Research Article

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Pre-service science teachers' levels of awareness of industry 4.0 concepts*[1]

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Abstract

With the developments experienced in recent years, the current period, called Industry 4.0, which includes concepts such as the internet of objects, artificial intelligence, dark factories, and embedded systems, has influenced many areas. One of the areas most affected by these developments is education. The knowledge level of pre-service teachers about these concepts is very important in this study, the purpose was to determine the pre-service science teachers' levels of awareness of Industry 4.0 concepts. "Industry 4.0 Conceptual Awareness Scale" prepared by Dogan and Baloglu (2020) was used as a data collection tool. The findings obtained in the study revealed that the preservice teachers' levels of awareness of Industry 4.0 concepts differed significantly concerning the variables of gender, academic average grade, mother and father's education levels, family income, following scientific journals and websites, and knowing the technological concepts prominent in education. Consequently, it was seen that the pre-service science teachers' awareness of Industry 4.0 concepts was generally at a level below the average, except for certain concepts.

Keywords:

Industry 4.0, Education 4.0, Conceptual Awareness, Digitalization in Education, Pre-Service Science Teacher.

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INTRODUCTION

Since its existence, human being has tried to solve their problems to continue their life in the best conditions and has benefited from nature to raise their living standards. The change in people's needs and the developments in the industry resulted in the classification of social developments. In every century, the concepts used and their scopes change according to the needs. Technological developments in the 21st century heralded a new society and a new industrial era. There is a discussion on the concepts of Industry 4.0 led by Germany and Society 5.0 led by Japan. Industry 4.0 can be considered the fourth stage of the industry (Özsoylu, 2017). The industry 4.0 revolution is simply defined as the Internet of people, computers, machines, and objects (Evans and Annunziata, 2012). Industry 4.0 is at a level that can completely change the connections in the production, consumption, and process stages (Yıldız, 2018). On the other hand, the rapid development of technology has affected people and societies, and the concept of society 5.0 has emerged. Society 5.0, also known as Super Smart Society (Fukuyama, 2018), is based on the view that technology is not a threat to societies, but rather a development for their benefit. For this reason, society 5.0 aims to use the developing technology for the benefit of society (Büyükgöze & Dereli, 2019).

Industry 4.0, the fourth industrial revolution, is a period in which all societies and individuals, industry-state relations, and international relationships will be affected, together with technologies communicating with each other, smart factories and design, production, and distribution systems that provide real-time information exchange and mass customization (Kılıç & Alkan, 2018). Developments in any field affect other fields and open new doors. Society and Individuals are affected by the emergence of products that change people's quality of life thanks to technology (Bacanak, Karamustafaoğlu & Köse, 2003). Therefore, it is inevitable that these changes in the industry and society will also affect education. To keep up with the developments soon and not fall behind the technological and technical systems, it is necessary to raise the awareness of the workforce and to ensure the adaptation of society to the change by associating the education processes with the new industrial revolution. It is also quite important to train qualified manpower equipped with scientific and technological knowledge and experience (Çavaş, 2019).

It is possible to talk about the concept of education 4.0 as the effect of the concept of Industry 4.0 on education. Education as a social phenomenon is equivalent to human history (Çelikkaya, 1995). In this respect, Education 1.0 was based on the transfer of information in agricultural societies, and students mostly followed their teachers and imitated their methods. In the education period to meet the needs experienced in Education 2.0 industrial establishments, educational institutions, according to Pooworawan (2015), began to be seen as a factory and students as products produced in these factories. Education 3.0 is the education period that aims to meet the needs of the technology society with the use of digital media tools. An important transformation that occurred in this period was the training of students as "information producers" rather than "information consumers". In addition, Education 4.0 is defined as a period in which innovation is dominant in education thanks to Industry 4.0 (Öztemel, 2018; Puncreobutr, 2016).

Educational processes should be reconsidered within the scope of the criteria required by the industrial revolution we are facing. Among the groups that need to change in the transition from the industrial society education model to the information society education model are teachers, students, and administrators, and among the phenomena are elements such as the learning method, learning style, education programs, and success criteria. While developing policies suitable for the fourth-wave education model, mass and standard education policies, which are at the center of education in industrial societies, are being questioned more and more (Toffler, 2008). This change, which takes place at the global level, considerably changes education policies and the place of the individual in society as well. Education models that take on the responsibility of raising individuals who will adapt to the fourth

industrial revolution must be dynamic, not static (Çeliktaş et.al., 2015). Developments in information systems remove education and training from being limited to school and bring the concept of lifelong education to the agenda (Özdemir, 2011).

In the world of Education 4.0, the expectation is that the understanding of education/learning will dominate everywhere and all the time; that personalized education adaptable to the abilities and talents of students should be implemented through education systems (Bates, 1997; Puncreobutr, 2016); and that there should be blended learning and out-of-school learning. The contents prepared by students and teachers together should be used with web interfaces and access systems for students to learn most appropriately through virtual mentors in the world of education 4.0. During the learning process, their knowledge will be measured, and at the same time, their ability to apply it in the field will be tested with the performance of the projects they work on. In short, the assessment should be done with a case evaluation instead of an exam (Öztemel, 2018).

It is pointed out that since the 21st century, the gap between the demands of the market and the skills of individuals who have grown up with the current understanding of education has increased. The new generations are expected to acquire the skills required by the political, economic, and social changes. In one study, which focused on whether Turkey was ready for the Fourth Wave Industrial Revolution within the scope of 'education', it was reported that if compliance with the information society structuring, which is the necessity of the current era, was achieved, it would be possible to achieve the goals with the increase in growth, employment and investment rates together with increased productivity (Yazıcı & Düzkaya, 2016); in addition, another study, in which the Industry 4.0 process in Turkey was examined in terms of educational partnerships, revealed that steps should be taken to accelerate the Industry 4.0 process by providing educational partnerships with countries such as Germany and Far East Asian countries (Genç, 2018). In this respect, global standards of the new understanding of education are established (Çetin, 2015).

The International Society for Technology in Education (ISTE, 2016) has determined the educational technology standards that students should have in the 21st century. Accordingly, education reveals the importance of developing technology in the training of new generations. The first of them is the contribution of technology to innovation and information structuring skills in education. The second is the effect of digital media tools on students' communication and collaboration. The third is the effect of digital technology on accessing, evaluating, and using the information in daily life. Fourth, digital tools contribute to problem-solving, critical thinking, and decision-making processes. Fifth, within the scope of digital citizenship, it allows students to solve personal, cultural, or social problems related to technology within the framework of legal and ethical behaviors. The sixth is the contribution of technological activities to the understanding of system formations.

Today's requirements make it necessary to have designer individuals and organizations who have advanced thinking skills, who benefit from digital technologies, who use personalized data and open-source content, who produce and transfer information, and who are capable of responding to the needs of the globally connected technological world (Hussin, 2018). Besides these requirements, one of the basic conditions for adapting to the Education 4.0 period is the integration of Industry 4.0 products such as artificial intelligence, three-dimensional printers, virtual reality, augmented reality, hologram technologies, and simulation technologies within the education processes. Education 4.0 will make use of these technologies in the creation of education systems and tools and will make them a part of the education program for students to learn.

Today, individuals are expected to have high levels of individual innovativeness so that they can access new information and re-produce the information. Individual innovativeness is an indicator of individuals' awareness of innovation and their level of the tendency to experience innovation. The first condition is

said to be the fact that individuals with high levels of individual innovativeness should have creative thinking skills and a good education level (Akçöltekin, 2017; Kılıçer, 2011).

In addition to having the skills of the new century with Education 4.0, it is important to train teachers who will accept the use of digital technologies, personalized data, open-source access, smart agents, mobilization, and the use of new approaches and technologies such as cloud computing as a basis. (Göker, 2020). In general, the integration of technology into education can be defined as increasing the quality of students' learning, having teachers use technology effectively in education, and making technology a part of the curriculum (Mazman & Koçak-Usluel, 2011). Considering that today's generation uses virtual reality, augmented reality, and many other Industry 4.0 concepts in the learning and teaching process, preservice teachers should also know these concepts and be able to reflect them into practice. Increasing the awareness and knowledge levels of students about these concepts also depends on the teachers who will train them. For this reason, it is necessary to raise the awareness of students and teachers who will teach the subject, to provide the necessary training on the subject, and to increase the awareness and knowledge levels of preservice teachers regarding Industry 4.0 concepts. From this point of view, preservice teachers should be trained in a way to have all these processes and equipment as one of the most important keys to the new industrial transformation. Considering all these, it is important to investigate not only how preservice teachers, who will be one of the cornerstones of the education system, perceive the concepts of Industry 4.0 but also how conscious they are of this subject.

In this study, the purpose was to determine the awareness levels of 4thgrade students from the department of Science Teaching in Turkey about the concepts of Industry 4.0. In line with this main purpose, answers to the following questions were sought:

1. What are 4thgrade students' levels of awareness of Industry 4.0 concepts who study in the department of Science Teaching?
2. Do 4thgrade students' levels of awareness of Industry 4.0 concepts who study in the department of Science Teaching differ depending on their gender?
3. Do 4thgrade students' levels of awareness of Industry 4.0 concepts who study in the department of Science Teaching differ depending on their academic grade average?
4. Do 4thgrade students' levels of awareness of Industry 4.0 concepts who study in the department of Science Teaching differ depending on the education levels of their mothers and fathers?
5. Do 4thgrade students' levels of awareness of Industry 4.0 concepts who study in the department of Science Teaching differ depending on their family income?
6. Do 4thgrade students' levels of awareness of Industry 4.0 concepts who study in the department of Science Teaching differ depending on the status of following scientific journals and websites, knowing the technological concepts prominent in education, and having prior knowledge about Industry 4.0?

METHOD

Research Design

In the study, the descriptive survey model, one of the quantitative research methods, was used. As it is known, survey models are research approaches that aim to describe a past or present situation as it is. In addition, the phenomenon, the individual, or the object that constitutes the subject of the research is defined as it is in its conditions (Fraenkel, Wallen & Hyun, 2012). As this study, which included the characteristics of quantitative research, tried to determine the awareness of the 4thgrade students from the department of Science Teaching regarding the concepts of Industry 4.0, the purpose was to define, describe and explain the current situation.

Participants

The universe of the study consisted of senior students studying in the Department of Science Teaching in the education faculties of universities in Turkey. The study's sample consists of 314 teacher candidates, 266 women and 48 men, who were chosen at random from the Faculty of Education of three universities in Turkey and are studying Science Education. The demographic characteristics of the preservice teachers participating in the study are given in Table 1.

Table 1. Demographic Characteristics of the Study Group

Demographic Characteristics	Variable	N	%
Gender	Female	266	84.7
	Male	48	15.3
Academic Average Grade	2.00-2.50	35	11.1
	2.51-3.00	161	51.3
	3.01-3.50	102	32.5
	3.51-4.00	16	5.1
Mother's Education Level	Elementary School	165	52.5
	Secondary School	58	18.5
	High School	61	19.4
	University	30	9.6
Father's Education Level	Elementary School Secondary	98	31.2
	School	72	22.9
	High School	77	24.5
	University	67	21.3
Family Income	Less than 3000 TL	130	41.4
	3000-6000 TL	147	46.8
	6000-9000 TL	22	7.0
	More than 9000 TL	15	4.8
Following Scientific Journals	Yes	196	62.4
	No	118	37.6
Knowing Technological Concepts Prominent in Education	Yes	250	79.6
	No	64	20.4
Having Prior Knowledge About Industry 4.0	Yes	50	15.9
	No	264	84.1
Total		314	100

When the demographic characteristics in Table 1 were examined, it was seen that 85% of the preservice teachers were female and that 15% were male. The academic average grade of 51% of the preservice teachers was between 2.51-3.00 out of 4, and the other half of the preservice teachers had different academic average grades. Graduation from elementary school was more frequent among the mothers (53%) and fathers (31%). Looking at the variable of the income levels of the families, it was seen that 47% of them had income ranging between 3000 TL and 6000 TL. It was seen that 62% of the preservice teachers in the sample followed scientific journals and websites; 80% of them knew the technological concepts prominent in education, and 84% of them did not have prior knowledge of Industry 4.0.

Data Collection Tool

The industry 4.0 Conceptual Awareness Scale, which was developed by Doğan and Baloğlu in 2020, was used as the data collection tool. The scale consisted of two parts. The first part, in line with the purpose

of the study, covered demographic information such as gender, average grade, education levels of the mother and father, family income, following scientific journals, knowing the technological concepts prominent in education, and having prior knowledge about industry 4.0. The scale included 39 items. In the scale prepared as a five-point Likert-type scale, there were statements containing 39 of the concepts of Industry 4.0. The preservice teachers reported their awareness levels by marking one of the options "not much", "little", "moderate", "much" and "a lot".

The industry 4.0 Conceptual Awareness scale developed by Doğan and Baloğlu (2020) has been revealed as one-dimensional. In the study, it was determined that the results of the DFA analysis performed to determine the construct validity of the scale, AGFI, and GFI fit indices were not included in the referenced values. It has been demonstrated in many studies that GFI and AGFI are not independent of sample size (Hu & Bentler, 1999). In addition, both indices decrease with increasing model complexity, especially for smaller sample sizes (Anderson & Gerbing, 1984). In this context, it can be said that the Goodness of Fit Index-GFI .84 and Adjusted Goodness of Fit Index 0.82 values obtained in the study are within acceptable limits even if they do not have perfect fit values (Demir & Akengin, 2010). When other fit indices are examined; It was determined that the χ2/df value met the perfect fit criteria, and the RMSEA and NFI CFI values were among the acceptable fit criteria (Hu & Bentler, 1999; Schermelleh-Engel & Moosbrugger, 2003).

However, considering the low AGFI and GFI values and the relevant modification suggestions, items with high error covariances were matched with each other (m2-m3, m4-m28, m11-m29, m26-m38). The results of the fit indices made after the modification are given in Table 2.

The Cronbach Alpha reliability coefficient of the scale was calculated as .96 by Dogan and Baloglu. Within the scope of this study, the Cronbach alpha internal consistency coefficient for the whole scale was calculated as .889, which was found close to the original.

Table 2. Confirmatory Factor Analysis Fit Indices

	χ2	df	χ2/df	AGFI	GFI	NFI	CFI	RMSEA
Before modification	1384.08	702	1.97	.79	.82	.90	.95	.056
After modification	1168.77	698	1.67	.82	.84	.91	.96	.046

Data Analysis

SPSS package program was used for the statistical operations in the study. Normality distributions were examined before deciding on which analyses to be performed. Depending on the fact that the values of mode (2.5), median (2.38) and mean (2.45) were statistically close to each other; the p-significance value was 0.085; and that the kurtosis and skewness values, which should be between +1.5 and -1.5, were -0.351 and 0.254, respectively, it could be stated that the data were normally distributed (George and Mallery, 2003; Köklü, Büyüköztürk & Çokluk Bökeoğlu, 2006). As the data demonstrated normal distribution, the decision was to perform parametric analyses. Using the data, values such as descriptive statistics, mean and standard deviation were calculated. As the independent variables (gender, following scientific journals and websites, knowing the technological concepts prominent in education, and having prior knowledge of Industry 4.0) had two categories, the independent groups t-test was applied. One-way analysis of variance (ANOVA) was used because the other independent variables (academic average grade, mother's education level, father's education level, and family income) had more than two categories as well as because homogeneity was met.

Research Ethics

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FINDINGS

The descriptive statistics of the 39-item scale regarding the pre-service science teachers' conceptual awareness of Industry 4.0 are given in Table 3.

Table 3. Descriptive Statistics Regarding the Industry 4.0 Conceptual Awareness Scale

Industry 4.0 Concepts	Mean	S
1. Internet of objects	2.63	1.10
2. Artifical Intelligence	3.00	.88
3. Learner (Smart) Robots	2.82	.93
4. 3D Printers	2.87	1.06
5. Advanced Automation	2.10	2.87
6. Cybersecurity	.97	1.06
7. Cyber Physical Systems	2.28	1.02
8. Cloud Information Technology	2.50	1.23
9. Big Data and Data Analytics	2.13	1.05
10. Virtual Reality	3.32	1.08
11. Augmented Reality	2.91	1.28
12. Mixed Reality	2.16	1.09
13. Smart Production Technologies	2.60	1.06
14. Dark Factories	1.80	.94
15. Embedded systems	1.82	.96
16. Machine-Machine Cooperation	2.17	1.05
17. Sensor Technologies	2.79	1.17
18. Computer Vision	2.28	1.08
19. Customized Product Development	2.68	1.11
20. Deep Learning	2.38	1.10
21. Data-Oriented Service	2.28	1.06
22. Energy 4.0	1.84	1.02
23. Digital Supply Chain	2.03	1.03
24. Unmanned Systems	2.76	1.17
25. Agile and Flexible Production-Service	2.02	1.00
26. Hologram Technologies	2.50	1.22
27. Wearable Technologies	2.92	1.22
28. Digital Diagnosis, Diagnosis, Treatment	2.76	1.17
29. Nanotechnology	3.49	1.10
30. Industrial Internet	2.19	1.06
31. Advanced Production Techniques	2.13	1.09
32. Technological Innovation	2.38	1.09
33. Rapid Prototype Production	2.13	1.09
34. Micro Factories	2.08	.99
35. Factories Producing Their Own Energy	2.50	1.10
36. Artificial neural networks	2.15	1.06
37. Intelligent Storage and Transfer	2.31	1.06
38. Simulation Technologies	2.77	1.15
39. Additive Production	1.84	.95
Mean	**2.39**	**.71**

Considering the means of the 39 items in the industry 4.0 Conceptual Awareness Scale, the awareness levels of the participants were generally low at 2.39. However, it was revealed that the preservice teachers' levels of awareness of nanotechnology with a mean of 3.49, virtual reality with 3.32 and artificial intelligence with 3.00 were found to be high. Among the scale items, the concepts of cyber security with

a mean of 0.97, dark factories with 1.80, embedded systems at 1.82, and energy at 4.0 with 1.84 were found to be the concepts with the lowest awareness levels. Pre-Service science teachers' levels of industry 4.0 conceptual awareness concerning gender are given in Table 4.

Table 4. t-Test Results of the Pre-service Science Teachers' Levels of Industry 4.0 Conceptual Awareness concerning Gender

	Gender	N	Mean	S	df	t	p
Industry 4.0 Conceptual Awareness Scale	Female	266	2.40	.697	312	-2.699	.007
	Male	48	2.70	.747			
	Total	314					

According to Table 4, it was seen that the pre-service science teachers' levels of awareness of the industry 4.0 concepts differed significantly in terms of the variable of gender in favor of the male students ($p<0.05$). Pre-service science teachers' levels of awareness of the industry 4.0 concepts concerning their academic average grade are given in Table 5.

Table 5. ANOVA Test Results of the Pre-service Science Teachers' Levels of Awareness of the Industry 4.0 Concepts concerning Their Academic Average Grade

		Sum of Squares	df	Mean Squares	F	p	Groups with a Significant Difference
Industry 4.0 Conceptual Awareness level	Between Groups	8.449	3	2.816	5.810	.001	I>II
	Within Groups	150.261	310	.484			I>III
	Total	158.710	313				IV>III

I: 2.01-2.50 II: 2.51-3.00 III: 3.01-3.50 IV: 3.51-4.00

One-way analysis of variance (ANOVA) was applied to determine whether the pre-service science teachers' levels of awareness of the industry 4.0 concepts differed for their academic average grades. According to Table 5, since the p-value was less than 0.05, it was understood that there was a significant difference between the groups. It was seen that the awareness levels of the preservice teachers, whose academic average grade was between 2.01-2.50, regarding the industry 4.0 concepts were higher than the awareness levels of the preservice teachers whose academic average grade was between 2.51-3.00 and 3.01-3.50. It was also seen that the awareness levels of the preservice teachers with an academic average grade between 3.51-4.00 regarding the concepts of Industry 4.0 were higher than those of the pre-service teachers whose academic average grade was between 3.01-3.50. Pre-service science teachers' levels of awareness of the industry 4.0 concepts to mothers' education level are given in Table 6.

Table 6. ANOVA Test Results of the Pre-service Science Teachers' Levels of Awareness of the Industry 4.0 Concepts concerning Mother's Education Level

		Sum of Squares	df	Mean Squares	F	p	Groups with a Significant Difference
Industry 4.0 Conceptual Awareness level	Between Groups	6.266	3	2.0889	4.247	.006	III>I
	Within Groups	152.443	310	.4917			IV>I
	Total	158.710	313				

I: Elementary School II: Secondary School III: High School IV: University

One-way analysis of variance (ANOVA) was applied to determine whether the pre-service science teachers' levels of awareness of the industry 4.0 concepts differed depending on the variable of the mother's education level. The results are given in Table 6. According to the table, since the p-value was

lower than 0.05, it was seen that there was a significant difference between the groups. It was found that the industry 4.0 awareness levels of the pre-service science teachers of the mothers whose education level was high school were higher than those of the pre-service science teachers of the mothers whose education level was elementary school. It was also revealed that the awareness levels of the pre-service science teachers of the mothers whose education level was university were higher than those of the pre-service science teachers of the mothers whose education level was elementary school. Pre-service science teachers' levels of awareness of the industry 4.0 concepts concerning their father's education level are given in Table 7.

Table 7. ANOVA Test Results of the Pre-service Science Teachers' Levels of Awareness of the Industry 4.0 Concepts concerning Father's Education Level

		Sum of Squares	df	Mean Squares	F	p	Groups with a Significant Difference
Industry 4.0 Conceptual Awareness level	Between Groups	5.660	3	1.8869	3.821	.01	IV>I
	Within Groups	153.049	310	.4937			IV>II
	Total	158.710	313				IV>III

I: Elementary School II: Secondary School III: High School IV: University

One-way analysis of variance (ANOVA) was applied to determine whether the pre-service science teachers' levels of awareness of the industry 4.0 concepts differed with respect to the variable of the father's education level. The results are presented in Table 7. According to the table, it was seen that there was a significant difference between the groups because the p-value was lower than 0.05. It was revealed that the industry 4.0 conceptual awareness levels of the pre-service science teachers of the fathers whose education level was university were higher than those of the pre-service science teachers of the fathers with other education levels. Pre-service science teachers' levels of awareness of the industry 4.0 concepts with respect to family income are given in Table 8.

Table 8. ANOVA Test Results of the Pre-service Science Teachers' Levels of Awareness of the Industry 4.0 Concepts with Respect to the Family Income

		Sum of Squares	df	Mean Squares	F	p	Groups with a Significant Difference
Industry 4.0 Conceptual Awareness level	Between Groups	4.125	3	1.3752	2.757	.042	IV>I
	Within Groups	154.584	310	.4986			IV>II
	Total	158.710	313				IV>III

I: Less than 3000 TL II: 3000-6000 TL III: 6000-9000 TL IV: More than 9000 TL

One-way analysis of variance (ANOVA) was applied to determine whether the awareness levels of the pre-service science teachers regarding the industry 4.0 concepts differed with respect to the income level of the family. The results are given in Table 8. According to the table, as the p-value calculated was $0.042<0.05$, there was a significant difference between the groups. It was found that the industry 4.0 conceptual awareness levels of the pre-service science teachers whose family income level was 9000 TL and above were higher than those of the preservice teachers with other family income levels. Pre-service science teachers' levels of awareness of the industry 4.0 concepts with respect to the following scientific journals and websites are given the Table 9.

Table 9. T-test Results of the Pre-service Science Teachers' Levels of Awareness of the Industry 4.0 Concepts with Respect to Following Scientific Journals and Websites

	Following	N	Mean	S	df	t	p
Industry 4.0 Conceptual Awareness Level	Yes	196	2.62	.700	312	5.903	.000
	No	118	2.16	.633			
Total		314					

To determine whether the industry 4.0 conceptual awareness levels of the pre-service science teachers differed depending on the following scientific journals and websites, independent groups t-test was conducted. The results of the analysis are given in Table 9. According to the table, as the p-value was 0.000<0.05, a significant difference was found in favor of the preservice teachers who followed scientific journals and websites. Pre-service science teachers' awareness of the industry 4.0 concepts with respect to their knowing technological concepts are given in Table10

Table 10. T-test Results of the Pre-service Science Teachers' Awareness of the Industry 4.0 Concepts with Respect to their Knowing Technological Concepts

	Knowing Technological Concepts	N	Mean	S	df	t	p
Industry 4.0 Conceptual Awareness Level	Yes	250	2.54	.715	312	4.706	.000
	No	64	2.09	.572			
Total		314					

Independent groups t-test was conducted to determine whether the industry 4.0 conceptual awareness of the pre-service science teachers differed from their knowing technological concepts prominent in education. The results are shown in Table 10. According to the table, as the p-value was less than 0.05, it was seen that there was a significant difference concerning the preservice teachers' knowledge of the concepts prominent in education. This significant difference was in favor of the preservice teachers who knew the concepts prominent in education. Pre-service science teachers' levels of awareness of the industry 4.0 concepts with respect to their previous knowledge are given in Table 11.

Table 11. T-test Results of the Pre-service Science Teachers' Levels of Awareness of the Industry 4.0 Concepts with Respect to Their Previous Knowledge

	Having Previous Knowledge	N	Mean	S	df	t	p
Industry 4.0 Conceptual Awareness Level	Yes	50	2.83	.708	312	4.266	.000
	No	264	2.37	.690			
Total		314					

To determine whether the industry 4.0 conceptual awareness of the pre-service science teachers differed concerning the variable of having prior knowledge of Industry 4.0 or not, independent groups t-test was conducted. The results are shown in Table 11. According to the table, as the p-significance value was lower than 0.05, there was a significant difference between the preservice teachers who had prior knowledge of Industry 4.0 and those who did not. In line with this result, it was revealed that the level of Industry 4.0 awareness was in favor of the preservice teachers who had previous knowledge of Industry 4.0 concepts.

DISCUSSION AND CONCLUSION

In the study, which aimed to determine the 4th-grade preservice teachers' awareness of the industry 4.0 concepts who were studying in the department of Science Teaching, the concepts with the highest awareness levels were nanotechnology, virtual reality, and artificial intelligence, respectively. It was seen that the preservice teachers were most aware of the concepts of nanotechnology, virtual reality, and artificial intelligence. Similarly, Aslan and Şenel (2015) reported in their study that the preservice teachers in secondary and high school science fields (science, physics, chemistry, biology) had moderate levels of awareness of nanoscience and nanotechnology (NBT). Unlike the findings obtained in the study, İpek, Atik, Tan, and Erkoç (2020a) concluded that although the biology teachers were aware that nanotechnology and nanoscience were multidisciplinary and related to biology, physics, and chemistry, the teachers did not have any knowledge about these subjects. In their study with Physics, Chemistry, and Biology teacher candidates, Enil and Köseoğlu (2016) found that while there was no significant difference in the nanotechnology awareness levels between the preservice teachers in terms of their departments, most of the preservice teachers had little knowledge about nanotechnology and acquired their first knowledge about nanotechnology mostly through TV programs. In another study carried out by Harman and Şeker (2018), nearly half of the pre-service science teachers mentioned the benefits of nanotechnology more in terms of its application area and quality of life, while a small number of pre-service science teachers pointed to the risks in terms of health, safety, purpose, and form of use. In addition, the researchers found that the pre-service science teachers had low levels of awareness of the concept of nanotechnology. In another study conducted by İpek and colleagues (2020b), who investigated science teachers' (physics, chemistry, and biology) levels of knowledge, exposure, and awareness regarding nanoscience and nanotechnology, it was revealed that the participants' levels of knowledge, exposure and awareness were inadequate and that they needed to increase their levels. Furthermore, the researchers attributed this situation to the weak positive correlations between awareness and knowledge and recommended doing activities to increase the awareness levels of science teachers. Similar to the findings obtained in the study, Çam, Çelik, Güntepe, and Durukan (2021), in their study with preservice teachers, examined the preservice teachers' knowledge about artificial intelligence technologies using open-ended questions and concluded that the preservice teachers had awareness of these technologies despite mentioning different points. In one other study conducted with teachers, it was concluded that they had limited knowledge about artificial intelligence and about how artificial intelligence could support them in practice. At the same time, the results of the study showed that the teachers needed support to be efficient and effective in practice (Chounta, et.al., 2021). Similarly, in a study conducted with university students, it was revealed that most of the students were not aware of artificial intelligence (Alimi, et.al., 2021).

Industry 4.0 concepts that science teacher candidates have low awareness of our cyber security, dark factories, embedded systems, and energy 4.0 concepts. When all 39 items in the industry 4.0 Conceptual Awareness Scale were examined, it was found that pre-service teachers' awareness of Industry 4.0 was at a low level. In the study conducted by Kaygısız and Sipahi (2019) with university students, the students stated that the concept of Industry 4.0 reminded them of words such as technology, the industrial revolution, competition, globalization, and consumption, and they reported that they had heard of Industry 4.0 concepts such as cyber security, simulation, virtual reality, Internet of objects, big data and analysis, and additive production. In a study carried out by Omar and Hasbolah (2018) with students studying in different departments, it was concluded that the student's awareness of Industry 4.0 concepts was at a low level. Similarly, another study conducted by Tinmaz and Hwa-Lee (2019) with undergraduate students in South Korea revealed that the student's awareness of Industry 4.0 was not good. In one other study conducted by Ujakpa Osakwe Iwa, Hashiyana, and Mutalya (2020) with university students, it was found that the students were aware of Industry 4.0 and that they needed more education about Industry 4.0-related applications, though. Sari and Wilujeng (2020) stated that the pre-service science teachers had good levels of perception regarding the changes in the education world due to Industry 4.0.

In the study, when the awareness levels of Industry 4.0 concepts were examined in terms of gender, it was concluded that the awareness of the male preservice teachers was higher than that of the female preservice teachers. In a study conducted by Torun and Cengiz (2019) with students studying in different departments at university, it was revealed that gender did not lead to a significant difference in the students' perceptions of Industry 4.0. According to another study carried out by Yelkikalan, Özcan, and Temel (2019) on the industry 4.0 awareness of university students, it was seen that there was a significant difference in terms of gender regarding the usefulness of Industry 4.0 technologies, ease of use and usage intentions, while there was no significant difference concerning gender in usage behavior. In the study, when the pre-service science teachers' awareness of Industry 4.0 concepts was examined concerning their academic average grades, it was seen that their awareness differed depending on their academic average grades. It was also seen that the preservice teachers who had a relatively low academic average grade had high levels of awareness of Industry 4.0 concepts. In addition, it was seen that the preservice teachers' awareness of Industry 4.0 concepts who had the highest academic average grade was higher than that of the preservice teachers with a lower academic average grade.

Depending on the results obtained in the study, it could be stated that the pre-service science teachers' awareness of Industry 4.0 concepts differed significantly concerning the mother's education level and the father's education. It was seen that the awareness levels of the preservice teachers regarding Industry 4.0 concepts whose mother's education levels were high school and university were higher than those of the preservice teachers whose mother's education level was elementary school. On the other hand, it was revealed that the awareness levels of the preservice teachers whose father's education level was university were higher than those of the preservice teachers whose father's education level was elementary school, secondary school, and high school. Similarly, in a study conducted by Nguyen and Nguyen (2020) with undergraduate students at a university in Vietnam regarding the adoption of Industry 4.0, it was found that the student's social status and environmental conditions were effective in their viewpoints about Industry 4.0. In a study conducted by Arslantaş, Özkan, and Külekçi (2012) with preservice teachers studying at education faculty, it was seen that the academic success of the students was higher when the education level of their parents was university. In the study, the pre-service science teachers' levels of awareness of Industry 4.0 concepts were also high in cases where they had high levels of family income. According to the results of a study conducted by Aydın and Tiryaki (2017) with university students, the student's anxiety levels were higher when their family income level was low. In another study conducted by Arslantaş, Özkan, and Külekçi (2012) with 748 students studying at education faculty, it was seen that the academic success of the students was low when the family income level was low. In the study, it was seen that the preservice science teachers who followed scientific journals and websites had a high level of awareness of Industry 4.0 concepts. It was revealed that the awareness levels of the preservice teachers who had prior knowledge about Industry 4.0 concepts were also high.

To conclude, it was revealed that the preservice science teachers' awareness of Industry 4.0 concepts was generally below the average, except for certain concepts. It was seen that concerning the low level of awareness, awareness of concepts was significantly affected by the education level of the parents as well as by the income level of the family and that the awareness of the male students was higher. Concerning their mother and father's education levels and family income level, the fact that the preservice teachers knew these concepts was also a factor in increasing their awareness. It could be stated that education and income level were effective in terms of the students' being knowledgeable and using these concepts in daily life. To achieve this, it is thought that these concepts will be integrated into the courses taken by the preservice teachers within the scope of their curriculum and that it will contribute to the training of preservice teachers better. In this way, we can make the teachers of the future ready to raise generations equipped with the knowledge and skills required by the current era.

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