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ARAŞTIRMA Açık Erişim

How Critical is Preschool Attendance for Students to Build a Higher Science Self-efficacy? A Comparative Study of Finland, Singapore, and Turkey Using PISA 2015 Data

Okul Öncesi Eğitime Katılım Fen Öz-yeterliğinin Gelişmesi Açısından Ne Ölçüde Önemlidir? PISA 2015 Verisine Dayalı Finlandiya, Singapur ve Türkiye Karşılaştırması

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Abstract. Preschool attendance rates have been increasing in recent decades yet there is some level of deviation throughout the participating countries in PISA. Finland and Singapore are the countries with a very high level of preschool attendance rates while the attendance rate in Turkey lags evidently behind the OECD average. In this study, we investigate the association between preschool attendance and science self-efficacy for these countries using the PISA 2015 data. PISA is an international survey study on 15-year-old students' science, mathematics and reading literacies to evaluate the education systems in the participating countries. Regression analyses for each country have revealed that students' preschool attendance is associated with their science self-efficacy scores to some degree in all three countries. The difference in self-efficacy seems to be getting larger as the preschool attendance increases. Singapore has the highest effect size while Turkey has the lowest one considering the magnitude of the association.
Keywords. Science self-efficacy, preschool attendance, PISA 2015, science education

Öz. Okul öncesi eğitime katılım oranlarında son yıllarda artış gözlenmesine rağmen PISA'ya katılan ülkeler arasında bu katılım oranları açısından belirli düzeyde farklılıklar bulunmaktadır. Finlandiya ve Singapur okul öncesi eğitime katılım oranının çok yüksek olduğu iki ülke iken Türkiye'de bu oran OECD ortalamasının belirgin bir şekilde gerisindedir. Bu çalışmada, bu üç ülke için öğrencilerin okul öncesi eğitime katılımları ile fen öz-yeterlikleri arasındaki ilişki PISA 2015 verisi kullanılarak araştırılmaktadır. PISA, 15 yaşındaki bireylerin fen, matematik ve okuma alanlarındaki okuryazarlık düzeylerini ölçerek katılımcı ülkelerin eğitim sistemlerini değerlendirmeyi amaçlayan uluslararası bir çalışmadır. Her bir ülke için yapılan regresyon analizleri, üç ülkede de okul öncesi eğitime katılımın fen öz-yeterlik puanını belirli ölçüde yordadığını ortaya koymuştur. Diğer bir ifadeyle, öğrencilerin okul öncesi eğitime katılım süreleri arttıkça fen öz-yeterlik puanlarının da arttığı göze çarpmaktadır. Bu iki değişken arasındaki ilişkinin büyüklüğü dikkate alındığında Singapur en yüksek etki büyüklüğü değerine sahipken, Türkiye etki büyüklüğünün en düşük olduğu ülke olarak dikkat çekmektedir.
Anahtar Kelimeler. Fen öz-yeterliği, okulöncesieğitimekatılım, PISA 2015, fen eğitimi

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The women's participation in salaried employment has been augmented in many countries since the 1970s. More than 60% of women between the ages of 15 and 64are actively working in the labor market in OECD countries based on 2018 data (OECD, 2019), which is one of the reasons why preschool education has been gaining more attention in recent decades. Thanks to this increased attention, the effects of preschool education on different outcomes have been widely studied recently. These studies highlighted numerous benefits of preschool attendance for students in the ensuing years of education (Barnett, 1995; Berlinski, Galiani, &Manacorda, 2008; Burger, 2010; Camilli, Vargas, Ryan, & Barnett, 2010; Diamond, Barnett, Thomas, & Munro, 2007; Hayes, 2000; Melhuish, 2011; OECD, 2011, 2014). Most of these studies, however, focused on the effects of preschool attendance within the cognitive domain, leading to a need for research in the affective domain, such as self-efficacy. Concerning this gap in the literature, we aim to question the relationship between students' preschool attendance and their science self-efficacy using Programme for International Student Assessment (PISA) 2015 data in this study.

PISA provides us with extensive data including both 15-year-old students' science self-efficacy levels and how long they attended preschool when they were at preschool age. It is a triennial global assessment implemented by Organisation for Economic Co-operation and Development (OECD) to collect data about students' science, mathematics and reading literacies in the participating countries or economies (OECD, 2016). Unlike other international large-scale assessments (such as; TIMSS and PIRLS), PISA focuses on the students' literacies in these domains rather than the curricula implemented in each participating country. It is for this reason that there exists a slight association between curriculum and PISA performances (Addey, Sellar, Steiner-Khamsi, Lingard, & Verger, 2017). Each PISA implementation focuses on one of these three literacies in a consecutive cycle and collects detailed information about this major domain while covering the other two domains in a nutshell. Since science literacyis the major domain in PISA 2015 the resulting data gives us an index of students' science self-efficacy, the dependent variable of this study.

As a psychological construct, self-efficacy was first described by Albert Bandura in the 1970s. Bandura (1977) defines self-efficacy as someone's belief

or conviction that he/she can successfully perform a behavior to produce its desired outcomes. He states that self-efficacy can derive from four major sources: mastery experiences, vicarious experiences, verbal persuasion, and psychological states. Mastery experiences, the most dominant source of self-efficacy, can be defined as learners' direct experiences in a specific task. Vicarious experiences, on the other hand, are individuals' indirect experiences about their environment based on observations. Verbal persuasion, as another source of self-efficacy, is described as being convinced by influential people to accomplish a certain task and learners' psychological or emotional state (e.g. depression, stress, or happiness) is the final source to influence their self-efficacy. Furthermore, underlining the substantial importance of learners' self-efficacy, Bandura claims that there exists a strong connection between self-efficacy and behavioral change. That is the reason why he assigns a central role for self-efficacy in behavioral change procedures. In this regard, self-efficacy has been acceptedas one of the most crucial factors affecting students' learning process.

Within this framework, science self-efficacy is defined as students' belief in their capability to accomplish tasks or activities about science (Britner&Pajares, 2006), so it is not surprising that self-efficacy is one of the important factors influencing science achievement (Loo & Choy, 2013; Pajares, 1997). Considering that preschool attendance increases students' readiness for school tasks and activities (Melhuish, 2011), science self-efficacy might be related to preschool attendance to some degree.

In this context, we aim to question if there is an association between students' science self-efficacy and how many years they attended preschool education. To investigate this relationship, we analyzethe PISA 2015 data for three countries; Finland, Singapore, and Turkey. In addition to Turkey, we choose Finland and Singapore because they have been continually among the top achievers although they have different education systems. In brief, the purpose of this study is to investigate the relationship between the duration of students' preschool attendance and their science self-efficacy in Finland, Singapore, and Turkey using the PISA 2015 data.

METHOD

In this study, we aim to investigate the long-term effects of preschool attendance on students' science self-efficacy beliefs using a causal-comparative model. We deliberately choose three countries; Finland, Singapore, and Turkey to compare in terms of these effects. The main reason why we compare Finland and Singapore is that both of these countries are consistently among the most successful countries in all subject areas in PISA although they have contrasting cultural profiles (Soh, 2014) and their educational systems differ from each other regarding many aspects. Another reason is that both of these two countries have very high preschool attendance rates. Turkey, on the other hand, diverges from Finland and Singapore with a high percentage of low achievers in PISA and a very low preschool attendance rate. Therefore, we believe that the comparison of these countries will be illuminating to reveal the nature of the relationship between preschool attendance and students' science self-efficacy.

Research Questions

In this study, we aim to inquire about the following research questions:

1. What are the comparative rates of 15-year-old students who had attended preschool in Finland, Singapore, and Turkey?
2. What are the mean science self-efficacy scores in Finland, Singapore, and Turkey?
3. What is the relationship between students' preschool attendance and science self-efficacy in Finland?
4. What is the relationship between students' preschool attendance and science self-efficacy in Singapore?
5. What is the relationship between students' preschool attendance and science self-efficacy in Turkey?
6. How does the relationship between students' preschool attendance and science self-efficacy differ in Finland, Singapore, and Turkey?

Study Group

72 countries or economies, including all member countries of OECD, participated in PISA 2015. However, we focus on three of these countries in

this study, which reveals a sample including 5882 students in 168 schools in Finland, 6115 students in 177 schools in Singapore, and 5895 students in 187 schools in Turkey. Table 1 summarizes the sample characteristics (gender and grade level) in each country.

Table 1. Gender and grade level statistics in Finland, Singapore, and Turkey

	Sample Size	Gender (%)		Grade level (%)				
		Female	Male	7th	8th	9th	10th	11th or 12th
Finland	5882	2863 *(48.7)*	3019 *(51.3)*	26 *(0.4)*	749 *(12.7)*	5100 *(86.7)*	1 *(0.0)*	6 *(0.1)*
Singapore	6115	2973 *(48.6)*	3142 *(51.4)*	4 *(0.1)*	109 *(1.8)*	482 *(7.9)*	5508 *(90.1)*	12 *(0.2)*
Turkey	5895	2938 *(49.8)*	2957 *(50.2)*	16 *(0.3)*	105 *(1.8)*	1273 *(21.6)*	4308 *(73.1)*	193 *(3.3)*

Ethics Committee Approval

The data we used in this study was obtained from PISA 2015 dataset, which is publicly available for all researchers. PISA is organized by OECD, which gains all the necessary ethical approvals in all participating countries (De Boeck & Scalise, 2019).

Variables

We have one dependent and one independent variable in this study, which are students' science self-efficacy and their preschool attendance, respectively. Regarding the independent variable, in the PISA dataset, the variable of DURECEC (duration in early childhood education and care), is calculated to provide the number of years a student attended preschool by subtracting his/her starting age for preschool education and care (ISCED 0 in the PISA 2015 student data) from his/her starting age for primary school (ISCED 1 in

the PISA 2015 student data). However, when we examined the DURECEC, ISCED 1 and ISCED 0 variables, we needed to make some corrections in calculating the DURECEC variable. Some students reported that they started primary school when they were 4 years old or younger, which was not plausible. Thus, we excluded any data that reported starting age for primary school as four or less. Moreover, we made a listwise deletion for the students who did not report a valid answer for any of ISCED 0 and ISCED 1.

After cleaning data for those two variables, we calculated the difference between them to get the duration of preschool attendance. Finally, we created a categorical variable recoding the revised DURECEC variable into three categories: Students who did not attend preschool or attended less than a year, students who attended preschool at least one year but less than two years, and students who attended preschool two years or more.

Regarding the dependent variable, the PISA dataset provides us with a science self-efficacy index (SCIEEFF), which is derived from students' ratings of how their confidence level in performing a variety of science assignments. An example of these tasks is to "identify the science question that underlies a report published on a magazineabout a health issue". Students self-evaluate their efficacy for each task based on a Likert scale with four options: "I could do thetask easily", "I could do the task with little effort", "I would struggle to do thetask on my own", and "I couldn't do the task". The responses are reverse-coded so that higher values refer to higher levels of self-efficacy. As a result, SCIEEFF is created with an OECD mean of zero and a standard deviation of one.

Data Collection Tools

Student Questionnaire. We used a refined version of the PISA 2015 dataset, which only covered respective data for three countries we focus on in this study. During each PISA implementation, in addition to the questions about science, mathematics and reading literacies, students were asked to respond to items about their demographic characteristics, home background, learning environment as well as their science self-efficacy, epistemological beliefs, and motivation. The data we used for preschool attendance and science-self-efficacy were pulled from this student-filled questionnaire, which was an online data collection tool including 56 items.

Process

During the implementation of PISA 2015, the data collectiontools wereadministered to the randomly selected participants in two sessions.The first session, in which students completed science, mathematics and reading literacy tests, took 120 minutes. In the second session, which took 30 minutes, the student questionnaire was applied. In most of the participant countries including Finland, Singapore, and Turkey, the data were collected by a computer-based assessment instead of paper and pencil form.

Data Analysis

In this study, we aim to investigate the relationship between students' preschool attendance and their science self-efficacy.To examine this relationship, we first needed to check if there was any effect of this nestedness in the data before performing any other analyses since both the dependent and independent variables in our study were student-level data, which were nested in different schools. This was the reason why we calculated the intraclass correlation coefficient (ICC) for Finland, Singapore, and Turkey. A large ICC value would indicate a need for multilevel data analyses. However, Finland and Turkey's ICC values were very small (see Table 2) so we could safely ignore any effect of the hierarchy in data for Finland and Turkey. The ICC value for Singapore seemed to be more critical, yet it was not too large to be worried about any drastic effect of the nestedness in the data. Therefore, we decided to run an ordinary multiple regression rather than a multilevel one.

Table 2. The corresponding ICC values of the data for Finland, Singapore, and Turkey

	Finland	Singapore	Turkey
ICC values	0.025	0.088	0.022

We performeda multiple regression analysis with two dummy-coded predictor variables. To create dummy variables, the category 'students who did not attend preschool or attended less than a year' was considered as baseline.We created the first dummy predictor to compare 'students who attended preschool at least one year but less than two years' with the baseline, and second dummy predictor to compare 'students who attended preschool two

years or more' with the baseline.Using these two dummy-coded predictors about students' preschool attendance and their science self-efficacy as the outcome, we created a regression model to make inferences about the relationship between students' preschool attendance and their science self-efficacy.

FINDINGS

As we stated earlier, we aim to investigate if there is any effect of preschool attendance on students' science self-efficacy using the PISA 2015 data revealed from three countries: Finland, Singapore, and Turkey. Table 3 illustrates the corresponding preschool attendance rates in these three countries.

Table 3. Preschool attendance rates in Finland, Singapore, and Turkey

Duration of Participation	Finland	Singapore	Turkey
0 ≤ preschool attendance < 1	2.7 %	1.5 %	**52.1 %**
1 ≤ preschool attendance < 2	25.4 %	4.1 %	29.3 %
2 ≤ preschool attendance	**71.9 %**	**94.4 %**	18.6 %

Note: The highest percentage in each country is indicated in bold.

Table 3 clearly shows that Turkey diverges from the other two countries regarding preschool attendance rates. More than half of the participants (52.1 %) in Turkey either attended preschool less than a year or did not attend at all while a majority of Finnish (71.9 %) and most of the Singaporean (94.4 %) students attended preschool at least two years or more. On the other hand, Turkish students outperform their peers in Finland and Singapore in terms of their science self-efficacy scores. Table 4 shows the mean science self-efficacy scores for each country.

Before proceeding further, we firstly calculated ICC values for each country to check if the nested nature of the data has any significant effect on science self-efficacy scores in the corresponding countries. The relatively low ICC valuesled us to conduct ordinary regression rather than a multilevel one. Then, wecreated dummy variables for each category of preschool attendance, the

Table 4. Mean science self-efficacy scores in Finland, Singapore, and Turkey

Duration of Participation	Finland	Singapore	Turkey
0 ≤ preschool attendance < 1	-0.305	-0.281	0.262
1 ≤ preschool attendance < 2	-0.051	-0.028	0.402
2 ≤ preschool attendance	-0.003	0.119	0.449
Grand Mean	*-0.023*	*0.107*	*0.338*

independent variable of this study, and we selected the dummy variable of 'students who did not attend preschool or attended less than a year' as the baseline category so that we can compare the other two categories with it. In other words, we compared 'students who attended preschool at least one year but less than two years' and 'students who attended preschool two years or more' with 'students who did not attend preschool or attended less than a year'.To prevent type 1 error inflation while comparing two dummy coded groupsand the baseline group, we set alpha as .025, which is the ratio of the experimentwise alpha level (.05) to the number of comparisons for each country.Table 5 summarizes the result of the regression analysis for Finland.

Table 5. Summary of the regression analysis for Finland

Model	*B*	*SE B*	*β*
Constant	-.305	.104	
Dummy One	.254	.109	.095*
Dummy Two	.302	.106	.117**
F		*4.508**	

Notes: *p< .025; **p< .01

Constant refers to baseline category ('students who did not attend preschool or attended less than a year'); Dummy One refers to the created dummy variable for 'students who attended preschool at least one year but less than two years'; Dummy Two refers to the created dummy variable for 'students who attended preschool two years or more'.

The regression model for Finland indicates that the self-efficacy of the 'students who attended preschool at least one year but less than two years' differs significantly from the 'students who did not attend preschool or attended less than a year' (p = .020). Besides, Dummy One has a positive coefficient of B = .254, which means that the 'students who attended preschool at least one year but less than two years' compared to the 'students who did not attend preschool or attended less than a year' will have a .254 increase in their self-efficacy scores on average in Finland. While interpreting these values, we need to keep in mind that the OECD mean is set to be zero with a standard deviation of 1. We also calculated Hedge's g, which is an unbiased estimate of the effect size standardized by the pooled standard deviation of the groups. Our calculation revealed a small effect size of 0.209. Similarly, the self-efficacy of the 'students who attended preschool two years or more' is significantly different from the 'students who did not attend preschool or attended less than a year' (p = .004) and the former group is expected to have a .302 higher self-efficacy than the latter group (B = .302), which also results in a small effect size of 0.263.

Then, we performed another regression analysis to evaluate if the increase in preschool attendance led to a positive gain on the science self-efficacy of Singaporean students. Table 6 summarizes the results of the regression analysis for Singapore.

Table 6. Summary of the regression analysis for Singapore

Model	*B*	*SE B*	*β*
Constant	-.281	.137	
Dummy One	.254	.161	.044
Dummy Two	.400	.138	.081**
F		*5.516***	

Notes: *p< .025; **p< .01
Constant refers to baseline category ('students who did not attend preschool or attended less than a year'); Dummy One refers to the created dummy variable for 'students who attended preschool at least one year but less than two years'; Dummy Two refers to the created dummy variable for 'students who attended preschool two years or more'.

The regression model for Singapore reveals that the difference between the science self-efficacy scores of the 'students who attended preschool at least one year but less than two years' and the 'students who did not attend preschool or attended less than a year' is not statistically significant (B = .254, p = .115) with a quite small effect size of 0.197. On the other hand, the science self-efficacy scores of the 'students who attended preschool two years or more' is significantly higher than the one for 'students who did not attend preschool or attended less than a year' (B = .400, p = .004) with a bigger effect size of 0.356.

In the final step of our analyses, we conducted another regression analysis for Turkey. Table 7 illustrates the model revealed from this analysis.

Table 7. Summary of the regression analysis for Turkey

Model	*B*	*SE B*	*β*
Constant	.262	.026	
Dummy One	.140	.043	.049**
Dummy Two	.188	.050	.056***
F		*9.584****	

Notes: *p< .025; **p< .01; ***p< .001
Constant refers to baseline category ('students who did not attend preschool or attended less than a year'); Dummy One refers to the created dummy variable for 'students who attended preschool at least one year but less than two years'; Dummy Two refers to the created dummy variable for 'students who attended preschool two years or more'.

As shown in Table 7, the self-efficacy scores of the 'students who attended preschool at least one year but less than two years' is significantly higher than the 'students who did not attend preschool or attended less than a year' (B = .140, p = .001) but with a quite small effect size of 0.108. Similarly, the average science self-efficacy score of the 'students who attended preschool two years or more' is significantly higher than the one for 'students who did not attend preschool or attended less than a year' with a small effect size of 0.143 (B = .188, p< .001).

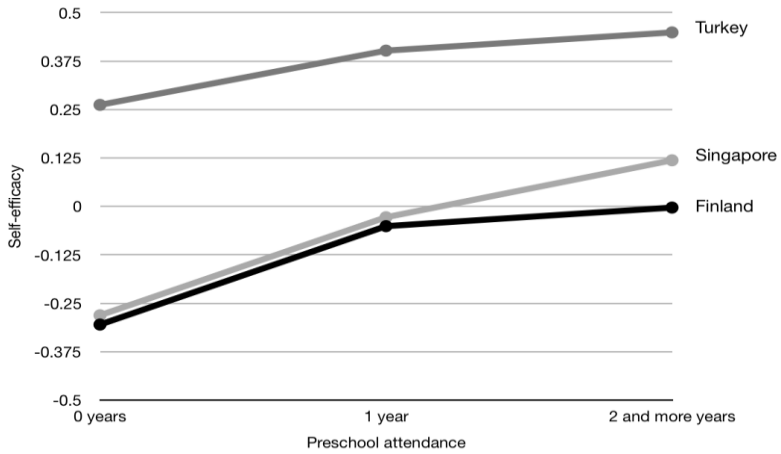

Figure 1. The change of students' science self-efficacy as their preschool attendance increases in each country comparatively

In addition, Figure 2 shows a comparison of effect size values for each country.

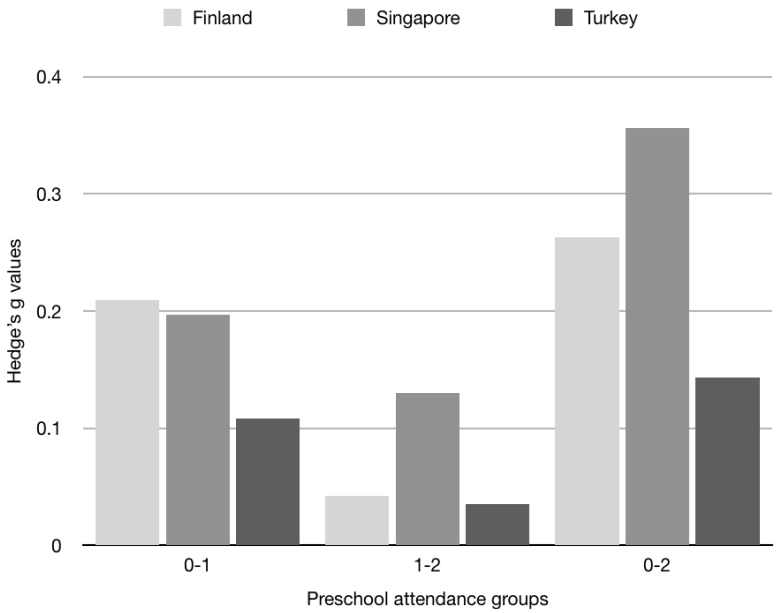

Figure 2. Hedge's g values comparing each category of preschool attendance in terms of science self-efficacy for each country

DISCUSSION

In this associational study, we compare three countries; Finland, Singapore, and Turkey, in terms of preschool attendance rates and the effect of preschool attendance on the students' science self-efficacy as measured in PISA when they are 15 years old. There is a long time lag between when the independent variable (preschool attendance) happens to occur and the dependent variable (students' science self-efficacy) is measured, yet the existing literature gives us enough motivation and confidence to check the long term effects of preschool attendance (Barnett, 1995, 1998; Melhuish, 2011; OECD, 2013; Pholphirul, 2017) especially on science self-efficacy which is well known to be constructed gradually on a long term experience.

Regarding the first aspect of our study, the comparison of these countries shows that Turkey lags evidently behind Finland and Singapore in terms of preschool attendance rate. More than half of the Turkish 15-year-old students did not attend preschool at all or attended less than a year, which points to an enormous percentage (52.1%) comparing to the percentages of Finland and Singapore, which are 2.7%, and 1.5% respectively. In 2012, the OECD average of the students who reported that they had attended preschool was 93% and it has been increasing (OECD, 2014). Considering the positive effects of preschool attendance on a variety of domains including the achievement (OECD, 2014), it is clear that this huge percentage of students not attending the preschool creates an important limitation for Turkey to reach the goal of building a scientifically literate society.

Although the preschool attendance rate in Turkey has been slowly going up, it is still much smaller than what it should be. The percentage of the students who reported that they had attended preschool at least one year was 30% in PISA 2009 (OECD, 2011) and increased by more than 1.5 times (47.9%) in PISA 2015 (see Table 3). However, the net percentage of Turkish five-year-old students attending kindergarten was only 59% in 2016 according to National Education Statistics published by the Turkish Ministry of National Education (MEB, 2017). In other words, the recent data shows that four out of 10 kids directly start primary school without any kinds of preschool education in Turkey, which is far behind the preschool attendance rates in Finland and Singapore.

In terms of students' science self-efficacy index, as illustrated in Table 4, Turkey has the highest one among these three countries. The index of 0.338 shows that the average of Turkish students' science self-efficacy scores departs 0.338 standard deviations from the OECD average in the positive direction. This result seems to be unexpected because, within each of these countries, students' science self-efficacy scores are positively correlated with their science literacy scores, which is what is expected based on the theoretical framework of self-efficacy, and yet Turkey is the country with the lowest science literacy and the highest self-efficacy averages among them. The elaboration of the reasons behind this result is out of the scope of this article but we believe further studies might be helpful to investigate this ambivalent data.

Concerning the second aspect of the study, which is the effect of preschool attendance on students' science self-efficacy scores on PISA 2015, Figure 1 illustrates that average science self-efficacy scores are escalated by increasing preschool attendance within all three countries. Comparing to 'preschool attendance less than a year', both the preschool attendance 'between one year and two years' and 'more than two years' are associated with higher average science self-efficacy scores for all countries. Moreover, all of these associations are statistically significant pointing out small to medium effect sizes as shown in Figure 2. The highest effect size is connected to the difference between students who attended preschool for less than a year and more than two years in Singapore. What is clear is that the longer period students attend preschool the better score they get in these three countries. However, the slopes of these escalations decrease as the number of years increases. That is, the effect sizes comparing students who attended less than a year and the ones who attended between one year and two years are larger than the effect sizes comparing the students who attended between one year and two years and those who attended more than two years. Further studies to reveal what happens after two years of preschool attendance might be helpful to understand the exact nature of the relationship between preschool attendance and science self-efficacy.

On another level, PISA results show that the relationship between preschool attendance and later learning outcomes is stronger in the countries having some quality features in preschool education (OECD, 2013) so we can argue that the degree to which preschool attendance affects students' science self-efficacy might be a measure of the quality of preschool education in the corresponding countries. Figure 2 evidently illustrates that the effectiveness of

preschool education in Turkey is smaller compared to Finland and Singapore. Focusing on the category that compares the students who attended less than a year and more than two years, it is obvious that preschool education in Singapore creates the biggest difference in students' science self-efficacy. From this point of view, what is revealed is that not only the 'quantity'; i.e. the attendance rate, but the 'quality' of the preschool education should be elevated in Turkey as well. OECD (2011, p. 4) highlights that extending preschool education can boost both students' performance and educational equity by decreasing the socio-economic gap as long as 'extending coverage does not compromise quality'. We believe that this is the harder-to-solve dimension of the issue because making the kindergarten education compulsory (after a solid structure has been built, of course) would change the preschool attendance rate drastically while increasing the quality of the education would require much more multifaceted and long term actions.

Taken together, preschool attendance seems to have long-term positive effects on students' science self-efficacy in all three countries we investigated in this study. The level of the effect not only changes from one country to the other but also depends on how long the students attended the preschool to some extent. Yet, it is obvious that longer duration results in higher self-efficacy levels in these countries. Although further investigations are required to question how preschool attendance affects students' science self-efficacy, based on what is revealed in this study, we can evidently claim that whether or how long students attend preschool is strongly associated with their science self-efficacy levels.

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Nurcan Cansız. She earned a B.S. degree in science education in 2006 and a Ph.D. degree in science education in 2014 at Middle East Technical University (METU). She was interested in socioscientific issues during her Ph.D. program. She was a visiting researcher at the University of Missouri between 2012 and 2013. After working as a research assistant at METU for seven years, she has been a member of the Department of Mathematics and Science Education at Artvin Coruh University since 2015. Her research interests include the analysis of PISA data, socioscientific issues, environmental education, teacher beliefs, and science literacy.

2006 yılında Orta Doğu Teknik Üniversitesi (ODTÜ) Fen Bilgisi Öğretmenliği bölümünde lisans eğitimini, 2014 yılında ise aynı bölümde doktora programını tamamlamıştır. Doktora eğitimi sırasında sosyobilimsel konular üzerinde çalışmaya başlamış ve 2012-2013 yılları arasında University of Missouri'de misafir araştırmacı statüsüyle doktora tezi üzerinde çalışmalarını devam ettirmiştir. ODTÜ'de yedi yıl boyunca araştırma görevlisi olarak çalıştıktan sonra 2015 yılından beriArtvin Çoruh Üniversitesi, Matematik ve Fen Bilimleri Eğitimi Bölümünde Dr. Öğretim Üyesi olarak halen görev yapmaktadır. Çalışma alanları arasında PISA verisinin analizi,sosyobilimsel konular, çevre eğitimi, öğretmen inançları, fen okuryazarlığı bulunmaktadır.

Ulaş Üstün. He has M.S.and Ph.D. degrees in physics education at METU. After working as a research assistant at METU for five years, he has been working as a faculty member at Artvin Çoruh University since 2013. He was a visiting post-doc researcher at Kansas State University (K-State) for two years, in one of which he worked as an instructor at K-State as well. His research interests include the analysis of PISA data, systematic reviews emphasizing meta-analysis, and the use of virtual experiments in science education.

ODTÜ'de fizik eğitimi alanında yüksek lisans ve doktora derecesi almıştır. ODTÜ'de beş yıl boyunca araştırma görevlisi olarak çalıştıktan sonra, 2013 yılından bu yana Artvin Çoruh Üniversitesi'nde öğretim üyesi olarak çalışmaktadır. İki yıl Kansas State Üniversitesi'nde ziyaretçi doktora sonrası araştırmacı olarak bulunmuş ve bu sürenin bir yılında aynı üniversitede öğretim görevlisi olarak çalışmıştır. Araştırma alanları arasında PISA verisinin analizi, meta-analiz başta olmak üzere araştırma sentezleri ve sanal deneylerin fen eğitiminde kullanımı yer almaktadır.

Mustafa Cansız. Mustafa Cansız received his B.S. and Ph.D. degree in Elementary Science Education Program at METU. He was a visiting researcher at the University of Missouri between 2012 and 2013. After working as a research assistant at METU for four years, he has been working as an assistant

professor at the Department of Mathematics and Science Education at Artvin Çoruh University since 2014. His research interests include the analysis of PISA data, teacher education, teacher beliefs, and science literacy.
Mustafa Cansız, lisans eğitimini ODTÜ Fen Bilgisi Öğretmenliği Bölümünde aldıktan sonra aynı üniversitenin İlköğretim bölümünde bütünleşik doktora programını tamamlamıştır. 2012-2013 yılları arasında University of Missouri'de misafir araştırmacı statüsüyle doktora tezi üzerinde çalışmalarını devam ettirmiştir.ODTÜ'de dört yıl boyunca araştırma görevlisi olarak çalıştıktan sonra 2014 yılından beri Artvin Çoruh Üniversitesi Matematik ve Fen Bilimleri Eğitimi Bölümünde Doktor Öğretim Üyesi olarak görev yapmaktadır. Araştırma alanları arasında PISA verisinin analizi,öğretmen eğitimi, öğretmen inançları ve fen okuryazarlığı yer almaktadır.

Ertuğrul Özdemir. He received his B.S.,M.S. and Ph.D.degrees in physics education atMETU.After working as a research assistant at the same university for seven years, he has been working as an assistant proffesor at the Department of Basic Educationat Artvin Çoruh University since 2011.His research interests include the analysis of PISA data, the use of virtual experiments in science education, and instructional comics in science education.
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Author Contributions/ Yazar Katkıları

This study was conducted by all the authors working together and cooperatively. All of the authors substantially and equally contributed to this work in each step of the study.
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Conflict of Interest/ Çıkar Çatışması

It has been reported by the authors that there is no conflict of interest.
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REFERENCES

Addey, C., Sellar, S., Steiner-Khamsi, G., Lingard, B., & Verger, A. (2017). The rise of international large-scale assessments and rationales for participation. *Compare: A Journal of Comparative and International Education*, *47*(3), 434-452.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review*, *84*(2), 191-215.

Barnett, W. S. (1995). Long-term effects of early childhood programs on cognitive and school outcomes. *The Future of Children, 5*(3) 25-50.

Barnett, W. S. (1998). Long-term cognitive and academic effects of early childhood education on children in poverty. *Preventive Medicine*, *27*(2), 204-207.

Berlinski, S., Galiani, S., &Manacorda, M. (2008). Giving children a better start: Preschool attendance and school-age profiles. *Journal of Public Economics*, *92*(5-6), 1416-1440.

Burger, K. (2010). How does early childhood care and education affect cognitive development? An international review of the effects of early interventions for children from different social backgrounds. *Early Childhood Research Quarterly*, *25*(2), 140-165.

Britner, S. L., &Pajares, F. (2006). Sources of science self-efficacy beliefs of middle school students. *Journal of Research in Science Teaching*, *43*(5), 485-499.

Camilli, G., Vargas, S., Ryan, S., & Barnett, W. S. (2010). Meta-analysis of the effects of early education interventions on cognitive and social development. *Teachers College Record*, *112*(3), 579-620.

De Boeck, P., & Scalise, K. (2019). Collaborative problem solving: Processing actions, time, and performance. *Frontiers in Psychology*, *10*, 1-9.

Diamond, A., Barnett, W. S., Thomas, J., & Munro, S. (2007). Preschool program improves cognitive control. *Science,318*(5855), 1387-1388.

Hayes, N. (2000). Early childhood education and cognitive development at age 7 years. *The Irish Journal of Psychology*, *21*(3-4), 181-193.

Loo, C. W., & Choy, J. L. F. (2013). Sources of self-efficacy influencing academic performance of engineering students. *American Journal of Educational Research*, *1*(3), 86-92.

MEB (Ministry of National Education) (2017). *National Education Statistics. Formal Education.* Ankara: Ministry of National Education Press.

Melhuish, E. C. (2011). Preschool matters. *Science*, *333*(6040), 299-300.

OECD (Organisation for Economic Co-operation and Development) (2019). *OECD data: Employment rate.*Retrieved February 4, 2020 from https://data.oecd.org/emp/employment-rate.htm

OECD (Organisation for Economic Co-operation and Development) (2011). Does participation in pre-primary education translate into better learning outcomes at school? *PISA in Focus*: 2011/1.

OECD (Organisation for Economic Co-operation and Development) (2013). *How do early childhood education and care (ECEC) policies, systems and quality vary across OECD countries?* Paris: OECD Publishing.

OECD (Organisation for Economic Co-operation and Development) (2014). Does pre-primary education reach those who need it most? *PISA in Focus*: 2014/06.

OECD (Organisation for Economic Co-operation and Development) (2016). *PISA 2015 Results (Volume I): Excellence and Equity in Education*. Paris: OECD Publishing.

Pajares, F. (1997). Current directions in self-efficacy research. *Advances in Motivation and Achievement*, *10*(149), 1-49.

Pholphirul, P. (2017). Pre-primary education and long-term education performance: Evidence from Programme for International Student Assessment (PISA) Thailand. *Journal of Early Childhood Research*, *15*(4), 410-432.

Soh, K. (2014). Finland and Singapore in PISA 2009: similarities and differences in achievements and school management. *Compare: A Journal of Comparative and International Education*, *44*(3), 455-471.

Genişletilmiş Türkçe Özet

Giriş: Kadınların ücretli işgücüne katılımı, 1970'lerden bu yana birçok ülkede artmaktadır. 2018 verisine göre, Ekonomik İşbirliği ve Kalkınma Örgütü (Organisation for Economic Co-operation and Development-OECD) üyesi ülkelerde, 15-64 yaş grubundaki kadınların % 60'ından fazlası iş gücüne aktif olarak katılmaktadır (OECD, 2019). Bu durum, okul öncesi eğitimin son yıllarda daha fazla dikkat çekmesinin sebeplerinden bir tanesidir. Bu artan ilgi sayesinde, okul öncesi eğitimin farklı boyutlardaki çıktıları son zamanlarda kapsamlı bir şekilde çalışılmaktadır. Bu çalışmalar, okul öncesi eğitime katılımın ileriki yıllarda öğrencilere birçok faydasının olduğunun altını çizmiştir (Barnett, 1995; Berlinski, Galiani ve Manacorda, 2008; Burger, 2010; Camilli vd., 2010; Diamond vd., 2007; Hayes, 2000; Melhuish, 2011; OECD, 2011, 2014). Ancak, bu çalışmaların çok büyük bir kısmı okul öncesi eğitimin bilişsel boyutundaki etkilerine odaklanmıştır ve bu durum öz-yeterlik gibi duyuşsal boyuta yönelik araştırmalar için ihtiyaç doğurmuştur. Literatürdeki bu boşluk dikkate alınarak, bu çalışmada Uluslararası Öğrenci Değerlendirme Programı (Programmefor International StudentAssessment-PISA) 2015 verileri kullanılarak öğrencilerin okul öncesi eğitime katılımları ile fen öz-yeterlikleri arasındaki ilişki araştırılmıştır.

Fen öz-yeterliği, öğrencilerin fen ile ilgili görev veya etkinliklerde başarılı olmaya yönelik kendi öz yeteneklerine olan inançları olarak tanımlanabilir (Britner ve Pajares, 2006). Bu nedenle öz-yeterliğin fen başarısını etkileyen önemli faktörlerden biri olması şaşırtıcı değildir (Loo ve Choy, 2013; Pajares, 1997). Okul öncesi eğitime katılımın, öğrencilerin okul görev veya sorumluluklarını yerine getirmede hazır bulunuşluklarını arttırdığı göz önüne alındığında (Melhuish 2011), fen öz-yeterliğinin belirli bir ölçüde okul öncesi eğitime katılımla ilişkili olduğu düşünülebilir.

Yöntem: Bu çalışmanın temel amacı, okul öncesi eğitime katılımın öğrencilerin fen öz-yeterlikleri üzerindeki uzun vadeli etkilerinin nedensel-karşılaştırma yöntemi ile araştırılmasıdır. Bu uzun vadeli etkiler açısından karşılaştırmak üzere Finlandiya, Singapur ve Türkiye bilinçli olarak seçilmiştir. Finlandiya ve Singapur'u karşılaştırmamızın temel nedeni, pek çok açıdan birbirinden farklı kültürel özelliklere (Soh, 2014) ve eğitim sistemlerine sahip olmalarına rağmen her ikisinin de, tutarlı bir şekilde, PISA'daki tüm konu alanlarında en başarılı ülkeler arasında yer almasıdır. Finlandiya ve Singapur'u seçmemizin diğer bir sebebi, her iki ülkede de okul öncesi eğitime katılımın çok yüksek olmasıdır. Öte yandan Türkiye, başarısı düşük öğrencilerin oranının yüksek olması ve okul öncesi eğitime katılımın düşük olması ile bu iki ülkeden ayrışmaktadır. Bu nedenle, bu üç ülkenin karşılaştırılmasının, okul öncesi eğitime katılım ile öğrencilerin fen öz-yeterlikleri arasındaki ilişkinin doğasının ortaya çıkarılmasında aydınlatıcı olacağına inanıyoruz.

Bu çalışmanın bağımlı değişkeni PISA veri setinde SCIEEFF olarak kodlanan öğrencilerin fen-öz-yeterlik düzeyleri, bağımsız değişkeni ise DURECEC kodlu öğrencilerin okul öncesi eğitime katılım süreleridir. Bu çalışma kapsamında DURECEC değişkeni, okul öncesi eğitime "hiç katılmayanlar" (bir yıldan az katılan öğrenciler de bu grupta yer almaktadır), "1-2 yıl katılanlar" (bir yıl katılan öğrenciler bu grupta yer almaktadır) ve "2 veya daha fazla yıl katılanlar" şeklinde gruplandırılmıştır.

Veri analizinde, ilgili üç ülkedeki okul öncesi eğitime katılımın öğrencilerin fen öz-yeterlikleri üzerindeki etkisini karşılaştırmak amacıyla her bir ülke için ayrı ayrı kukla değişkenli çoklu regresyon analizi yapılmıştır.

Bulgular: Okul öncesi eğitime katılım oranı göz önünde bulundurulduğunda Türkiye'nin diğer iki ülkeden ayrıştığı görülmektedir. Türkiye örnekleminde katılımcıların yarısından fazlası okul öncesi eğitime ya hiç katılmamıştır ya da bir yıldan az katılmıştır. Diğer taraftan, Finlandiya ve Singapur'da katılımcıların büyük çoğunluğunu okul öncesi eğitime iki yıl veya daha fazla katılanlar oluşturmaktadır.

Finlandiya için oluşturulan regresyon modeline göre, hiç katılmayan öğrencilerin fen öz-yeterlik düzeyi 1-2 yıl katılan öğrencilere kıyasla anlamlı bir farklılık göstermektedir (B = 0,254, p = 0,020). Bu çalışmada, yansız bir etki büyüklüğü tahmini olan Hedge g değeri de hesaplanmıştır. Bu hesaplamanın sonucu olarak küçük bir etki büyüklüğü değeri (0,209) elde edilmiştir. Benzer şekilde, okul öncesi eğitime 2 veya daha fazla yıl katılan öğrencilerin fen öz-yeterlik puanlarının, hiç katılmayan öğrencilere kıyasla anlamlı şekilde farklı olduğu görülmüştür (B = 0,302, p = 0,004). Bu fark yine küçük bir etki büyüklüğüne (0,263) karşılık gelmektedir.

Singapur için oluşturulan regresyon modeli, okul öncesi eğitime 1-2 yıl katılan öğrencilerle hiç katılmayanların fen öz-yeterlik ortalama puanları arasında istatistiksel olarak anlamlı bir fark bulunmadığını (B = 0,249, p = 0,115) ve bu farkın etki büyüklüğünün oldukça küçük (0,197) olduğunu göstermektedir. Diğer taraftan, okul öncesi eğitime 2 veya daha fazla yıl katılan öğrencilerin fen öz-yeterlik puanları, hiç katılmayanların puanlarından anlamlı derecede yüksektir (B = 0,396, p = 0,004) ve bu fark nispeten büyük bir etki büyüklüğüne (0,356) karşılık gelmektedir.

Türkiye için oluşturulan regresyon modelinde, okul öncesi eğitime 1-2 yıl katılan öğrencilerin fen öz-yeterlikleri, hiç katılmayanlarınkinden anlamlı bir biçimde yüksektir (B = 0,140, p = 0,001), ancak bu iki grup arasındaki fark küçük bir etki büyüklüğüne (0,108) karşılık gelmektedir. Benzer şekilde, 2 veya daha fazla yıl katılan öğrencilerin ortalama fen öz-yeterlik puanları, hiç katılmayan öğrencilerin puanlarından anlamlı şekilde yüksektir (B = 0,188, p< 0,001) ve bu iki grubun fen öz-yeterlik puanları arasındaki fark küçük bir etki büyüklüğüne (0,143) karşılık gelmektedir.

Tartışma ve Sonuç: Sonuç olarak, okul öncesi eğitime katılımın, bu çalışmada araştırdığımız üç ülkedeki öğrencilerin fen öz-yeterliklerine uzun vadeli olumlu etkilerinin olduğu görülmektedir. Okul öncesi eğitimin etki düzeyi, hem bir ülkeden diğerine hem de öğrencilerin okul öncesi eğitime ne kadar süre katıldığına bağlı olarak değişmektedir. Ancak, açık olan şey, bu ülkelerde okul öncesi eğitimde daha uzun süre geçirmenin daha yüksek öz-yeterlik düzeylerini beraberinde getirdiğidir. Her ne kadar okul öncesi eğitime katılımın, öğrencilerin fen öz-yeterliliğini nasıl etkilediğini sorgulayan daha fazla araştırmaya ihtiyaç olsa da, bu çalışmanın sonuçlarına dayanarak, öğrencilerin okul öncesi eğitime katılıp katılmamalarının ya da ne kadar süre katıldıklarının, onların fen öz-yeterlik düzeyleri ile güçlü bir şekilde ilişkili olduğunu açıkça söyleyebiliriz.