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Laboratory Use Self-Efficacy of Turkish Pre-Service Science Teachers Trained in Different Teacher Education Programmes

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In Türkiye, the science teacher education programme changed in 2018. While physics, chemistry and biology courses were taught through theoretical and laboratory applications in the previous programme (Programme-I), the course hours of these courses were reduced and laboratory hours were abolished in the new programme (Programme-II). The present research, which adopts a causal-comparative design of quantitative research, aims to compare the laboratory self-efficacy of pre-service science teachers who attended these two science teacher education programmes. The research data was collected from 289 pre-service science teachers educated in Programme-I and II through the science laboratory use self-efficacy scale and then analysed using the independent samples t-test. The results show that the total scores of laboratory use self-efficacy of pre-service science teachers trained in Programme-I is significantly higher. The scores of the pre-service science teachers from Programme-I were also found to be significantly higher than those from Programme-II in terms of the sub-dimensions using the physical environment and equipment, working independently, and crisis management. On the other hand, there was no significant difference between the two programmes in the sub-dimension applying scientific process skills. These results and their implications are discussed in the light of current literature.

Keywords: self-efficacy, science laboratory, teacher education, pre-service science teachers

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Samoučinkovitost uporabe laboratorija pri turških študentih, bodočih učiteljih naravoslovja, ki so se usposabljali v različnih programih izobraževanja učiteljev

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V Turčiji se je program izobraževanja učiteljev naravoslovja leta 2018 spremenil. Medtem ko smo v prejšnjem programu (Program-I) predmete s področij fizike, kemije in biologije poučevali s teoretično in z laboratorijsko uporabo, so se v novem programu (Program-II) ure teh predmetov skrajšale, laboratorijske ure pa so bile ukinjene. Namen te raziskave, ki uporablja vzročno-primerjalno zasnovo kvantitativne raziskave, je primerjati laboratorijsko samoučinkovitost študentov, bodočih učiteljev naravoslovja, ki so se udeležili teh programov izobraževanja učiteljev naravoslovja. Raziskovalni podatki so bili zbrani na vzorcu 289 študentov, bodočih učiteljev naravoslovja, ki so se izobraževali v programih I in II, s pomočjo lestvice samoučinkovitosti uporabe naravoslovnega laboratorija, nato pa so bili analizirani s t-testom za neodvisne vzorce. Rezultati kažejo, da je skupni rezultat samoučinkovitosti uporabe laboratorija pri študentih, bodočih učiteljih naravoslovja, ki so se izobraževali v Programu-I, bistveno višji. Ugotovljeno je bilo tudi, da so rezultati študentov, bodočih učiteljev naravoslovja, ki so se usposabljali v programu I, bistveno višji od tistih iz programa II glede naslednjih poddimenzij: uporaba fizičnega okolja in opreme, samostojno delo in obvladovanje kriznih situacij. Po drugi strani pa med obema programoma ni bilo pomembnih razlik pri poddimenziji rabe zmožnosti znanstvenega procesa. Ti rezultati in njihove posledice so obravnavani v luči aktualne literature.

Ključne besede: samoučinkovitost; naravoslovni laboratorij; izobraževanje učiteljev; študentje, bodoči učitelji naravoslovja

Introduction

Recognition of the significance of a thorough science education is widespread in the contemporary world. The information presented in research concerning the methods, locations and timing for implementing a high-quality science education has resulted in a fundamental shift in the comprehension of science education. In this framework, science is no longer simply embraced as a mere repository of knowledge; instead, proficiencies, experiments and practical work in laboratories are acknowledged as essential components of science (Al-Naqbi & Tairab, 2005). Within Türkiye, a developing economy, science education is held in high esteem and it is obligatory to teach science as an integrated course at the secondary school level, where physics, chemistry and biology are taught as a unified subject.

Research underscores the need for school science to closely mirror authentic scientific practices (Woolnough, 1999). Consequently, laboratories, which are a prevalent aspect of various scientific disciplines, hold immense significance for both the field of science and science education. Essentially, the execution of experiments within a laboratory is just as crucial for a comprehensive science education as grasping concepts and theories (Heradio et al. 2016; Kolil et al., 2020). Science lessons enriched with laboratory engagement provide learners with an opportunity to acquire an array of skills, including the ability to formulate inquiries, identify and resolve problems, collaborate effectively, engage in research and inquiry, and make observations (Chiapetta, 2007). These competencies are integral 21st-century skills that every individual should possess in today's world. Moreover, laboratory activities function as intermediaries that enable learners to achieve multiple objectives, such as honing scientific process skills, fostering positive attitudes towards science, and augmenting student motivation and participation (Fraser & Lee, 2009). Kipnis and Hofstein (2007) elucidate the significance of laboratories in science education by asserting that students can learn both within and from the laboratory environment. Laboratories that introduce learners to scientific concepts facilitate learning by providing opportunities to concretise abstract ideas and allowing students to learn through personal experience. In essence, students' hands-on experimentation within the laboratory contributes significantly to a more profound comprehension of scientific concepts (Snetinová et al. 2018). Additionally, laboratory experiments have a positive impact on students' performance in science lessons, as well as on their overall interest in science (Vinko et al., 2020). Viewed from this perspective, laboratories designed for scientific experimentation, demonstration and inquiry take centre stage in the realm of science education (Kwok, 2015). In line with this, the science curriculum devised by the Ministry of National Education (MoNE) in Türkiye underscores the importance of middle school students cultivating higher-order cognitive skills such as problem-solving, creative and analytical thinking, and the application of scientific knowledge through laboratory activities or daily life situations while learning science (MoNE, 2018).

Laboratory activities play a pivotal role in the realm of science education. Nevertheless, the utilisation of laboratories in science education within Türkiye and educators' viewpoints on their usage are generally limited (Güneş et al., 2013). Although a substantial number of studies carried out in Türkiye converge on the necessity and significance of incorporating laboratory activities into science teaching, there have been accounts of various issues, obstacles and disruptions in practice (Böyük et al., 2010; Çelik et al., 2021; Kaymak & Karademir, 2019; Soğukpınar & Gündoğdu, 2020). This suggests that teachers' competencies should be enhanced, as it is teachers who are responsible for translating curriculum recommendations into practical implementation. In this context, Pešková et al. (2019) contend that educators exhibiting high self-efficacy are more inclined to embrace reforms. Nevertheless, mandating teachers to incorporate laboratories into their teaching methods falls short of ensuring the effective integration of laboratories in science education. Thus, the initial step towards enhancing the quality of science education is to provide comprehensive teacher training, thereby reinforcing the foundation of undergraduate education. Hernawati et al. (2018) accentuate the crucial importance of undergraduate education by asserting that educators constitute a fundamental driving force for elevating the educational standards of a nation.

Science teacher training in Türkiye

The primary objective of a comprehensive undergraduate education is to cultivate teachers who have mastered the necessary teaching competencies and are well prepared to deliver effective science education. In Türkiye, the Ministry of National Education (MoNE) has periodically reformed the science curriculum to ensure that individuals are equipped to stay aligned with the demands of the times. Additionally, teachers are required to possess the requisite skills to implement the MoNE curriculum. Furthermore, the programmes offered by education faculties at the undergraduate level have been revamped by the Higher Education Council (YÖK) since 2018, with the aim of addressing existing problems and shortcomings in the existing undergraduate programmes (YÖK, 2018). The updated curriculum was introduced to incoming first-year undergraduate students during the 2018–2019 academic year, while returning students continued under the previous programme.

A comparison of the science education undergraduate programme that was revised in 2018 (Programme-II) and its predecessor (Programme-I) reveals the removal or consolidation of certain science subject area courses and laboratory components in the new programme. Programme-I was implemented in Türkiye from 2007 to 2018. Pre-service science teachers trained according to Programme-I had taken the courses Physics-I lab, Physics-II lab, Physics-III lab, Chemistry-I lab, Chemistry-II lab, Biology-I lab, Biology-II lab, Science Teaching Lab Applications-I and Science Teaching Lab Applications-II, with two hours per week being allocated to each course. Thus, there were a total of 18 hours per week of laboratory courses in Programme-I. On the other hand, in Programme-II, which has been implemented since 2018, laboratory courses were largely removed. Physics, chemistry and biology courses were planned as two hours of theory and two hours of practice per week, while laboratory courses are limited to two courses (Science Teaching Laboratory Practices-I and Science Teaching Laboratory Practices-II), with a total of four hours per week. In the curriculum, the practical and theoretical courses were also merged. Notably, the new curriculum saw a reduction in the number of subject area courses and classroom hours, along with an augmentation in the quantity of pedagogical courses. Nonetheless, it is important to note that content knowledge significantly influences science teachers' self-efficacy beliefs in their teaching endeavours (Posnanski, 2002; Rubeck & Enochs, 1991).

The limited allocation of laboratory hours in the updated programme raises the need for research to assess its efficacy. The reluctance of science teachers to engage in laboratory activities throughout their careers is attributed to the inadequate emphasis on laboratory applications during their pre-service education (Böyük et al., 2010). Despite the criticisms directed towards the programme in place before 2018, it is thought-provoking that the new programmes have led to a decrease, rather than an increase, in the number of laboratory course hours and courses focused on laboratory-related topics.

Teacher self-efficacy

Bandura (1986) emphasises the significance of mastery experiences, vicarious learning, verbal persuasion and physiological-affective states as the primary foundations of self-efficacy. Consequently, the experiential opportunities offered during undergraduate education directly impact the self-efficacy of pre-service teachers. In relation to this, Usta Gezer (2014) asserts the need to enhance teachers' perceptions of self-efficacy. Teachers with elevated self-efficacy beliefs exhibit improved performance and accomplishments, leading to heightened student achievement (Bandura, 1997; Saracaloğlu & Yenice, 2009; Schwarzer & Hallum, 2008). Conversely, educators possessing low self-efficacy perceptions tend to avoid adopting novel teaching methods, resulting in ineffective instruction (Berg & Smith, 2016; Karabatak & Turhan, 2017). To elucidate further, classrooms led by science teachers with strong self-efficacy beliefs foster elevated questioning, exploration, problem-solving abilities and favourable attitudes towards science among students (Shahzad & Naureen, 2017).

Specifically concerning science education, in addition to general pedagogical self-efficacy, the self-efficacy of teachers in utilising science laboratories stands out. The focus of the present research can be defined as individuals' confidence in their competence to effectively employ laboratories and their belief in their ability to conduct laboratory activities successfully, in accordance with Bandura's conceptualisation of self-efficacy. Teachers' perceptions and behaviours within the laboratory are interlinked. Put differently, teachers' viewpoints about the laboratory environment influence their actions, while their past experiences play a part in shaping these viewpoints (Levitt, 2001). As a result, the attitudes and past encounters of science educators mould their self-efficacy perceptions. Therefore, to enhance the self-efficacy of science teachers and ensure proficient laboratory practices, it is essential for science teachers to possess hands-on laboratory experience. In essence, the experiences encountered by pre-service teachers will influence their self-efficacy beliefs, and these beliefs, in turn, will influence their future laboratory performances (Kılıç et al., 2015; Kızkapan & Saylan Kırmızıgül, 2021). Pajares (2002) highlights the pivotal role of experience in fostering self-efficacy. Simply possessing laboratory competencies is insufficient for science teachers; concurrently, they must exhibit high self-efficacy to effectively translate these competencies into their teaching methodologies.

There are studies in the literature on the effects of different teaching methods on the self-efficacy beliefs of pre-service science teachers (Afacan & Gürel, 2019; González-Gómez et al. 2022; Kaya et al., 2020), teachers' self-efficacy levels (DeCoito & Myszkal, 2018; Stepp & Brown, 2021; Süzer, 2019) and the relationship between pre-service science teachers' science self-efficacy beliefs and science content knowledge (Leader-Janssen & Rankin-Erickson, 2013; Menon & Sadler, 2016; Thomson et al., 2017). Moreover, studies have been conducted on the effect of the teaching practice course on the personal self-efficacy of pre-service teachers (Plourde, 2002), the effect of reflective inquiry-based activities carried out in the general biology laboratory on laboratory use self-efficacy (Usta Gezer, 2014), the effect of constructivism-based activities on science teaching self-efficacy belief levels (Bleicher & Lingren, 2005), the effects of animation and simulation applications in the general physics laboratory on the physics self-efficacy of pre-service teachers (Yener et al., 2012), the effect of virtual laboratory applications in the chemistry laboratory on experiment self-efficacy (Kolil et al., 2020), and the effect of gender on science self-efficacy (Sezgintürk & Sungur, 2020).

Research problem and research questions

To the best of our knowledge, there is no research focusing on a comparison of the laboratory self-efficacy of pre-service teachers studying in the old (implemented until 2018) and new (implemented since 2018) undergraduate teacher education programmes in Türkiye. Therefore, there is a need for original and up-to-date research studies to evaluate whether the changes made in the revised programme are appropriate. The present research is an attempt to test the effectiveness of the revision in the context of the science laboratory self-efficacy beliefs of pre-service science teachers. The research is significant because its results have the potential to inform teacher education policies and may serve as a guide for the possible revision of undergraduate programmes. Based on these considerations, the current research aimed to determine and compare the laboratory self-efficacy of pre-service science teachers who were educated with the programme enacted in 2018 (Programme-II) and the former programme implemented before 2018 (Programme-I). In line with this aim, the research questions are formulated as follows:

1. What are the laboratory self-efficacy levels of pre-service science teachers who were educated in Programmes I and II?
2. Is there a significant difference between the laboratory self-efficacy levels of pre-service teachers who were educated in Programmes I and II?

Method

Participants

In this research, the accessible population is pre-service science teachers in two universities in the Central Anatolia Region of Türkiye. The sample consisted of 305 pre-service science teachers. However, 16 of them were excluded since they were outliers based on the outlier test of SPSS. Thus, analysis was conducted on the data of 289 pre-service science teachers, constituting more than 10% of the accessible population. The sampling unit of the research was the universities in the Central Anatolia Region, and the observation unit was the pre-service science teachers studying in these universities. Therefore, cluster sampling was used in the research (Büyüköztürk et al., 2011). The reason for carrying out the research with these groups of pre-service science teachers is that the participating pre-service science teachers had been included in two teacher training programmes that differ in terms of laboratory practices, thus making it possible to compare the programmes (Programme-I and II) in terms of the competencies of the pre-service science teachers with regard to laboratory self-efficacy. Descriptive data regarding the sample are presented in Table 1.

Table 1
Descriptive data on the pre-service science teachers in the sample

Programme Type		Grade		Gender	
		3	4	Male	Female
Programme-I	*N*	81	105	24	162
	%	43.5	56.5	12.9	87.1
Programme-II	*N*	63	40	11	92
	%	61.2	38.8	10.7	89.3

Data collection instrument and process

The research data were collected through the Science Laboratory Use Self-Efficacy Scale (SLUSES), developed by Kızkapan and Saylan Kırmızıgül (2021). The scale was developed as a five-point Likert type. The sub-dimensions of the scale are "self-efficacy in using the physical environment and equipment in the science laboratory (SE_PEE)" (7 items), "self-efficacy in applying scientific process skills (SE_SPS)" (6 items), "self-efficacy in working independently in the science laboratory (SE_WI)" (9 items), and "crisis management self-efficacy in the science laboratory (SE_CM)" (5 items). Thus, the scale consists of four dimensions and 27 items. Higher scores from the scale correspond to high self-efficacy. The lowest score that can be obtained from the scale is 27 and the highest score is 135. The researchers calculated the Cronbach's alpha reliability coefficient of the scale as .78 for the first sub-dimension, .73 for the second sub-dimension, .68 for the third sub-dimension, and .59 for the fourth sub-dimension. In the current research, the Cronbach's Alpha reliability coefficient was calculated as .86 for the first sub-dimension, .78 for the second sub-dimension, .77 for the third sub-dimension, and .74 for the fourth sub-dimension. The data of the pre-service teachers in Programme-I were obtained from data collected during the development of the scale in the autumn semester of the

2019–2020 academic year, while the data of the pre-service science teachers in Programme-II were collected in the autumn and spring terms of the 2021–2022 academic year.

Data analysis

The Statistical Package for Social Sciences (SPSS) 26 was used for data analysis. First, descriptive statistics were conducted to evaluate the pre-service science teachers' laboratory use self-efficacy in line with the first research question. Secondly, the assumptions of variable type, normality, extreme value and homogeneity of variances were checked to determine the tests to be used in the comparison of the groups. In the research, the dependent variable (laboratory use self-efficacy) is continuous, while the independent variable (two different teacher training programmes) is discrete. The normality of the scores was checked by means of the kurtosis and skewness values. The kurtosis values were calculated as .056, .511, .020, .353 and -.005 for the sub-dimensions and the total of the scale, respectively. Similarly, the skewness values were calculated as -.083, -.249, -.236, -.071, and -.149 for the sub-dimensions and the total of the scale, respectively. Since these values are between (-1) and (+1), it is accepted that the scores obtained from the sub-dimensions and the overall scale show a normal distribution (Fraenkel & Wallen, 2006). Finally, the independent samples t-test was conducted to compare the science laboratory self-efficacy of the teachers trained in the two different teacher training programmes in order to answer the second research question.

Research design

In this research, a causal-comparative design is utilised as a quantitative research method design. A causal-comparative design is used to determine the cause or consequences of differences that already exist between groups of individuals (Fraenkel & Wallen, 2006). A causal-comparative design is adopted in the research because the aim is to determine and compare the laboratory self-efficacy of student teachers who are involved in two different teacher training programmes.

Results

Results regarding the first research question

Descriptive statistical analyses of pre-service science teachers' self-efficacy in using the science laboratory were conducted based on two groups of pre-service science teachers trained according to two different teacher training programmes. Table 2 presents the pre-service science teachers' levels of laboratory self-efficacy on each subscale and the total grades from SLUSES.

Table 2

Descriptive results regarding the scores from SLUSES

	Programme	*N*	Mean	Std. Deviation	Std. Error Mean
SE_PEE	Programme-I	193	27.87	2.974	.214
	Programme-II	96	26.09	3.792	.387
SE_SPS	Programme-I	193	23.63	2.493	.179
	Programme-II	96	23.13	3.407	.348
SE_WI	Programme-I	193	33.48	3.237	.233
	Programme-II	96	31.18	4.377	.447
SE_CM	Programme-I	193	19.76	2.128	.153
	Programme-II	96	18.72	2.516	.257
Total	Programme-I	193	104.73	8.441	.608
	Programme-II	96	99.11	11.595	1.183

N: Number of participants

The pre-service science teachers' scores can range from 7 to 35 for SE_PEE, from 6 to 30 for SE_SPS, from 9 to 45 for SE_WI, from 5 to 25 for SE_CM, and from 27 to 135 for the whole scale. According to the results given in Table 2, the mean scores of the pre-service science teachers are closer to the higher end of the scale in each sub-dimension and in total. In addition, while the mean scores of the students in Programme-I and Programme-II are close to each other in each sub-dimension and the overall scale, the averages of the students in Programme-I are higher.

Results regarding the second research question

Within the scope of the research, inferential statistics were conducted to decide whether the differences between the scores of the students in Programme-I and II were significant or not. In line with this, the scores of the groups were compared using the independent samples t-test. The results are presented in Table 3.

Table 3
Independent samples t-test results for the groups' laboratory use self-efficacy

		Levene's Test for Equality of Variances		t-test for Equality of Means			
		F	Sig.	*t*	*df*	Sig. (2-tailed)	Effect Size
SE_PEE	Equal variances assumed	9.138	.003	4.34	287	.000	.52
	Equal variances not assumed			4.01	154.86	.000	
SE_SPS	Equal variances assumed	11.992	.001	1.42	287	.156	.17
	Equal variances not assumed			1.28	147.18	.202	
SE_WI	Equal variances assumed	10.783	.001	5.05	287	.000	.60
	Equal variances not assumed			4.57	148.30	.000	
SE_CM	Equal variances assumed	3.190	.075	3.67	287	.000	.45
	Equal variances not assumed			3.47	164.34	.001	
Total	Equal variances assumed	13.181	.000	4.68	287	.000	.67
	Equal variances not assumed			4.22	146.65	.000	

Sig: Significance, df: Degree of freedom

When Table 3 is examined, a statistically significant difference is found between the total scores of laboratory use self-efficacy of the pre-service science teachers who were trained in Programme-I and Programme-II ($p <. 05$, $t(146.65) = 4.24$). This difference is in favour of Programme-I. Likewise, in the sub-dimensions SE_PEE ($p < .05$, $t(154.86) = 4.01$), SE_WI ($p < .05$, $t(148.30) = 4.57$), and SE_CM ($p < .05$, $t(164.34) = 3.47$), the scores of the pre-service science teachers from Programme-I were found to be significantly higher than those from Programme-II. Besides statistical significance, the effect size (*d*) value for the total score of laboratory self-efficacy and the sub-dimensions SE_PEE, SE_WI, and SE_CM was calculated to vary between .45 and .67. According to this result, the difference between the laboratory use self-efficacy mean scores of the pre-service teachers trained in Programme I and Programme II is at a moderate level (Cohen, 1988). On the other hand, in the sub-dimension SE_SPS, there is no significant difference between the pre-service science teachers from Programme-I and Programme-II ($p > .05$, $t(147.17) = 1.28$).

Discussion

The research aimed to determine and compare the laboratory self-efficacy of pre-service science teachers educated with Programme-I, including 18 hours of laboratory per week, and Programme-II, including only four hours of laboratory per week. According to the results, the self-efficacy mean scores of all of the pre-service science teachers are closer to the higher end of the scale in each sub-dimension and in total. In parallel with this result, Kaya and Böyük (2011) found in their research that science teachers' laboratory self-efficacy levels were high. A number of studies have pointed out that the teacher's self-efficacy belief affects the students' achievement, motivation, self-esteem and attitude towards school (Caprara et al., 2006; Engin, 2020; Mojavezi & Tamiz, 2012; Shahzad & Naureen, 2017, Vlah et al., 2021). In order for teachers to be successful in their professions, they must have a high level of laboratory self-efficacy belief. It is thought that pre-service teachers with a high level of laboratory self-efficacy are more likely to have a positive attitude towards experiments and general laboratory applications later in their career. By increasing the quantity and calibre of experiments, meaningful and diverse learning environments can be developed (İnce Aka, 2016). Thus, this result of the present research is promising.

The results revealed a significant difference between the total scores of the laboratory use self-efficacy of pre-service science teachers trained in Programme-I and Programme-II, with the difference being in favour of Programme-I. Since Programme-I has more hours of laboratory applications, pre-service science teachers completing this programme may have higher levels of laboratory self-efficacy. Laboratories are vital learning environments for science education (Singer et al., 2005), especially for future science teachers. When pre-service science teachers are given the opportunity to learn about and use the laboratory equipment and to conduct experiments, their self-efficacy beliefs in using the laboratory are enhanced. Concordantly, the research of Kılıç et al. (2015) also revealed that laboratory use positively affects science teachers' self-efficacy beliefs regarding laboratory use. Therefore, this result obtained in the present research is meaningful.

According to the results, no significant difference was found between the pre-service teachers from Programme-I and Programme-II in the sub-dimension SE_SPS. In other words, regardless of whether the pre-service science teachers took 18-hour or 4-hour laboratory, their self-efficacy in applying scientific process skills is almost the same. The probable reason for this is that in both of the science teacher training programmes suggested by the Higher Education

Council (2009, 2018), the content of laboratory courses equally and explicitly mentions the importance of science process skills in experiments. The analyses revealed that in the sub-dimensions SE_CM, SE_WI and SE_PEE, the scores of the pre-service science teachers from Programme-I are significantly higher than those from Programme-II. Accordingly, the pre-service teachers who took more hours of laboratory courses have higher crisis management self-efficacy as well as higher self-efficacy in working independently in the science laboratory and in using the physical environment and equipment in the science laboratory. Undoubtedly, the more experiments are performed in the laboratory, the more knowledge is acquired about laboratory safety and accidents. Moreover, the pre-service teachers from Programme-I had an opportunity to spend more time in laboratories and conduct experiments individually in addition to doing group work. As Yener et al. (2012) states, when individuals are given an opportunity to learn about and use laboratory equipment, their self-efficacy beliefs in using the laboratory are enhanced. Thus, this result is in agreement with the literature.

Conclusion

As stated above, the Turkish science teacher training programme underwent modifications in 2018. The previous programme, Programme-I, was implemented before 2018 in Türkiye, and included 18 hours per week of laboratory courses in total, with two hours being allocated to each of the courses Physics-I lab, Physics-II lab, Physics-III lab, Chemistry-I lab, Chemistry-II lab, Biology-I lab, Biology-II lab, Science Teaching Lab Applications-I and Science Teaching Lab Applications-II. On the other hand, in the new programme, Programme-II, which has been implemented since 2018, laboratory courses were largely removed. Physics, chemistry and biology courses were planned as two hours of theory and two hours of practice per week. Laboratory courses in Programme-II are limited to two courses (Science Teaching Laboratory Practices-I and Science Teaching Laboratory Practices-II), with a total of four hours per week. The present research has shown that students in Programme-II have lower laboratory self-efficacy than those in Programme-I. Therefore, we conclude that reducing laboratory hours in the science teacher training programme in Türkiye in 2018 was not an appropriate change. However, the research is limited to comparing pre-service teachers trained through Programme-I and II only in terms of their self-efficacy. There is a need for new studies examining the strengths and weaknesses of the new programme in terms of different variables. Based on this conclusion and the limitations of the research, the following implications can be drawn for researchers and practitioners:

- The number of laboratory class hours needs to be extended by the Higher Education Council. In this way, more applications can be added to improve pre-service science teachers' self-efficacy beliefs in laboratory use when the critical impact of direct experiences on self-efficacy beliefs is taken into account.
- In order to increase the effectiveness of laboratory courses, faculty members need to be able to restructure syllabuses and diversify the activities by allocating space for more details.
- The two-hour practice courses in Programme-II should be devoted not only to problem solving, but also to laboratory activities.
- The laboratory self-efficacy views of science teachers or primary school students should be the subject of future research. To increase the laboratory self-efficacy of primary school students, in-service teachers and pre-service teachers, in-service or pre-service training can be organised by identifying which dimensions are lacking.
- In future studies, the relationships between laboratory self-efficacy and some other variables, such as attitude and motivation, can be examined.

Limitations

The present research had certain limitations that must be considered. First, the sample size of the research (N = 289) was relatively small. Although more suitable design and methods were available for the research, it was not possible to obtain additional data, since the last pre-service teachers trained according to Programme I had graduated about two years earlier. Therefore, we cannot make causal inferences based on the results of our current research. Secondly, we adopted the concept of self-efficacy included in Bandura's (1997) social-cognitive theory. Although Bandura's theory is widely used, it has been subject to certain criticisms (e.g., Williams & Rhodes, 2016). According to Williams and Rhodes (2016), the reason why self-efficacy predicts behaviour to a large extent is because people tend to do what they are behaviourally motivated to do (self-efficacy as motivation). Considering this argument, new research to be conducted may reveal different results from the current research. Finally, we adopted Bandura's four-dimensional self-efficacy model in our research, but the four dimensions put forward by Bandura may not be the only factors affecting teacher self-efficacy. Palmer (2006), who criticises Bandura's model in this regard, states that teachers' self-efficacy is not only affected by mastery experience, but can also be affected by teachers' competences in content knowledge and pedagogical knowledge. Therefore, different results may be obtained in studies based on new models to be developed in line with Palmer's (2006) suggestions. These constraints suggest that the outcomes of the present research should be considered as initial and investigative. It is necessary to conduct more extensive studies involving a wider range of student teacher groups to validate the results before asserting definitive conclusions.

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