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PERCEPTION SCALE OF PRESERVICE SCIENCE TEACHERS' SOCIO-SCIENTIFIC REASONING SKILLS

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Abstract. *In this study, an assessment tool was developed to measure the reasoning skills (RS) of preservice science teachers on socio-scientific issues (SSI). As a result of the literature review, the scale was developed based on five dimensions. These dimensions are complexity, questioning, having different perspectives, skeptical approach and the limitations and adequacy of science. The developed scale consists of a total of 18 items. 577 preservice science teachers participated in the study voluntarily. First-level confirmatory factor analysis (CFA) was conducted to evaluate the construct validity of the items created in line with the theoretical framework. In addition, second-level CFA was applied to test whether the dimensions represented the students' perceptions of socio-scientific reasoning (SSR) skills. When the literature was examined, it was decided that the values of the fit indices were appropriate for model verification. The findings reveal that the developed scale can be used for valid and reliable measurements in determining the perceptions of preservice teachers regarding their SSR skills.*

Keywords: *preservice science teachers, scale development, scientific literacy, socio-scientific reasoning*

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Introduction

Rapid developments in science and technology in our age are changing many areas of our lives. On the one hand, societies are trying to keep up with these changes and ensure the development of their countries, while on the other hand, they are trying to cope with new problems that arise. One of these problems is the increasing need for an educated workforce that can use rapidly developing technology. Countries that have reached an advanced level in science and technology can only achieve both social and economic development when they have an educated workforce (Klimuk et al., 2020). For this reason, the education of the necessary workforce has become very important. Another problem is that human life becomes easier with developing technology, and the values that societies have, such as justice, privacy of personal information, equality, and trust, can be negatively affected by rapid developments in the social field (Brey, 2018). Although technological advances occur in line with the needs of society, social concerns can develop if they are not compatible with social values. For example, scientific and technological developments in biomedicine also bring with them the problem of human rights (Kirby, 1987; Taylor, 1999; Zillen et al., 2017). Resnik (2001), in his study on the risks that scientific discoveries and innovations may pose to society, emphasized that scientific developments should not be prevented, but instead, human rights should be protected by law. When scientific developments in society affect the current order and social harmony, disagreements, discussions, and dilemmas arise among individuals. While some advocate the preservation of the current order and perceive developments as threats to the future of society, others consider science and technology as gains for the progress of society. Complex, scientific or technological issues related to ethical, political or social dilemmas can create debate in society (Viehmann et al., 2024). These dilemmas and confusing issues that cause uncertainties among individuals are defined as "socio-scientific issues" (Sadler, 2004). Levinson (2006) has emphasized many social problems that have emerged as a result of scientific developments such as SSI. Stem cells, organ donations and surrogacy can be given as examples of social problems that arise in the field of health. The number of these examples increases when different areas, such as environmental problems, military activities, etc., are considered. Individuals are expected to overcome uncertainty by making

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decisions on these issues. When students are considered as the decision makers of the future, it is very important for them to gain scientific thinking and correct decision-making skills while they are at school. Science classes are very suitable environments for this (Eggert et al., 2013).

Theoretical Background

SSI and Scientific Literacy in Science Education

When the content of science courses is considered, it can be seen that many subjects have socio-scientific content. Nuclear power plants, radiation release, genetically modified organisms, stem cells, drug use, vaccines, etc. are subjects that are addressed scientifically in science courses such as physics, chemistry, and biology. At this point, when science teachers teach scientific concepts in their courses, they should establish a context with socio-scientific problems, which will enable students to understand the concepts better and gain awareness of social problems. However, in education systems where education is provided with a standard-based curriculum, and students are prepared for national and international exams, science teachers unfortunately cannot give much space to social problems in their courses (Tal & Kedmi, 2006). Tal and Kedmi (2006) touched upon this problem in their study and suggested that science teachers abandon the traditional content-based, value-avoiding approach. Instead, they emphasized the need for a socio-cultural approach that ensures students' participation in decision-making processes. In this case, SSI should be considered as learning materials (Bell & Lederman, 2003; Genisa et al., 2020). Indeed, studies also point to the importance of including SSI in the curriculum (Lee et al., 2006; Lewis & Leach, 2006; Nida et al., 2020; Ratcliffe, 2007).

Addressing SSI in science education and making joint decisions for solutions will also be good evidence that students are scientifically literate individuals (Lee, 2007; Lee & Grace, 2010). However, the attitudes of individuals (Topçu, 2010) and the scientific literacy level of individuals (Viehmann et al., 2024) are very important in solving these multidimensional and complex problems. Scientific literacy, one of the student outcomes of our age, requires understanding basic scientific concepts, having a scientific way of thinking, and using scientific knowledge for society (Singh & Singh, 2016). In this context, the content of science education that addresses SSI has gained importance in increasing the scientific literacy level of individuals.

SSR in Science Education

Regardless of the type of problems we encounter in daily life, we need to think about the problem and adjust our level of thinking according to the situation of the problem (Yeşildere & Türnüklü, 2007). While ordinary problems with certain limits, stereotyped solutions and certain formulas are solved faster and easier, higher-level thinking skills such as logical thinking and SSR are required to solve socio-scientific problems with scientific, cognitive, affective and moral dimensions.

RS are the ability to analyze, solve and make the right decisions for complex problems of society with social, ethical, scientific and technological dimensions. Therefore, RS play a supporting role in solving socio-scientific problems encountered by individuals and in decision-making processes (Sağlam & Çoban, 2018; Zeidler et al., 2019). Scientific developments are increasing the number and variety of socio-scientific problems every day and accordingly, the importance of decision-making in science education is increasing (Nahum et al., 2010; Papadouris & Constantinou, 2010). In this case, it is becoming increasingly important for students to apply scientific processes to a socio-scientific issue and to make decisions using their socio-scientific RS in this process. By using these skills, students will feel more ready to take on a role in solving social problems.

In recent years, it has been observed that studies aiming to contribute to the development of reasoning skills in socio-scientific issues have increased. For example, Ozturk and Roehrig (2024) addressed the problem of sulphide mining and used a revised version of the Quantitative Assessment of Socioscientific Reasoning (QuASSR) scale developed by Romine et al. (2017) in their study. It was concluded that the STEM unit developed as an SSI made significant contributions to the development of socio-scientific RS of middle school students. As a similar example, Cansız (2023) conducted a study that contributed to middle school students' decision-making abilities about nuclear power plants with a collaborative learning activity. In another study conducted with high school students on climate change, which was considered as an SSI, the importance of the factors affecting the SSR was emphasized and the effect of attitude on reasoning was found to be significant (Kristensen & Knain, 2023). Orhan and Genç (2024) compared the socio-scientific RS of teachers in their studies conducted with teachers from different

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branches. For this purpose, they adapted the Quantitative Assessment of SSR (QuASSR) Romine et al. (2017) scale as a data collection tool. The research concluded that the reasoning skills of science, social studies, and classroom teachers were at a moderate level, with no statistically significant differences observed between the branches.

Studies on developing a measurement tool on reasoning on SSI have also been conducted. Sakschewskia et al. (2014) developed a tool to measure reasoning and decision-making skills on SSI and examined the issue of energy in this context. Romine et al. (2017) evaluated SSR quantitatively in their study. The theory of the study included four dimensions for socio-scientific reasoning: complexity, perspective-taking, questioning, and skepticism. In their study, they used two scenarios prepared for the socio-scientific issue of fossil fuels. Romine et al. (2020) aimed to develop a measurement tool using multiple scenarios in a further study. In addition to their previous studies, they also scenarioized the problems of water management and antibiotic use in agriculture. Considering the importance of the comprehensibility of SSI for non-scientists and decision-making skills, scale development studies were also conducted for non-scientists (Drummond & Fischhoff, 2017; Golumbic et al., 2023).

Sadler et al. (2007) evaluated socio-scientific RS in four dimensions in their studies: understanding the complexities inherent in SSI, being able to look at events from different perspectives, being able to do research on the subject, and being skeptical of biased information when necessary. Zeidler et al. (2019) evaluated the "Affordances and limitations of science" dimension as a fifth dimension in socio-scientific RS in their study. Socio-scientific RS given by Zeidler et al. (2019) in five dimensions constitute the theoretical framework of this study. These dimensions are briefly defined below:

- Complexity: In this dimension, individuals are expected to grasp the dilemmas and uncertainties of the SSI, understand the complex content of the issue and reason accordingly.
- Inquiry: In order to evaluate the subject in question from a scientific and social perspective, the necessary questions must be asked, and answers to these questions must be sought.
- Perspective taking: Requires being able to see events from different perspectives. It requires understanding what others think about the event, empathizing, and being able to see differences by evaluating them.
- Skepticism: Requires considering the possibility that the information given about the issue may be biased or prejudiced. It is necessary to approach with skepticism whether the claims made are true or not and investigate the claims.
- Affordance and Limitations of Science: It requires the ability to understand and evaluate the scientific content of a socio-scientific subject and to make suggestions with a scientific perspective. If necessary, it may require the identification of aspects of the subject that cannot be explained by science.

Purpose and Importance

When the literature is examined, it is seen that the studies generally focus on determining the level of students' socio-scientific reasoning skills or how these skills can be developed. There are also scales on SSR developed on this subject (Romine et al., 2017; Romine et al., 2020; Sackschewskia et al., 2014). However, when measuring students' SSR skills or aiming to develop these skills, the subject of their perception on this subject has not been encountered in the literature. The active participation of students who negotiate an SSI in science classes, think scientifically and use their reasoning skills in such studies is important. For this reason, determining how students perceive their reasoning skills on SSI is important in order to contribute to their development of these skills. Understanding how students evaluate their own thinking processes and their own perspectives will help teachers adapt SSI activities accordingly, and thus help students achieve higher success in these activities. In this study, a scale was developed, and a validation study was conducted to determine the perceptions of preservice science teachers regarding SSR skills. Considering the importance of SSI in science, priority was given to preservice teachers studying in science in the sample selection. Thus, it was aimed to obtain information about the perception levels of reasoning on SSI of preservice teachers who will work in science education.

The scale items are based on the RS expressed in the studies of Zeidler et al. (2019). While developing the scale items, it was aimed to minimize the participants' existing prejudices towards a certain socio-scientific issue or the possibility of giving biased answers based on what they had heard before from the media, etc., in their responses to the scale items. Therefore, contrary to the examples encountered in the literature, the items were not prepared for a specific socio-scientific issue. In addition, scenario-type measurement methods prepared for a specific issue were not used in the scale development process. Thus, it was planned not to experience the time problem that may occur during the application phase of a scenario-type scale and the possible biased perception problem that may

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arise from the selected issue. At the same time, it was ensured that the participants' thoughts were not limited by being evaluated only on a selected sample situation. As a result, this scale development study aimed to evaluate the perceptions of preservice science teachers regarding their SSR skills quickly and reliably.

Research Methodology

General Background

In this study, a five-dimensional scale was developed based on the theoretical basis taken from the studies of Sadler et al. (2007) and Zeidler et al. (2019). In this context, the developed scale consists of a total of 18 items in the dimensions of complexity (3 items), questioning (5 items), perspective taking (4 items), skepticism (3 items), and capabilities and limitations of science (3 items).

Sample

The role of preservice teachers studying in the field of science education is great in teaching SSI and providing the correct perspective on these issues. In this context, it is very important for preservice science teachers to have SSR skills. Therefore, only science education preservice teachers were included in the sample group of the study, using the purposive sampling technique (Andrade, 2021). For this purpose, universities with science education programs in Turkey were determined in the first stage. In the second stage, those with a high number of students in the relevant programs were selected from among these universities. According to these criteria, the necessary legal permissions were obtained for the implementation of the application in the four education faculties determined.

Considering that each of the variables subject to factor analysis should have at least 5 to 10 times the number of observers and that the recommended sample size is at least 300 participants (Comrey & Lee, 1992, as cited in Yong & Pearce, 2013), it was aimed to keep the sample size as large as possible. In this context, the researchers selected a total of 577 preservice teachers studying in the Science, Biology, Physics and Chemistry Teaching Programs of the Education Faculties of four universities as a sample. Demographic data regarding the sample are shown in Table 1.

Table 1
Demographic Information of the Selected Sample

Demographic Variable		*f* (%)
Gender	Female	463 (80.2)
	Male	144 (19.8)
Grade	1st grade	153 (26.5)
	2nd grade	141 (24.4)
	3rd grade	164 (28.4)
	4th grade	119 (20.6)
Program	Biology Education	120 (20.8)
	Chemical Education	78 (13.5)
	Physics Education	82 (14.2)
	Elementary Science Education	297 (51.5)

Instrument and Procedures

In this study, while creating scale items for SSR skill perception, the five skill dimensions suggested by Zeidler et al. (2019) were taken into consideration. Accordingly; "Complexity" dimension for the individual's perception of the ability to comprehend the multifaceted structure of SSI, "Questioning" dimension for the perception of the ability to look at issues critically and deeply with a sense of curiosity, "Perspective taking" dimension for the ability

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to approach issues from different perspectives, "Skepticism" dimension for being able to provide a critical stance against the claims presented, and finally "Competences and limitations of science" dimension for the ability to be aware that science may not always solve every problem and may also have limits and ethical dimensions, provides a comprehensive structure for the research while developing scale items for preservice teachers' perception of SSR skills.

Considering all these dimensions, 25 scale items (15 positive and 10 negative items) were developed. Scale items were expressed in a way that would describe the socio-scientific RS of preservice teachers, and the answers were rated on a 5-point Likert type from "completely agree" to "completely disagree". For positive items in the scale, the scale was scored from 5 to 1 with the options "I completely agree = 5", "I largely agree = 4", "I moderately agree = 3", "I slightly agree = 2" and "I completely disagree = 1" according to the degree of agreement with the statement, and for negative items, the opposite options were scored from 1 to 5. In order to ensure content validity, two field education experts were consulted on the suitability and adequacy of the items to determine SSR skills. In the first stage, the trial form of the scale was applied to 30 preservice science teachers; the items were rearranged in line with expert opinions and feedback from preservice teachers. In the first stage, the trial form of the scale was applied to 30 preservice teachers and necessary adjustments were made to the items in line with expert opinions and feedback received from the preservice teachers.

The finalized scale was sent to the preservice teachers for their evaluation. Two main methods were followed in collecting the data. The first is that the data collection tool is applied directly to preservice teachers by researchers in face-to-face classrooms. The other data collection method is to send the data collection tool online, especially to preservice teachers in different cities, with the permission of the relevant units of the universities. In both methods, the importance of voluntary participation in the research was emphasized to the preservice teachers.

Data Analysis

First, reverse coding was performed for negative items and series mean assignment was made to missing values (Mertler & Vannata, 2017), and the data was made ready for analysis. Confirmatory factor analysis (CFA) was applied to evaluate the construct validity of the scale items created according to the theoretical framework of the concept of SSR. CFA is one of the basic methods used in testing a previously determined hypothesis, theory or model regarding the relationship between variables and examining construct validity (Kline, 2015; Tabachnick & Fidell, 2013). In this study, a model was tested for the theoretically determined structure of the concept of reasoning with CFA. For this purpose, first of all, the conformity of the scale items prepared by the researchers to the five-factor structure proposed by Zeidler et al. (2019) was tested with first-level CFA. Then, the representation of the SSR skill variable by these factors together was tested with second-level CFA.

Considering the sample size and the number of observed variables, the values given in Table 2 for CFA were considered in line with the recommendations in the literature (Byrne, 2010).

Table 2
Fit Indices and Criteria Considered for the CFA Model

Fit indices*	Criterion	Evaluation
χ^2/df (Chi-square goodness of fit/degrees of freedom)	<5	good fit
GFI (Global Fit Index)	≥ .90	good fit
AGFI (Adjusted Global Fit Index)	≥.90	good fit
SRMR (Standardized Root Mean Square Residual)	≤ .05	good fit
RMSEA (Root Mean Square Error of Approximation)	≤ .08	acceptable fit
NFI (Normed Fit Index)	≥.90	good fit
NNFI (Non-Normed Fit Index)	≥.90	good fit
CFI (Comparative Fit Index)	≥.92	good fit

To assess the internal consistency of the scale, Cronbach alpha (α) reliability values were calculated for both the overall scale and each dimension separately. The reliability coefficient was taken as a criterion to be .60 and above (Griethuijsen et al., 2014). In addition, within the scope of the reliability of the scale, inter-item total correla-

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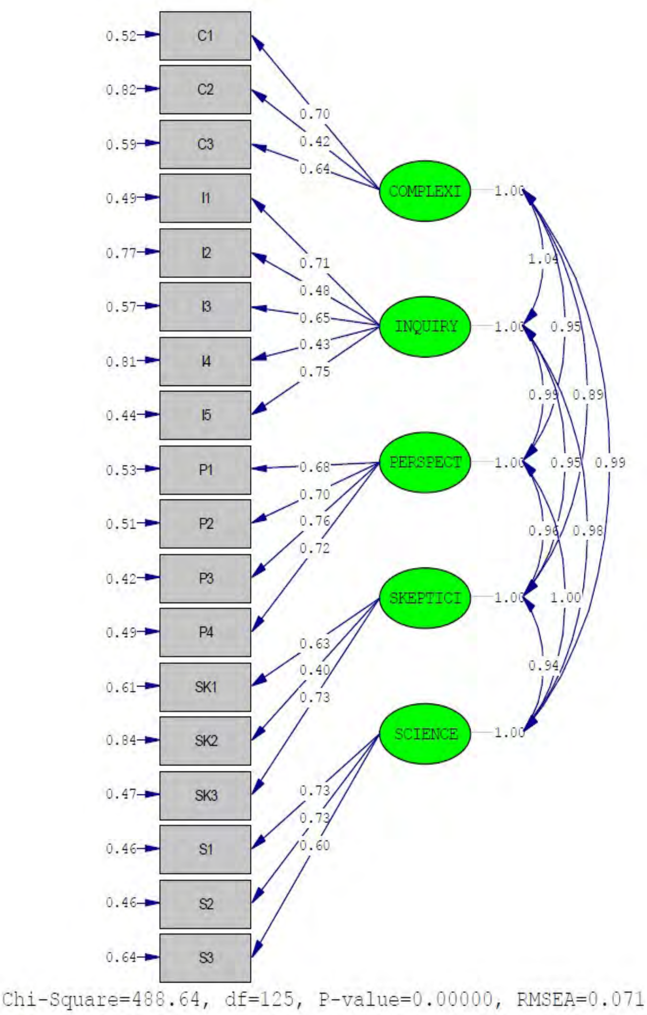
tion values and corrected item-total correlation values were calculated. In the inter-item total correlation matrix, attention was paid to ensure that all values were positive as an indication that the items measured the same feature. Care was taken to ensure that the corrected item-total correlation values were above .3 (Pallant, 2016).

Research Results

Validity

In the model validation phase with CFA, firstly the t values of the items regarding their explanation status of the observed variable were checked. A total of 7 items (1 item skepticism, 1 item questioning, 2 items complexity, 2 items scientific knowledge and 1 item perspective taking) with a t value below 1.96 (Kline, 2015), high measurement errors and low representation power of the factor they were located in were removed from the scale. The model, which confirms the suitability of the 5-factor theoretical structure of the concept of SSR consisting of 18 items (Zeidler et al., 2019) to the sample data through the analysis, is shown in Figure 1.

Figure 1
First Order Confirmatory Factor Analysis Results for the Five-Factor SSR Model (Standardized Values)



When the fit indices of the model were evaluated, the Chi-square goodness of fit (χ^2) statistic was found to be significant (p < .01). This test is expected to yield significant results at sample sizes of 200 and above; therefore, it is emphasized that it would be more accurate to look at the χ^2/df value (Byrne, 2010; Hoe, 2008). In the study, the

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χ^2/df value was calculated as 3.91, χ^2 = 488.64 and *df* = 125. This value being 5 and below is expressed as a good fit (Byrne, 2010). In addition, other fit indices calculated for the model are as follows: RMSEA= 0.071, SRMR= 0.048, GFI=0.91, NFI=0.97, NNFI= 0.97, CFI=0.98. According to the literature, these values of the fit indices are suitable for the validation of the model (Byrne, 2010). These findings supported the construct validity of the scale.

Kline (2015) drew attention to two situations that should be considered in validated models:

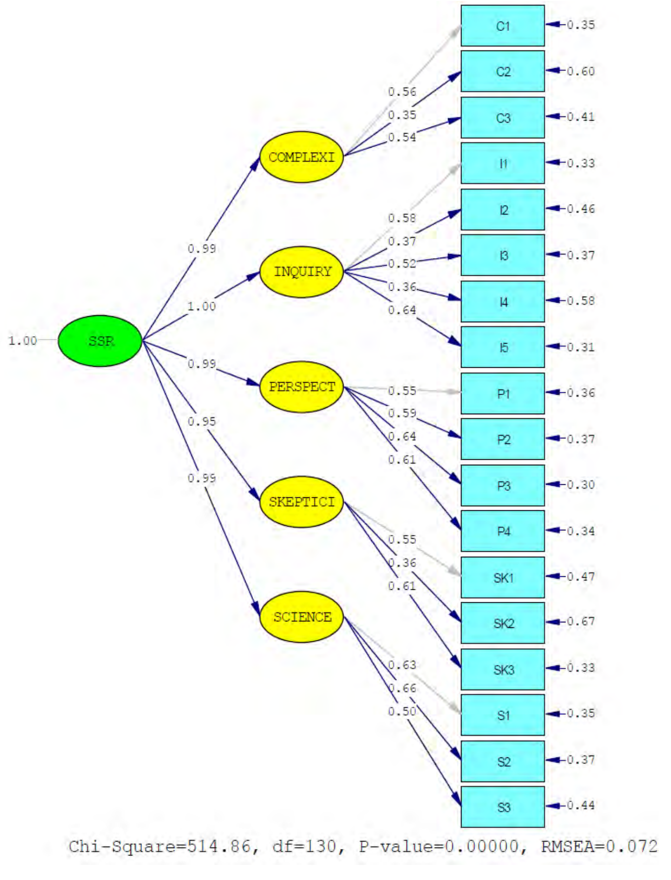
1. All of the indicators determined to be under a common factor should have high loadings on that factor. This is an indicator of convergent validity. As seen in Figure 1, all of the indicators determined to be under common factors are above .30 and have acceptable loadings ranging between .42 and .76. DeVellis (2012) recommended that factor loadings should be ≥0.30 to ensure that the characteristics to be measured are sufficiently differentiated. Therefore, it can be said that the scale has convergent validity.

2. The absence of very high correlations between factors (e.g., *r* > .85) is also an indicator of discriminant validity. It was determined that the 5 dimensions of the scale showed normal distribution and correlations between these dimensions were calculated. In calculating the correlation coefficient, the Pearson correlation coefficient was considered since the data were continuous variables and normally distributed (Pallant, 2016). It was determined that the correlations between the factors took values ranging from .572 to .765. This finding also showed that the scale had discriminant validity.

Second-level confirmatory factor analysis was applied to test whether the five factors in the model obtained in the first-level confirmatory factor analysis represented the superordinate concept of SSR skills. The second-level confirmatory factor analysis revealed the variances explained by the SSR variable in the five factors, which are first-level variables (Figure 2).

Figure 2

Second Order Confirmatory Factor Analysis Results for the Five-Factor SSR Model (Standardized Values)



The fit indices calculated for the model obtained with the second-level CFA given in Figure 2 are as follows: *p* < .01, χ^2/*df*=3.96 (χ^2 = 514.86, *df* = 130), RMSEA= 0.072, SRMR= 0.049, GFI=0.91, NFI=0.97, NNFI= 0.97, CFI=0.97.

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According to the literature, these values of the fit indices are suitable for the validation of the model (Byrne, 2010). These findings revealed that five factors, supported by the first-level confirmatory factor analysis, represented the SSR variable defined as the superstructure.

Reliability

Cronbach's Alpha coefficient calculated for the reliability of the scale was found to be .92 for 18 items. Cronbach's Alpha reliability coefficients calculated for the sub-dimensions of the scale are as follows: complexity .60, inquiry .74, perspective-taking .81, skepticism .60 and affordances & limitations of science .73. When the inter-item correlation matrix was examined, it was determined that all values were positive. This is another indication that the items measure the same feature. In addition, it was found that the item-total score correlations between each test item and the total score of the test were positive and showed values above .30, and these correlations varied between .392 and .724 (Table 3). These values indicate that all items in the scale are aimed at measuring a common variable. These findings show that the scale is a suitable measurement tool for making reliable measurements in determining the SSR skills of preservice teachers.

Table 3
Corrected Item-Total Correlation

Item No	Corrected Item -Total Correlation	Item No	Corrected Item -Total Correlation
C1	.657	P2	.666
C2	.415	P3	.718
C3	.615	P4	.683
I1	.677	SK1	.569
I2	.455	SK2	.392
I3	.622	SK3	.667
I4	.440	S1	.688
I5	.724	S2	.700
P1	.644	S3	.559

Discussion

According to the findings, the scale developed was applied to preservice teachers studying in science education fields such as science, physics, chemistry and biology, and its validity and reliability studies were completed, contributing to the field as a measurement tool. First and second level confirmatory factor analyses were conducted to test the construct validity of the developed scale and the representation of these items in SSI. For the first level CFA, seven items were removed from the scale due to the fact that the t values were below 1.96 (Kline, 2015), the measurement errors were high, and the factor representation powers were low. As a result of the first-level CFA, it was determined that the proposed model exhibited a good fit (χ^2/df = 3.91, RMSEA = 0.071, SRMR = 0.048, GFI = 0.91, NFI = 0.97, NNFI = 0.97, CFI = 0.98). As a result of the second-level CFA and first-level confirmatory factor analysis, it was proven that the five factors supported represented the SSR variable defined as a superstructure (χ2/df=3.96 (χ2=514.86, df=130), RMSEA= 0.072, SRMR= 0.049, GFI=0.91, NFI=0.97, NNFI= 0.97, CFI=0.97). The Cronbach's Alpha internal consistency coefficient calculated for the entire scale was found to be .92, and the Cronbach's Alpha coefficients of the sub-dimensions were found to vary between .60 and .81. As a result, all reliability coefficients calculated were .60 and above (Griethuijsen et al., 2014), which was interpreted as the test being suitable for making reliable measurements.

With this developed scale, preservice science teachers will be able to evaluate their own RS regarding SSI, which will contribute to the professional development of preservice teachers. SSI education has gained importance as an approach that supports scientific literacy skills, especially in science learning, within the education system (Macalalag, 2023; Sadler, 2011a, 2011b). Today, individuals should go beyond learning science with the science education they receive and integrate what they learn into daily life. In this regard, as Zeidler et al. (2019) stated,

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it is important to focus on the role that SSI training plays in gaining "functional scientific literacy. This developed scale will contribute to the development of these skills, which are described in the literature and which we expect individuals of our age to have. Sadler et al. (2007) emphasized that SSI education provides students with skills such as better understanding science and ethical sensitivity, as well as developing decision-making skills. For this purpose, they proposed SSR as a structure for the negotiation of complex events (Zeidler, 2019). With this developed scale, individuals will be able to create their own awareness in socio-scientific reasoning. Thus, they will have the opportunity to complete the deficiencies they have noticed in their decision-making skills.

The most notable difference of this scale, developed in comparison to other socio-scientific reasoning skill scales in the literature, is that it does not focus on a specific SSI or use methods such as scenario-based approaches. In this respect, the study differs from other scales on this subject in the literature (e.g., Drummond & Fischhoff, 2017; Golumbic et al., 2023; Romine et al., 2017; Romine et al., 2020; Sakschewskia et al., 2014). In this way, it was considered that the participants may have prejudices about a selected SSI due to the media or their previous experiences and therefore may give biased answers. This approach increased the validity of the scale and ensured that the participants' answers reflected a general reasoning skill on SSI. In addition, unlike other scales (e.g., Romine et al., 2017; Romine et al., 2020), by not using measurement methods based on a specific scenario, time management problems and subject-specific biased perceptions were prevented during the application.

Considering the critical role of SSI in science education, how preservice teachers perceive their RS on these issues is an important finding. With the scale developed in this study, the perceptions of preservice science teachers regarding their socio-scientific RS can be assessed reliably and quickly.

Conclusions and Implications

It is important for science teachers to start developing their skills, such as scientific thinking and research, discussing and evaluating social issues while they are still at university. In this way, science teachers will step into the profession well-trained and more equipped. For this, environments should be created where preservice science teachers can use the knowledge they learn during their education to solve social problems and reason.

When planning education programs, developing course content and determining new strategies, knowing the perceptions of preservice science teachers on SSR will increase the quality of the education to be provided.

The scale developed within the scope of this research was not specifically designed for a particular socio-scientific issue or scenario. In this way, it was aimed to prevent the participants from having a prejudiced or biased attitude towards a specific topic or scenario. As a result, it was possible for the participants to exhibit an objective attitude and thus make a more general evaluation. However, this scale can also be used with other tools that measure socio-scientific RS through case studies, as in the scenario method. In this way, it can be determined how compatible the individual's own perception of SSR skills and the current skill measured are in reality.

In the study, considering the critical importance of SSI in science education, preservice science teachers were selected as participants. However, since the scale items were not specifically developed for a specific subject, the perceptions of preservice teachers studying in other branches regarding SSI can also be evaluated.

In order to obtain important information about the place of SSI in today's science education, the application of the scale to science teachers in the profession is recommended as the next step. Thus, science teachers will have the opportunity to evaluate their own educational practices and perceptions of SSI. As a result, it will be possible for them to develop more conscious and effective approaches in science classes. Their self-awareness on this issue will increase and contribute to their professional development.

The data collected with the help of this scale can provide important information for designing educational programs aimed at improving science teachers' thinking skills regarding SSI. Likewise, it can shed light on initiatives aimed at increasing the thinking skills and awareness levels required for science teachers to effectively integrate SSI into their lessons.

This scale is a valuable tool for assessing the perceptions of science teachers and preservice science teachers towards SSI. It will also contribute to our understanding of the place and importance of SSI in educational processes.

Ethics

All procedures performed in social studies involving human participants comply with ethical standards. It was approved by Hacettepe University Ethics Committee on 16.04.2022 with protocol number E-35853172-600-00002139219.

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Declaration of Interest

The authors declare no competing interest.

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Appendix (Translated from the original scale into English)

Perception Scale of Preservice Science Teachers' Socio-Scientific Reasoning Skills

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
	1	2	3	4	5
C1. I can understand the complex structure of the socio-scientific issues.	☐	☐	☐	☐	☐
C2. I have difficulty in understanding the complex structure of the socio-scientific issues.	☐	☐	☐	☐	☐
C3. While making a decision about socio-scientific issues I can try different ways of solution.	☐	☐	☐	☐	☐
I1. I can have a critical view about the new information, which can be useful in decision-making about socio-scientific issues.	☐	☐	☐	☐	☐
I2. While reasoning about socio-scientific issues, I can do research about their aspects that are not discussed yet.	☐	☐	☐	☐	☐
I3. When making a decision about socio-scientific issues, I can correctly evaluate various information I inquired about.	☐	☐	☐	☐	☐
I4. I have difficulty in inquiring the topic in details in the process of decision-making about socio-scientific issues.	☐	☐	☐	☐	☐
I5. While reasoning about socio-scientific issues, I can inquire about different dimensions of the issue.	☐	☐	☐	☐	☐
P1. When searching for ways of solution in socio-scientific issues, I can look at the topic from the view of other people.	☐	☐	☐	☐	☐
P2. I consider different points of view when making decisions about socio-scientific issues.	☐	☐	☐	☐	☐
P3. I can evaluate different proposals about solutions of socio-scientific issues.	☐	☐	☐	☐	☐
P4. I can use different points of view, regarding the socio-scientific issues, in the decision-making process.	☐	☐	☐	☐	☐
SK1. I can see prejudiced and unfair points of view that can affect my decision about socio-scientific issues.	☐	☐	☐	☐	☐
SK2. While reasoning about socio-scientific issues, I cannot distinguish prejudiced and unfair information, which are results of biased points of view.	☐	☐	☐	☐	☐
SK3. When making a decision about socio-scientific issues I can recognize biased approaches.	☐	☐	☐	☐	☐
S1. I know how scientific information contributes to the solution of socio-scientific issues.	☐	☐	☐	☐	☐
S2. I can understand the importance of scientific processes in the solution of socio-scientific issues.	☐	☐	☐	☐	☐
S3. I can understand that the socio-scientific issues have dimensions that are outside the perspective of science.	☐	☐	☐	☐	☐

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