doi: 10.26529/cepsj.1149

Determining Pre-Service Teachers' Astronomy-Related Self-Efficacy Belief Levels

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This study aims to reveal the astronomy-related self-efficacy beliefs of pre-service teachers studying science education, primary school education, and social studies education programmes. The study is conducted using the survey design, a quantitative research method. The study sample consists of 322 pre-service teachers in their third or fourth year of a science education, primary school education, or social studies education programme at a university in Turkey's Central Anatolia Region during the 2016 fall semester. The Astronomy Teaching Self-Efficacy Belief Scale developed by Güneş was used as the data collection tool. SPSS 22 was used to analyse the data, and the analyses benefited from descriptive and inferential statistics. Based on the findings, the pre-service teachers' total scores for astronomy self-efficacy showed no significant difference in terms of certain variables (i.e., gender, age, year, and having taken a previous astronomy course). However, significant differences were found regarding self-efficacy scores in terms of the programme and having taken part in astronomy and sky-gazing activity. Concerning the obtained results, the following suggestions can be made: pre-service teachers should be actively involved during the astronomy course, and their classroom management experiences should be promoted to improve their astronomy self-efficacy belief levels.

Keywords: astronomy education, astronomy self-efficacy belief, pre-service teacher

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Ravni prepričanja o samoučinkovitosti v povezavi s poznavanjem astronomije pri študentih pedagoških smeri

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Raziskava skuša predstaviti prepričanja o samoučinkovitosti glede znanja astronomije pri študentih pedagoških smeri naravoslovja, osnovnošolskega poučevanja in družboslovnih programov. Študija je bila izvedena z uporabo ankete, pri čemer se je poslužila kvantitativne raziskovalne paradigme. Vzorec sestoji iz 322 študentov pedagoških smeri naravoslovja v njihovem tretjem ali četrtem letniku, osnovnošolskega poučevanja ali družboslovja na univerzi osrednje turške pokrajine Anatolije v jesenskem semestru leta 2016. Kot pripomoček za zbiranje podatkov je bila uporabljena lestvica prepričanj o samoučinkovitost glede znanja astronomije, ki jo je razvil Günes. SPSS 22 je bil uporabljen za analizo podatkov, pri čemer ta obsega opisno in vzorčno statistiko. Na podlagi ugotovitev se rezultati statistično pomembno ne razlikujejo glede na spremenljivke spola, starosti, letnika in predhodnega obiskovanja predmeta astronomije, pomembne razlike pa so dokazane glede na študijski program in sodelovanje pri astronomiji ter pri opazovanju neba. Dobljeni izsledki dopuščajo naslednje sklepe: študentje pedagoških smeri bi morali aktivno sodelovati pri predmetu astronomije, v nadaljevanju pa bi se jih moralo spodbujati pri upravljanju razreda, da se izboljša tudi njihova prepričanja o samoučinkovitosti glede znanja astronomije.

Ključne besede: poučevanje astronomije, prepričanje o samoučinkovitosti glede znanja astronomije, študentje pedagoških smeri

Introduction

The process of learning science involves a combination of observations and interpretations that enable students' meaningful learning (Pundak et al., 2017). As a result, astronomy has become included in this combination. Therefore, having individuals who have been interested in the sky since an early age continue these interests using the knowledge they gain from scientifically reliable sources by observing and interpreting is considered necessary.

From an international point of view, the debate on how to teach astronomy within the curricula has been chiefly about whether it should be taught as a separate course or as a part of other fields. In both cases, the topics planned to be taught include the formation of day and night, the seasons, the phases of the moon, eclipses, tides, planets, and stars (Taşcan & Ünal, 2015). Each country expresses the importance they attach to astronomy education in their education system. For instance, Serbia requires 33 seminars over three years on various topics in astronomy every second Tuesday throughout the academic year at the Department of Astronomy and 33 seminars held at the Astronomical Observatory (Atanackovic & Arbutina, 2021). In Thailand, new topics such as the celestial sphere, astronomical coordinate systems, and the sun's apparent motion had been introduced within astronomy to all science classes, as of 2008 (Jansri & Ketpichainarong, 2020).

Turkey has drawn attention to the topics addressed in teaching astronomy. When viewed nationally, it is seen to give relatively high importance to astronomy topics in its primary and secondary school curricula. The Ministry of National Education (MoNE) has started including astronomy topics (e.g., Let's Get to Know Our Planet; The Earth's Crust and the Motion of Our Planet; The Sun, Earth, and Moon; The Solar System and Eclipses; The Solar System and Beyond; Seasons and Climate) starting in the third-grade science curriculum (2018a). Unlike in previous curricula, the subject areas of the world and the universe have also been included in the first units with the aim of developing students' sense of curiosity about astronomy and of developing their interest in science. In this respect, having education regarding basic concepts in astronomy be effectively presented by increasing observation and critical thinking in schools will make an essential contribution to individuals' meaningful learning and interest in astronomy (Oğuz et al., 2012). In other words, having students take an active role in teaching topics on astronomy is very important in being able to create learning environments that will contribute to meaningful learning and to help students' critical thinking and discussions of processes in terms of conceptualising knowledge on astronomy (Akimkhanova et al., 2020; Güneş,

2010). Teachers who display such an approach attach importance to students' ideas and show they trust the students so as to increase the value of this importance. As in many other subjects, this aspect allows students to trust themselves in astronomy. Meanwhile, teachers' self-confidence in performing their duties and competencies in influencing the performance of their students relate directly to their self-efficacy beliefs (Bandura, 1994; Gusken & Passaro, 1994).

Self-efficacy belief is based on social learning theory and is expressed as individuals' ability to take charge of the events that affect their lives (Bandura, 1977). According to Bandura (1997), four main factors affect the perception of self-efficacy in individuals: direct experiences of success, indirect experiences based on observation, verbal persuasion, and psychological and physiological situations. Çakıroğlu et al. (2005) stated that one of the most important topics in teacher training programmes regarding the goal of teaching qualified and effective teachers was providing them with self-efficacy. Meanwhile, Tschannen-Moran and Woolfolk Hoy (2001) argued that teachers and academics (lecturers) should have self-efficacy beliefs and that these beliefs should be integrated into teaching strategies. At the same time, they argued that teacher-student communications should be increased and that lessons may become more productive due to this integration.

As seen above, instructors have a great responsibility in developing self-efficacy beliefs. The question that comes to mind is whether instructors have the necessary knowledge and skills for improving self-efficacy beliefs. Pajares (1992) stated that individuals' self-efficacy beliefs were related to their level of knowledge and skills specific to the subject. From this point of view, instructors who lack knowledge and skills in any subject obviously will have difficulty developing their learners' self-efficacy levels. Similarly, pre-service teachers should have the necessary knowledge and skills to meaningfully and self-confidently teach students subjects (Bağdiken & Akgündüz, 2018). Thus, similar to what Pajares (1992) found in his study, pre-service teachers with sufficient knowledge and skills in astronomy can be considered to have an adequate level of self-efficacy beliefs. In contrast, teachers and pre-service teachers with sufficient self-efficacy beliefs can transfer their knowledge and skills on astronomy to those who have learned meaningfully (Demirci, 2017; Güneş, 2010). In this context, self-efficacy belief can be said to be the key to realising astronomy-related studies.

Although developing self-efficacy beliefs in astronomy is vital for meaningful learning, studies on the field of self-efficacy in the literature have primarily involved mathematics self-efficacy (Gülten et al., 2012; İskenderoğlu et al., 2016; Pajares, 1996), science self-efficacy (Akbaş & Çelikkaleli, 2006; Kaya, 2013; Riggs & Enochs, 1990), and academic self-efficacy (Choi, 2005; Ekici, 2012; Høigaard

et al., 2014; Oğuz, 2012; Yağcı & Aksoy, 2015). In this sense, although studies are found on self-efficacy in science, studies on the field of astronomy are generally related, especially in the context of the current study, to the conceptual meanings students have regarding topics in astronomy (Baloğlu Uğurlu, 2005; Bülbül et al., 2013; Cin, 2007; Durukan & Sağlam Arslan, 2013; Göncü & Korur, 2012; Küçüközer, 2007; Şensoy, 2012) and students' knowledge levels (Bostan, 2008; Kanlı, 2014; Kaplan & Çifçi Tekinarslan, 2013; Taşcan, 2013); the number of studies on astronomy self-efficacy is relatively low (Carter, 2005; Güneş, 2010). Of these, a limited number is found on the self-efficacy of pre-service teachers. For example, only Durukan and Sağlam Arslan (2013), Küçüközer (2007), and Şensoy (2012) have studied conceptual interpretation; Bostan (2008) and Kanlı (2014) studied knowledge levels, İyibil and Saglam Arslan (2010) studied mental models, and Carter (2005) and Güneş (2010) studied astronomy self-efficacy. Other studies have been directed toward students and teachers.

In light of the presented literature, the lack of self-efficacy studies on pre-service teachers is noteworthy. When considering that students encounter many concepts related to astronomy during their learning process and are introduced to these concepts primarily through their teachers, determining pre-service teachers' self-efficacy related to these concepts and subjects that will occur in the teaching profession is vital. In this way, the conceptual comprehension studies related to astronomy in the literature (Baloğlu Uğurlu, 2005; Küçüközer et al., 2010; Plummer, 2006; Trundle et al., 2006; Trundle & Troland, 2005) can be guided by investigating the reasons behind the subject in relation to self-efficacy beliefs on astronomy.

Different studies in the literature have obtained various results regarding self-efficacy scores in terms of gender. Akbaş and Çelikkaleli (2006) stated that teacher candidates' self-efficacy beliefs on science teaching do not vary according to gender, while Cassidy and Eachus (2002) found men to have higher self-efficacy beliefs than women did. In view of these differences in the literature, the current study aims to examine how self-efficacy scores vary with regard to gender. Studies in the relevant literature have used age and grade level as other variables. Özenoğlu-Kiremit's (2006) study evaluated science teacher candidates' biology-related self-efficacy beliefs according to age and determined that such beliefs regarding biology teaching increase with age. Similarly, pre-service teachers' levels of self-efficacy beliefs toward biology teaching also increased with higher grade levels (i.e., freshman, sophomore, junior, senior). In this context, the variables of age and grade are considered important in determining self-efficacy beliefs. Differentiating between pre-service teachers' self-efficacy scores based on age and grade will provide significant opportunities for teacher training institutions that consider this.

Self-efficacy beliefs are fundamental in individuals' behaviour and are said to be related to the above-mentioned variables based on four sources (Ekici, 2009): first-hand experience of similar behaviour, the opportunity from others to follow the same kind of behaviour, being convinced by an authority, and self-awareness of physiological and emotional states. First-hand experience plays a vital role in self-efficacy (Woolfolk Hoy, 2000), because when people gain work-related experience, they feel more qualified to finish or perform the work (Bandura, 1977). In this sense, the study aims to determine the effect pre-service teachers' previous astronomy courses and previous experience with astronomy and sky observations have on their self-efficacy beliefs on astronomy.

Purpose of the research

Pre-service teachers' self-efficacy regarding their confidence in and expectations from astronomy is a crucial element in teaching astronomy subjects to students (Demirci, 2017). In particular, this situation becomes more prominent in science, classroom education, and social sciences involving topics on astronomy. For example, one of the aims of the social studies curriculum is to recognise the general geographical characteristics of the environment and world in which students live (MoNE, 2018). The publications on teacher qualifications prepared by the School-Based Professional Development Unit of Turkey's Ministry of National Education state that classroom teachers should have competence in providing information about scientific developments (MoNE, 2008) and, in this sense, emphasise that students should gain the ability to recognise the antecedents of scientific concepts such as the basic concepts in astronomy (MoNE, 2009). Similarly, this is essential in science education (e.g., physics, chemistry, biology) because of its relationship to the universe, the world, and nature (Göncü & Korur, 2012). Meanwhile, other natural science departments, such as mathematics, are interested in the calculations in astronomy rather than the topics or concepts in the subject.

The current study will discuss the need for science and social science teachers to have experience in terms of having an effective astronomy education (Güneş, 2010), the importance of topics on astronomy in science, classroom education, and social sciences departments, and how these pre-service teachers will teach this course. Self-efficacy is very important in guiding individuals' behaviours, attitudes, and taking action. In this sense, unlike the studies on determining attitudes towards astronomy that are frequently carried out in the literature, this current study will complement the other studies by determining pre-service teachers' ability to use the knowledge and skills necessary for their students to learn in the future. Obtaining information about pre-service

teachers' levels of self-efficacy beliefs will shed light on their future teaching. Studies have proven teacher efficacy to be strongly related to many meaningful educational outcomes (Vlah et al., 2021). Teachers' self-efficacy beliefs about the subject are thought to affect students' conceptual learning or academic achievement (Nie et al., 2013; Şirin & Metin Peten, 2020). Even if pre-service teachers' self-efficacy levels cannot be identified at the desired level, the suggestions this study makes can firmly guide new teachers. This is because new teachers can be more productive in their future teaching lives by considering the current study results and the suggestions presented to learn what they need to do to develop their self-efficacy beliefs toward astronomy. In this context, this study aims to reveal the astronomy self-efficacy of prospective teachers studying science education, classroom education, and social studies education programmes.

The research questions are as follows:

1. Does a statistically significant difference exist between male and female pre-service teachers' self-efficacy total and factor scores?
2. Does a statistically significant difference exist between the self-efficacy total and factor scores of pre-service teachers of different ages?
3. Does a statistically significant difference exist between the astronomy self-efficacy total and factor scores of pre-service teachers in terms of whether or not they have taken an astronomy course?
4. Does a statistically significant difference exist between the astronomy self-efficacy total and factor scores of pre-service teachers in terms of whether they have engaged in astronomy and sky-watching activities?
5. Does a statistically significant difference exist between the astronomy self-efficacy total and factor scores of 3rd- and 4th-year teacher candidates?
6. Does a statistically significant difference exist between the self-efficacy total and factor scores of teacher candidates in different programmes?

Method

Research design

The research was carried out as a survey study (i.e., a quantitative research design). Survey studies aim to determine participants' characteristics, such as their opinions, interests, abilities, and attitudes; these studies differ from other studies using larger samples (Fraenkel & Wallen, 2006; McMillan & Schumacher, 2006). Studies with larger samples are concerned with how participants' views are distributed over the sample rather than why they have particular views (Fraenkel & Wallen, 2006).

The primary purpose of survey studies is to describe a current situation (Çepni, 2012). Therefore, the study has used the survey model to determine pre-service teachers' self-efficacy beliefs about astronomy. In addition, this design is appropriate for studying self-efficacy beliefs with respect to different variables.

Participants

The research sample consists of 3rd- and 4th-year pre-service teachers studying science, classroom education, and social studies education programmes in Turkey's Kayseri Province in the 2016 fall semester. The sample consists of 322 pre-service teachers (122 in the science education programme, 110 in the classroom education programme, and 90 in the social studies education programme). Some departments (e.g. teaching mathematics) have not been included in the study, and the simple random sampling method has been preferred in selecting the sample. Designated pre-service teachers were included in the study on a volunteer basis. Moreover, the participants were informed that the study results would be presented in scientific publications. In such cases, they were also told that their identity would be kept strictly secret, and their approval was obtained. Table 1 shows the frequency distribution of the pre-service teachers in the different programmes with respect to their demographic characteristics (e.g., age, gender, grade level, and whether or not they had taken an astronomy course or taken part in astronomy/sky-gazing activities).

Table 1

Demographic Characteristics of the Participants

Variable	Category	Science Education	Classroom Education	Social Studies Education
Age	19–21 years old	79	77	48
	22 years or older	43	33	42
Gender	Female	103	92	45
	Male	19	18	45
Grade level	3rd	59	47	46
	4th	63	63	44
Took a previous astronomy course	Yes	19	12	6
	No	103	98	84
Participated in an astronomy/sky-watching activity	Yes	15	10	16
	No	107	100	74
	Total	**122**	**110**	**90**

When examining Table 1, participants in the 19–21-year age group are the most common among the pre-service teachers studying for all three programmes in terms of age. In terms of gender, the science education and classroom education programmes have more females than males, while the social studies education programme has equal numbers of males and females. In terms of grade level, more 4th-year students were in the science education programme, while 3rd-year students were more frequently in the classroom and social studies education programmes. The number of pre-service teachers who answered 'no' in terms of having taken astronomy courses was relatively high in all three programmes; similarly, those who answered 'no' in terms of participating in an astronomy/sky-gazing activity comprise an even more significant majority in all three programmes.

Data collection tool

The Astronomy Teaching Self-Efficacy Belief Scale was used as the data collection tool. It was developed by Riggs and Enochs (1990) and adapted into Turkish by Özkan et al. (2002) as the Science Teaching Self-Efficacy Scale. This version of the scale consists of two factors: Personal Science Teaching Efficacy Belief and Science Teaching Outcome Expectancy. Güneş (2010) adapted the scale in his study to examine the relationship between astronomy knowledge with the nature of science and the astronomy self-efficacy belief of pre-service teachers from science and technology and the social studies departments. This version of the scale was also used in the current study. The scale consists of two factors: Personal Self-efficacy in Astronomy Teaching (PSAT) and Expected Results in Astronomy Teaching (ERAT). The scale has 23 items: 13 for PSAT and 10 for ERAT. It is a five-point Likert-type scale (1 = Strongly Disagree and 5 = Strongly Agree). The items on the scale are intended to measure self-efficacy for general astronomy teaching and are not based on any specific concept in astronomy. 'I think I will always find better ways to teach astronomy' can be stated as an example item. Güneş (2010) calculated Cronbach's alpha of reliability for the scale as .80, for the factor of PSAT as .87, and for the ERAT factor as .78. Within the scope of the present study, the items were re-analysed, and the decision was made to subtract six items due to their difficulty and differentiation. Validity and reliability analyses have been performed over a total of 17 items.

Within the scope of the content validity study, all the items on the scale were examined by five experts in terms of scientific appropriateness, representational power of the property to be measured, comprehensibility and clarity, and representation of the target group. Three of these experts are faculty members

in science education, one is a faculty member in classroom education working in the field of astronomy, and one is a faculty member in the department of measurement and evaluation who conducts doctoral studies on measurement and science education programmes and also has studies on astronomy. The appropriate changes as proposed by the experts were made to the scale.

- *Item 8 (Pre-Adjustment):*
  I generally think I cannot teach astronomy lessons effectively.
- *Item 8 (Post-Adjustment):*
  I think I cannot teach astronomy effectively.

Similar to the example above, the expression 'astronomy' has been changed to 'topics in astronomy', and the modified sentences were clarified. The experts deemed the addition of the words 'topics in' to be appropriate in order to be able to adopt an education-oriented approach. After making these corrections, the scale was prepared for application.

In terms of criterion validity, the first developed form of the scale had been applied to 3rd- and 4th-year undergraduate pre-service teachers in science and social studies education programmes. Similarly, the current study applies the scale to 3rd- and 4th-year pre-service teachers in science, classroom, and social studies education programmes. The variables of age, gender, education programme, grade level, having taken an astronomy class, and having participated in an astronomy/sky-watching activity are considered to be related to the self-efficacy beliefs of pre-service teachers. The first form of the scale is compatible with the study in terms of department and gender. In both studies, similar stages were followed in the data collection stage. In terms of criterion validity, the results from both scales could not be correlated because the scale in the previous study could not be applied to this sample.

Factor analysis was used to determine the construct validity of the scale. The original scale has the two factors of PSAT and ERAT. As a result of the exploratory factor analysis conducted in the present study, the scale was also determined to consist of the same two factors (PSAT and ERAT). In order to test the accuracy of the two-factor structure determined by the exploratory factor analysis, confirmatory factor analysis was applied using LISREL software. Hu and Bentler (1999) specified the critical values for the criteria used in the model fit of the items as $CFI > .90$, $RMSEA < .05$, and $NFI > .90$. As a result of the analysis of the current study, all values were found to have perfect fit limit values, and thus the models of the scale items were found to be appropriate.

In order to determine the reliability of the scores obtained from the scale, Cronbach's alpha of reliability was determined using the SPSS 22 software. As

a result of the analysis of Factor 1, Cronbach's alpha was calculated as .794 and as.667 for Factor 2. Cronbach's alpha for the 17 items was calculated as .752. As this value is acceptable (Pallant, 2007), the scores participants obtain from the self-efficacy scale can be said to be reliable.

Data collection process

The data collection tool was applied to pre-service teachers in the 2016 fall semester. They participated in the study voluntarily and signed the Social and Humanities Informed Consent Form. The participants were also told that the results of the study would be presented in a scientific publication. As such, they were also told that their identity would be kept strictly confidential, and then their approval was obtained. The pre-service teachers were first asked to fill out the descriptive information (e.g., gender, age, grade level) that was considered helpful in analysing the research on the scale and then to carefully read the statements about teaching astronomy and mark the option indicating their agreement with each statement. The pre-service teachers were given 30 minutes to answer the scale. The scale was applied to everyone in the sample group within 15 days.

Before the statistical analysis, the scales were examined to see if the pre-service teachers had completely filled out the scales, and an analysis was carried out over the 322 scales that were found to be missing no data.

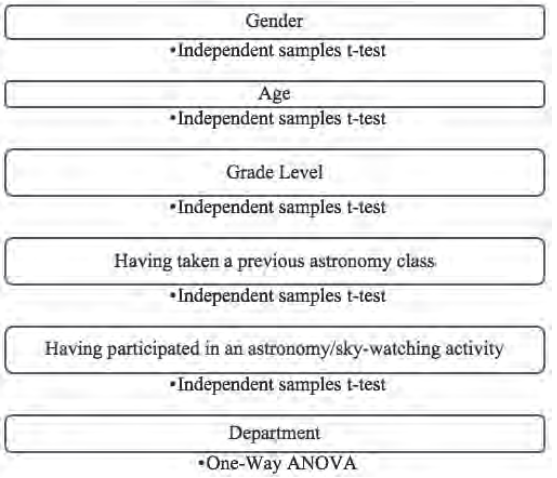
The study has observed all the rules in the Higher Education Institutions Scientific Research and Publication Ethics Directive, and no action in conflict with the Actions Against Scientific Research and Publication Ethics was performed in the second part of the implementation.

Data analysis

SPSS 22 was used to analyse the data. Descriptive statistics have been made primarily for the identified sub-problems, and whether the assumptions related to appropriate analysis had been achieved were verified. Inferential statistics have been used for different variables. The descriptive statistics and inferential statistics tables are explained in the Results. Figure 1 displays the independent variables and statistics.

Figure 1

Inferential statistics used for the variables



Results

This section presents the statistical analysis findings from the Astronomy Teaching Self-Efficacy Belief Scale applied to pre-service teachers studying in different programmes in terms of the various variables. The findings are presented according to the respective categorical variables.

Investigating Pre-Service Teachers' Self-Efficacy Beliefs According to Gender

The descriptive statistics on pre-service teachers' self-efficacy scores according to gender are presented in Table 2.

Table 2

Descriptive Statistics of Pre-Service Teachers' Self-Efficacy Scores According to Gender

		n	x	*SD*	Skewness	Kurtosis	Min	Max
PSAT	Female	240	12.50	4.10	-.22	-.48	0	20
	Male	82	12.33	4.93	-.28	-.47	0	20
ERAT	Female	240	9.61	3.05	-.42	-.53	1	14
	Male	82	9.84	3.17	-.49	-.64	2	14
Total	Female	240	22.12	5.32	-.12	-.49	7	34
	Male	82	22.17	6.59	-.56	.62	2	34

According to Table 2, the number of individuals in each gender group should be greater than 15 (Pallant, 2007). In addition, a normal distribution is considered to have been achieved as the kurtosis and skewness values are between +2 and -2. Finally, the Levene test results are examined for the homogeneity of variance (see Table 3).

Table 3
Levene Test Results

Levene Statistic	Sig.		
	PSAT	ERAT	Total
	.08	.75	.11

According to Table 3, the Levene test regarding the equality of variances shows the variance for all factors and the scale to be equal ($p > .05$) for the analysis of astronomy self-efficacy scores. The results from the independent samples t-test for the data obtained from the pre-service teachers regarding gender are presented in Table 4.

Table 4
Independent Samples t-Test Results of Pre-Service Teachers' Self-Efficacy Scores According to Gender

		x	t	*df*	*p**
PSAT	Female	12.50	.32	320	.75
	Male	12.33			
ERAT	Female	9.61	-.58	320	.56
	Male	9.84			
Total	Female	22.12	-.08	320	.94
	Male	22.17			

Note. *$p < .05$

When examining Table 4, the pre-service teachers' scores for the PSAT and ERAT sub-scales and total scores were determined to show no significant difference according to gender ($p > .05$). Moreover, when considering the averages, the female and male pre-service teachers both have low mean scores.

Investigating Pre-Service Teachers' Self-Efficacy Beliefs According to Age

The descriptive statistics on the self-efficacy scores of the pre-service teachers according to age are presented in Table 5.

Table 5

Descriptive Statistics of Pre-Service Teachers' Self-Efficacy Scores According to Age

	Age (yrs)	*n*	x	*SD*	Skewness	Kurtosis	Min	Max
PSAT	19-21	204	12.57	4.33	-.29	-.40	0	20
	22+	118	12.27	4.31	-.20	-.39	0	20
ERAT	19-21	204	9.68	3.12	-.40	-.64	1	14
	22+	118	9.65	3.01	-.50	-.41	2	14
Total	19-21	204	22.25	5.61	-.25	-.09	6	34
	22+	118	21.92	5.76	-.37	.37	2	34

According to Table 5, the number of individuals in each age group is greater than 15, and the kurtosis and skewness values are between +2 and -2, which shows the normal distribution. The Levene test results have been examined for homogeneity of variance (see Table 6).

Table 6

Levene Test Results

Levene Statistic	Sig.		
	PSAT	ERAT	Total
	.93	.42	.72

According to Table 6, the Levene test for the equality of variances shows the variance for the sub-factors and the whole scale to be considered equal for analysing astronomy self-efficacy scores in terms of age ($p > .05$). The independent samples t-test for the data obtained from the pre-service teachers in terms of age is given in Table 7.

Table 7

Independent Samples t-Test Results of Pre-Service Teachers' Self-Efficacy Scores According to Age

	Age (yrs)	*n*	x	*SD*	t	*df*	*p**
PSAT	19-21	204	12.57	4.33	.60	320	.55
	22+	118	12.27	4.31			
ERAT	19-21	204	9.68	3.12	.08	320	.94
	22+	118	9.65	3.01			
Total	19-21	204	22.25	5.61	.50	320	.62
	22+	118	21.92	5.76			

Note. $*p < .05$

When examining Table 7, no significant difference has been determined to exist between pre-service teachers' self-efficacy scale sub-factors or total scores with respect to age ($p > .05$).

Investigating Pre-Service Teachers' Self-Efficacy Beliefs According to Having Taken a Previous Astronomy Class or Participated in an Astronomy/Sky-Watching Activity

The descriptive statistics regarding the pre-service teachers' self-efficacy scores with respect to having taken a previous astronomy class or participated in an astronomy/sky-watching activity are shown in Table 8.

Table 8

Descriptive Statistics of Pre-Service Teachers' Self-Efficacy Scores According to Having Taken a Previous Astronomy Class or Participated in an Astronomy/Sky-Watching Activity

		n	x	*SD*	Skewness	Kurtosis	Min	Max
Astronomy Course	Yes	37	23.78	5.81	-.13	-.90	12	33
	No	285	21.92	5.62	-.33	.19	2	34
Astronomy and Sky Activity	Yes	41	23.95	5.50	-.46	-.63	12	32
	No	281	21.87	5.65	-.28	.20	2	34

According to Table 8, the number of individuals in each group is seen to be greater than 15, and the kurtosis and skewness values to be between +2 and -2. In this context, the group shows normal distribution. The Levene test results have been examined for the homogeneity of variance (see Table 9).

Table 9

Levene Test Results

Levene Statistic	Sig.	
	Astronomy course	Astronomy/sky-gazing activity
	.64	.85

According to Table 9, the Levene test for the equality of variance shows the variance for both factors and the whole scale to be able to be accepted as equal for the analysis of astronomy self-efficacy scores related to having taken a previous astronomy class or been involved in an astronomy/sky-gazing activity ($p > .05$).

The independent samples t-test for the data obtained from pre-service teachers regarding having taken a previous astronomy class or participated in an astronomy/sky-gazing activity is given below.

Table 10

Independent Samples t-Test Results of Pre-Service Teachers' Self-Efficacy Scores According to Having Taken a Previous Astronomy Class or Been Involved in an Astronomy/Sky-gazing Activity

		n	x	*SD*	t	*df*	*p**
Astronomy Course	Yes	37	23.78	5.81	1.90	320	.06
	No	285	21.92	5.62			
Astronomy and Sky Activity	Yes	41	23.95	5.50	2.22	320	.03*
	No	281	21.87	5.65			

Note. * $p < .05$

When examining Table 10, the pre-service teachers' scores obtained from the self-efficacy scale were found to show no significant difference with respect to whether or not they had taken an astronomy class ($p > .05$); however, a significant difference was determined with respect to whether or not they participated in an astronomy/sky-gazing activity ($p < .05$).

Investigating Pre-Service Teachers' Self-Efficacy Beliefs According to Grade Level

The descriptive statistics regarding pre-service teachers' self-efficacy scores according to grade-level variables are presented in Table 11.

Table 11

Descriptive Statistics of Pre-Service Teachers' Self-Efficacy Scores According to Grade Level

	Grade	*n*	x	*SD*	Skewness	Kurtosis	Min	Max
PSAT	3rd year	152	12.59	4.02	-.22	-.41	1	20
	4th year	170	12.35	4.58	-.26	-.48	0	20
ERAT	3rd year	152	9.55	9.55	-.38	-.68	2	14
	4th year	170	9.78	9.78	-.49	-.49	1	14
Total	3rd year	152	22.13	5.17	-.18	-.38	6	32
	4th year	170	22.13	6.09	-.35	-.19	2	34

According to Table 11, the number of individuals in each group with regard to grade level is seen to be greater than 15, and the kurtosis and skewness values to be between +2 and -2. In this sense, the group shows normal distribution. The Levene test results have been examined for the homogeneity of variances (see Table 12).

Table 12

Levene Test Results

Levene Statistic	Sig.		
	PSAT	ERAT	Total
	.06	.33	.09

According to Table 12, the Levene test for the equality of variances shows the variance for the sub-factors and the whole scale to be able to be considered equal for the analysis of astronomy self-efficacy scores with respect to grade level ($p > .05$). The independent samples t-test for the data obtained from the pre-service teachers regarding grade level is given in Table 13.

Table 13

Independent Samples t-Test Results of Pre-Service Teachers' Self-Efficacy Scores According to Grade Level

	Grade	*n*	x	*SD*	t	*df*	*p**
PSAT	3rd year	152	12.59	4.02	.49	320	.62
	4th year	170	12.35	4.58			
ERAT	3rd year	152	9.55	9.55	-.69	320	.49
	4th year	170	9.78	9.78			
Total	3rd year	152	22.13	5.17	.00	320	.99
	4th year	170	22.13	6.09			

Note. $*p < .05$

When examining Table 13, no significant difference has been determined to exist between pre-service teachers' sub-factors and total scores with respect to grade level ($p > .05$).

Investigating Pre-Service Teachers' Self-Efficacy Beliefs According to Department

The descriptive statistics regarding pre-service teachers' self-efficacy scores according to their department are presented in Table 14.

Table 14

Descriptive Statistics of Pre-Service Teachers' Self-Efficacy Scores According to Programme

	Programme	*n*	x	*SD*	Skewness	Kurtosis	Min	Max
PSAT	Science	122	14.20	4.10	-.40	-.62	3	20
	Classroom	110	11.40	4.17	-.23	-.40	0	19
	Social Studies	90	11.40	4.07	-.30	-.01	0	20
ERAT	Science	122	9.64	2.85	-.47	-.29	2	14
	Classroom	110	10.19	3.12	-.59	-.37	1	14
	Social Studies	90	9.08	3.23	-.24	-.90	2	14
Total	Science	122	23.84	5.53	-.36	-.23	7	34
	Classroom	110	21.59	6.18	-.19	-.09	6	31
	Social Studies	90	20.48	5.84	-.36	.59	2	34

When examining Table 14, the highest mean among the total score averages is among the pre-service science teachers (x = 23.84), and the lowest

average belongs to the pre-service social science teachers (x = 20.48). In general, the mean scores of the pre-service teachers' astronomy self-efficacy are low. The number of individuals in each group with respect to programme/department is also e greater than 15, and the kurtosis and skewness values are between +2 and -2. In this sense, the group shows a normal distribution. The Levene test results have been examined for the homogeneity of variance (see Table 15).

Table 15

Levene Test Results

Levene Statistic	Sig.		
	PSAT	ERAT	Total
	.44	.30	.17

According to Table 15, the Levene test for the equality of variances shows the variance for the sub-factors and the whole scale to be equal for the analysis of astronomy self-efficacy scores with respect to programme ($p > .05$). One-way ANOVA results are shown in Table 16.

Table 16

One-Way ANOVA Results for Pre-Service Teachers' Astronomy Self-Efficacy Scores According to Their Department

		Sum of Squares	*df*	Mean Square	*F*	*p**
PSAT	Between Groups	592.70	2	296.35	17.52	.00*
	Within Groups	5397.28	319	16.92		
	Total	5989.98	321			
ERAT	Between Groups	61.53	2	30.76	3.30	.04*
	Within Groups	2975.58	319	9.33		
	Total	3037.11	321			
Total	Between Groups	632.75	2	316.38	10.45	.00*
	Within Groups	9657.77	319	30.28		
	Total	10290.52	321			

Note. $*p < .05$

Table 16 shows the output from the one-way ANOVA analysis and whether a statistically significant difference exists between the groups' means. As seen from this table, t significant mean differences are found between groups for the dependent variable of programme/department ($F_{(2, 319)} = 10.450$, $p < .05$;

$F_{(2,\ 319)} = 17.515$, $p < .05$; $F_{(2,\ 319)} = 3.298$, $p < .05$). When calculating the effect size for the total score, the result is .06. In other words, the pre-service teachers' department accounts for approximately 6% of the variance in their self-efficacy scores. The results from the Bonferroni posthoc test, which was conducted to determine the differences among the groups, are given in Table 17.

Table 17

Post-Hoc Test Results

Dependent Variable	(I) programme	(J) programme	Mean Difference (I-J)	Std. Error	Sig.	Bonferroni
PSAT	Science	Classroom	2.25*	.72	.01	Science > Classroom Science > Social Studies
		Social Studies	3.36*	.76	.00	
	Classroom	Science	-2.25*	.72	.01	
		Social Studies	1.11	.78	.47	
	Social Studies	Science	-3.36*	.76	.00	
		Classroom	-1.11	.78	.47	
ERAT	Science	Classroom	2.80*	.54	.00	Classroom > Science Science > Social Studies
		Social Studies	2.80*	.57	.00	
	Classroom	Science	-2.80*	.54	.00	
		Social Studies	.00	.58	1.00	
	Social Studies	Science	-2.80*	.57	.00	
		Classroom	.00	.58	1.00	
Total	Science	Classroom	-.55	.40	.51	Classroom > Social Studies
		Social Studies	.56	.42	.56	
	Classroom	Science	.55	.40	.51	
		Social Studies	1.11*	.43	.03	
	Social Studies	Science	-.56	.42	.56	
		Classroom	-1.11*	.43	.03	

As a result of the Bonferroni posthoc test performed in Table 17; departmental differences were found between the science and classroom (in favour of science) and between the science and social studies (in favour of science) for PSAT, between the science and classroom (in favour of classroom) and between the science and social studies (in favour of science) for ERAT.

When considering the averages in general, the pre-service teachers studying in the various departments have low levels of self-efficacy with regard to astronomy. Noteworthily, the lowest levels occur among the pre-service teachers in all three department types for the ERAT factor in particular.

Conclusion, Discussion and Recommendations

This study has been conducted to examine the status of self-efficacy beliefs regarding astronomy teaching for teachers enrolled in science education, classroom education, and social studies education programmes. The results were evaluated according to different variables (gender, age, programme, grade level, whether or not they had taken an astronomy course, and whether or not they had participated in an astronomy/sky-gazing activity). The study took the variable of gender into consideration for the first sub-problem and has concluded no significant difference to be present in terms of total astronomy self-efficacy scores between the female and male pre-service teachers. Other studies in the literature have also stated that no significant difference exists for self-efficacy beliefs in terms of gender (Akbaş & Çelikkaleli, 2006; Çakıroğlu et al., 2005). As Akbaş and Çelikkaleli (2006) asserted, the reason for no variance in the self-efficacy beliefs of pre-service teachers in terms of gender can be said to result from the increasing success of women's roles in society and, therefore, no limitation occurs between women and men. However, Anderman and Young (1994) and Britner and Pajares (2006) reported finding a difference between males' and females' self-efficacy levels.

Similarly, Formanek et al. (2019) examined the relationship between students' motivation and course participation in an open online course on astronomy and found males to show higher self-efficacy levels. According to Bandura (2002), the reason for obtaining different findings in studies may be intercultural differentiation, because self-efficacy beliefs according to gender may differ between cultures. The current study is limited to a conclusion about whether there is a difference in terms of gender only, and the cultural dimension can be investigated in future studies.

The current study concludes that the astronomy self-efficacy beliefs of pre-service teachers do not differ according to age. Considering the studies conducted with different age groups on the relationship between self-efficacy and age, Seferoğlu and Akbıyık (2005) also found no significant difference according to age in terms of computer self-efficacy perceptions; their reason for this was that participants may be close in age. When considering the same situations, the pre-service teachers of the current study have also been determined to be very close in age, and thus their astronomy self-efficacy levels are thought to resemble one another.

In contrast, it was determined that there was no significant difference in the science self-efficacy beliefs of primary school teachers according to the age variable, while there was a significant difference between those younger than

25 years old and other groups in the sub-factors of efficacy belief and outcome expectation. It has been determined that this difference is in favour of teachers who are older than 25 for efficacy belief and in favour of those younger than 25 for outcome expectation according to the study conducted by Bozkurt Uluçay and Akıllı (2021). Yıldırım and Karataş (2020) stated that students' self-efficacy levels decrease as age increases. Research needs to be increased to explain the relationship between self-efficacy and age in the literature better.

Similarly, while the current study is limited to the fact that there is no significant difference between the astronomy self-efficacy of pre-service teachers who had taken astronomy classes, it is recommended to determine the reasons for this situation for future studies. Because, when considering that individuals gain experience from work and will feel more able to finish or perform work they had previously done, those who had experience with an astronomy/sky-gazing activity will inevitably have higher self-efficacy beliefs. Those who had previously taken a course in astronomy were similarly expected to have higher self-efficacy; however, this study found no difference. In this regard, Bandura (1977) states that the knowledge, skills, and learned strategies will not be functional unless the person can use them under appropriate conditions. According to Pasachoff and Percy (2005), the most effective methods for learning astronomy are based on direct experience and observations. This situation may result from different variables, such as the difference in course content or teaching process, and thus in student academic achievement. Güneş' (2010) study on pre-service teachers showed a statistically significant relationship between academic achievement and self-efficacy belief in teaching astronomy. Moreover, Susman and Pavlin (2020) stated that in-service teachers expounded on how they felt uncomfortable teaching astronomy topics during the teacher training despite having worked on models of the solar system, moon phases, and eclipses. This result also supports the results from the current study.

When considering that students' self-efficacy beliefs are sensitive to changes in their lifelong learning experiences (Oğuz, 2012), differentiating by one grade level may not be enough to show variations in their self-efficacy beliefs. In addition, the introduction of similar courses in the field of education that have topics on astronomy in the 3rd and 4th years of schooling may be another reason for the similarity of self-efficacy beliefs toward astronomy teaching in these grades. Unlike the current study, Şenler (2017) studied the self-efficacy beliefs of science teacher candidates regarding science teaching and examined their views on scientific inquiry; it was found that pre-service teachers' self-efficacy beliefs decrease after their second year as their grade level increases (i.e., from sophomore year to junior year and from junior year to senior

year). The reason for this was explained as students' self-confidence increasing in their sophomore year through their education and field courses, while the more intense lessons in their junior and senior years and increased exam anxiety had caused lower self-efficacy. Bailey et al. (2017) stated physiological and affective states also possibly impact self-efficacy. In this case, they stated any change in self-efficacy to be related not only to the existence of a source but also to how the individual internalises the information arising from that source. A difference was observed to occur among the pre-service teacher groups with regard to programme/department for both sub-factors and the total score. This generally was in favour of the pre-service science teachers for all scores (sub-factors and total). When considering that students who developed academic skills regarding science since elementary school are also able to develop competencies such as expectations and self-perception, this is thought to have a greater effect on their self-efficacy development when compared to pre-service classroom or social studies teachers. Demirtaş et al. (2011) reached a different result in their study in terms of total scores obtained from the self-efficacy scale, with pre-service teachers studying in the Turkish, social studies, music, and painting education departments perceiving themselves to be better qualified, compared to pre-service teachers studying in the classroom, preschool, science, or elementary mathematics teaching departments. Demirtaş et al. stated the reason for self-efficacy scores being higher is due to those lessons (e.g., music and painting) being more popular with students. In this sense, saying that studies in the literature on self-efficacy conducted over certain variables such as programme/department have achieved consistent results would be difficult.

Ashton (1984) claimed no other teacher trait to show as consistent and close a relationship with student achievement as teachers' self-efficacy. The importance of this situation was also stated in Walan and Chang Rundgren's (2014) study. In this context, the importance of determining self-efficacy beliefs in relation to teaching topics on astronomy has been emphasised through the present study's results. In terms of developing self-efficacy in this sense, self-efficacy beliefs regarding astronomy teaching are important (Bailey et al., 2017) and organising activities and projects where pre-service teachers can gain experience is recommended so that their self-confidence may increase. In this sense, activities suitable for the constructivist approach may be beneficial. For example, increasing student participation when teaching topics on astronomy and focusing on class management are thought to increase teachers' self-efficacy. In this sense, it can be said that the importance of practical applications will be remarkable, because the factor that has the strongest effect on the development of individuals' self-efficacy perceptions is direct experiences (Bandura, 1977).

Thus, the results of these applications can be analysed in future studies.

The current research has used the survey study design for determining the participants' statuses. The change in pretest-posttest practices of pre-service teachers' self-efficacy beliefs regarding astronomy can also be examined by considering different variables. Different studies may also be carried out using qualitative-based research methods to investigate the reasons for their lack of self-efficacy.

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