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# Investigation of The Relationship Between Preservice Science Teachers' 21st Century Skills and Science Learning Self-Efficacy Beliefs with Structural Equation Model

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**ABSTRACT**

The aim of this study was investigated the relationship between preservice science teachers' 21st century learner and teacher skills and their science learning self-efficacy beliefs. The research method used was the correlational research method, one of the quantitative research methods. The sample of the study was consisting of 318 preservice science teachers studying in the third and fourth grades of the science education department of the education faculties at three public universities. Data collection tools of this study were the 21st Century Learner Skills Scale, the 21st Century Teacher Skills Scale and the Science Learning Self-Efficacy Questionnaire. The data obtained were analyzed by structural equation modeling (SEM). In the results obtained from the SEM1, SEM2 and SEM3, a correlation was determined between the preservice science teachers' 21st century teacher skills, 21st century learner skills and science learning self-efficacy beliefs. In addition, the preservice science teachers' science learning self-efficacy beliefs positively correlated with their 21st century learner skills and negatively correlated with their 21st century teacher skills while their 21st century learner skills positively correlated with their 21st century learner skills. The preservice science teachers' 21st century skills and science learning self-efficacy beliefs was found to be predicting each other. Studies to identify the relationship between different dimensions of science education and 21st century skills should be performed to contribute to the relevant literature.

## Introduction

In the constantly developing world, a modern world person possessing the 21st century skills plays a critical role. 21st century skills represent the features of individuals in this century's information society that enable them to be good citizens and qualified workers and help one to adapt to changing world conditions at all times (Ananiadou & Claro, 2009; Partnership for 21st Century Learning [P21], 2016). These skills are acknowledged as an increasingly popular topic in recent years and evaluated in terms of various characteristics and abilities. According to the reviews, it is observed that cognitive skills, self-management skills, cooperation skills, flexibility skills, and innovation skills come into prominence (Orhan-Göksun, 2016). Consequently, 21st century skills are defined as a requirement for raising self-believing and active individuals who can adapt to novel conditions applying technology (Eryılmaz & Uluyol, 2015).

## 21st Century Skills

Highlights the significance of implementing 21st century skills to individuals and the necessity of adjusting the curriculum accordingly (P21, 2016). This situation has been addressed in today's science education. It has been included in the curriculum's goals and objectives, and achieving these skills has become an increasingly popular topic in international discussions (McGregor & Kearton, 2010). In our country, 21st century skills are integrated into science curricula. When the science curriculum is reviewed, it can be seen that the "Field-Specific Skills" part includes 21st century skills (Ministry of National Education [MNE], 2018; İpekşen, 2019). Accordingly, it is recently minded that both learners and teachers have these 21st century skills in order to teach them.

Another aspect of the studies based on 21st century skills is that most of the studies carried out dealt with 21st century skills from a different point of view (Trilling & Fadel, 2010; Wagner, 2008). However, according to Orhan-Göksün (2016), it is extremely important to examine 21st century skills from multiple directions, and accordingly, 21st century learner skills are "Cognitive Skills," "Autonomous Skills," "Cooperation and Flexibility Skills," and "Innovation Skills" while 21st century teacher skills can be considered as "Confirmatory Skills", "Administrative Skills", "Productive Skills", "Flexible Teaching Skills" and "Technopedagogical Skills". 21st century learner skills considering the sub-skills it covers; problems with mental and physical development, being able to come up with new ideas, working by agreement with others and being responsible are the skills required (Kartal, 2020; P21, 2016; Senemoğlu, 2018; Thomas, 2004; Trilling & Fadel, 2010). 21st century teacher skills are those needed to provide effective classroom management, an approach that confirms the right behaviors, to use technology and pedagogy skills together, to produce materials, and to ensure teaching regardless of the classroom environment (Orhan-Göksün, 2016). Within the scope of these skills, studies were carried out with preservice teachers studying in different departments and it was stated that 21st century learner skills and 21st century teacher skills developed in interaction (Dağhan, Nuhoğlu-Kibar, Menzi-Çetin, Telli & Akkoyunlu, 2017; Kıyasoğlu & Çeviker-Ay, 2020; Orhan-Göksün & Kurt, 2017).

## Science Learning Self-Efficacy Belief

It is also crucial for individuals to be aware of their competencies in terms of raising successful generations. Therefore, it is possible to be conscious of how well actions can be performed following competencies in terms of knowledge and skills (Morgil, Seçken & Yüzel, 2004; Senemoğlu, 2018). This situation, which can be described by the concept of self-efficacy belief, progresses throughout life regarding individuals' judgment about how well they can take actions required while dealing with possible situations (Bıkmaz, 2002; Kurbanoğlu, 2004). According to Bandura (1995), self-efficacy belief affects many facts such as perception, motivation, and performance. In this regard, revealing science learning self-efficacy beliefs in the sense of science education plays a vital role (Enochs & Riggs, 1990).

In order to increase the success of science, it is deemed necessary to develop science learning self-efficacy beliefs (Yıldırım & Karataş, 2020). The science learning self-efficacy beliefs are related to "Daily Life Practice", "Conceptual Understanding", "Science Communication", "Practical Application" and "Higher Order Thinking" (Zorlu, 2017). Considering the contents of science education, it is known that it is associated with daily life and that there will be permanent learning as long as it is applied in daily life (Doğan, Kıvrak & Baran, 2004; Enginar, Saka & Sesli, 2002). For permanent learning, it is important that similarities, differences, and relationships are established and transferred to other environments and can be used to solve problems and require this conceptual concept (Sinan, 2007). Permanent learning also develops by pouring the theory into practice, thus revitalizing the newly learned concepts in the mind and structuring the knowledge (Bozkurt, 2008). In addition, individuals should be used to understanding the world in solving problems, as well as higher order thinking skills such as coming up with new ideas for the problems they face, critical thinking, scientific thinking, problem solving, decision making and basing this decision on a justification (Demirel, 2015). The

notification of what is obtained in this process by forming scientific communication contributes to science and ensures continuity in the questioning of information as a whole (Dökme & Ozansoy, 2004).

**Hypothesis and Aim of Study**

In addition to the studies in which the concept of 21st century skills is addressed in the related literature (Kivunja, 2014; Şahin, 2009; Voogt & Roblin, 2012), studies examining the way they are expressed by prospective teachers (Günüç, Odabaşı & Kuzu, 2013), their level of possession (Karakaş, 2015), their perceptions (Anagün, Atalay, Kılıç & Yaşar, 2016), their level of use (Orhan-Göksun, 2016), and the impact of various teaching strategies on their acquiring the 21st century learning skills (Korkmaz, 2019; Nouri, Zhang, Manila & Norén, 2020; Pana & Escarlos, 2017; Senan, 2013) were conducted. Cansoy (2018) declared that observing good examples for the advancement of 21st century skills and listening to successful stories can facilitate educators' practices. These studies reveal positive relationships with 21st century skills, showing that many factors influence 21st century skills, and emphasize the necessity for additional work on this subject. Hence, researches based on these issues are extremely valuable. Along with the studiesin which the self-efficacy beliefs concerning science education are examined in the literature on self-efficacy beliefs (Hamurcu, 2006), it is observed that studies investigating the relationships with intelligence types (Berkant & Ekici 2007), self-regulation education (İsrael, 2007), science content knowledge (Menon & Sadler, 2016), science teacher identity (Menon, 2020), feedback (Akkuzu-Güven & Uyulgan, 2020) and achievement (Azar, 2010; Britner & Pajares, 2001; Schunk, 2001) have been conducted. In these studies, it has been concluded that there is a positive relationship with self-efficacy belief. Still, if the importance of high self-efficacy according to Bacak (2018) in regards to education is considered, studies on factors affecting self-efficacy perceptions should be included more. In this sense, it is essential to reveal the self-efficacy beliefs of prospective teachers during their undergraduate education (Azar, 2010).

Based on the information mentioned above, it is observed that many studies have been conducted on 21st century skills and science learning self-efficacy beliefs. Still, more studies are needed on these subjects. Notably, the high self-efficacy beliefs of science teachers can enhance the quality of science education and affect society there away. According to Bautista (2011) and Tschannen-Moran, Hoy and Hoy (1998), teachers with adequate self-efficacy also influence learners positively. Consequently, the self-efficacy belief is remarkably vital for both learners and teachers (Erden, 2007). The acquisition of 21st century skills, which is one of the aims of science education, may be affected by this situation. Because, 21st century skills can be acquired and improved in learning environments organized by science teachers. From this perspective, 21st century skills and science learning self-efficacy belief are thought to be interrelated parameters as learning and teaching skills. Besides, we have failed to find any studies in the relevant literature examining 21st century skills as learner together with teacher skills and belief in self-efficacy in science learning. It is believed that eliminating this deficiency would contribute to the field of education and would guide studies conducted in the future. This study aims to investigate the relationship between preservice science teachers' 21st century learner and teacher skills and their science learning self-efficacy beliefs.

*Hypothesis and Models of Study*

In line with the aim of this study and the literature, structural models with structural equation modeling (SEM) has been established. Science learning self-efficacy beliefs and 21st century skills are among the dimensions of science education (MNE, 2018). Therefore, the science learning self-efficacy beliefs with 21st century skills is associated with one another. In this study, this association was investigated separately with SEM1 and SEM2. In order for teaching to occur, there must be learning. In order to have teaching skills, it is necessary to have learning skills. In this case, the effects of 21st century learning skills on 21st century teaching skills were investigated by SEM3.

**Structural Models (SEM1, SEM2 and SEM3) with Structural Equation Modeling.** In this model, the effect of preservice science teachers' science learning self-efficacy beliefs on the 21st century skills was investigated (Figure 1).

Hypothesis: Preservice science teachers' science learning self-efficacy beliefs predict 21st century learner and teacher skills.

**Figure 1**

*SEM1*
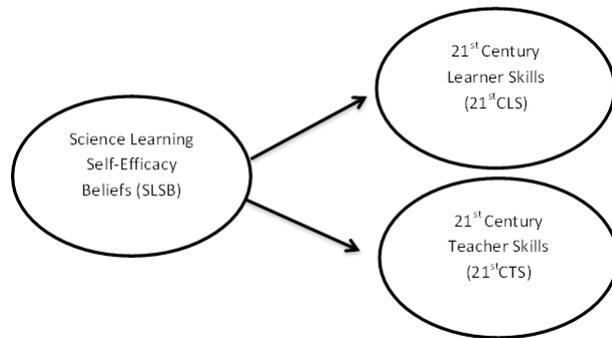


In this model, the effect of preservice science teachers' 21st century skills on the science learning self-efficacy beliefs was investigated (Figure 2).

Hypothesis: Preservice science teachers' 21st century learner and teacher skills predict the science learning self-efficacy beliefs.

**Figure 2**

*SEM2*
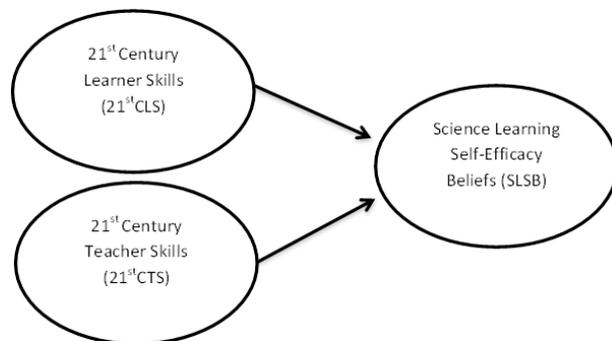


In this model, the effect of preservice science teachers' 21st century learner skills on the 21st century teacher skills was investigated (Figure 3).

Hypothesis: Preservice science teachers' 21st century learner skills predict the 21st century teacher skills.

**Figure 3**

*SEM3*
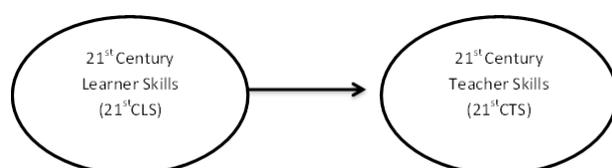
## Methods

Please The research method used was the correlational research method, one of the quantitative research methods. The correlational research method aims to define the presence and/or degree of co-change between two and more variables. Correlational research is also relational analysis, correlation type relationships, or relationships obtained by comparison (Karasar, 2016). This study investigated whether there is a relationship between preservice science teachers' self-efficacy beliefs in science learning and 21$^{st}$ century learner and teacher skills. In the research, the degrees of relations were determined, and the formulation for 21$^{st}$ century learner and teacher skills was made. In this research, Structural Equation Modeling (SEM) was applied to reveal the relations. Structural equation modeling is a multivariate statistical method that explicitly considers the measurement errors of variables inspected in a given model, which enables the development, estimation, and testing of multivariate complex models, and calculates the direct and indirect effects of the variables in the given model (Bayram, 2013; Seçer, 2015).

## Participants

The convenience sampling method was used in the research. In the study, three public universities in Western Anatolia were reached. Therefore, prospective teachers who acquired specific characteristics in regards to the science teaching profession were included. Preservice teachers in the third and fourth grades of science teaching programs are at the level required by the science teaching profession. Thus, 318 preservice science teachers studying in the third and fourth grades of the science education department of the education faculties of three public universities constitute the sample of the study. Distribution of the sample by grade and gender is given in Table 1.

**Table 1**

*Distribution of the Sample by Grade and Gender*

| Grade | Gender | | Total |
| --- | --- | --- | --- |
| | Male | Female | |
| 3 | 31 | 126 | 157 |
| 4 | 25 | 136 | 161 |
| Total | 56 | 262 | 318 |

## Participants Data Collection Tools

### 21$^{st}$ Century Learner Skills Scale

The 21$^{st}$ Century Learner Skills Scale was developed by Orhan-Göksün (2016). The scale was prepared for preservice science teachers. This scale consists of four factors which are "Cognitive Skills," "Autonomous Skills," "Cooperation and Flexibility Skills," and "Innovation Skills" and 31 items. The scale is a five-point Likert-type scale. The reliability coefficient of the scale (Cronbach's Alfa) was determined to be 0.89 (Orhan-Göksün, 2016). In this study, the reliability coefficient of the scale (Cronbach's Alfa) was determined to be 0.91. The reliability coefficients of the factors (Cronbach's Alfa) were determined as 0.89 for "Cognitive Skills", 0.69 for "Autonomous Skills," 0.88 for "Cooperation and Flexibility Skills," and 0.66 for "Innovation Skills".

## 21st Century Teacher Skills Scale

The 21st Century Teacher Skills Scale was developed by Orhan-Göksün (2016). The scale was prepared for preservice science teachers. The scale consists of five factors: "Confirmatory Skills", "Administrative Skills", "Productive Skills", "Flexible Teaching Skills" and "Technopedagogical Skills", and 27 items. The scale is a five-point Likert-type scale. The reliability coefficient of the scale (Cronbach's Alfa) was determined to be 0.87 (Orhan-Göksün, 2016). In this study, the reliability coefficient of the scale (Cronbach's Alfa) was determined to be 0.85. The reliability coefficients of the factors (Cronbach's Alfa) were determined as 0.84 for "Confirmatory Skills", 0.71 for "Administrative Skills", 0.67 for "Productive Skills", 0.85 for "Flexible Teaching Skills" and 0.74 for "Technopedagogical Skills".

## Science Learning Self-Efficacy Questionnaire (SLSB)

The Science Learning Self-Efficacy Questionnaire initially developed by Lin and Tsai (2013) was adapted to Turkish by Zorlu (2017). SLSB is a five-point Likert type scale consisting of five factors as "Daily Life Practice", "Conceptual Understanding", "Science Communication", "Practical Application" and "Higher Order Thinking", and 28 items. The reliability coefficient of the scale (Cronbach's Alfa) was determined to be 0.93 (Zorlu, 2017). In this study, the reliability coefficient of the scale (Cronbach's Alfa) was determined to be 0.92. The reliability coefficients of the factors (Cronbach's Alfa) were determined to be 0.79 for "Daily Life Practice", 0.66 for "Conceptual Understanding", 0.75 for "Science Communication", 0.71 for "Practical Application" and 0.73 for "Higher Order Thinking".

## Confirmatory Factor Analysis CFA of Scales

Confirmatory factor analysis (CFA) results of the study's scales are given in Table 2.

**Table 2**

*CFA Results of the Scales Used in the Research*

| Scale | Fit Index | Value | Fit |
|---|---|---|---|
| The 21st Century Learner Skills Scale | $X^2/(sd=434)$ | 2.85 | Acceptable |
| | RMSEA | 0.077 | Acceptable |
| | SRMR | 0.078 | Acceptable |
| | NFI | 0.93 | Acceptable |
| | NNFI | 0.90 | Acceptable |
| | CFI | 0.91 | Acceptable |
| | GFI | 0.99 | Good Fit |
| | AGFI | 0.96 | Good Fit |
| The 21st Century Teacher Skills Scale | $X^2/(sd=324)$ | 2.14 | Acceptable |
| | RMSEA | 0.073 | Acceptable |
| | SRMR | 0.064 | Acceptable |
| | NFI | 0.93 | Acceptable |
| | NNFI | 0.94 | Acceptable |
| | CFI | 0.91 | Acceptable |
| | GFI | 0.98 | Good Fit |
| | AGFI | 0.87 | Acceptable |
| The Science Learning Self-Efficacy | $X^2/(sd=350)$ | 2.97 | Acceptable |
| | RMSEA | 0.066 | Acceptable |
| | SRMR | 0.077 | Acceptable |

| | | |
|---|---|---|
| NFI | 0.90 | Acceptable |
| NNFI | 0.90 | Acceptable |
| CFI | 0.91 | Acceptable |
| GFI | 0.91 | Acceptable |
| AGFI | 0.86 | Acceptable |

When Table 2 was analyzed, it was discovered that the scales of the study had mostly acceptable values according to the fit indices in Table 3 of the literature measure (Çelik & Yılmaz, 2016). According to these data, it can be stated that the scales applied in the study are suitable for construct validity of factors.

**Table 3**

*SEM Fit Indices*

| Fit Measure | Good Fit | Acceptable |
|---|---|---|
| $X^2/(sd)$ | $0 < X^2/(sd) \leq 2$ | $2 < X^2/(sd) \leq 3$ |
| RMSEA | $0 < RMSEA \leq 0.05$ | $0.05 < RMSEA \leq 0.08$ |
| SRMR | $0 < SRMR \leq 0.05$ | $0.05 < SRMR \leq 0.10$ |
| NFI | $0.95 \leq NFI \leq 1$ | $0.90 \leq NFI < 0.95$ |
| NNFI | $0.97 \leq NNFI \leq 1$ | $0.95 \leq NNFI < 0.97$ |
| CFI | $0.97 \leq CFI \leq 1$ | $0.95 \leq CFI < 0.97$ |
| GFI | $0.95 \leq GFI \leq 1$ | $0.90 \leq GFI < 0.95$ |
| AGFI | $0.90 \leq AGFI \leq 1$ | $0.85 \leq AGFI < 0.90$ |

*Note.* (Çelik & Yılmaz, 2016)

**Analysis of Data**

Lisrel 10 software was used in the analysis of the data. The data obtained from the scales were analyzed by structural equation modeling (SEM). In the study; data obtained from the 21st Century Learner Skills Scale, the 21st Century Teacher Skills Scale and the Science Learning Self-Efficacy Questionnaire were modeled using SEM.

**Findings**

SEM1, SEM2 and SEM3 were used to investigate the relationship between preservice science teachers' 21st century learner and teacher skills and their science learning self-efficacy beliefs.

**Figure 4**

*Structural Equation Modeling (SEM1) between 21st Century Teacher Skills (21stcts), 21st Century Learner Skills (21stcls), and Science Learning Self-Efficacy Beliefs (SLSB)*

**Table 4**

*Fit Indexes for SEM1 between 21st Century Teacher Skills, 21st Century Learner Skills, and Science Learning Self-Efficacy Beliefs*

| Fit Index | Value | Fit |
|---|---|---|
| $X^2$/(sd=3567) | 3.34 | Acceptable |
| RMSEA | 0.078 | Acceptable |
| SRMR | 0.015 | Good Fit |
| NFI | 0.94 | Acceptable |
| NNFI | 0.96 | Acceptable |
| CFI | 0.93 | Acceptable |
| GFI | 0.91 | Acceptable |
| AGFI | 0.86 | Acceptable |

When Figure 4 and Table 4 were examined, structural equation modeling was appropriate between 21st century teacher skills, 21st century learner skills, and science learning self-efficacy beliefs. The results obtained from SEM1 are given in Table 5.

**Table 5**

*Structural Relationships for 21stcts, 21stcls and SLSB Variables*

| Variables | Standardized Solution | T-values |
|---|---|---|
| SLSB → 21stCTS | 0.27 | 4.06 |
| SLSB → 21stCLS | 0.46 | 5.62 |
| Structural Relationships | Error | $R^2$ |
| *21stCTS=0.053*SLSB* | 0.051 | 0.20 |
| *21stCLS=0.16*SLSB* | 0.016 | 0.073 |

When Table 5 is observed, the preservice science teachers' science learning self-efficacy beliefs predicted 21st century learner skills and 21st century teacher skills (SLSB→21stCTS=0.27, SLSB→21stCLS=0.46). It was determined that the preservice science teachers' science learning self-efficacy beliefs predicted their 21st century learner and teacher skills ($p<.05$). According to structural equations in SEM1, the preservice science teachers' science learning self-efficacy beliefs, 21st century learner and teacher skills define the difference in 21st century learner skills by 20% and 21st century teacher skills by 7.3%.

**Figure 5**

*Structural Equation Modeling (SEM2) between 21st Century Teacher Skills (21stcts), 21st Century Learner Skills (21stcls), and Science Learning Self-Efficacy Beliefs (SLSB)*
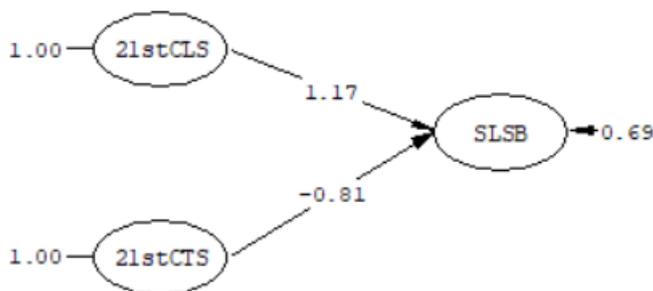
**Table 6**

*Fit Indexes for SEM2 between 21ˢᵗ Century Teacher Skills, 21ˢᵗ Century Learner Skills, and Science Learning Self-*

*Efficacy Beliefs*

| Fit Index | Value | Fit |
|---|---|---|
| $X^2$/(sd=3566) | 3.30 | Acceptable |
| RMSEA | 0.075 | Acceptable |
| SRMR | 0.072 | Acceptable |
| NFI | 0.95 | Good Fit |
| NNFI | 0.98 | Good Fit |
| CFI | 0.98 | Good Fit |
| GFI | 0.94 | Acceptable |
| AGFI | 0.91 | Good Fit |

When Figure 5 and Table 6 were examined, SEM2 was appropriate between 21ˢᵗ century teacher skills, 21ˢᵗ century learner skills, and science learning self-efficacy beliefs. The results of the obtained structural equation model are given in Table 7.

**Table 7**

*Structural Relationships for 21ˢᵗcts, 21ˢᵗcls and SLSB Variables*

| Variables | Standardized Solution | T-values |
|---|---|---|
| 21ˢᵗCTS → SLSB | -0.81 | -4.23 |
| 21ˢᵗCLS → SLSB | 1.17 | 5.24 |
| Structural Relationships | Error | $R^2$ |
| *SLSB =3.25* 21ˢᵗCLS-4.05* 21ˢᵗCTS* | 0.022 | 0.31 |

When Table 7 is observed, a positive linear relationship between the preservice science teachers' 21ˢᵗ century learner skills and science learning self-efficacy beliefs is determined (21ˢᵗCLS→SLSB=1.17). Still, a negative relationship between preservice science teachers' 21ˢᵗ century teacher skills and science learning self-efficacy beliefs was determined (21ˢᵗCTS→SLSB=-0.81). It was determined that the preservice science teachers' 21ˢᵗ century learner and teacher skills predicted their science learning self-efficacy beliefs (p<.05). According to structural equations in SEM2, preservice science teachers' 21ˢᵗ century learner and teacher skills define the difference in science learning self-efficacy beliefs by 31%.

**Figure 6**

*Structural Equation Modeling (SEM3) Between 21ˢᵗ Century Teacher Skills (21ˢᵗcts) and 21ˢᵗ Century Learner Skills (21ˢᵗcls)*
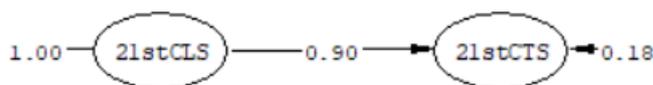
**Table 8**

*Fit Indexes for SEM3 between 21st Century Teacher Skills and 21st Century Learner Skills*

| Fit Index | Value | Fit |
|---|---|---|
| $X^2$/(sd=1594) | 2.96 | Good Fit |
| RMSEA | 0.047 | Good Fit |
| SRMR | 0.051 | Acceptable |
| NFI | 0.98 | Good Fit |
| NNFI | 0.95 | Good Fit |
| CFI | 0.96 | Good Fit |
| GFI | 0.97 | Good Fit |
| AGFI | 0.96 | Good Fit |

When Figure 6 and Table 8 were examined, SEM3 was appropriate between 21st century teacher skills and 21st century learner skills. The results of the obtained structural equation model are given in Table 9.

**Table 9**

*Structural Relationships for 21stcts and 21stcls Variables*

| Variables | Standardized Solution | T-values |
|---|---|---|
| 21stCLS → 21stCTS | 0.90 | 6.62 |
| Structural Relationships | Error | $R^2$ |
| *21stCTS=0.50*21stCLS* | 0.014 | 0.82 |

When Table 9 is observed, a positive linear relationship between the preservice science teachers' 21st century learner skills and 21st century teacher skills is determined (21stCLS→SLSB=1.17). It was determined that the preservice science teachers' 21st century learner skills predicted their 21st century teacher skills (p<.05). According to structural equations in SEM3, preservice science teachers' 21st century learner skills define the difference in 21st century teacher skills by 82%.

## Discussion, Conclusion and Recommendations

In this study, structural equation modeling was used to investigate the relationship among science teacher self-efficacy beliefs of 21st century learner and teacher skills. The results of this study's findings, accordingly, are discussed in this section with the relevant literature.

According to the findings obtained from SEM1 in the study, it was found that the preservice science teachers' science learning self-efficacy beliefs predicted the 21st century skills (Figure 4, Table 4 and Table 5). According to this result, it can be said that 21st century skills will develop with the development of the preservice science teachers' science learning self-efficacy beliefs. The self-efficacy belief is not the skill, ability or capacity of the individual. It is the individual's belief in the capacity for knowledge and skills (Akkoyunlu, Orhan & Umay, 2005; Azar, 2010; Leithwood, 2007; Yıldırım & İlhan, 2010). They seek ways to learn science by increasing the desire and motivation to learn science by developing the science learning self-efficacy beliefs. With the development of the science learning self-efficacy beliefs, they persistently try more and more patiently as they look for ways to overcome the difficulties encountered in learning science. With increased science learning self-efficacy beliefs, their level of resoluteness increases, and when they fail to learn science, they recover more quickly and look for ways to learn sciencecompensate (Akkoyunlu & Orhan, 2003; Bandura 1995; Eggen & Kauchak, 1999; Hazır-Bıkmaz, 2004; Tschannen-Moran & Hoy, 2001). Therefore, it can be said that learning science will have a positive effect on 21st-century skills with the development of science learning self-efficacy beliefs.

According to the findings obtained from SEM2 in the study, the preservice science teachers' 21st century learner skills positively correlated with their science learning self-efficacy beliefs, and 21st century learner skills were determined to be a predictor of science learning self-efficacy beliefs (Figure 5, Table 6 and Table 7). According to the obtained result, if 21st century learner skills of preservice science teachers improve, their science learning self-efficacy beliefs will also develop. The 21st century learner skills discussed in the research are cognitive, collaboration, flexibility, autonomy, and innovative skills. It can be stated that with the development of 21st century learning skills, better learning and in-depth learning are achieved. The belief in self-efficacy develops thanks to a good learning process since cognitive skills involve the ability to learn, process, and apply information, analyze, evaluate, and decision making. Better use of cognitive skills by in-depth learners may be one reason for improving self-efficacy beliefs (Ekinci, 2015). Cognitive skills cover features such as asking questions, seeking meaning, attempting to develop perspective, associating the old with new information, comparing others' views with own views, forming views, being curious, caring, enjoying learning (Biggs, 1999; Gibbs, 1994; Ramsden, 2000; Thomas & Bain, 1984). These features lead to the development of self-efficacy beliefs. Collaboration and flexibility skills have features of learning together for the same purpose, planning the learning process according to evolving circumstances, providing learning based on different ideas, and creating a shared learning environment (Michaels, Truesdell & Brown, 2015; Trilling & Fadel, 2010; Tuncel, 2009). These features of collaboration and flexibility skills advance beliefs of adaptation to daily life, practical learning, and higher order thinking according to the conditions varying from science learning self-efficacy beliefs. Autonomous and innovative skills involve accessing new information based on existing information, self-management, self-regulation, working with individuals or groups, and structuring information by adapting to growing and developing technologies (Anagün & et al., 2016; Hasırcı, 2006; International Society for Technology in Education [ISTE], 2007; Karataş, 2014). Autonomous and innovative skills improve science learning self-efficacy beliefs as it will assist in solving problems faced by analyzing existing information and generating original ideas (Pehlivanoğlu, 2011). In his study İpekşen (2019) concluded that the use of "Concrete Experience" and "Abstract Conceptualization" learning styles increased as the use of science teachers' "Autonomous" skills increased, and the use of "Reflective Observation" and "Active Experience" learning styles decreased as their use of "Autonomous" skills decreased. The preservice science teachers' 21st century teacher skills negatively correlated with their science learning self-efficacy beliefs, and 21st century teacher skills were determined to be a predictor of science learning self-efficacy beliefs (Figure 2 and Table 4). The fact that self-confidence of teachers decrease due to the fact that they see their deficiencies during teaching process and think that they have some features that need to be developed accordingly, can be shown as a reason for the decline of the preservice science teachers' self-efficacy beliefs with the development of their 21st century teacher skills. Although this situation is seen as unfavorable, the preservice science teachers will understand their deficiencies in science learning with the development of their 21st century teacher skills. Besides, science is an extensive field in terms of its subjects and study areas. As we consider this aspect in today's constantly developing and varying conditions, it can be regarded as an ordinary situation in which educators feel deficiencies in the science teaching process. Since eliminating these shortcomings is essential, it can be said that their self-efficacy beliefs will develop more when they improve themselves.

According to the findings obtained from SEM2 in the study, it was determined that there is a significant positive relationship between the preservice science teachers' 21st century learner skills and 21st century teacher skills and 21st century learner skills are predictors of 21st century teacher skills (Figure 6, Table 8 and Table 9). According to this result, when the 21st century learner skills of prospective science teachers develop, their 21st century teacher skills will also advance. This result complies with the results of the studies conducted in the related literature (Burns & Sinfield, 2004; Leung, Siu & Spector, 2000; Minton, 2005; Orhan-Göksün, 2016; Rogers, 2010; Slater & Ravid, 2010;

Tennant, McMullen & Kaczynski, 2009; Tican & Deniz, 2019). 21st century learner and teacher skills cannot be considered independently of each other. It can also be assumed that 21st century learner skills are required for the development of the 21st century teacher skills (Burns & Sinfield, 2004; Minton, 2005; Tennant, McMullen & Kaczynski, 2009). For instance, cognitive, autonomous, collaborative, and flexibility skills should be developed for the development of administrative skills. It can be assumed that the development of cognitive, innovative, autonomous, cooperative, and flexibility skills are necessary for the development of technopedagogical skills. In this perspective, it can be stated that with the development of 21st century learner skills, 21st century teacher skills will also develop. 21st century learner skills being the predictor of 21st century teacher skills, leads us to the conclusion that learning skills are essential for teaching. According to Alkan (1987), teaching is an integral part of the learning process that completes it. It is also essential know well how to learn in order to teach. A good learning process can also ensure an excellent teaching process (Morgan & Saxton, 1994). For teaching skills to be at the desired level in individuals, the knowledge, skills, values, and attitudes gained must be at a certain level. In this context, 21st century learning skills of prospective science teachers should be developed.

Increasing the education system's quality depends on providing qualified teacher input to the system (Atik-Kara & Sağlam, 2014). For training qualified teachers, required applications should be made in the education process, and preservice teachers should be conscious of their skills and perceptions. In this context, it is thought that better-equipped teachers will be trained thanks to studies on developing 21st century learner and teacher skills in undergraduate education before the 21st century preservice science teachers start their career. This study was conducted with the preservice science teachers. It should be recommended to conduct studies with secondary school students and science teachers. In this study, the relationships between science learning self-efficacy beliefs and 21st century skills were investigated. Studies to identify the relationship between different dimensions of science education and 21st century skills will contribute to the relevant literature.

**Note**

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