 2 and 2 groups were at level 3 for pattern recognition. This shows that students are good at breaking down a large problem into manageable parts, but they should develop their skills in identifying similarities and differences in data to create a product.

Keywords Computational thinking, problem-solving, STEM education

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Informal Science Communication Meetings Shaped by Student Questions: Exploring Middle School Students' Questions

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Questioning is crucial to scientific investigation and science instruction (Baram-Tsabari et al., 2006) since curiosity-driven questioning is significant for developing scientific thinking (Jirout, 2020). Researchers emphasized an encouraging environment so that students can generate intellectual questions about scientific concepts, processes, and practices (Eshach et al., 2014). Since science education and science communication share common goals like engaging the public about science, science communication meetings with experts are a significant way to raise the curiosity and interest of students towards scientific issues by learning from credible sources (Baram-Tsabari & Osborne, 2015; Chin & Chia, 2004). Science communication meetings provide a platform to increase student-scientist interaction that may promote students' interest in science as well as increase students' scientific literacy by critically evaluating claims via evidence-based arguments (Barzilai & Chinn, 2020; Roberts, 2013). While students become equipped for post-truth conditions, students' questions can be examined in the aspects of number, focus, and quality.

Considering the importance of science communication, in this project, middle school students, teachers, and scientists were brought together to investigate the effects of these meetings on students' interests and attitudes toward science and to examine the number, focus, and quality of student questions before and during these meetings. This study aims to investigate the characteristics of students' questions with qualitative analysis techniques. The following research question motivated the present study: "What are the characteristics of student questions?"

Many researchers have used Baram-Tsabari et al. (2005) classification for investigating students' questions from different settings like submitting questions to websites or science magazines as well as asking questions during class hours (Cakmakci et al., 2011; Chin & Brown, 2002; Yerdelen-Damar & Eryılmaz, 2010). In this study, scientists in the science communication meetings were determined based on students' questions, and the questions were analyzed according to Baram-Tsabari et al.'s (2006) classification.

This study was conducted in a full scholarship, boarding, technologically equipped, quality education foundation school. The participants consisted of ninety 7th grade students (34 girls, 57 boys) who voluntarily asked questions on the topic of solar system science. Prior to the science communication session, students were asked to write their questions about "Solar System and Beyond" on Google Forms for one class period. The questions were transferred to an excel spreadsheet to be collected together and all researchers were given access to the file. After the students completed the unit in their schools, a science communication meeting was organized with two scientists in the field of physics in the school environment. During the science communication meeting, a random number generator was used to select student questions and to encourage students. Then, a wheel of fortune with students' names was used to identify the students who asked the selected questions. The session ended with the scientists answering the students' questions.

Qualitative analysis was used to assess the number, focus, and type of questions students asked before and during the science communication sessions. The researchers categorized the students' questions with reference to Tsabari et al.'s (2006) framework. Sentences without question structure or incomplete sentences were excluded from the data. For inter-rater agreement, three researchers separately categorized the 81 questions submitted via Google Forms and met to solicit feedback. The researchers achieved 100% agreement on the categories.

Out of 91 students (34 female and 57 male) who participated in the meetings, 81 of them shared questions about the solar system unit. 53 males and 28 females sent a total of 81 questions which means almost all females (82%) and males (93%) asked questions. Baram-Tsabari et al., (2006)'s classification was used as the categories of cognitive level and motivation. The cognitive level includes the type of information requested and the order of requested information. The motivation includes school-related and spontaneous motivation.

Type of requested information

The nature of the question and the knowledge it generates were considered while categorizing the questions in the type of information requested category. The categories were described from the highest to the lowest as a general request for information, factual, explanatory, methodological, prediction, and open-ended, respectively. Out of 81 questions, 31 were categorized as open-ended, 27 were factual, 11 were the prediction, 6 were explanatory, 5 were methodological, and three as general request questions.

The order of requested information

The questions were examined according to properties, comparisons, and causal relationships in the order of the requested information category. Out of 81 questions, 50 of them were in the properties category, 19 included causal relationships and 12 included comparison type of questions. The highest number of questions were in the properties level, while the lowest number of questions were in the comparison level.

Motivation for information request

The motivation for generating the question was classified as school-related if the question is related to the 7th grade National Science Curriculum. Otherwise, the remaining questions were coded under the spontaneous category. In the motivation for raising the question category, out of 81 questions, almost half of the questions were from spontaneous motivation with 40 questions, and the rest were school-related motivation with 41 questions.

Keywords: science communication, student questions, science questions

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A Causal Comparative Study: Students' Confidence Scores through Environmental Problems

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It is aimed to compare two different groups' confidence in their knowledge of environmental problems. To make this comparison, environmental knowledge of the students according to their gender status, PISA 2018 data was used.

Conducting environmental education research has grown in importance to train-educate teachers with high environmental sensitivity and knowledge (Güven&Aydoğdu 2012). In the literature review, it was determined that there was not much awareness of the students' attitudes towards the environment, and it was found that there was a lack of knowledge about environmental problems (Andersson&Wallin 2000; Pruneau et al. 2003; Lee et al., 2015). However, in some studies, it has been found that students are aware of and conscious of problems such as global climate change. With this research, it is possible to find out how much the students are confident by their knowledge of the environmental problems and to see if there is a statistically significant difference between boys and girls.

Research Question: Is there a statistically significant difference in the mean score of confidence of the knowledge about environmental problems between girls and boys?

The sample of this study consisted of 15-year-old students from 79 several countries who took part in PISA 2018. This sample included 426 365 students from 20 663 various schools.

The findings of the PISA (Program for International Student Assessment) study have been released. PISA evaluates the usage of 15-year-old students' knowledge and abilities in reading, mathematics, and science in real-life situations on a global scale and publishes key statistics on the participating nations' basic education levels. Furthermore, PISA not only assesses students' abilities in three areas, but also collects information on their motivations, self-perceptions, learning styles, school environments, and families, providing useful information about students' socioeconomic and cultural backgrounds, as well as the impact of these factors on their success.

The independent sample t test was applied by transferring the data to SPSS through the subset of the questionnaire selected by reaching the OECD's in PISA 2018 published data. The OECD has made the PISA dataset used in this study accessible for download.

The scoring technique, in which the data is changed into a categorized organization, was the first stage in preparing data for analysis after it has been collected. The participant's responses were transformed into categorized organizations as scores of females and males by PISA 2018 results. The points of responses were collected throughout the research analysis phase. The maximum possible score was 24, while the lowest possible score was 6. The focus of the study was on the mean of scores based on student replies. The mean of the females' and males' scores was compared. The goal of these studies was to see if females or males have greater scores. It is intended to interpret the data and test the hypothesis in the section of inferential statistics. It was decided if the expectations were supported or not after evaluating the results. Using IBM SPSS Statistics 25, the independent t-test among parametric tests was performed to assess if there is a significant difference between the two independent samples, females and males, by comparing their means of the scores.

To compare two different groups, the independent t-test was applied. Males have an average score of 16.37 (SD=4.14) and females have 16.45 (SD=4.42). The variance of the groups is not equal ($p=.00<.05$). The difference, .08, was significant ($t(422358.518)=6.18$, $p=.00<.05$, 95%

CI: .05 to .10). Therefore, the mean scores of males and females are different. The effect size (Cohens'd) is equal to .01 which means that there is a very small effect.

Independent t-test results show that there is a statistically significant difference in environmental knowledge in the two groups. It was found that the mean of females was higher than males. This implies that gender influences confidence in students' knowledge of environmental problems.

Keywords : Global Climate Change, Environmental Problems, Gender Status

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Science Teachers' Views on Nature of Science and Its Inclusion in the Science Curriculum

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One of the important research areas in science education is Nature of Science (NOS). Many approaches were developed in the context of NOS (e.g. Abd-El Khalick & Lederman, 2000; Allchin, 2011; Irzik & Nola, 2014; Matthews, 2012). The most recent NOS approach is Erduran and Dagher (2014)'s "Family Resemblance Approach (FRA) to NOS" which was entitled as "Reconceptualized FRA to NOS (RFN)" by Kaya and Erduran (2016). This study's theoretical framework is based on the RFN that includes the cognitive-epistemic and social-institutional systems of science. The categories of "aims and values of science", "methods and methodological rules", "scientific practices", and "scientific knowledge" forms the cognitive-epistemic system of science while the categories of "scientific ethos", "professional activities", "social values", "social certification and dissemination", "social organizations and interactions", "political power structures", and "financial systems" forms the social-institutional system of science. Furthermore, the RFN is a comprehensive approach that might be pedagogically applicable in classrooms by teachers (Erduran & Dagher, 2014).

Having competent science teachers is significant in order to teach NOS to students. Thus, examining the NOS views of science teachers can be a reasonable starting point. This is because there is an interrelation between students' NOS understandings and teachers' NOS views (Azninda et al., 2021). However, although the studies that assess teachers' views of NOS are high number, the studies that assess teachers' views of the RFN are limited in the literature. On the other hand, NOS in the curriculum can be applied to the classroom environment in the scope of the teachers' views of NOS. Therefore, science teachers' views of NOS inclusion in the science curriculum is another important point that needs to be investigated. The aim of this study is to examine the views of science teachers about NOS and the inclusion of NOS in the Turkish science curriculum.

The sample of the study is 10 Turkish science teachers who were selected by purposeful sampling. School type (public, private), teaching experience, educational background (bachelor, master, and so on), and gender of the science teachers were considered as selection criteria. The semi-structured interviews were conducted to the science teachers to explore their views about the RFN categories and the inclusion of these categories in the Turkish science curriculum. The semi-structured interview protocol includes 29 open-ended questions related to demographic information, nature of science, and science curriculum. The teachers were also asked to interpret some curriculum statements shown during the interview in terms of the inclusion of NOS. To provide validation of the interview questions, a pilot study was conducted with two science teachers and an expert opinion was gotten before the main interviews. The thematic analysis technique (Braun & Clarke, 2006) was used in order to analyze the data from interviews. The audio recordings of the interviews were transcribed and codes were generated. Inter-rater reliability of coding was provided by calculating agreement ratios (96.09 and 93.60 %) among 2 coders and researchers. After the interviews, the RFN Questionnaire (Kaya et al., 2019) consisting of 70 items was used to examine the science teachers' level of RFN understandings and support the findings of the interviews. The RFN Questionnaire is 5 points Likert scale and contains items about the RFN categories and educational application. Descriptive statistics were conducted in the RFN Questionnaire data analysis.

According to the RFN Questionnaire analysis results, the scores of the science teachers change between 248 and 304, out of 350. Based on the criteria that Akgun and Kaya (2020)

indicated, it can be said that 4 science teachers have a moderate level of RFN understanding while 6 science teachers have a high level of RFN understanding. Additionally, the average questionnaire score of the science teachers was found as 278,7 meaning a high level of RFN understanding. The results also indicate that the experienced science teachers have a moderate level of RFN understanding. According to the thematic analysis findings, some limited or naïve RFN views of the science teachers appeared. For example, some science teachers explained scientific methods as research steps consisting of identifying problems, constructing hypotheses, collecting data, and so on. Moreover, almost all science teachers could not explain the types of scientific knowledge. On the other hand, the result regarding science teachers' views about the social-institutional system was found parallel with the RFN categories. The teachers explained their views about social-institutional aspects of science by giving some examples. Most of the science teachers told that experimentation and observation were emphasized more in the science curriculum as an example of NOS. Furthermore, some science teachers indicated that there is a limited inclusion of the social-institutional system in the science curriculum. With respect to the teachers' interpretation of some given curriculum statements, it was found that the science teachers who interpreted the RFN categories limited also interpreted the relationship between statements and the RFN categories limited. The science teachers also suggested that the inclusion of scientific knowledge, methods, and research should be increased in the science curriculum and NOS might be given as a topic or objective explicitly in the curriculum.

Keywords: Nature of Science, Science Teachers, Science Curriculum

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Exploring Middle School Students' Perceived Value of Science Communication Meetings

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We live in an information age where the spread and acceptance of misinformation are becoming more common, along with the ease of access to information. Educators have been exploring how well learners and teachers are equipped for post-truth conditions and how to improve their preparedness (Sinatra & Lombardi, 2020). One of the effective responses to improve individuals' understanding of science and prevent the spread of disinformation is to bring individuals together with scientists (Kappel & Hormen, 2019). Science communication (SC) improves awareness of science by promoting the creation and regulation of understanding and attitudes about science (Burns et al., 2003). For effective SC to happen, students' expectations and values for SC activities need to be addressed in the planning and implementation of these activities. Within this broader aim, the project, supported by the university's scientific research projects, organizes science communication meetings to bring middle school students and scientists together that are guided with students' questions. As part of the project, in this study, three SC meetings were organized between 7th-grade students and scientists on topics parallel to science curriculum units to provide a SC experience that promotes student-scientist interaction. Therefore, the aim of this study is to explore the extent of students' perceived value of SC meetings from the perspective of the expectancy-value theory (EVT). According to EVT, subjective task value, which is a motivational construct, encompasses four categories: intrinsic value, utility value, attainment value and cost (Wigfield & Eccles, 2000). To better understand student performance, choices, and persistence in STEM fields, it is important to understand student's expectancies and values related to STEM tasks (Ball et al., 2017). With this goal, this study explores the research question: how much and in what ways do students value SC meetings according to the expectancy-value theory?

The study employed a mixed method design where quantitative results aided by qualitative data (Creswell, 2014). In the study, 84 7th-grade students from a private middle school attended three SC meetings organized about science units in the science curriculum with the participation of invited scientists from the field. During the implementation of the unit in science lessons, students were asked to share their questions about the unit. Then, these questions were analyzed to determine the appropriate scientist in the field. An hour interactive SC meeting was organized shaped by students' questions. After each meeting, students answered the questionnaire created by researchers with items based on expectancy-value theory (EVT). The students scaled how useful, important and interesting they found the meetings with a five-point Likert scale and answered the open-ended question about the best part of the meeting. This study combines both quantitative (Likert-type question) and qualitative (open-ended questions) data collection and analysis methods. While the study uses numerical data to analyze the students' perceived value of the SC meetings, it also uses qualitative data in the form of students' responses to open-ended questions to provide a more in-depth understanding of their experiences and perspectives.

Two researchers independently coded the written student responses. Initial codes were created with open coding of the first SC meeting responses. During the coding for the following meetings, these codes were revised, new codes were added in need and their definitions were proposed in a combination of bottom-up and top-down categories. The coding scheme was finalized by adapting emerging coding categories with the EVT categories. Interrater reliability level was calculated with the agreement between researchers for student responses coded with

the final version of the scheme. Results showed almost perfect agreement (κ = .91), and disagreements between coders were negotiated to a consensus through a review of the data and codes.

Regarding the responses to the Likert-type question on how useful, important and interesting they found the meetings, findings revealed that SC meeting value scores increased with each meeting for utility (M1 = 3.57, SD1 = 1.36, M2 = 3.94, SD2 = 1.14, M3= 4.00, SD3 = 1.28), attainment, (M1 = 3.29, SD1 1.33 = M2 = 3.67, SD2 = 1.14, M3= 3.83, SD3 = 1.32) and intrinsic value (M1 = 3.29, SD1 = 1.35, M2 = 3.62, SD2 = 1.27, M3= 3.82 SD3 = 1.31). Considering the responses to the open-ended question about the best part of the meeting, the main categories for the students' perspectives about the value of the SC meetings were utility, attainment, and intrinsic value and nature of the meetings. Supporting the descriptive findings from the quantitative data, the frequency of the value-related students' comments about the best part of the meetings had increased for intrinsic and attainment value. For the first two meetings, the most frequently mentioned category was the "meeting structure" category which includes comments about question-answer based nature of the meeting. The cost value did not emerge as a category regarding the students' responses. The percentage of frequency of codes from students' ideas about the best part of the three SC meetings within the total codes is given in Table 1.

Categor	**Sub-category**	**1st Meetin**	**2nd Meetin**	**3rd Meetin**	**Example**
EVT	Utility	26.32%	19.13%	18.75%	*It eliminated my questions about some subjects since it was related to the lessons, and therefore it was also helping in the exams.*
	Intrinsic	8.77%	13.91%	63.75%	*The very funny narration of the scientist increased my interest.*
	Attainment	18.42%	21.74%	33.75%	*Met and getting to know an important professor*
Othe	Meeting ıcture	37.72%	40.00%	17.50%	*We can ask any question we want to the expert of the subject and get correct answers*
	Not applicable	8.77%	5.22%	8.75%	*Many things were good, Mitochondria*

Table 1. Frequency percentage of the categories and sample student response

Keywords : Science communication, expectancy-value theory, science education

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Pre-service Teachers' Plausibility Perceptions of Global Climate Change: Results of the Updated Plausibility Perception Measure Scale

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Global climate change is one of the most significant issues in today's world. It is considered as a socio-scientific issue (SSI) since climate crisis is a complex scientific topic that are socially relevant and controversial (Zeidler & Nichols, 2009). Teaching and learning SSIs is challenging and requires learners to participate in a discussion environment, communication, as well as debate (Zeidler & Nichols, 2009).

Plausibility is considered as a person's subjective judgment of the truthfulness of a statement (Lombardi & Sinatra, 2012). Furthermore, plausibility is an essential component of conceptual change theory, which emphasizes the development of conceptual knowledge (Nadelson et al., 2018; Duit & Treagust, 2003; Posner et al.,1982). Teachers should be trained for making plausible judgments for complex environmental problems (Ceyhan & Mugaloglu, 2020; Zelezny, 1999). For this reason, it is very important to examine the plausibility perceptions of pre-service teachers on global climate change, because they will be the teachers of the future.

Lombardi and Sinatra (2012) developed the Plausibility Perception Measure (PPM) in response to the IPCC's Fourth Assessment Report, published in 2007, to measure individuals' plausibility judgments about climate change. However, the last IPCC report was published in 2022. Since this report includes different factors on climate change, and important changes in climate crisis since 2007, there is a need for the updated version of the PPM scale. The current study aims to update the plausibility perception measure scale according to the last IPCC report, published in 2022, and to investigate the plausibility perceptions of pre-service teachers about climate change. This study aims to answer the following questions:

- Does the updated PPM scale measure the three identified factors in the IPCC 2022 report? --What are the pre-service teachers' plausibility perceptions towards global climate change?

Participants of the current study were preservice teachers from a large, research-intensive public university in Summer 2022. 330 pre-service teachers at Bogazici University participated in the study, who were studying in chemistry education, physics education, science education, mathematics education, computer education and primary education programs. 207 (62.7%) of the participants were first or second year, 123 (37.3%) of them were senior or junior pre-service teachers. 247 (74.9%) of the participants did not take an environmental course in their undergraduate education, while 83 (25.1%) of them took an environmental course. 221 of the participants were female, 103 of them were male, and, 4 of them were non-binary, and 2 of them selected prefer not to answer.

Data sources for the current study included the updated plausibility perception measure scale. For the data collection procedure, Bogazici University faculty of education students were contacted, and students completed the PPM scale online. Participation in the study was completely voluntary. Students will be asked to agree to participate the study before the survey. Purposive sampling method was used in this study. Students accessed the link by scanning the QR code prepared by the researchers and the PPM scale completion took an average of 15 minutes.

After data collection, descriptive statistics were conducted by using SPSS and CFA analysis was conducted by using JASP. In the data analysis process, 1 of the 16 items decreased the reliability value. Therefore, the analysis was continued with 15 items. In its final form, the scale included 15 items and the participants rated each statement on a ten-point Likert scale ranging from "10 = strongly plausible" to "1 = strongly implausible". In the plausibility perception measure scale, items 1 to item 6 are related to factor 1, items 7 to item 11 are related to factor 2, and items 12 to item 15 are related to factor 3. The study instrument was reviewed and approved by the social and human studies ethics committee at the university. After, CFA is conducted to see if the updated PPM results fit the model our not. Since there are 3 determined factors in updated PPM scale, 3 factors model was used.

The value of Cronbach's alpha (α=.93) represents an excellent consistency measure (> .90) (Crocker & Algina, 1986). The corrected item-total correlation values of all items show good discrimination and there is no problematic item (<.30).

For content validity, 2 content experts evaluated each item for each factor, based on the ratings from 1 to -1. The item-objective congruence index was found as 1 which is valid since items that have item-objective congruence above .70 accepted as valid measures of their proposed objectives (Rovinelli & Hambleton, 1976).

CFA was conducted to test the construct validity of the instrument and to evaluate the factor structure of the model which is a three-factor model and has 15 items. The results of the CFA revealed three-factor model had a good fit for the data (TLI $\geq$ .90, CFI $\geq$ .90, RMSEA $\leq$ .08). All factor loadings are significant (p <.001).

The minimum score of the scale that the participants can have is 15, the maximum score is 150 (M = 115.35 (SD = 20.03)). Regarding average percentages, 58% of the participants found the statements highly plausible. The minimum score for factor 1 is 6.00 and the maximum score is 60.00 (M = 48.44 (SD = 8.71)). Considering average percentages, %68 (SD = 10.7) of the participants found the statements of factor 1 highly plausible. The minimum score for factor 2 is 5.00 and the maximum score is 50.00 (M = 36.05 (SD = 7.11)). %46 (SD = 5.2) of the participants found the statements of factor 2 highly plausible. The minimum score for factor 3 is 4.00 and the maximum score is 40.00. Participants' scores for factor 3 were M = 30.84 (SD = 6.36). %59 (SD = 5.0) of the participants found the statements in factor 3 highly plausible.

Keywords: Global Climate Change, Plausibility Perception, Pre-service Teacher Education

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Investıgatıng The Dıfferentıal Relatıonshıp Between The Bıg Fıve Domaıns Of Socıal And Emotıonal Skılls And Mathematıcs Achıevement Usıng Oecd's SSES

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The goal of the study is to investigate the differential relationship between the social and emotional skills measured by the "big five" skill domains and mathematics achievement for socioeconomic status, gender, and level of SEL evaluation groups.

The current study is unique because it is one of the pioneer studies which investigate the differential relationship between social and emotional skills scores measured by the big five domain and mathematics achievement for socioeconomic status groups, gender groups, and level of SEL evaluation groups in Turkey. Investigating and reporting the differential relationships for SES groups is significant to identify whether the relationship holds for all groups or shows different pattern for some groups.

The research questions of the study:

(i) To what extent the big five domains of SSES- task performance, emotional regulation, engaging with others, collaboration, open-mindedness-could predict mathematics achievement?

(ii) Is there any differential relationship between the SSES scores measured by big five model and mathematics achievement for boys and girls?

(iii) Is there any differential relationship between the SSES scores measured by big five model and mathematics achievement when socioeconomic status is taken for low, medium, and high levels?

(iv) Is there any differential relationship between the SSES scores measured by the big five model and mathematics achievement for students who are not evaluated, informally evaluated, formally evaluated in social and emotional skills at their school?

The methodology of the study is described in the following parts as the design, the population and sample, the instrument, collection of data and the data analysis. In the study, correlational design was implemented to investigate the relationships between the variables.

The OECD's Survey on Social and Emotional Skills study (OECD, 2021) is a survey based two age groups: 10-year-old students enrolled in school in grade 2 or more and 15-year-old students enrolled in school in grade 7 or more. In the OECD's main study on social and emotional skills, 10 cities from different countries involved in the data collection process (OECD, 2021). Participated cities and countries in the data collection process of SSES study are Bogota, Colombia; Daegu, Korea; Helsinki, Finland; Houston, Texas, United States; Istanbul, Turkey; Manizales, Colombia; Moscow, Russian Federation; Ottawa, Ontario, Canada; Sintra, Portugal; and Suzhou, People's Republic of China (OECD, 2021). In the current study, the participants are 9th grade, 10th grade, and 11th grade students in Istanbul, Turkey.

This study utilized SSES 2019 survey questionnaires and data on social-emotional skills from Turkey provided by OECD. The OECD SSES gathered data by four contextual surveys designed for students, parents, teachers, and administrators (Kankaraš & Suarez-Alvarez, 2019).

In the present study, first of all, confirmatory factor analysis was applied to statistically test whether the sample data confirms the measurement model with five domains (task performance, emotional regulation, engaging with others, collaboration, and open-mindedness) and fifteen subdimensions (empathy, trust, self-control, cooperation, emotional control, optimism, stress resilience, assertiveness, energy, sociability, creativity, curiosity, tolerance, persistence, responsibility, and self-control). After that by means of the SEM, significance,

directions and explained variance of the relationships between the five domains and mathematics achievement was reported in results section. Also, SEM was used to predict the power of the relationships between the five domains and mathematics achievement (Schumacker & Lomax, 2004; Ullman & Bentler, 2012).

The results indicated that 8% of the variance in mathematics achievement (R^2=0.077) was explained by the social and emotional skills domains, especially with open mindedness, emotional regulation and engaging with other domains. Also, there is a differential relationship between mathematics achievement and social and emotional skills for boys and girls. The relationship between social and emotional skills and mathematics achievement is stronger for girls (R^2=0.092) than boys (R^2=0.056). On the other hand, the results showed that while for low level SES students this model explains 13% of the variance in mathematics achievement (R^2=0.130), for medium level SES students, it explains 9% of the variance in mathematics achievement (R^2=0. 091). Furthermore, for high level SES group, the model explains 6% of the variance in mathematics achievement (R^2=0. 056). Therefore, it can be stated that there is differential relationship between social and emotional skills and mathematics achievement for different levels of SES. Lastly, there is a differential relationship between the five domains SSES model and mathematics achievement for non-evaluated (R^2= 0.062), informally evaluated (R^2=0. 080) and formally evaluated (R^2=0.091) SEL groups. Overall, the findings suggest that grouping variables need to be taken into consideration to understand the relationship between the mathematics achievement and emotional skills.

Keywords: Mathematics Achievement, Social and Emotional Skills, OECD' SSES

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Understanding nature of science among students with different metacognitive awareness levels

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Several decades, Nature of Science has had a significant field in Science Education research and it is a critical issue to how Nature of Science is implemented in science classrooms (Lederman et al., 2002 ; McComas et al.,1998). Research shows that students from different grade levels and teachers do not have well-informed views of Nature of Science (Akerson et al., 2000 ; Akerson et al., 2005 ; Akerson et al., 2011). Metacognition allows students to think about their own learning which is a significant method in science learning by providing planning, evaluating their process (Flavell, 1979). Students need to develop metacognitive awareness to understand the nature of science, they need to think about their own learning process and be aware of how they learned (Peters et al., 2010). The aim of this causal-comparative study will be to examine the middle school students' understanding of the nature of science by comparing their nature of science views of students who have different levels of metacognitive awareness. This study can contribute to literature for the development of instruction methods by considering metacognitive process skills in teaching the nature of science in middle school Science Curriculum. To make sense of the seven aspects of the nature of science, it provides the comparison of understanding Nature of Science of middle school learners who develop metacognitive awareness in regards to the dimensions of knowledge of cognition and knowledge of regulation. High metacognitive awareness levels are related to metacognitive strategies while teaching Nature of Science, thus this study will be a basis for designing Nature of Science instructions having metacognitive strategies in the future. In this study following research question is addressed: “Are there any statistically significant differences in understanding the nature of science among middle school students who have different metacognitive awareness levels (high,moderate and low)?”

The target population is students in 6th, 7th and 8th grades in public and private schools in İstanbul. A convenience sampling method will be used to select schools. Data for the study will be collected from two valid and reliable sources: The Metacognitive Awareness Inventory for Children Form A and Form B” (Karakelle et al., 2007) and ScienTest (Yalaki et al., 2019). Each scale will be administered to the students in their classrooms in one lesson hour. It will be ensured that students are not affected ethically throughout the entire research process by matching students with their school numbers. No information will be collected rather than their demographic characteristics; gender, grade level. R Studio Program will be used to analyze the data from “The Metacognitive Awareness Inventory for Children Jr.MAI” and "SicenTest scales. Firstly, descriptive statistics of 6th, 7th and 8th grade students such as; metacognitive awareness total scores, means,standard deviation etc. will be analyzed from the scale “The Metacognitive Awareness Inventory for Children. Students' metacognitive awareness scores will be divided into three interval points of groups as high, moderate and low levels of metacognitive levels. To answer the research question one way ANOVA will be conducted, this test is chosen since there are more than two groups that have low,moderate and high levels of metacognitive awareness. After conducting ANOVA, p values will be examined. If a statistical difference in means of some of the groups is determined, a post-hoc test will be used, since ANOVA is insufficient to analyze which pair groups are different.

According to literature, there are some studies for metacognition and understanding nature of science (Sukaesih et al, 2020; White et al., 2005; Peters et al., 2010) In one study with eighth grade students, two gorups were exposed to the same inquiry and science process skills, one group received metacognitive instruction. A significant difference was found between the two groups in terms of metacognition and NOS understanding (Peters et al., 2010). Based on the literature review, in the present study, it is expected that there will be a significant difference between middle school students with different (high-moderate-low) metacognitive awareness levels in terms of understanding the nature of science, students with high metacognitive levels will have high levels of understanding the nature of science, and students with low metacognitive levels will have low levels of understanding the nature of science. The present study results will be important for developing metacognitive instruction strategies for nature of science in future.

Keywords : metacognition, metacognitive awareness, understanding nature of science

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Pre-Service Science Teachers' Experiences in Computer Simulation and Virtual Reality Application: Atom and Molecule Concepts

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Representations and visualizations are overutilized in the field of science education. Learning can be developed better by using images, visualizations, and representations (Mayer, & Moreno, 1998). Representations and models are used especially in abstract fields such as chemistry. As Kozma, & Russell (1997) stated, more than other sciences, chemistry requires a grasp of the impenetrable and unseen. Moreover, Cooper et al. found that representing molecules in a 3D (3-dimensional) format enhanced representational competence skills rather than representing molecules in a 2D (2-dimensional) format. 3D formats can be virtual reality applications, while 2D can be computer simulations.

Whereas the change in representational competence skills of undergraduate students is measured, there is a gap in the literature on the effects of using simulations and virtual reality on representational competence skills (Nielsen, Brandt, & Swensen, 2018; Stull, & Hegarty, 2016; Stull, Gainer, Padalkar, & Hegarty, 2016). The purpose of this single case study is to investigate the effects of using simulation and virtual reality applications on preservice science teachers' representational competence skills.

Representational competence is defined as the capacity to create and apply various precise descriptive representations of a situation or an issue in a competent and linked manner. Kozma, & Russell (1997) determined the basis of representational competence skills in their study, such as identifying and analyzing features of a particular representation, transforming one representation into another, generating or selecting an appropriate representation, explaining why a particular representation or set of representations is more appropriate, and describing how different representations might say the same thing.

The research questions of this study determined as:

1. How pre-service science teachers' representational competence skills are affected by using computer simulations?

2. How pre-service science teachers' representational competence skills are affected by using virtual reality applications after using simulations?

3. How do pre-service science teachers integrate virtual reality applications and computer simulations in their instruction through lesson activities?

The sample of this study involves 10 pre-service science teachers from the Department of Science Education at Boğaziçi University. Five of the students are studying in their third year at the university, whereas five of them are fourth-year students. In order to determine the pre-service science teachers, a participant application form is distributed. People with epilepsy do not be included in the study.

In order to sample participants, an invitation brochure is distributed to third and fourth-grade undergraduate students of the Department of Science Education. The brochure will include a QR code to direct volunteer participants to a Google Form named Participant

Invitation Form. This form consists of the participant's demographic information and prior experience in using computer simulations and virtual reality. After sampling, each participant is provided with an informed consent form and is invited to a workshop that will continue for three sessions, as can be seen in Table 1.

Table 1. Group, Data Collection Instruments, and Treatments by Sessions

Participants	**Sessions**	**Type of the Sessions**	**Instruments**	**Treatments**	**Instruments**
Preservice Science Teachers (PsST) N= 10	1	Individual	Pre-Test 1+ Interview 1		
	2	Group		PhET Simulations	Post Test 1
	3	Individual	Interview 2+ Pre-Test 2+ Interview 3	Virtual Reality Demo+ Virtual Reality Application (Nanome)	Post Test 2 + Interview 4

The first session of the workshop consists of a Pre-Test 1, which includes 2 open-ended questions and a face-to-face semi-structured interview that is planned to take 20-30 minutes. This session is planned individually. Before proceeding to the second session of the workshop, appointments are requested from the participants for the group workshop that takes place in the second session.

In the second session of the workshop, which is planned to take 60 minutes, the participants are asked to use PhET simulations. After treatment, Post Test 1, consisting of eight open-ended questions, is filled by the participants.

In the third session of the workshop, which lasts 120 minutes, there are two face-to-face semi-structured interviews. The first interview is about representations in Post Test 1. Then Pre-Test 2 is conducted. The second face-to-face semi-structured interview about representations in Pre-Test 2 is conducted. The interviews are planned to last approximately 20-30 minutes. Then the participants are asked to use a demo application and virtual reality application named Nanome via using virtual reality equipment. After using a virtual reality application, Post Test 2 is distributed. When the participants completed the workshop, they are asked to design a classroom activity that includes virtual reality applications.

Before and after the workshops on computer simulation and virtual reality application, the participants are asked to answer the questions of Pre-Test, Pre-Test 2, Post Test 1, and Post Test 2. The tests include similar but not identical open-ended questions, which include drawing a storyline of atoms of and molecules. Four semi-structured interviews are designed to understand the effects of computer simulation and virtual reality application on their representational competence skills.

In the data analysis process, interview records are transcribed verbatim. After each interview is transcribed with text transcriptions, they are sent to the interviewees for review & correction. From these transcripts, the researcher applies thematic analysis where similar statements and concepts are examined, and the emergent themes are identified with phrases and patterns of words (Braun & Clarke, 2012). By sorting these categories into meaningful and manageable segments, the researcher will use findings to answer the study's research questions.

The preliminary results of the study showed that pre-service science teachers have positive views on computer simulations. Participant A stated that "*Because it (computer simulation) attracts a lot of attention, and I can observe, for example, the cell, if possible, but it is impossible to observe the atom, for example, with a microscope. Or at the same time, for example, the structure of the world, the layers, the core, etc., I definitely use it because it is very difficult to imagine and concretize."*. In the first pre-test drawings, it was determined that the participants had the ability to identify and analyze the features and feature patterns of the notation. In the first post-test, it was seen that they had the ability to transform one representation into another, to match the features of one representation with others, and to explain the relationship. For instance, Participant B stated that *"(computer simulation) showed me that I could be more descriptive in the drawing. So, I felt like I need to draw electrons. You know, the nucleus is not so important; after all, we draw neutral atoms, but not in the form of ions. So, I thought my drawing of electrons would be important. I drew the electrons."* In the second pre-test, the continuity of the mentioned skills was observed, and in the second post-test, it was also determined that the skill of creating or choosing a suitable representation to explain the claims about the relationships between chemical concepts was developed after the virtual reality application. For instance, Participant C stated that "*Obviously, virtual reality had an effect on this. Because we chose the direct bond and put it. Then, when we placed the atoms, I could see the bonds directly. In this way, it showed me how many bonds atoms actually made. So, I just knew that when they joined, they made a bond. Thinking that using this line would be a tool to show how many bonds actually made, and virtual reality guided me to this."* Participants were able to integrate virtual reality applications into their course activities.

Keywords: Virtual Reality Applications, Computer Simulations, Representational Competence

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Preservice Mathematics Teachers' Knowledge of and Attitudes toward Probability and its Teaching

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Probability is considered one of the challenging topics in mathematics education because of its nature which includes ambiguity. Even if it is regarded as a subtopic of mathematics, it requires a different reasoning process than mathematical reasoning (Kapadia & Borovcnik, 2012). The mathematical reasoning process results in a solution that shows one correct answer. In contrast, probabilistic reasoning produces estimations from endless possibilities which place uncertainty at the heart of probability and change from one context to another (Kvatinsky & Even, 2002). Attitudes were stated as a subheading under the affective domain in mathematics education by McLeod (1992). In his model, attitudes consist of cognitive and affective sides moderately. Even if there is no consensus about its definition, researchers mostly agree that attitudes are composed of negative and positive judgments. When it is considered for teaching probability, the complicated thinking process of probability might influence the teachers' attitudes. A lack of probabilistic knowledge can be the reason for the negative feeling, while positive attitudes can be associated with sufficient knowledge about teaching probability and itself (Estrada Roca & Batanero, 2020).

Accordingly, this study investigates preservice mathematics teachers' attitudes toward and knowledge of probability and its teaching. The study has the following research questions:

- What is the current state of knowledge of preservice mathematics teachers about probability and its teaching?
- What are preservice mathematics teachers' attitudes toward probability and its teaching?
- Is there a statistically significant relationship between preservice mathematics teachers' knowledge of probability and their attitudes toward probability and its teaching?
    - What is the relationship between prospective teachers' probabilistic knowledge and their attitudes toward probability and teaching probability?

In this study, participants are chosen by using convenient sampling. The students who will participate in the study are in their junior and senior years and seniors have started their teaching experience as interns. In total, it has been expected that 150 preservice mathematics teachers will participate in the study.

The data has been collected as a part of Kemal Akoğlu's Start-up Project at Boğaziçi University (Project Number: 1872, Project Code: 22DSUP5). In this study, two instruments will be used. To investigate preservice teachers' probabilistic knowledge in education, they will be asked to take the probability concept inventory built by Gómez-Torres et al. (2016) and adapted by Kurt and Coşkuntuncel (2020). To assess preservice mathematics teachers' attitudes toward probability and its teaching, five points Likert type scale developed by Estrada et al. (2018) and adopted in Turkish by Özyıldırım Gümüş (2021) will be used since it is specially built for probability and its teaching. The participants will take both instruments via online form. After collected data is analyzed, some participants will be invited to interview based on their choices in attitude scale and probability concept inventory. Therefore, the study design is a mixed research design where qualitative data will support and enrich quantitative data.

Descriptive statistics will be used to analyze the attitude scale and probability concept inventory results. The scores will be examined according to different characteristics such as taken courses, semester, or GPA. In addition, the relationship between the scores on the

attitude scale and the probability concept inventory will be analyzed using the Pearson correlation coefficient.
The data collection of the study is in progress. Thus, after the analysis of the collected data results can be mentioned. However, it has been expected that student's attitudes toward probability and its teaching will be correlated with their knowledge about it based on the literature reviewed. Also, the difference between the scores of seniors and juniors on probabilistic knowledge is expected. Estrada and Batanero (2019) found that the preservice teachers have higher scores on attitude scale compared to scores on attitude scales related to teaching statistics. They argue that introducing the probability concept in the early years of school might be the reason. The probability concept is introduced in the late middle school years in Turkey. Therefore, in this study, the negative attitude of the preservice mathematics teachers toward probability and its teaching can be found. At the end of the study, it is expected that the results will be valuable to reconsider the education of mathematics teachers and make required adjustments in the curriculum. Thus, our knowledge of one of the problematic topics in mathematics will be refreshed. However, while evaluating the results the number of participants and their demographic properties needs to be considered. In this study, the convenient sampling method is used which can be a limitation of the study. Therefore, while generalizing the results, careful attention needs to be taken.

Keywords: Teaching probability, probabilistic knowledge, attitude, preservice mathematics teachers

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Pre-service Mathematics and Science teachers' Views on Designing Interdisciplinary Mathematical Modelling Tasks

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This study is a part of an ongoing doctoral dissertation on developing pre-service mathematics and science teachers' learning to design interdisciplinary mathematical modelling tasks through a Professional Development Module. *Interdisciplinarity* or an *interdisciplinary approach* is an approach to solve complex problems by benefiting from different disciplines (Klein & Newell, 1996). Interdisciplinarity in education can help to produce solutions to complex problems in the world, but may be challenging to apply in the classroom (Borromeo Ferri, 2019). Teachers and pre-service teachers as future teachers may necessitate support to alleviate the associated challenges of interdisciplinary education. By providing necessary support to pre-service teachers' learning to design interdisciplinary tasks, it is aimed to develop their competencies about interdisciplinary teaching, and therefore their future students' understanding of interdisciplinarity.

This study aims to explain the following research question:

- How do pre-service mathematics and science teachers' views on learning to design interdisciplinary mathematical modelling tasks change after a Professional Development Module on interdisciplinary mathematical modelling tasks?

This study is a part of a doctoral dissertation, which uses *Design-based Research* (DBR) as a methodological framework. DBR is "a practical research methodology" which can combine theory and practice in education (Anderson & Shattuck, 2012, p. 16). The current study is a part of the Exploration Phase of the broader DBR study. This study, which included the design of a Professional Development (PD) Module, was situated in the context of an elective course, SCED 48F: Special Topics: Interdisciplinary Mathematics and Science Education, which was initially offered in the Fall 2022 at Boğaziçi University. The participants (n=9) were purposefully chosen among the pre-service mathematics and science teachers who took the course and consented to attend the study. The purposeful sampling method (Creswell, 2013) was used.

The PD Module in this study is the initial version of the design and contained eight-week-long instructional intervention. The course had sessions in two days in a week and two blocked lessons in each day. The next revised version of the module is planned to be implemented in the Fall 2023 based on the analyses of data gathered in the Fall 2022.

The broader study uses pre-test, post-test, semi-structured interviews, participant artifacts, and researcher journals as data. The current study uses interviews (pre-and post-interview) as qualitative data. The interviews included open-ended questions on interdisciplinarity, interdisciplinary education, interdisciplinary mathematics/science education, mathematical modelling, and interdisciplinary mathematical modelling tasks. The data from interviews are planned to be analyzed through *thematic analysis* (Braun & Clarke, 2012). Initially the interviews are transcribed and then themes will be determined. The analysis is currently ongoing.

The participants' views on learning to design interdisciplinary mathematical modelling tasks are expected to positively change after a Professional Development Module on interdisciplinary mathematical modelling tasks. Pre-service mathematics and science teachers in this study were not familiar to the interdisciplinary mathematical modelling tasks before they took the elective course. Before the implementation of the PD module in the elective course, the pre-service teachers were initially introduced to the concepts of interdisciplinarity, interdisciplinary research, interdisciplinary mathematics/science education. Thus, the pre-

interview (and also the post-interview) is expected to reveal themes on interdisciplinarity and interdisciplinary mathematics/science education. Besides, sub-themes might differ in the pre-interview and post-interview. However, before the PD module intervention, pre-service teachers had limited experiences on designing tasks, mathematical modelling tasks, designing interdisciplinary mathematical modelling tasks. Hence, the participants' views on designing interdisciplinary mathematical modelling are expected to be more general and superficial in the pre-interview compared to those in the post-interview. The participants are expected to give more detailed examples of interdisciplinary mathematical modelling tasks in the post-interview. In general, the participants are expected to give positive feedback about the PD module.

Keywords: Interdisciplinary Mathematical Modelling, Teacher Education, Task Design, Design-based Research

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Analyses of Mathematics Performance, Immigration Status and Well-being of Students in Turkey Using PISA 2018

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Immigrant students' influence on their native classmates is a specific type of peer effect: immigrants are peers with a different culture, a different manner of interacting with others, and, most commonly, restricted language ability. (Brunello & Rocco, 2013) In a new addition to the extensive research on peer influences, there are many studies that focus on immigration and educational achievement. However, there is limited research that used student characteristics specified reported by the Program for International Student Assessment (PISA). Over the past two decades, PISA has become the world's premier yardstick for evaluating the quality, equity, and efficiency of school systems and an influential force for education reform. It has helped policymakers lower the cost of political action by backing difficult decisions with evidence. Many parents and politicians are concerned that too many immigrant students will have a negative impact on native students' school performance, either because of negative peer effects or because immigrants, with their limited proficiency in the host country's language, will reduce teacher attention for natives. Therefore, this study investigated the effects of mathematics performance both on immigration status (native, first-generation immigrants, and second-generation immigrants) and the well-being (the meaning of life, self-efficacy, and positive feeling) of students in Turkey. This study aims to show whether there is a statistical difference between immigration and mathematics performance and whether there is a relationship between students' mathematics performance and well-being or not. In this light, this research and the need to produce explaining that considers the complexity of migratory processes and whether there is an effect on the results of Turkey's achievement in the large-scale international exam PISA 2018.

This study is a kind of quantitative research using one-way ANOVA and Pearson correlation. PISA assesses students around 15 years old and at grade 7 or higher. The participants of this study were born in Bulgaria, Germany, Netherlands, Russia, Turkey, and Another Country (TUR) 2, 19, 2, 5, 6748, 44, respectively. Also, the immigration status of the participants is native, first-generation immigrants, and second-generation immigrant students 6663, 37, and 17, respectively, who attended the PISA 2018 test in Turkey. So, in total, there are 6890 participants who attended PISA 2018. The instrument measures the meaning of life, self-efficacy, and positive feeling by using 4-type of the Likert Scale as well-being status. According to Avvisati, Donné, and Paccagnella (2019), PISA's main purpose is to produce comparable measurements of student background, practices, attitudes, and perceptions. For validating questionnaire constructs, many methodological techniques have been established. Based on the validity test, all items that are in the PISA questionnaire related to positive feelings and mathematics performance; self-efficacy, and mathematics performance have $p = .000$, which means that all items are valid. The estimation of reliability was checked by using Cronbach's Alpha which is $\alpha = 0.751$ which is an acceptable reliability threshold (>.70). In this study, using PISA students' immigration status and well-being as independent variables and mathematics performance as the dependent variable, one-way ANOVA and Pearson correlation were conducted. Statistical analyses investigate whether there is a statistically significant difference between independent and dependent variables. For this study, software called the Statistical Package for the Social Sciences (SPSS) is required to be used.

One-way ANOVA was conducted to test whether there is a statistically significant difference in mathematics performance among students with different immigration statuses. Before the main analysis, the required assumptions were checked. For normality, according to immigration status, math performance scores have normal distribution since their skewness and kurtosis are between -2 and +2, with more than 30 participants. The PISA 2018 participants are chosen randomly for random sampling, all with the same probability so, they are independent of each other. Homogeneity of variance means that the variance among the groups should be approximately equal with p=.139. A one-way ANOVA revealed that there was not a statistically significant difference in mathematics performance between at least two groups ($F(2, 6714) = .956$, $p = .384$). There was no statistically significant difference between native and first-generation (p=.350), native and second-generation (p=.999), and first-generation and second-generation (p=.503)

For looking at whether there is a statistical relationship between mathematics performance and the well-being of students, the Pearson correlations were estimated to assess bivariate separate linear relationships between meaning in life and mathematics performance; positive feelings and mathematics performance; self-efficacy, and mathematics performance. There was no significant correlation between the meaning in life and mathematics performance, $r(6747) = -.003$, $p = .793$. There was a significant positive linear relationship between the positive feelings and mathematics performance, $r(6458) = .049$, with a small strength of the relationship, $p = .000$. This means that students with higher mathematics performance also have higher positive feelings. There was a significant positive linear relationship between self-efficacy and mathematics performance, $r(6636) = .084$, with a small strength of the relationship, $p = .000$. This means that students who have higher mathematics performance also have higher self-efficacy. However, it should be noted that these relationships do not show any causal relationships.

Keywords: immigration, mathematics performance, satisfaction with life, positive affect, self-efficacy.

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Research Trends on Systems Thinking Approach in Science Education

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The systems thinking approach requires understanding and interpreting complex systems (Senge, 1990). In science education, students' ability to solve the connections between parts should be developed to understand and contextualize many complex system relationships that we encounter in everyday life (Evagorou et al., 2009). Therefore, using a systems thinking approach in science education is very important. The significance of this review is to show how the boundaries of knowledge about systems thinking in science education have expanded from the past to the present by revealing patterns through systematic content analysis. This review study aims to examine how the systems thinking approach to science education is positioned in peer-reviewed empirical research articles indexed in the Web of Science database through the end of 2022 and to reveal the trends used in the existing literature. This review article addressed the following research question: “How did research studies address systems thinking in science education?”

This study used the methodology developed by the Evidence for Policy and Practice Information and Co-ordinating Center (EPPI-Center) for systematic reviews of educational research literature (Bennett et al., 2004). The methodological procedure was carried out in three main steps, as follows: (1) determination of inclusion and exclusion criteria, (2) keywording, and (3) generation of systematic categories. Inclusion and exclusion criteria were established to identify articles for the review (Bennett et al., 2004). The articles were filtered as open access so that this systematic review could produce reproducible results. As the researchers were not proficient in languages other than English, articles published in the database in English were included in the review. Review articles, meta-analyses, editorials, theses, dissertations, government, position papers, institutional reports, and working papers were excluded because this study aims to examine peer-reviewed studies that provide first-hand empirical data. The abstracts of the articles were then scanned, and those that did not meet the inclusion criteria were eliminated. The researchers agreed to search using the keywords "systems thinking," and "science education," and "systems thinking," and "science education" in the first search to avoid missing articles. A total of 27 articles were found that met these criteria. The review articles were tabulated to analyze and categorize the review’s content information (Alexander, 2020) consistently and systematically. Content analysis, a systematic approach to coding and categorizing data, was used in this study (Vaismoradi et al., 2013). Analysis of the texts revealed trends by identifying patterns of concepts and calculating their frequency.

As a result of the literature review, it was found that the number of studies on the systems thinking approach in the field of education has been gradually increasing since 2020 and that these studies have been conducted mainly in the United States of America and secondly in Germany. The systems thinking approach has been studied with different participants, but the most focused group has been middle and high school students. It was found that the systems thinking approach was primarily explored in the context of science, environmental education, and biology courses, and the most common topic was ecosystems. The characteristics of systems thinking were defined mainly as complexity, relationships, components, interactions, interdependencies, and dynamics. It was observed that there is ambiguity due to the interchangeable use of systems thinking characteristics (Haas et al., 2020; Mambrey et al., 2020; Uskola & Puig, 2022), skills (Bergan-Roller et al., 2018; Evagorou et al., 2009; Ghalichi

et al., 2021) and abilities (Bielik et al., 2022; Hrin et al., 2016; Mahler et al., 2017). This ambiguity in the literature makes it difficult to understand and apply systems thinking, which is already a complex topic. Since it has been argued that complex systems and their relationships in science education are best conveyed using the systems approach teaching method, it is believed that uncovering these uncertainties with this review article will contribute to the literature. It is emphasized that the use of a systems thinking approach in science education is beneficial for students to understand natural phenomena and gain the ability to solve complex problems that they may encounter in everyday life from a holistic perspective.

Keywords: systems thinking; science education; journal content analysis.

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STEM Stereotypes: Scale development and validation

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STEM stereotypes are generalized beliefs about individuals taking part in STEM fields (Luo et al., 2021). Such stereotypes result in discrimination and marginalization of particular social groups such as women (Rice & Barth, 2016). As a result, these people do not identify with STEM domains leading to decreased motivation in pursuing STEM careers (Starr, 2018). However, it is essential this problem is addressed in today's world because there is a great need for innovation, scientific and technological solutions requiring an increase in highly qualified workers in the labor market (UNICEF, 2020).

STEM stereotypes have been frequently studied qualitatively (Fralick et al., 2009; Meador, 2018), however, there are few quantitative studies (Garriott et al., 2017; Luo et al., 2021). This study aims to develop and validate a scale that measures general beliefs, gender and SES specific stereotypes in each STEM domain namely, science, mathematics, technology and engineering. As a result, this scale will contribute to enabling large-scale assessment of students' STEM stereotypes, previously identified in the qualitative literature, by bringing general beliefs, gender and SES stereotypes together under each STEM domain.

The sample of the study were 210 female and 186 male public middle school students mainly from 7th and 8th grades. Students begin to develop STEM stereotypes by the time they reach middle school. If students are exposed to gender, income and trait-based STEM stereotypes leading them to lose interest in STEM, it becomes harder for students to persist in the STEM pipeline (Hughes & Roberts, 2019). Therefore, identifying STEM stereotypes of middle school students as early as possible is vital.

The initial items of scale were developed based on findings from qualitative research addressing STEM stereotypes and findings from research on STEM education. The scale investigated stereotypes under four separated disciplines of STEM because the literature suggests that, for instance, male and female students have different perceptions of each STEM domain (OECD, 2019; Archer et al., 2020) and, the gender disparity varies drastically in terms of employment and university degree among the four disciplines (Mau & Li, 2018; UNICEF, 2020). Current studies suggest that STEM fields are commonly considered male and middle class (Hughes et al., 2013). In addition, stereotypes can be trait-based, such as people in STEM domains being seen as objective, rational, geniuses and technology-obsessed (Brickhouse, 2001; Starr, 2018). Thus, each STEM discipline is divided into three sub-dimensions which investigate stereotypes related to general beliefs, gender and SES and also the items of these sub-dimensions were contextualized in terms of STEM careers, courses and projects (See Table 1).

Table 1. Item examples of engineering sub-scale.

Sub-Scale	Engineering	Item Examples
Sub-dimension	General Beliefs	People who take part in engineering-related projects are geniuses.
	Gender	The work environments of professions related to engineering are more suitable for men.

Socioeconomic Status	Engineering courses are generally preferred by people with well-educated families.

A 16-step instrument design process as described by McCoach et al. (2013) was followed in the present study. Thirteen out of 16 steps have been completed. The last three stages will be completed and presented at ESERA.

A principal axis factor analysis was run on the 21 items written for each STEM domain with oblique rotation using SPSS 27 version. In other words, four independent EFAs were conducted to identify the factor structure and pattern for each domain. Sample size of the current study was 396 exceeding the recommended cut off values (Tabachnick & Fidell, 2013).

The Kaiser–Meyer–Olkin (KMO) statistic, a measure of the sampling adequacy, was found as .87 for science, as .85 for mathematics, as .88 for technology, and as .90 for engineering. The KMO was marvelous for engineering and meritorious for the other domains based on the criterion of Hutcheson and Sofroniou (1999). The Bartlett test of sphericity, a statistical test for the existence of correlations among items, was significant for all EFAs. SPSS uses Kaiser's criterion to retain factors having eigenvalues greater than 1. However, according to Field (2018), Kaiser's criterion might overestimate the number of factors to retain when the number of items is more than 30 and a scree plot might produce more reliable results when all communalities are not greater than .70. Since some communalities were less than .70 and the sample size larger than 200 in the present study, we used the scree plot rather than Kaiser's criterion to decide on how many factors to be retained. The scree plot for each domain suggested 3 factors compatible with the conceptual framework of the study. Thus, we retained 3 factors for each domain. The factor loading of all items in each domain was greater than .40, the threshold value recommended by Pituch and Stevens (2016) and no cross-loading was observed. Each item was clustered on the hypothesized factor as specified in the conceptual framework of the scale. The factor loadings ranged from .53 to .77 for the science domain, from .59 to .86 for the mathematics domain, from .48 to .88 for the technology domain, from .71 to .89 for the engineering domain. Cronbach's alpha of the subscales ranged between .78 and .94, which supported the reliability of the results (Field, 2018).

Keywords: STEM Stereotypes, gender, Socioeconomic Status (SES)

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