Curricular Studies & Perspectives

Year: 2025 Volume: 1 Issue: 1 pp. 32-48

ISSN: 3108-6772
DOI: https://doi.org/10.29329/csp.2025.1384.3 www.curricularstudies.com

Needs analysis study on science field skills training for pre-service teachers

Ali Çetin[1], Halil Somuncu[2]

[1] Siirt University, Faculty of Education, Siirt, Türkiye, alicetin@siirt.edu.tr, https://orcid.org/0000-0002-1174-6997
[2] Siirt University, Faculty of Education, Siirt, Türkiye, halil.somuncu@siirt.edu.tr, https://orcid.org/0000-0001-7030-6484
Corresponding Author: Ali Çetin, Siirt University, Türkiye.

ARTICLE INFO

Keywords
science field skills, Türkiye Century Maarif Model, need analysis, pre-service science teachers

Article Type
Research Article

Received : 6 Dec 2025
Accepted : 25 Dec 2025

The purpose of this study is to evaluate pre-service science teachers' levels of knowledge regarding the Science Field Skills (SFS) defined within the Türkiye Century Maarif Model (TCMM). Their awareness of the process components of these skills, their views on the necessity of training in these skills, and to assess current teacher education programs in terms of adequacy. The study was conducted using a case study design within qualitative research approaches. The study group comprised 32 pre-service science teachers enrolled at a state university. Data were collected via an open ended questionnaire and analyzed using content analysis. Findings indicate that the large majority of pre-service teachers do not possess sufficient knowledge about Science Field Skills and their process components. Nevertheless, participants believe that training on SFS would make significant contributions to individual development, professional competence, and societal awareness. Participants also reported that courses addressing field skills within current teacher education programs are limited and do not sufficiently develop the targeted skills. Their recommendations emphasized that SFS training should be practice oriented, related to everyday life, and include design and inquiry based activities. In conclusion, to effectively implement the skill based approach envisaged by TCMM, teacher education programs should be restructured in accordance with Science Field Skills. At the end of the study, recomendations for practitioners (academicians and teachers), teacher education programs, future research and policymakers are listed.

Introduction

Education performs primary functions for societal development, such as equipping individuals with the knowledge, skills, and behaviors required in daily life, facilitating professional qualification, enabling the discovery and development of personal talents, and transmitting existing values to new generations (MoNE, 2017). The effective fulfillment of these core functions depends on the qualifications of teachers within the system. Consequently, the effort and concern to train qualified teachers have always occupied an important place on societies' agendas. Among the three fundamental elements of the education system—learning, students, and teachers—the preparation of teachers has become increasingly important in the competitive environment created by globalization, generating a need for teachers with superior qualifications (Üstüner, 2004).

Research indicates that expectations for qualified teachers include affective attributes such as empathy, respect, and fairness, in addition to subject matter and pedagogical knowledge and mastery of field related skills (Abide, 2021; Yaman, Bal İncebacak & Sarışan Tungaç, 2022;

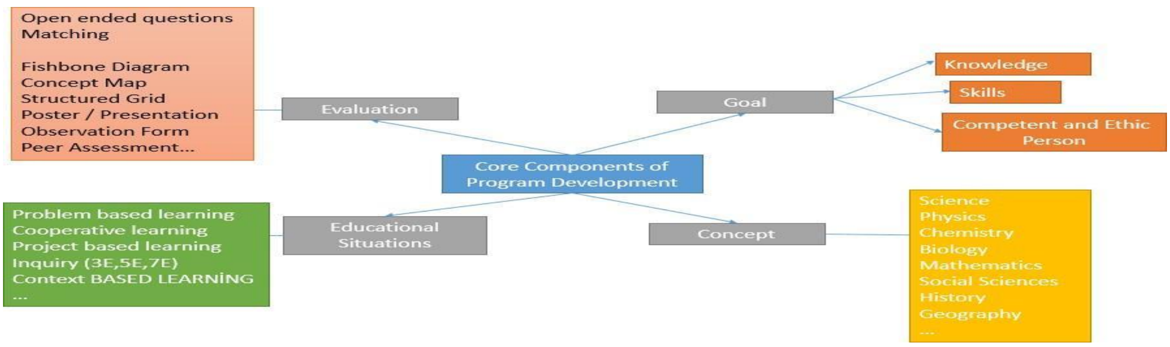
Minott, 2022). Effective teacher characteristics are further classified under the subdimensions of competence in subject knowledge, instructional skills, personality traits, and professional development (Korkmaz, 2021). Within this study, teacher competencies are conceptualized through the framework of Pedagogical Content Knowledge (PCK), which emphasizes teachers' ability to integrate subject matter knowledge with appropriate pedagogical strategies in order to support meaningful and inquiry based learning. Accordingly, teacher education programs should comprehensively encompass the features identified in the literature to ensure the preparation of qualified and effective teachers. Although teacher education policies vary across countries, there is a common recognition that theoretical knowledge in vocational education must be applied in practice; therefore, university instruction should be planned in alignment with classroom practice (Goh, Canrius & Wong, 2020).

Recent international research increasingly emphasizes skills based teaching, inquiry oriented learning, and competency driven teacher education as central components of effective teacher training programs (Darling-Hammond et al., 2020; Voogt et al., 2022). Studies conducted after 2020 highlight the necessity of aligning pre service teacher education with contemporary curriculum reforms, focusing on higher order thinking skills, inquiry processes, and evidence based instructional practices (Tondeur et al., 2021). In parallel, recent needs analysis studies underscore the importance of systematically identifying gaps between existing and expected teacher competencies to inform the design of targeted and sustainable professional development programs (Kaufman & Guerra-Lopez, 2013).

In 2024, Türkiye implemented the Türkiye Century Maarif Model (TCMM). This model directly addresses the fundamental elements of curriculum development—objectives, content, instructional situations, and assessment situations—and presents these stages in detail. As with all curricula, knowledge is included among the objectives intended to be imparted to students. While multiple definitions of knowledge exist in the literature, TCMM's student centered orientation implies that knowledge should be internalized and defined by students themselves. The model emphasizes that knowledge should be understood by students rather than merely transmitted by teachers or textbooks, which foregrounds the concept of skills within the model. In addition to knowledge and skills, TCMM aims to cultivate competent and virtuous individuals. The content component includes subject specific areas such as Mathematics, Physics, Chemistry, Biology, History, Geography, Philosophy, Social Studies, and Science. Instructional situations incorporate innovative teaching methods and techniques. Finally, assessment situations have been reshaped under TCMM, expanding classical measurement tools with alternative and process oriented assessment practices.

Figure 1

The Türkiye Century Education Model within the framework of the fundamental components of the curriculum



As illustrated in figure 1, the Türkiye Century Education Model (TCMM) differs from its predecessors through the innovative approach it introduces to the components of objectives, instructional processes, and assessment. From this perspective, TCMM is not merely a process of curriculum design; rather, it is a model that also articulates an educational philosophy aimed at shaping society. TCMM is an education model that supports the multifaceted development of the individual rather than focusing solely on academic achievement (Arslankara & Arslankara, 2024). Its knowledge and skill centered instructional approach goes beyond traditional models that place knowledge at the center, promoting student centered, active learning and emphasizing socio emotional development. In this respect, TCMM aims for students to be producers rather than mere consumers of knowledge (Sarıgöz, 2023). The model's integrated treatment of knowledge and skills, the concurrent articulation of content and skill oriented statements in the construction of learning outcomes, and the positioning of skills as tools through which students organize and transform knowledge collectively underscore the central significance of the skills framework introduced alongside the model. Within the skill classes, domain specific and conceptual skills are used together with content when preparing learning outcomes. Conceptual skills are applicable across domains and are particularly relevant for concept instruction within the model. Domain specific skills are specific to a field and represent the direct skills expected to be developed in students for that field.

Individuals educated within the system must be able to examine cause and effect relationships, apply learned knowledge to new situations, and solve problems. To achieve these goals, educators commonly aim to cultivate science literate and scientifically literate individuals (Karışan, Bilican & Şenler, 2017). Encouraging students to ask questions, think critically, and solve problems enables them to acquire skills they will need throughout life (Branch & Solowan, 2003). The primary approach of science curricula is inquiry based learning (MoNE, 2017). The rationale for adopting this approach is supported by national and international studies indicating that inquiry is of great importance in science learning environments and that science learning should occur through inquiry (Çetin & Özdemir, 2018; Perry & Richardson, 2001; Bel, Urhahne, Schanze & Ploetzner, 2010). During inquiry, students ask questions, conduct investigations, and analyze information to transform data into useful knowledge (Perry & Richardson, 2001; Rushton, Lotter & Singer, 2011). For these processes to be implemented effectively in classroom settings, teachers bear significant responsibilities; foremost among these is that teachers must possess the skills necessary to conduct inquiry based instruction (Zion & Mendelovici, 2012).

Scientific inquiry comprises activities through which students develop ideas about scientific thinking and how scientific investigations are conducted. Students capable of scientific inquiry acquire the skills necessary to conduct scientific research (Şenler, 2014). The National Research Council (1996, 2000) lists these skills as follows:

- Identifying questions; designing and conducting scientific investigations.
- Using appropriate tools for data collection, analysis, interpretation, and performing calculations.
- Constructing scientific explanations based on evidence.
- Recognizing and analyzing alternative explanations.
- Connecting scientific arguments.

Research indicates that teachers often favor teacher centered practices over inquiry based instruction in classroom settings (Asay & Orgill, 2010; Bayır & Köseoğlu, 2013; Mansur, 2015; Kaya & Yılmaz, 2016). International studies similarly report that teachers frequently fail to guide students toward exploratory scientific questioning, do not implement activities requiring experimental or manual skills, do not foster argumentation, and do not enable students to collect and analyze data (Lee, Hart, Cuevas & Enders, 2004; Rushton et al., 2011). Primary reason include teachers' perceived inadequacy in preparing and implementing classroom activities and the perception that preparation and implementation are time and labor intensive tasks (Lougrahn, 2006). Therefore, teacher education programs should provide experiences that prepare pre service teachers to understand the nature of inquiry, to conduct inquiry themselves, and to design learning environments in which their students can engage in inquiry.

Because inquiry based learning is a student centered approach focused on questioning, critical thinking, and problem solving, it enables students to develop skills they will need throughout life (Branch & Solowan, 2003). TCMM also includes decision making, problem solving, and critical thinking among higher order thinking skills. The alignment between inquiry and TCMM's higher order thinking skills highlights the model's emphasis on scientific inquiry. TCMM expects students to follow scientific processes, perform evidence based analyses, interpret events, and express conclusions. In this context, the Science Field Skills (SFS) within TCMM gain importance (MEB, 2024a). SFS consist of 13 distinct domain specific science skills and their process components; these skills are illustrated in table 1.

Table 1

Science field skills and process components

1.Scientific Observation Skill Identifying characteristics Collecting and recording data Explaining data	**5.Operational Definition Skill** Defining characteristics Making measurements Making definitions appropriate to the purpose	**10.Inductive Reasoning Skill** Identifying patterns Making generalizations
2.Classification Skill Identifying characteristics and/or determining variables Sorting based on characteristics Grouping Labeling	**6.Hypothesis Formulation Skill** Identifying the problem Determining independent and dependent variables Identifying variables Controlling variables Proposing hypotheses	**11.Deductive Reasoning Skill** Formulating and testing hypotheses based on theoretical foundations Using valid hypotheses to explain new situations
3.Prediction Based on Scientific Observation Skill Formulating predictions based on prior knowledge and experience Comparing predictions that are based on observation and those that are not Justifying predictions using observational data Making predictions about unobserved situations Questioning the validity of predictions	**7.Experimentation Skill** Designing experiments Conducting experiments and analyzing data	**12.Evidence Utilization Skill** Collecting and recording data Organizing data into sets Making data-based explanations
4.Prediction Based on Scientific Data Skill Formulating predictions based on data or information Comparing data-based and non-data-based predictions Making calculations and predictions	**8.Scientific Inference Skill** Identifying characteristics Collecting and recording data Interpreting and evaluating data	**13.Scientific Inquiry Skill** Identifying questions or problems Developing models to answer/solve problems Planning and conducting research Analyzing and interpreting data Producing explanations and solutions based on evidence Evaluating and sharing information
	9.Scientific Modeling Skill Proposing models for explanations Revising models based on new evidence	

Table 1 shows that the acquisition of domain specific skills involves interwoven processes and that the fulfillment of subskills is obligatory. This interdependent, holistic structure necessitates the definition of process components alongside domain skills. Providing detailed descriptions of skills is important for the effective implementation of teaching learning practices and for the collection of learning evidence (assessment) (Yıldırım & Çalışkan, 2024). For example, the process components of the scientific observation domain skill include: describing qualities, collecting and recording data, and explaining data. Students' attainment of scientific observation depends on their ability to perform these three sub processes in sequence. This assumption also shapes teaching learning practices. Teachers should design activities that sequentially address these three processes when planning lessons.

When examined in a comparative perspective, the Science Field Skills defined in the Türkiye Century Maarif Model show strong alignment with internationally recognized frameworks such as the Next Generation Science Standards (NGSS), PISA scientific literacy framework, and major 21st century skills initiatives. Similar to NGSS, TCMM emphasizes scientific inquiry practices including hypothesis formulation, experimentation, data analysis, and evidence based explanation. Likewise, the focus on reasoning, modeling, and evidence utilization corresponds with the core competencies assessed within the PISA scientific literacy framework, particularly in relation to explaining phenomena scientifically and interpreting data. From a broader perspective, these skills are also consistent with 21st century skills initiatives that prioritize critical thinking, problem solving, and inquiry oriented learning, indicating that the Science Field Skills represent a nationally contextualized articulation of globally shared science education priorities.

Considering the structure of TCMM, the skills framework, and the technical characteristics of science field skills, there is a clear need to plan a training program for pre service teachers. The aim of this study is to determine the needs for a training program to be developed for pre service science teachers. Accordingly, the present study adopts Kaufman's Needs Assessment Model as its theoretical framework for needs analysis, focusing on identifying gaps between pre service science teachers' existing competencies and the competencies required for the effective implementation of Science Field Skills within the Türkiye Century Maarif Model. In line with this aim, the following sub problems were addressed:

1. What are pre service teachers' levels of knowledge regarding the Science Field Skills defined in the Türkiye Century Maarif Model?
2. What are pre service teachers' levels of knowledge regarding the process components of the Science Field Skills defined in TCMM?
3. What are pre service teachers' views on the necessity of training in Science Field Skills?
4. Are there courses in the science teacher education program related to Science Field Skills? If so, what are pre service teachers' views on the adequacy of the theoretical/practical components of these courses?
5. What recommendations do pre service teachers propose regarding the planned Science Field Skills training?

Methodology

Research Design

This study employed the case study strategy, one of the qualitative research methods. Case studies are frequently used in social sciences such as education, sociology, and psychology (Ceylan Çapar & Ceylan, 2022). A case study investigates and describes a phenomenon within its real life context

(Yin, 2013). During such an inquiry, a holistic perspective is adopted because the phenomenon may be influenced by various contextual factors (Ekiz, 2003). In line with Yin's (2013) typology, this study was designed as a holistic single-case study, as it focused on a single bounded system consisting of pre service science teachers enrolled in one science teacher education program. The case was examined as a whole without defining embedded subunits.

Study Group

The sample for this study consisted of pre service science teachers enrolled in the 2nd and 3rd years of a science teacher education program at a university in Türkiye. Announcements were made in course groups, and participants were invited to complete the opinion form in the researchers' office. Participation was voluntary. The study group was selected using convenience sampling, as the participants were pre service science teachers who were readily accessible to the researchers and met the inclusion criteria of being enrolled in the 2nd or 3rd year of the science teacher education program. Table 2 presents participants' gender, grade level, and prior participation in TCMM related activities.

Table 2

Participant information

Variable		f	%
Gender	Female	25	78
	Male	7	22
Grade level	2nd year	12	38
	3rd year	20	62
Have you participated in any TCMM-related activity?	Yes	3	9
	No	29	91

As presented in Table 2, the study sample consisted of 32 pre-service science teachers. The majority of the participants were female (78%), while male participants accounted for 32% of the sample. In terms of academic standing, 62% of the pre-service teachers were enrolled in their third year of study, whereas 38% were in their second year. Regarding prior experience with TYMM-related activities, only three participants reported having previously taken part in such an activity, which they identified as an academic seminar.

The number of participants was determined based on the scope and design of the study. As a holistic single-case study, the aim was not statistical generalization but an in depth exploration of pre service science teachers' views within a specific educational context. Data were collected from all pre service science teachers who volunteered and met the inclusion criteria during the data collection period, resulting in a total of 32 participants. This sample size was considered sufficient to obtain rich and meaningful qualitative data relevant to the research purpose.

Data Collection Instrument

The ―Needs Analysis – Opinion Form on Science Field Skills‖ (SFS OF) was developed by the researchers to determine pre service science teachers' knowledge levels, perceptions, and training needs regarding the Science Field Skills defined in the Türkiye Century Maarif Model (Appendix 1). The development of the instrument followed a systematic, multi stage process.

In the first stage, an item pool was created based on the research questions of the study, the structure and process components of the Science Field Skills framework, and relevant literature on skills based science education and needs analysis. The initial pool aimed to comprehensively capture participants' views on both domain specific skills and their associated process components

In the second stage, the draft form was reviewed by two faculty members specializing in science education, both holding doctoral degrees and having professional experience in teacher education and curriculum studies. One of the experts was an associate professor, and the other was an assistant professor, each working at different universities. The experts evaluated the items using criteria such as content relevance to Science Field Skills, alignment with the research purpose, clarity and comprehensibility of the wording, and appropriateness for pre service science teachers.

Based on the experts' feedback, revisions were made to improve the clarity of expressions, eliminate ambiguous or overlapping items, and enhance the overall coherence of the form. Following this revision process, the instrument was finalized and converted into an online format using Google Forms for data collection. The final version of the SFS OF consisted of open ended questions addressing the research aims, along with a section collecting participants' demographic information. As the instrument was designed for an exploratory qualitative needs analysis, a pilot implementation and statistical reliability analysis were not conducted.

Data Collection Procedure

Information about the study was shared in 2nd and 3rd year science education courses and in related social media groups. Participants were invited to the researchers' office to complete the form voluntarily. Thirty two pre service teachers whose personal information matched the study criteria came to the researchers' office and completed the form. While completing the form, participants engaged in interviews with the researchers and recorded their responses in detail. In accordance with Yin's (2013) principles of case study research, triangulation was supported through the use of multiple sources of evidence, including participants' written responses, demographic information, and researchers' field notes taken during the data collection process. In addition, a clear chain of evidence was maintained by systematically linking the research questions, data collection instrument, analytical procedures, and reported findings.

Data Analysis

Content analysis was employed to analyze the qualitative data obtained from the opinion forms. The analysis process followed a systematic and iterative procedure. First, all responses were read repeatedly by both researchers to gain familiarity with the data.

In the second stage, open coding was conducted independently by the researchers, during which meaningful units related to Science Field Skills, their process components, and training needs were identified and labeled. Following independent coding, the researchers compared their codes and discussed similarities and differences. Through this process, a consensus was reached, and a common coding scheme was established.

In the third stage, related codes were grouped into categories, which were then organized under broader themes aligned with the research questions. Throughout the analysis, constant comparison was used to ensure consistency across categories and themes.

To enhance the trustworthiness of the analysis, researcher triangulation was applied by involving two independent coders, and representative direct quotations from participants were included in the findings section. In addition, frequencies of certain codes were calculated and reported descriptively where appropriate to support the qualitative findings.

Findings

In this section, the findings related to the research questions are presented in tabular form, followed by a detailed explanation of the results.

1. What are pre service teachers' levels of knowledge regarding the Science Field Skills defined in the Türkiye Century Maarif Model?

To determine participants' knowledge levels regarding the Science Field Skills defined in TCMM, the following question was asked: ―What is your level of knowledge regarding the Science Field Skills defined in the Türkiye Century Maarif Model? Please select one of the options below and explain. Participants first selected one of the options (―I have knowledge, ―I have very little knowledge, ―I have no knowledge‖) and then provided explanations. Table 3 summarizes participants' responses.

Table 3

Pre service teachers' knowledge levels regarding science field skills

	f	%	Explanation
I have knowledge	6	19	*In our courses the 2024 TCMM curricula were introduced and compared with the 2018 curriculum *I have information about skills, values, etc. *I know there are 13 domain skills.
I have very little knowledge	19	59	*To provide students with knowledge and skills *I have only heard of it *I have limited knowledge such as that skills and values are combined *Bilgim var ama yeterli mi, bilemiyorum.
I have no knowledge	7	22	* I have no knowledge at all

According to table 3, pre service science teachers' knowledge levels regarding the Science Field Skills defined in the Türkiye Century Maarif Model were generally limited. While only six participants (19%) reported that they had knowledge of the Science Field Skills, the majority of the participants indicated either having very little knowledge (59%) or no knowledge at all (22%). Participants who reported having knowledge stated that this information was mainly acquired through coursework or participation in academic seminars, whereas those reporting very limited knowledge emphasized brief or superficial exposure to the model during their courses. These findings indicate that most pre service science teachers lack sufficient and systematic knowledge of the Science Field Skills, highlighting a clear need for structured training aligned with the requirements of the Türkiye Century Maarif Model.

2. What are pre service teachers' levels of knowledge regarding the process components of the Science Field Skills defined in TCMM?

To determine participants' knowledge levels regarding the process components of the Science Field Skills, the following question was asked: ―What is your level of knowledge regarding the process components of the Science Field Skills defined in the Türkiye Century Maarif Model? Please select one of the options below and explain. Participants selected one of the options (―I have knowledge, ―I have very little knowledge, ―I have no knowledge) and provided explanations. Table 4 summarizes participants' responses.

Table 4

Pre service teachers' knowledge levels regarding process components of science field skills

	f	%	Explanation
I have knowledge	4	13	*Domain skills include process components *Process components are included in the outcomes.
I have very little knowledge	16	50	*There is a process-oriented progression and the student must engage with and structure the topic *Students consolidate knowledge through experiments and observations.

I have no knowledge	12	37	*I have no knowledge at all.

According to table 4, pre service science teachers' knowledge levels regarding the process components of the Science Field Skills defined in the Türkiye Century Maarif Model were notably limited. Only four participants (13%) reported that they had knowledge of the process components, whereas half of the participants (50%) indicated having very little knowledge and a substantial proportion (37%) reported having no knowledge at all. Participants who selected the option ―I have knowledge‖ emphasized that domain specific skills include process components and that these components are embedded within learning outcomes. In contrast, those reporting very limited knowledge referred to general statements about process oriented instruction, indicating a superficial understanding of the concept. These findings suggest that pre service teachers' awareness of process components is largely insufficient, which may hinder the effective planning and implementation of skill based and inquiry oriented science instruction as envisioned by the TCMM.

3. What are pre service teachers' views on the necessity of training in Science Field Skills?

To determine participants' views on the necessity of SFS training, the following question was asked: ―How do you think the gains you would obtain from Science Field Skills training would contribute to your individual development, professional development, and societal development within the framework of science teacher education? Participants provided explanations for individual, professional, and societal contributions. Table 5 summarizes their views.

Table 5

Participants' views on the necessity of science field skills training

		f	%	Explanation
Individual development	Developing subject knowledge	9	28	*I think it will deepen my subject knowledge *I will be able to convey knowledge more effectively.
	Developing personal perspective	7	22	*It will enable broader thinking *it will help me think more analytically about events.
	Development of personal skills	5	16	*Bilimsel düşünme ve problem çözme becerilerimi geliştirir. *Becerilerimi keşfetme konusunda etki eder.
	No opinion	11	34	
Professional development	Enhancing competence	12	38	*It will enable me to become a more competent teacher *it will increase my knowledge and equipment in science.
	Effective teaching	9	28	*It will enable better and more lasting instruction *I can create a planned and programmatic roadmap for teaching *We will become teachers who strive to improve and teach well.
	No opinion	11	34	
Societal development	Scientific advancement	8	25	*We can advance scientifically as a society *it can foster scientific ethics and academic integrity *it can improve society's perspective on science.
	Critical thinking	5	16	*It can spread a culture of critical thinking and contribute to sustainable development, technology, and innovation.
	Improvement in social relations	3	9	* It increases social relations.

No opinion	16	50

Table 5 presents pre service science teachers' views on the necessity of training related to the Science Field Skills. The findings indicate that participants primarily emphasized the importance of such training for professional development, particularly in terms of enhancing teaching competence (38%) and supporting effective teaching practices (28%). In addition, a considerable number of participants highlighted individual development, noting that Science Field Skills training could contribute to the development of subject knowledge (28%), personal perspectives (22%), and personal skills (16%).

Although fewer participants referred to societal development, some participants emphasized the role of Science Field Skills training in promoting scientific advancement (25%), critical thinking (16%), and social relations (9%). The relatively high proportion of participants who expressed no opinion in the societal development category suggests that pre service teachers may perceive the benefits of Science Field Skills training primarily at the individual and professional levels rather than at a broader societal level. Overall, these findings demonstrate that pre service teachers view Science Field Skills training as necessary, particularly for improving their professional competence and instructional effectiveness.

4. Are there courses in the science teacher education program related to Science Field Skills? If so, what are pre service teachers' views on the adequacy of the theoretical/practical components of these courses?

To determine whether participants had taken courses related to Science Field Skills and their views on the adequacy of theoretical/practical components, the following question was asked: "Are there courses in the science teacher education program related to Science Field Skills? If so, what are your views on the adequacy of the theoretical/practical components of these courses?" Table 6 summarizes participants' responses.

Table 6

Courses related to science field skills and perceived adequacy

				Level of Proficiency					
				Adequate		Moderate		Inadequate	
		f	%	f	%	f	%	f	%
I took courses	Approaches to Science Learning and Teaching	6	18	4	12	1	3	1	3
	Science Teaching	5	16	3	10	1	3	1	3
	Science Curriculum	4	13	4	13				
	Material Design in Science Teaching	1	3			1	3		
I did not take courses		16	50						

Table 6 presents pre service science teachers' experiences with courses related to Science Field Skills and their views on the adequacy of the theoretical and practical components of these courses. According to the findings, half of the participants (50%) reported that they had taken at least one course related to Science Field Skills, most commonly Approaches to Science Learning and Teaching, Science Teaching, Science Curriculum, and Material Design in Science Teaching.

Among the participants who had taken these courses, perceptions of adequacy varied across courses. While some participants evaluated the theoretical and practical components as adequate, others rated them as moderate or inadequate, indicating inconsistencies in how Science Field Skills are addressed within the teacher education curriculum. Notably, relatively few participants reported a high level of proficiency gained from these courses, suggesting that exposure to Science Field Skills may be limited or implicit rather than systematic.

In addition, the fact that half of the participants had not taken any courses explicitly related to Science Field Skills highlights a significant gap in the science teacher education program. Participants' statements further indicate that although certain courses were perceived as beneficial, the extent to which Science Field Skills were explicitly emphasized and reinforced varied depending on instructional practices. Overall, these findings suggest that existing courses may not sufficiently or consistently support the development of Science Field Skills, underscoring the need for structured and explicit training aligned with the Türkiye Century Maarif Model.

The participants' statements are presented below:

> *"We focused sufficiently on the curriculum during the course and examined it in detail; however, since I did not review it afterwards, not much comes to mind."*
>
> *"Primarily because our instructor was an excellent role model, the course was very engaging and beneficial for me; however, under different circumstances, I might have found it boring.I am not entirely sure."*

5. What recommendations do pre service teachers propose regarding the planned Science Field Skills training?

In order to determine the views of the participating pre-service teachers regarding the scope of Science Field Skillseducation, the question ―What suggestions do pre-service teachers wish to express regarding the planned implementation of Science Field Skillseducation?‖ was addressed. The views of the pre-service teachers are presented in table 7.

Table 7

Pre-service teachers' views on the scope of science field skills education

		f*	%
Content of Science Field Skills Education	Should be related to daily life	10	25
	Should be practice-based	8	20
	Should enhance subject-matter knowledge	7	18
	Should include instructional methods	6	15
	Should include design-based activities	5	12
	Should include a skill-oriented assessment process	4	10

*Since the pre-service teachers provided suggestions in more than one category, the total frequency exceeds the number of participants

Table 7 presents pre service science teachers' views on the scope of Science Field Skills education and their suggestions regarding the planned implementation of such training. As shown in the table, the most frequently emphasized suggestions were that Science Field Skills education should be related to daily life (25%) and practice based (20%). Participants also highlighted the importance of enhancing subject matter knowledge (18%) and incorporating instructional methods (15%) and design based activities (12%) into the training process.

In addition, some participants emphasized the inclusion of a skill oriented assessment process (10%), indicating an awareness that assessment practices should align with skill based instruction. Taken together, these findings suggest that pre service teachers expect Science Field Skills education to be authentic, application oriented, and methodologically rich, rather than limited to theoretical content. This expectation reflects a preference for training programs that integrate real life contexts, active learning approaches, and assessment practices aligned with the skill based structure of the Türkiye Century Maarif Model.

Conclusion and Discussion

In this study, pre-service science teachers' levels of knowledge regarding the Science Field Skills (SFS) developed within the scope of the Türkiye Century Education Model (TCEM), their awareness of the process components of these skills, their perceptions of the adequacy of the current teacher education program, and their views on education related to SFS were examined. The findings revealed that the majority of pre-service teachers had limited knowledge of SFS and their process components. However, they believed that education focused on SFS would provide significant contributions at the individual, professional, and societal levels.

While a small proportion of pre-service teachers reported having sufficient knowledge of science subject-specific skills, the majority selected the options ―I have very limited knowledge‖ or ―I have no knowledge.‖ This finding indicates that although TCEM was officially implemented in 2024, the model particularly subject-specific skills has not yet been sufficiently and systematically addressed within teacher education programs. Similarly, the low level of knowledge regarding the process components of subject-specific skills suggests that skill-based instruction remains largely at a conceptual level, with insufficient development of practical implementation and process awareness. The literature emphasizes that one of the main reasons teachers struggle to implement inquiry-based and skill-oriented instruction in classroom settings is their lack of knowledge and experience in these areas (Asay & Orgill, 2010; Bayır & Köseoğlu, 2013; Mansur, 2015; Kaya & Yılmaz, 2016).

In terms of individual development, pre-service teachers stated that education in Science Field Skills would contribute to deepening subject-matter knowledge and enhancing analytical and critical thinking skills. This finding aligns with the TCEM approach, which positions learners not merely as consumers of knowledge but as producers of knowledge (Sarıgöz, 2023; Arslankara & Arslankara, 2024). Moreover, this emphasis on individual skill development is consistent with studies demonstrating that inquiry-based learning enhances students' problem-solving and critical thinking skills (Branch & Solowan, 2003; Perry & Richardson, 2001).

Regarding professional development, a large proportion of pre-service teachers indicated that SFS education would enable them to become more competent and effective teachers. This finding is consistent with studies highlighting subject-matter knowledge, instructional skills, and continuous professional development as key determinants of teacher quality (Korkmaz, 2021; Minott, 2022; Yaman, Bal-İncebacak, & Sarışan-Tungaç, 2022). Pre-service teachers' expectations of effective teaching also support research emphasizing the need for teacher education programs to establish a strong connection between theoretical knowledge and classroom practice (Goh, Canrinus, & Wong, 2020; Lougrahn, 2006).

From a societal development perspective, pre-service teachers stated that SFS education would support scientific advancement, promote a culture of critical thinking, and positively influence society's perception of science. This finding aligns with the holistic approach of TCEM, which aims not only to improve academic achievement but also to cultivate virtuous, competent, and socially responsible individuals (Yıldırım & Çalışkan, 2024). Considering that fostering scientifically literate individuals is a common goal of education systems worldwide (Karışan, Bilican, & Şenler, 2017), the awareness demonstrated by pre-service teachers can be regarded as a significant finding.

The limited number of pre-service teachers who had taken courses related to SFS within teacher education programs, along with the fact that most of these courses were evaluated as ―moderate‖ or ―inadequate,‖ indicates that current programs are insufficient in supporting the skill-based structure of TCEM. This finding is consistent with national and international studies reporting that teachers face challenges in transferring inquiry-based and skill-oriented instructional practices into classroom environments (Lee et al., 2004; Rushton et al., 2011; Zion & Mendelovici, 2012).

Finally, an examination of pre-service teachers' suggestions reveals that their expectations regarding SFS education center on a structure that is related to daily life, practice-based, design-oriented, and includes skill-focused assessment and evaluation processes. This finding demonstrates a strong alignment with TCEM's learning–teaching and assessment philosophy and suggests that pre-service teachers have intuitively internalized the underlying principles of the model (MEB, 2024a; MEB, 2024b).

Recommendations

Based on the findings of the study, the following recommendations are proposed:

Recommendations for teacher education programs:

- Mandatory and practice-oriented courses that directly address the Türkiye Century Education Model (TCEM) and Science Field Skills(SFS) should be incorporated into undergraduate science teacher education programs.
- Existing course contents should be restructured to explicitly include subject-specific skills and their process components.
- Applied learning environments should be created within courses to enable pre-service teachers to design and implement skill-based activities.

Recommendations for practitioners (academicians and teachers):

- SFS education for pre-service teachers should be conducted through real-life problem situations and inquiry-based scientific activities.
- Greater emphasis should be placed on contemporary instructional approaches such as design-based learning, inquiry-based learning, and argumentation.
- The use of skill-oriented assessment and evaluation tools (e.g., performance tasks, rubrics, and process-based assessment) should be expanded.

Recommendations for policymakers:

- To strengthen the teacher education dimension of TCEM, coordinated program development initiatives should be carried out between universities and the Ministry of National Education.
- Standardized and sustainable training programs focusing on Science Field Skillsshould be planned for both pre-service and in-service teacher education.

Recommendations for future research:

- Experimental and quasi-experimental studies should be conducted to examine the effectiveness of educational programs developed for Science Subject-Specific Skills.
- The generalizability of findings should be enhanced through comparative studies involving different universities and various teacher education fields.
- Mixed-methods research should be undertaken to investigate the relationships among pre-service teachers' attitudes toward SFS, self-efficacy, and classroom implementation skills.

Declarations

Acknowledgements: We would like to thank the participating science teachers for their voluntary contribution to this study.

Authors' contributions: AÇ determined the research problem, conducted the literature review, designed the study, developed the data collection instruments, and wrote the manuscript. HS collected the data and reviewed the manuscript and references. All authors read and approved the final manuscript.

Competing interests: The authors declare that they have no competing interests.

Funding: The authors declare that this research received no external funding.

Ethics approval and consent to participate: Ethical approval was not required for this study, as it did not involve any intervention with human participants. Participation was voluntary.

References

Abide, Ö. F. (2021). Farklı eğitim kademelerindeki öğrencilerin nitelikli okul, nitelikli ders ve nitelikli öğretmen özelliklerine yönelik algılarının karşılaştırmalı olarak incelenmesi. *Kesit Akademi Dergisi, 7*(26), 463–482.

Arslankara, V. B., & Arslankara, E. (2024). Türkiye yüzyılı maarif modeli'nin felsefi temelleri: Ontolojik, epistemolojik ve aksiyolojik bakış açılarından bir değerlendirme. *İstanbul Eğitim Dergisi, 1*(1), 121–145. https://doi.org/10.71270/istanbulegitim.istj.1557889

Asay, L., & Orgill, M. (2010). Analysis of essential features of inquiry found in articles published in *The Science Teacher*, 1998–2007. *Journal of Science Teacher Education, 21*(1), 57–79. https://doi.org/10.1007/s10972-009-9152-9

Bell, T., Urhahne, D., Schanze, S., & Ploetzner, R. (2010). Collaborative inquiry learning: Models, tools, and challenges. *International Journal of Science Education, 32*(3), 349–377. https://doi.org/10.1080/09500690802582241

Bayır, E., & Köseoğlu, F. (2013). Kimya öğretmen adaylarında sorgulayıcı-araştırma odaklı öğretime ilişkin anlayış oluşturma. *E-aji Asian Journal of Instruction, 1*(2), 29–43.

Branch, J. L., & Solowan, D. G. (2003). Inquiry-based learning: The key to student success. *School Libraries in Canada, 22*(4), 6–12.

Ceylan Çapar, M., & Ceylan, M. (2022). Durum çalışması ve olgubilim desenlerinin karşılaştırılması. *Anadolu Üniversitesi Sosyal Bilimler Dergisi, 22*(Özel Sayı 2), 295–312. https://doi.org/10.18037/ausbd.1227359

Çetin, A., & Özdemir, Ö. F. (2018). Mode-method interaction: The role of teaching methods on the effect of instructional modes on achievements, science process skills, and attitudes towards physics. *Eurasia Journal of Mathematics, Science and Technology Education, 14*(5), 1815–1826. https://doi.org/10.29333/ejmste/85217

Darling-Hammond, L., Flook, L., Cook-Harvey, C., Barron, B., & Osher, D. (2020). Implications for educational practice of the science of learning and development. *Applied Developmental Science, 24*(2), 97–140. https://doi.org/10.1080/10888691.2018.1537791

Ekiz, D. (2003). *Eğitimde araştırma yöntem ve metodlarına giriş: Nitel, nicel ve eleştirel kuram metodolojileri*. Anı Yayıncılık.

Goh, P. S. C., Canrinus, E. T., & Wong, K. T. (2020). Preservice teachers' perspectives about coherence in their teacher education program. *Educational Studies, 46*(3), 368–384. https://doi.org/10.1080/03055698.2019.1584856

Karışan, D., Bilican, K., & Şenler, B. (2017). Bilimsel sorgulama hakkında görüş anketi: Türkçeye uyarlama, geçerlik ve güvenirlik çalışması. *İnönü Üniversitesi Eğitim Fakültesi Dergisi, 18*(1), 326–343. https://doi.org/10.17679/inuefd.307053

Kaufman, R., & Guerra-Lopez, I. (2013). *Needs assessment for organizational success*. ASTD Press.

Kaya, G., & Yılmaz, S. (2016). Açık sorgulamaya dayalı öğrenmenin öğrencilerin başarısına ve bilimsel süreç becerilerinin gelişimine etkisi. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi, 31*(2), 300–318. https://doi.org/10.16986/HUJE.2016016811

Korkmaz, G. (2021). Öğretim becerileri, kişilik özellikleri, alan bilgisi ve mesleki gelişim bağlamında etkili öğretmen özellikleri. *Türk Eğitim Bilimleri Dergisi, 19*(1), 525–541. https://doi.org/10.37217/tebd.898343

Lee, O., Hart, J. E., Cuevas, P., & Enders, C. (2004). Professional development in inquiry-based science for elementary teachers of diverse student groups. *Journal of Research in Science Teaching, 41*(10), 1021–1043. https://doi.org/10.1002/tea.20037

Loughran, J. J. (2006). *Developing a pedagogy of teacher education: Understanding teaching and learning about teaching* (1st ed.). Routledge.

Mansur, N. (2015). Science teachers' views and stereotypes of religion, scientists and scientific research: A call for scientist-science teacher partnerships to promote inquiry-based learning. *International Journal of Science Education, 37*(11), 1767–1794. https://doi.org/10.1080/09500693.2015.1049575

Millî Eğitim Bakanlığı. (2017). *Öğretmenlik mesleği genel yeterlilikleri*. Öğretmen Yetiştirme ve Geliştirme Genel Müdürlüğü. Erişim tarihi: 22 Mart 2025, https://kamudanhabernet.teimg.com/kamudanhaber-net/images/upload/OYRETMENLYK_MESLEYY_GENEL_YETERLYLYKLERY.pdf

Millî Eğitim Bakanlığı. (2024a). *Türkiye yüzyılı maarif modeli alan becerileri*. Erişim tarihi: 22 Mart 2025, https://tymm.meb.gov.tr/alan-becerileri

Millî Eğitim Bakanlığı. (2024b). *Türkiye yüzyılı maarif modeli fen bilimleri alan becerileri*. Erişim tarihi: 22 Mart 2025, https://tymm.meb.gov.tr/beceriler/fen-bilimleri-alan-becerileri

Minott, M. (2022). Teacher characteristics they value: London upper secondary students' perspectives. *Educational Studies, 48*(1), 33–43. https://doi.org/10.1080/03055698.2020.1740879

National Research Council. (1996). *National science education standards*. The National Academies Press. https://doi.org/10.17226/4962 Cloudinary+1

National Research Council. (2000). *Inquiry and the national science education standards: A guide to teaching and learning*. The National Academies Press.

Perry, V. R., & Richardson, C. P. (2001). The New Mexico Tech master of science teaching program: An exemplary model of inquiry-based learning. In *Proceedings of the 31st Annual Frontiers in Education Conference* (Vol. 1, pp. T3E-1–T3E-4). IEEE. https://doi.org/10.1109/FIE.2001.963917

Rushton, G. T., Lotter, C., & Singer, J. (2011). Chemistry teachers' emerging expertise in inquiry teaching: The effect of a professional development model on beliefs and practice. *Journal of Science Teacher Education, 22*(1), 23–52. https://doi.org/10.1007/s10972-010-9224-x

Sarıgöz, O. (2023). Ortaokul matematik dersi öğretim programının 21. yüzyıl becerileri yönünden incelenmesi. *E-Uluslararası Eğitim Araştırmaları Dergisi, 14*(2), 1–16. https://doi.org/10.19160/e-ijer.1200499

Şenler, B. (2014). Turkish adaptation of the competence scale for learning science: Validity and reliability study. *Eğitimde Kuram ve Uygulama, 10*(2), 393–407. https://doi.org/10.17244/eku.00515

Tondeur, J., Aesaert, K., Pynoo, B., van Braak, J., Fraeyman, N., & Erstad, O. (2017). Developing a validated instrument to measure pre-service teachers' ICT competencies: Meeting the demands of the 21st- century. *British Journal of Educational Technology, 48*(2), 462–472. https://doi.org/10.1111/bjet.12380

Üstüner, M. (2004). Geçmişten günümüze Türk eğitim sisteminde öğretmen yetiştirme ve günümüz sorunları. *İnönü Üniversitesi Eğitim Fakültesi Dergisi, 5*(7), 63–82.

Voogt, J., Knezek, G., Christensen, R., & Lai, K. W. (2023). Teacher professional development for the integration of 21st century skills. *Computers & Education, 9*(4), 39–50.

Yaman, S., Bal-İncebacak, B., & Sarışan-Tungaç, A. (2022). Öğretmen niteliklerinin belirlenmesinde paydaşların görüşleri. *Ahmet Keleşoğlu Eğitim Fakültesi Dergisi, 4*(2), 376–397. https://doi.org/10.38151/akef.2022.24

Yıldırım, Y., & Çalışkan, A. (2024). Türkiye yüzyılı maarif modeli'nin 21. yüzyıl insan profili açısından değerlendirilmesi. *Elektronik Eğitim Bilimleri Dergisi, 13*(26), 204–220. https://doi.org/10.55605/ejedus.1548121

Yin, R. K. (2013). *Case study research: Design and methods*. Sage.

Zion, M., & Mendelovici, R. (2012). Moving from structured to open inquiry: Challenges and limits. *Science Education International, 23*(4), 383–399.

Appendix 1

FEN BİLİMLERİ ALAN BECERİLERİ EĞİTİMİ GELİŞTİRİLMEYE YÖNELİK İHTİYAÇ ANALİZİ- GÖRÜŞ FORMU

Değerli öğretmen adayı;

Türkiye Yüzyılı Maarif Modeli kapsamında fen bilimleri dersi öğretim programı hazırlanmış ve 2024 yılından itibaren Türkiye'deki ilköğretim düzeyindeki okullarda uygulanmaya başlanmıştır. Hazırlanan öğretim programında fen bilimleri alan becerileri ve süreç bileşenleri yer almaktadır. Beceriler ve süreç becerilerinin öğretmen adaylarına kazandırılması, öğretmen adaylarının ihtiyaç duyacakları konuların belirlenmesi amacıyla Fen Bilimleri Alan Becerilerini geliştirmeye yönelik ihtiyaç analizi çalışması yapılmaktadır. Bu görüş formunda 5 adet açık uçlu soru bulunmaktadır. Sorulara içtenlikle vereceğiniz cevaplar çalışmanın geçerliği açısından önemlidir. Kişisel bilgileriniz çalışmanın hiçbir yerinde kullanılmayacaktır. Çalışmaya katılımınızdan dolayı teşekkür ederiz.

Doç. Dr. Ali ÇETİN Arş. Gör. Halil SOMUNCU,

1. Türkiye Yüzyılı Maarif Modelinde tanımlanan fen bilimleri alan becerileri hakkındaki bilgi düzeyiniz nedir? Aşağıdaki seçeneklerden birini seçerek açıklayınız.

Bilgim var	Açıklayınız:
Çok az bilgim var	Açıklayınız:
Hiç bilgim yok	

2. Türkiye Yüzyılı Maarif Modelinde tanımlanan fen bilimleri alan becerilerinin süreç bileşenleri yönelik bilgi düzeyiniz nedir? Aşağıdaki seçeneklerden birini seçerek açıklayınız.

Bilgim var	Açıklayınız:
Çok az bilgim var	Açıklayınız:
Hiç bilgim yok	

3. Fen Bilimleri Alan Becerileri eğitimi kapsamında edineceğiniz kazanımların fen bilgisi öğretmenliği çerçevesinde bireysel gelişiminize, mesleki gelişiminize ve toplumsal gelişime nasıl katkı sağlayacağını düşünüyorsunuz?‖

Bireysel Gelişiminize Faydaları	Açıklayınız:
Mesleki Gelişiminize Faydaları	Açıklayınız:
Toplumsal Gelişime Faydaları	Açıklayınız:
Fikrim yok	

4. Fen Bilgisi öğretmenlik programında fen bilimleri alan becerilerine ilişkin alınan ders var mı? Varsa bu kapsamdaki teorik/uygulama çalışmalarının yeterliliği hakkında görüşleri nelerdir?

Ders aldım	Alınan dersin adı: , Alınan dersin yeterliğine ilişkin görüşler:
Ders almadım	

5. Gerçekleştirilmesi planlanan Fen Bilimleri Alan Becerileri eğitimi kapsamında almak istediğiniz eğitime yönelik aşağıdaki hususlarda önerilerinizi belirtiniz.

a. Fen Bilimleri Alan Becerileri eğitimi kapsamında özellikle hangi hususlara yönelik eğitim almak/ bilgi edinme istiyorsunuz?

b. Fen Bilimleri Alan Becerileri eğitimi kapsamında hangi konu başlığı/içerik çerçevesinde bilgi verilmesini önerirsiniz?

c. Fen Bilimleri Alan Becerileri eğitimi kapsamında uygulamaya dönük hangi öğrenme-öğretme süreçlerinin yürütülmesini önerirsiniz?

d. Fen Bilimleri Alan Becerileri eğitimi kapsamında hangi süreç ve sonuç değerlendirmesi yapılmasını önerirsiniz?
