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International Journal of Curriculum and Instruction 14(3) (2022) 2490- 2504

IJCI
International Journal of Curriculum and Instruction

Science Learning Skills of Science and Mathematics Education Students

Engin Meydan [a]*

[a] *Çanakkale Onsekiz Mart University, Ezine Vocational School, 17100, Turkey*

Abstract

In the study, it was aimed to determine and compare the perceptions of science teaching students and mathematics teaching students towards science learning skills. The research was carried out using descriptive method and scanning model. The universe consists of students studying at a university located in the west of Turkey, and the sample consists of students from science and mathematics teaching. The Science Learning Skills Scale adapted to Turkish by Şenler (2014) was used in the study. The scale used in the research consists of scientific inquiry and communication subscales, and these subscales also consist of four dimensions. No significant difference was found in terms of gender and department variable in the dimensions of proposing questions and hypotheses, planning and analyzing data, interpreting and reaching conclusions of the scientific inquiry subscale. While there was no significant difference according to the gender variable in the experimental and data collection sub-dimension of the scientific inquiry subscale, a significant difference was found in favor of the science teacher according to the department variable. There was no significant difference in the dimensions of expressing, evaluating, interacting, and negotiating the communication subscale in terms of gender and department variables.

Keywords: Science teacher candidates; mathematics teacher candidates; science learning skills; inquiry; communication

1. Introduction

What is expected from teaching in the 21st century is to provide students with critical thinking, creative thinking, communication, research, problem solving, decision making, information and communication technologies skills. In other words, the aim of education is to raise individuals who can keep up with the changes and developments in the 21st century. In the Science and Technology Curriculum (MEB, 2022), which has been implemented since the 2005-2006 academic year, it is aimed to raise students as individuals who research and questionary, think critically, and have advanced problem-solving and decision-making skills. Science and technology course, students; It aims to understand the nature of science and scientific knowledge, basic science concepts,

* Engin MEYDAN ORCID ID.: https://orcid.org/0000-0002-1860-1715
E-mail address: enginmeydan@comu.edu.tr

principles, laws and theories, and to use scientific inquiry skills while solving problems and making decisions (MEB, 2022). In addition to knowledge, science teaching should also provide the skills to use this knowledge in practice. OECD (2006); He states that science competencies include knowledge, skills, inquiry and communication and that these factors should be taken into account in the evaluation of students. “Since science progresses as it is shared, an individual who does scientific inquiry and has scientific interests should also have good communication skills. Communication skill includes not only verbal or written communication, but also mathematical symbols, graphics, tables and figures used to convey information such as findings and results to the other party. In this context, a student with communication skills should be able to convey the desired information to the other party in different forms” (Şenler, 2014, 398).

Science consists of two main components: knowledge and acquiring knowledge (Özgelen, 2012). Scientific knowledge consists of concepts such as hypotheses, theories, facts and laws. In order to acquire scientific knowledge, students should use their high-level thinking skills in science learning. These skills are basically realized by applying the knowledge to the desired area using problem solving skills and various scientific processes (Krau, 2011; Miri & Uri, 2007; Nuthall, 1999; Pappas, Pierrakos, & Nagel, 2012; Yao, 2012; Zohar & Dori, 2003). The main purpose of science education is to teach activities that encourage students to use higher-order thinking skills such as reasoning, critical, reflective and scientific process skills. These activities, which were later adopted, enable them to develop themselves in order to solve the difficulties of daily life (Aktamis & Yenice, 2010; Davidson & Worsham, 1992; Zachariades, Christou & Pitta-Pantazi, 2013). However, educators generally believe that this important goal does not work as planned for all students (Zohar & Vaaknin, 2001). The common belief among educators is that only very successful students can perform applications that require skills. Mediocre or unsuccessful students, on the other hand, can barely master the basic facts and cannot succeed in such tasks (Zohar, 1999). In research on conceptual skills, it has been observed that the more high-level thinking skills are facilitated in the learning process, the more aware students are of their own thoughts. Thus, their learning performance increased and their conceptual development was found to be supported (Donald, 2002; Perkins, Jay, & Tishman, 1993). In addition, these learning skills were effective in solving the problems, uncertainties, questions or dilemmas faced by the students. In science classrooms, it has been observed that students' knowledge and experience increase in studies carried out to increase their learning skills. In addition, as a result of the supportive explanations and decisions made for their development, it has been determined that skill performances in other areas have increased. Finally, students should transfer the skills they have gained as scientific knowledge and apply them to new situations (Gillies, Nichols, Burgh, & Haynes, 2014). The learning process that does not have features that will strengthen thinking skills is not beneficial for students (Saragih et al., 2017). Learning is not enough just in terms of telling and listening. At the same time, it is necessary for students to use materials that will enable them to find the concept itself throughout the learning process (Suwono & Dewi, 2019). As a result of the inadequacy of the applied learning process, the quality of higher-order thinking skills in science learning decreases. This process is a systematic process consisting of design, implementation and evaluation stages, respectively, and forms the basis of classroom learning practices. (Joyce et al., 2015). The learning design process must be properly prepared. In the learning process, students, goals, methods and evaluation issues play an important role in the emergence of students who have gained quality science learning skills. It is necessary to pay attention to these issues and to solve the problems that arise in the classroom practices at an early age. These operations are performed carefully and correctly. If these processes are applied carefully and correctly, significant science learning skill gains will be obtained. Today, it can be said that having thinking skills is the basic key of education and training (Zain, 2017).

1.1. Purpose of the research

The aim of the research is to determine the perceptions of Science Teaching and Mathematics Teaching students towards science learning skills and to determine whether there is a difference in the perception of science learning skills between the students of these two teaching departments. The research sought answers to the following questions:

1. What is the scientific inquiry status of science and mathematics teaching students, and is there a difference between them at the level of gender and department?

   1.1 What is the question and hypothesis proposition status of science and mathematics teaching students, and is there any difference between them at the level of gender and department?

   1.2 What is the planning status of science and mathematics teaching students and is there a difference between them at the level of gender and department?

   1.3 What is the state of experimentation and data collection of science and mathematics teaching students, and are there any differences between them at the level of gender and department?

   1.4 What is the status of data analysis, interpretation and conclusion of science and mathematics teaching students, and is there any difference between them at the level of gender and department?

2. What are the communication skills of Science Teaching and Mathematics Teaching students among their science learning skills? Is there a difference between them at the level of gender and department?

2.1 What is the state of expressing science learning skills of Science Teaching and Mathematics Teaching students, and is there a difference between them at the level of gender and department?

2.2 What are the assessment skills of Science Teaching and Mathematics Teaching students among science learning skills? Is there any difference between them at the level of gender and department?

2.3 What are the interaction skills of Science Education and Mathematics Teaching students among science learning skills, and are there any differences between them at the level of gender and department?

2.4 What is the level of negotiation skills of Science Teaching and Mathematics Teaching students among science learning skills, and is there a difference between them at the level of gender and department?

2. Method

2.1. Research model

In the research, descriptive survey model was used in quantitative research methods. The descriptive survey model of quantitative research is to determine the current situation and to reveal the relationships between the elements discussed. In this study, the relationship between the two selected groups and the existing situations of these groups were tried to be determined and compared.

2.2. Universe and sample

The universe of the research is the prospective teachers studying at a university in the west of Turkey, the sample is the students of the Department of Mathematics and Science Education, Science Education and Mathematics Education. Researcher in research; tries to determine the universe by developing criteria suitable for the purpose. The best way to determine a universe is to develop criteria suitable for the purpose and to include those who meet these criteria in the study universe (Karasar, 2005, 110). The selection of students from these two departments in the research is to consider whether their science learning skills differ or not according to the department.

Table 1. Demographic Characteristics of the Students Participating in the Research

Gender	**N**	**%**
Women	99	58.6
Male	70	41.4
Total	169	100

From Table 1, it was determined that 99 of the participants in the sample to which the scale was applied were female and 70 were male. Looking at the table, it is understood that 58.6 of the sample consists of women and 41.4 of them are men. The entire sample consists of 169 people.

Table 2. Distribution of the sample group of the study according to the departments

Department	N	%
Science	82	48.5
Mathematics	87	51.5
Total	100	100

In the sample in which the scale was applied in Table 2, 82 of the participants stated that they were studying in the Department of Science Education and 87 in the Undergraduate Department of Mathematics Teaching. Looking at the table, it is understood that 48.5 of the sample studied Science Teaching and 51.5 of them studied Mathematics Teaching.

2.3. Data collection tool

In the study, Chang et al. (2011), consisting of two sub-scales, namely inquiry and communication, and adapted into Turkish by Şenler (2014), "Science Learning Skills Scale" was used. Science Learning Skills Scale; It consists of scientific inquiry subscale and communication subscale. Scientific inquiry subscale includes question and hypothesis proposition, planning, experimentation and data collection, data analysis and interpretation; On the other hand, the communication subscale consists of "expressing, evaluating, interacting and negotiating" sub-dimensions. The Cronbach Alpha value of the scale used in the research is .93, which shows that the scale is reliable.

2.4. Data collection

The theoretical dimension of the research consists of studies on the subject. Later, Chang et al. Data were collected using the "Science Learning Skills Scale" developed by Şenler (2014) and developed by Şenler (2014). The data were collected from Science Teaching and Mathematics Teaching students who are expected to have science learning skills.

2.5. Analysis of data

SPSS 21.0 statistical package program was used in the analysis of the data, it was investigated whether there was a difference between the Science Learning Skills of Science and Mathematics Teaching Students at the level of department and gender, and the Kolmogorov-Smirnov test was applied to determine whether the data showed a normal distribution

3. Results

This section consists of the findings obtained in the research.

Table 3. Skewness and Kurtosis values of the scale

Subscales	Dimensions	Skewness	Kurtosis
Scientific Inquiry	Proposing Questions and Hypotheses	-,377	1,568
Sub-Scale	Planning	-301	1,395
	Experimenting and Data Collection	-,767	1,816
	Data Analysis and Interpretation	-,165	1,550
	Expression	-,335	,733
	Evaluation	-,783	2,647
	Interacting	-,529	1,751
	Negotiation	-080	1,770

Table 3 shows the kurtosis and skewness values according to the dimensions. Since the values in the table are between +2 and -2 as in the study of George and Mallery (2010), it can be said that they show a normal distribution. For this reason, parametric tests were used in the study. Descriptive statistical analyzes, t-test and one-way analysis of variance were performed on the collected data.

Table 4. Descriptive Statistics Analysis of the Dimensions of the Scale

Subscales	Dimensions	$\bar{x}$	Ss
Scientific Inquiry	Proposing Questions and Hypotheses	4,05	,456
Sub-Scale	Data Analysis and Interpretation	3,84	,448
	Experimenting and Data Collection	3,80	,601
	Planning	3,63	,501
Communaciton Scale	Negotiation	4,10	,460
	Interacting	4,00	,566

When Table 4 is examined, when the answers given for the dimensions in the scale according to the answers of the undergraduate students are examined, Belonging to the Scientific Inquiry Sub-Scale; Sub-Scale of Communication as Suggesting Questions and Hypotheses ($\bar{x}$=4.05), data analysis and interpretation ($\bar{x}$=3.84), experimenting and data collection ($\bar{x}$=3.80), planning ($\bar{x}$=3.63) owned; negotiating ($\bar{x}$=4.10), interacting ($\bar{x}$=4.00), evaluation ($\bar{x}$=3.84), expressing ($\bar{x}$=3.80).

Table 5. Descriptive Statistics Analysis of Question and Hypothesis Proposition Dimensions

Substances	N	%
I can ask what I cannot understand through observation.	82	48,5
I can find appropriate possible answers to questions by reasoning.	87	51,5
I can gather information on research questions for better understanding.	169	100

The pre-service teachers who participated in the research stated that they could ask what they could not understand through observation, that they could find appropriate possible answers to the questions by reasoning, and that they could gather information about the research questions in order to understand better.

Table 6. Descriptive Statistics Analysis of the Planning Dimension

Substances	$\bar{x}$	**Ss**
I can consider factors likely to influence an experiment.	3,76	,698
Depending on the research question, I can choose the appropriate study method.	3,73	,659
As a result of the experiment, I can tell what kind of data should be collected.	3,63	,632
I can design an experiment appropriate to the research question.	3,38	,838

The pre-service teachers who participated in the research state that they can consider the factors likely to affect an experiment, choose the appropriate study method, and say what kind of data should be collected as a result of the experiment, depending on the research question. Pre-service teachers stated that they were undecided about designing an experiment suitable for the research question.

Table 7. Descriptive Statistics Analysis of Experimenting and Data Collection Dimensions

Substances	$\bar{x}$	**Ss**
I can carefully record the observations and results of the experiment.	4,07	,720
I can experiment by following the experimental steps.	4,05	,590
I can use experimental materials to collect data.	4,03	,680

The pre-service teachers who participated in the research stated that they could carefully record the observations and results related to the experiment, they could conduct an experiment by following the experimental steps, and they could use experimental materials to collect data.

Table 8. Descriptive Statistics Analysis of Data Analysis, Interpretation and Conclusion Dimensions

Substances	$\bar{x}$	**Ss**
I can draw conclusions based on mathematical relationships in experimental data.	4,04	,630
I can classify or compare the data obtained as a result of the experiment.	3,98	,607
Based on the results of the experiment, I can make inferences explaining experimental events or natural events.	3,73	,758
I can use learned scientific terms to describe experimental data.	3,59	,833

The pre-service teachers who participated in the research stated that they could reach conclusions based on the mathematical relationships in the experimental data, classify or compare the data obtained as a result of the experiment, make inferences explaining experimental events or natural events based on the experimental results, and use the scientific terms they learned to explain the experimental data.

Table 9. Descriptive Statistics Analysis of the Expression Dimension

Substances	x̄	Ss
I can use graphics or mathematical notation to explain data.	4,04	,610
I can show relationships between data through graphs or mathematical symbols.	3,85	,758
I can describe relationships between data verbally or in writing.	3,82	,732
I can bring and present raw data in an easily understandable form.	3,50	,824

The pre-service teachers who participated in the research stated that they could use graphics or mathematical signs to explain the data, show the relationships between the data through graphics or mathematical symbols, and describe the relationships between the data verbally or in writing. In addition, pre-service teachers stated that they were undecided about bringing and presenting the raw data in an easily understandable form.

Table 10. Descriptive Statistics Analysis of the Evaluation Dimension

Substances	x̄	Ss
I can analyze whether what I am expressing is consistent with what I want to express.	3,89	,681
Based on the information learned, I can evaluate whether the verbal or written statements of others are correct.	3,88	662
I can distinguish between facts and inferences.	3,83	660
I can evaluate questions from a different perspective.	3,78	,700

The pre-service teachers who participated in the research stated that they could analyze whether what they said was consistent with what they wanted to express, they could evaluate whether the verbal or written statements of others were correct based on the information they learned, they could distinguish between facts and inferences, and they could evaluate the questions from a different perspective.

Table 11. Descriptive Statistics Analysis of the Interaction Dimension

Substances	x̄	Ss
I can ask my friends whose expressions are not understandable to explain again.	4,02	,823
I can ask questions about incomprehensible expressions of my classmates.	4,00	,654
I can explain my thoughts in different ways if my classmates don't understand.	3,99	,744

The pre-service teachers who participated in the research stated that they could ask their friends for explanations whose expressions were not understood again, they could ask questions about the incomprehensible expressions of their classmates, and they could explain their thoughts in different ways if their classmates did not understand.

Table 12. Descriptive Statistics Analysis of the Negotiation Dimension

Substances	$\bar{x}$	Ss
In line with the suggestions of my classmates, I can evaluate whether my thoughts contradict each other.	4,18	,577
I can correct my misconceptions in line with the ideas of my classmates.	4,17	,600
I can share my ideas with my classmates through discussion.	4,03	,731
I can find similarities and differences in different views through discussion.	4,00	,659

The pre-service teachers who participated in the research stated that they could evaluate whether their thoughts contradicted each other in line with the suggestions of their classmates with different opinions, they could correct their wrong thoughts in line with the ideas of their classmates, they could share their ideas with their classmates through discussion, and they could find the similarities and differences in different opinions through discussion.

Tablo 13. Bilimsel Sorgulama Alt Ölçeğinin boyutlarına ilişkin cinsiyete göre t-testi sonuçları

Dimension	Gender	n	$\bar{x}$	Ss	t	df	p
Proposing Questions and Hypotheses	Woman	99	4,06	,432	,362	167	,935
	Male	70	4,03	,489			
Planning	Woman	99	3,60	,474	-,664	167	,484
	Male	70	3,66	,540			
Experimenting and Data Collection	Woman	99	3,73	,584	-,447	167	,900
	Male	70	3,83	,628			
Data Analysis and Interpretation	Woman	99	3,82	,433	-,723	167	,790
	Male	70	3,87	,471			

Looking at Table 13, question and hypothesis proposition ($t(167)=.935$; $p>.05$), planning ($t(167)=.484$; $p>.05$), experimentation and data in the scientific inquiry subscale it is seen that there is no significant relationship between the dimensions of collecting ($t(167)=.900$; $p>.05$) and data analysis and interpretation ($t(167)=.790$; $p>.05$) and the gender variable.

Table 14. T-test results by gender regarding the dimensions of the Communication Sub-Scale

Dimension	Gender	n	$\bar{x}$	Ss	t	df	p
Expression	Woman	99	3,84	,486	1,026	167	,296
	Male	70	3,75	,604			
Evaluation	Woman	99	3,81	,451	1.190	167	,648

	Male	70	3,90	,561			
Interacting	Woman	99	4,02	,514	,389	167	,675
	Male	70	3,98				
Negotiation	Woman	99	4,09	,419	-,120	167	,165
	Male	70	4,10	,515			

Looking at Table 14, expression (t(167)=.296; p>.05), evaluation (t(167)=.648; p>.05), interacting (t(167)) in the communication subscale =.675; p>.05) and negotiating (t(167)=.165; p>.05) dimensions and gender variable does not seem to have a significant relationship.

Table 15. t-Test Results according to the Section on the Dimensions of the Scientific Inquiry Subscale

Dimension	**Department**	**n**	$\bar{x}$	**Ss**	**t**	**df**	**p**
Proposing Questions and Hypotheses	Science	82	4,13	,440	2,265	167	,790
	Maths	87	3,97	,459			
Planning	Science	82	3,66	,513	,943	167	,870
	Maths	87	3,59	,490			
Experimenting and Data Collection	Science	82	3,81	,660	,176	167	,026
	Maths	87	3,80	,543			
Data Analysis and Interpretation	Science	82	3,87	,403	1,022	167	,232
	Maths	87	3,80	,487			

When Table 15 is examined, proposing questions and hypotheses in the scientific inquiry subscale (t(167)=,790; p>,05), planning (t(167)=,870; p>,05), and data analysis and interpretation (There is no significant relationship between t(167)=.232; p>.05) dimensions and the quotient variable. When the related table is examined, it is seen that there is a significant relationship between the sub-scale of scientific inquiry (t(167)=.026; p<.05) and the department variable. It is seen that the pre-service science teachers who participated in the study recorded the observations and results of the experiment more carefully than the pre-service mathematics teachers, they did experiments by following the experimental process steps, and they were able to use experimental materials more to collect data.

Table 16. T-test results according to the section related to the dimensions of the Communication Sub-Scale

Dimension	**Department**	**n**	$\bar{x}$	**Ss**	**t**	**df**	**p**
Expression	Science	82	3,79	,586	-,351	167	,283
	Maths	87	3,82	,492			

Evaluation	Science	82	3,90	,520	1,503	167	,496
	Maths	87	3,79	,478			
Interacting	Science	82	4,04	,574	,955	167	,870
	Maths	87	3,96	,559			
Negotiation	Science	82	4,12	,441	,627	167	,878
	Maths	87	4,08	,479			

When Table 16 is examined, the communication subscales include expressing (t(167)=.283; p>.05), evaluation (t(167)=.496; p>.05), interacting (t(167)=.870 ; p>.05) and negotiating (t(167)=.878; p>.05) dimensions and the department variable does not seem to have a significant relationship.

4. Discussion and Conclusion

The results obtained in line with the findings obtained in the research are given below according to the sub-problems:

Considering the answers given to the items in the question and hypothesis proposition dimension in the scientific inquiry sub-scale, it was concluded that the science and mathematics teaching students were able to ask what they could not understand through observation, they could find the appropriate possible answers to the questions by reasoning, and they could gather information about the research questions in order to understand them better. In line with the answers given to the items, it was concluded that there was no significant difference between gender and department variables.

In line with the answers given to the items in the planning dimension in the scientific inquiry sub-scale, it was concluded that science and mathematics teaching students could consider possible factors in influencing an experiment, choose the appropriate study method, and say what kind of data should be collected as a result of the experiment. In addition, it was concluded that pre-service teachers were undecided about designing an experiment suitable for the research question. In line with the answers given to the items, it was concluded that there was no significant difference between gender and department variables.

In line with the answers given to the items in the sub-scale of scientific inquiry, in the dimension of conducting experiments and collecting data, it was concluded that science and mathematics teaching students could carefully record their observations and results about the experiment, conduct experiments by following the experimental process steps, and use experimental materials to collect data. It was concluded that the answers given to the items were not related to the gender variable, but there was a significant difference between the department variable (t(167)=.026; p<.05). It was concluded that the pre-service science teachers participating in the research were able to record the observations and results of the experiment more carefully, follow the experimental process steps and use the experimental materials more to collect data compared to the pre-service mathematics teachers.

In line with the answers given to the items in the sub-scale of scientific inquiry, in the dimension of data analysis, interpretation, and conclusion, science and mathematics teaching students were able to come to a conclusion based on the mathematical relations in the experimental data, classify or compare the data obtained as a result of the experiment, and explain experimental events or natural phenomena based on the results of the experiment. It was concluded that they could make inferences and use the scientific terms they learned to explain the experimental data.

In line with the answers given to the items in the expression dimension in the communication subscale, it was concluded that science and mathematics teaching students could use graphics or mathematical signs to explain the data, show the relationships between the data through graphics or mathematical symbols, and describe the relationships between the data verbally or in writing. In addition, it was concluded that the pre-service teachers were undecided about bringing and presenting the raw data in an easily understandable form. In line with the answers given to the items, it was concluded that there was no significant difference between gender and department variables.

When the answers given to the items in the evaluation dimension in the communication subscale are examined, it is seen that science and mathematics teaching students are able to analyze whether what they express is consistent with what they want to express, evaluate whether the verbal or written statements of others are correct based on the information they have learned, distinguish between facts and inferences, and have different questions. It was concluded that they could evaluate it from a single point of view. It is also among the results that there is no significant difference between the gender and department variables in line with the answers given to the items.

When the answers given to the items in the dimension of interacting in the communication subscale were examined, it was concluded that science and mathematics teaching students could ask their friends to explain their expressions again, they could ask questions about the incomprehensible expressions of their classmates, and they could explain their thoughts in different ways if their classmates did not understand. In line with the answers given to the items, it was concluded that there was no significant difference between gender and department variables.

When the items in the dimension of negotiation in the communication subscale are examined, science and mathematics teaching students will be able to evaluate whether their thoughts contradict each other in line with the suggestions of their classmates with different views, correct their wrong thoughts in line with the ideas of their classmates, share their ideas with their classmates through discussion, and discuss the similarities and differences in different views. concluded that they can be found. It is also among the results that there is no significant difference between the gender and department variables in line with the answers given to the items.

According to the results obtained in the study conducted by Arslan Efe and Özmen (2018) using the same scale, the science learning skills of female and male students are different, and the science learning skills and communication levels of female students are higher than male students; At the level of scientific inquiry, it was determined that there was no significant difference according to gender. There are studies (Aydınlı, 2007; Dönmez & Azizoğlu, 2010) showing significant differences in favor of female students in skills that can be called scientific inquiry skills. In addition, studies on scientific inquiry do not show any significance according to gender (Aydoğdu, 2006; Başdağ & Güneş, 2006). In this study, a result was found in favor of science students only in the sub-dimension of experimenting and collecting data among the students of science teaching and mathematics teaching departments. This is an expected difference from science teaching students. In the study, it was also concluded that there was no significant difference in communication and scientific inquiry skills between science teaching and mathematics teaching students.

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