DOKUZ EYLÜL ÜNİVERSİTESİ
EĞİTİM BİLİMLERİ ENSTİTÜSÜ

Batı Anadolu Eğitim Bilimleri Dergisi, (2023), 14 (2), 1467-1488.
Western Anatolia Journal of Educational Sciences, (2023), 14 (2), 1467-1488.
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Determining the Awareness in the Adaptation Process of Changing Chemical Labeling System: The Views of the Pre-service Science Teachers[1]

Değişen Kimyasal Etiketleme Sistemine Uyum Sürecindeki Farkındalığın Belirlenmesi: Fen Bilgisi Öğretmen Adaylarının Görüşleri

Simge KOC , Assist. Prof. Dr., Dokuz Eylul University, simge.koc@deu.edu.tr

Geliş tarihi - *Received:* 26 April 2023
Kabul tarihi - *Accepted*: 23 December 2023
Yayın tarihi - *Published*: 28 December 2023

[1] Presented in the 3rd International Science, Education, Art & Technology Symposium - UBEST (III. Uluslararası Bilim, Eğitim, Sanat ve Teknoloji Sempozyumu) held at 23-25 Sep. 2022.
Koc, S. (2023). Determining the awareness in the adaptation process of changing chemical labeling system: the views of the pre-service science Teachers. *Western Anatolia Journal of Educational Sciences*, 14 (2), 1466-1487. DOI. *10.51460/baebd.1287970*

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Abstract. Possible accidents in the school environment pose risks for both teachers and students. A new regulation on chemicals is being worked on to make school laboratories safer environments. The aim is to create a general and universal labeling system for the whole world in schools, industries, chemical sectors and daily life. The study aims to determine the awareness of pre-service science teachers in the process of adaptation to the changing chemical labeling system. In the study conducted by the researcher, a 6-question semi-structured interview was used. In addition, two of the open-ended questions contain sub-question titles in order to determine the views in more detail. While preparing the form, the dimensions examined in the research (introduction of chemicals, use of glass materials, fire safety, electrical safety, personal protective measures, biological hazards and first aid) were taken into consideration. The interview was conducted with 10 randomly selected volunteer pre-service science teachers. The data obtained from the interview records were coded and grouped into categories using content analysis method. Qualitative data were then tabulated by calculating frequencies and percentages. Coding reliability (percentage of agreement) was calculated for each item. According to the results, most of the pre-service science teachers were able to make the corresponding matches in the old and new chemical labeling system, but they could not provide sufficient explanations about the regulations that should be included in a typical chemical label, the new pictograms and the reasons for the change in the chemical labeling system. Courses taught in faculties of education should be enriched in terms of laboratory safety content. In addition to theoretical knowledge, active learning experiences should be continuous.
Keywords: Chemical labeling system, pre-service science teachers, laboratory safety professional development

Öz. Okul ortamında meydana gelebilecek olası kazalar hem öğretmenler hem de öğrenciler için risk oluşturmaktadır. Okullardaki laboratuvarları daha güvenli hale getirmek amacıyla kimyasallara ilişkin yeni bir yönetmelik üzerinde çalışılmaktadır. Amaç, tüm dünya için okullarda, endüstrilerde, kimya sektörlerinde ve günlük yaşamda genel ve evrensel bir etiketleme sistemi oluşturmaktır. Çalışma, fen bilgisi öğretmen adaylarının değişen kimyasal etiketleme sistemine uyum sürecindeki farkındalıklarını belirlemeyi amaçlamaktadır. Araştırmacı tarafından yürütülen çalışmada 6 soruluk yarı yapılandırılmış görüşme kullanılmıştır. Ayrıca, görüşme sorularından ikisi, görüşleri daha ayrıntılı olarak belirlemek amacıyla alt soru başlıkları içermektedir. Form hazırlanırken araştırma kapsamında incelenen boyutlar (kimyasalların tanıtılması, cam malzeme kullanımı, yangın güvenliği, elektrik güvenliği, kişisel koruyucu önlemler, biyolojik tehlikeler ve ilk yardım) dikkate alınmıştır. Görüşme, rastgele seçilen 10 gönüllü fen bilgisi öğretmen adayı ile gerçekleştirilmiştir. Görüşme kayıtlarından elde edilen veriler içerik analizi yöntemi kullanılarak kodlanmış ve kategoriler halinde gruplandırılmıştır. Nitel veriler daha sonra frekans ve yüzde hesaplanarak tablo halinde sunulmuştur. Her bir madde için kodlama güvenirliği (uyuşma yüzdesi) hesaplanmıştır. Sonuçlara göre, fen bilgisi öğretmen adaylarının çoğu eski ve yeni kimyasal etiketleme sisteminde karşılık gelen eşleştirmeleri yapabilmiş, ancak tipik bir kimyasal etiketinde bulunması gereken düzenlemeler, yeni piktogramlar ve kimyasal etiketleme sistemindeki değişimin nedenleri hakkında yeterli açıklama yapamamıştır. Eğitim fakültelerinde okutulan dersler laboratuvar güvenliği içeriği açısından zenginleştirilmelidir. Teorik bilgilerin yanı sıra aktif öğrenme deneyimleri sürekli hale getirilmelidir.
Anahtar Kelimeler: Kimyasal etiketleme sistemi, fen bilgisi öğretmen adayları, laboratuvar güvenliği mesleki gelişimi

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Genişletilmiş Özet

Giriş. Bilim ve teknolojideki ilerlemenin olumlu etkileri, toplumları dünyanın zorluklarıyla başa çıkmak için yeni yollar bulmaya yönlendirmektedir. Bu sürecin bir getirisi olarak insanoğlu değişimlere kolayca adapte olmuş ve yeni sorular oluşmuştur. Fen etkinliklerinin dikkatli bir şekilde planlanması sürecinde hazırlıklı olmak ve öğrencilerin bağımsız projelere girişmelerine izin vermeden önce eksiksiz yönergeler sunmak gerçekten önemlidir (National Science Teachers Association-NSTA, 2007). Öğrencilerin sağlık, refah ve güvenliğinin korunabilmesi tüm tehlikeli durumların rapor edilmesi ile sağlanabilir. Ayrıca, bir fen öğretmeninin yeterli güvenlik gözetimini sağlamak için sürekli olarak hazır bulunması da öncelikli bir ihtiyaçtır. Ne yazık ki, Türkiye'deki ortaokul fen laboratuvarlarında çok sık kaza meydana gelmektedir. Buna ek olarak, rapor edilmeyen birçok başka kaza olması da muhtemeldir. Bu kazalar karşısında, okullardaki laboratuvar güvenlik önlemlerinin ve uygulamalarının yeterli olup olmadığını bilmek önemlidir. Bu alanda yapılan çalışmalar, güvenliğin önemini vurgulamaktadır. Laboratuvar güvenliğinin amacı, insanları, grupları, araştırma alanının çevresini ve ekipmanı olası kazalardan ve bunların zararlı etkilerinden korumaktır. Çocukların laboratuvarlarda güvenliği ve sağlığı, okullardaki fen müfredatında öncelikli olarak ele alınması gereken konulardır. Öğrencilerin güvenli bir şekilde araştırma yapabilmeleri için güvenli laboratuvar ortamlarının oluşturulması gerekmektedir. Ayrıca, laboratuvarların en az sınıflar kadar güvenli ve emniyetli tutulması gerekmektedir.

Yöntem. Araştırma yarı yapılandırılmış görüşme formu kullanılarak nitel araştırma yöntemi ile gerçekleştirilmiştir. Değişen kimyasal etiketleme sistemine uyum sürecindeki farkındalık konusunda görüşmeler yapmak üzere, rastgele dağılım dışında, 2022-2023 eğitim-öğretim yılında İzmir-Türkiye ilinde Dokuz Eylül Üniversitesi'nde öğrenim gören 10 gönüllü fen bilgisi öğretmen adayı araştırmanın örneklemini oluşturmuştur. Yarı Yapılandırılmış Görüşme Forumu'nun uygulandığı araştırma sonucunda görüşme kayıtlarından elde edilen veriler içerik analizi yöntemiyle kodlanarak kategorilere ayrılmıştır. Birbirine benzeyen belirli kavram ve görüşler birleştirilerek yorumlanmıştır. Kodlama işlemi toplanan ve yazıya dökülen (ses kayıtlarının deşifre edilmesi) görüşme formları farklı zamanlarda iki kez analiz edilmesi ile elde edilmiş ve her bir madde için kodlama güvenilirliği (uyuşma yüzdesi) hesaplanmıştır. Kodlama güvenirliğini hesaplamak için uyuşma yüzdesi formülü kullanılmıştır.

Bulgular. 10 fen bilgisi öğretmenine uygulanan yarı yapılandırılmış görüşme formundan elde edilen verilere yer verilmiştir. Öğretmen adaylarının piktogram tanımlarına ilişkin görüşleri ve elde edilen kategoriler için yüzde değerleri, yeni etiketleme sistemine eklenen piktogramlara ilişkin görüşleri ve elde edilen kategoriler için yüzde değerleri, yeni kimyasal etiketleme sistemine ilişkin görüşleri ile olası uyum nedenleri ve elde edilen kategoriler için yüzde değerleri, yeni kimyasal etiketlerde yer alması gereken tanımlara ilişkin görüşleri ile elde edilen kategorilere ilişkin yüzde değerleri, kimyasal etiketinde bulunması gereken piktogramlara ilişkin görüşleri ve elde edilen kategoriler için yüzde değerleri, yeni kimyasal etiketlerdeki piktogramların eski sistemdeki karşılıklarına ilişkin görüşleri ve elde edilen kategoriler için yüzde değerleri açıklanmaktadır

10 fen bilgisi öğretmenine uygulanan yarı yapılandırılmış görüşme formundan elde edilen verilere yer verilmiştir. Öğretmen adaylarının piktogram tanımlarına, yeni etiketleme sistemine eklenen piktogramlara, yeni kimyasal etiketleme sistemine, yeni kimyasal etiketlerde yer alması gereken tanımlara, kimyasal etiketinde bulunması gereken piktogramlara, yeni kimyasal etiketlerindeki

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piktogramların eski sistemdeki karşılıklarına ilişkin görüşleri ve elde edilen kategoriler için yüzde ve frekans değerleri açıklanmaktadır.

Sonuç, Tartışma ve Öneriler. Öğretmen adaylarının adaptasyon sürecindeki farkındalıklarını ortaya koymak amacıyla piktogram tanımlarına ilişkin görüşleri ilk soruda 9 alt soru ve toplamda 6 soru ile ifade edilmiştir. Sonuçlara göre, fen bilgisi öğretmen adaylarının çoğu eski ve yeni kimyasal etiketleme sisteminde karşılık gelen eşleştirmeleri yapabilmiş, ancak tipik bir kimyasal etiketinde bulunması gereken düzenlemeler, yeni piktogramlar ve kimyasal etiketleme sistemindeki değişimin nedenleri hakkında yeterli açıklama yapamamıştır. Eğitim fakültelerinde okutulan dersler laboratuvar güvenliği içeriği açısından zenginleştirilmelidir. Teorik bilgilerin yanı sıra aktif öğrenme deneyimleri sürekli hale getirilmelidir.

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Introduction

Positive effects of progression in science and technology guide societies to find new ways to cope with world's challenges. As a return of this process human beings has been easily adapted the changes and also new questions formed.

An easy way of using different disciplines together can be ensured with active learning activities. A better way to support subdomain topics in a mixture in science education can be achieved with practical laboratory usage. Laboratory usage is one of the most effective implementations within the methods as a part of science education. Laboratory methos enables students to study separately or with the group activities.

Taking precautions with the scientific methods in order to protect people and equipment in case of possible accidents during the laboratory usage with specifications of problematically situations and intended for better regulations identified as laboratory safety.

It is really important to being prepared in the process of planning the science activities carefully and providing complete directions before allowing students to attempt independent projects (National Science Teachers Association-NSTA, 2007). It can be achieved by protecting the health welfare and safety of the students and reporting all hazardous conditions. And it is also a priority need for a science teacher to being present continuously to ensure adequate safety supervision (National Fire Protection Association-NFPA, 2004).

Unfortunately, accidents have been reported to be occurring too frequently in Turkish middle school science laboratories. In addition, it is likely that there are many other accidents that are not being reported. Faced with these accidents, it is important to know whether or not the laboratory safety precautions and practices in Turkish schools are adequate.

The aim of laboratory safety is to protect people, environment of research area and equipment from the possible accidents and their harmful effects. Safety and welfare of children in laboratories are the issues to be addressed primarily in science curriculum at schools.

Increasing the level of awareness about laboratory safety can be considered as a measure of pre-service science teachers' having certain goals and achievements. The objectives are explained below:

- Knows the properties of chemical materials.
- Knows the chemicals that should not come into contact with each other.
- Recognize the current labeling system and read pictograms when labeling chemicals.
- Has knowledge about the definitions on a chemical label.
- Creates a material safety data sheet.
- Explains the situations to be considered during the storage of chemicals.
- Uses the storage of chemicals matrix according to the NFPA 704 System.
- Realizes proper disposal of chemical wastes
- Understands the importance of efficient use of resources.

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- Understands the importance of sustainable development in combating climate change
- Can replace old and worn chemical labels with new ones.
- Chooses the right glass material for the experiment.
- Uses the spirit stove in a safe way.
- Explains how to clean a broken glass material containing chemicals.
- The portable fire extinguisher is used appropriately.
- Performs fire extinguisher control.
- Know and explain "The MoNE Fire Prevention and Extinguishing Directive" and teacher responsibilities.
- Realizes safe use of electrostatic generator.
- Recognizes the types of personal protective goggles, selects and uses the appropriate one for the purpose.
- Knows and applies what needs to be done for personal hand and face protection safety.
- Performs the process of changing chemically contaminated gloves appropriately.
- Knows the pathogens that enter the body through infectious diseases and takes necessary precautions.
- Knows emergency first aid practices and applies them when necessary.

Studies emphasize the importance of safety in workspaces. Safe laboratory environments need to be created for students to conduct research safely. In addition, laboratories should be kept as safe and secure as classrooms.

Methodology

In this section, research design, sample and data collection tools are explained.

Research Design

In the research, a qualitative research feature with a semi-structured interview form was used. The qualitative research is defined as a type of research in which qualitative data collection methods such as observation, interview and document analysis are used and a process is followed to reveal perceptions and events in a natural environment in a realistic and holistic way (Yıldırım & Şimşek, 2013).

Sample

In order to make interviews on the subject the awareness in the adaptation process of changing chemical labeling system, except for random distribution, 10 volunteer pre-service science teachers from Dokuz Eylül University, have formed the sample of the research in the academic year of 2022-2023 in the city of İzmir-Turkey. The distribution of sample according to gender is given in the Table 1.

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Table 1.
Distribution of the Sample by Gender

	Gender	Frequency (f)	Percentage (%)
Female	Female	7	70
Male	Male	3	30
Total		10	100

As seen in Table 1, 7 (70%) of the 10 pre service science teachers in the sample were female and the remaining 3 (%30) were male. When the results are examined, it can be said that the number of teachers participating in the study are not similar to each other in terms of gender distribution. However, the distribution of male and female students in the sample is similar to the distribution of male and female students in the faculty in the academic year of 2022-2023 of the university (https://bef.deu.edu.tr/tr/2784-2/).

Data Collection Tools

In this study interview was used as a specific research tool and as a distinctive research technique. With the interview, it is aimed to determine the views of pre-service science teachers about the adaptation process to the change in the chemical labeling system in more detail. The most important convenience provided by the semi-structured interview technique to the researcher is that it provides more systematic and comparable information since the interview is carried out in accordance with the pre-prepared interview protocol. (Balcı, 2005).

The Semi-Structured Interview Form used in the study was prepared by the researcher as a preliminary interview form consisting of 8 questions. In the interview form, the questions were prepared to represent the content of the study. The dimensions examined within the scope of the research were taken into account in the preparation process of the form. The content validity of the form was ensured with the opinions of two experts of science education.

After the interview form was prepared, a pre-interview was held with a volunteer pre-service science teacher. The answers were analyzed and the transcript was completed. Question items that were not clearly clarified were revised. The pre-interviewed pre-service teacher was excluded from the research. The form was reorganized according to the suggestions and corrections and a "semi-structured interview form" consisting of 6 items was formed.

In the final form of the interview, there are a total of 6 open-ended questions about the meanings of the new symbols, the differences between the old and the new labeling system, the factors that cause the labeling system to be changed, the explanations that should be included in a chemical label, the explanations that should be used according to the type of chemical, and the newly added pictograms in the adaptation process. In addition, two of the open-ended questions contain sub-question titles in order to determine the views in more detail. To learn about pre service science teachers' views, content analysis was carried out for the data gathered through semi structured

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interview form. The purpose of content analysis is to reach concepts and relationships that can explain the collected data (Yıldırım & Şimşek, 2013).

As a result of the research in which the Semi-Structured Interview Form was applied, the data obtained from the interview recordings were coded with the content analysis method and divided into categories. Certain concepts and views that are similar to each other have been combined and interpreted. The coding process can be done by different researchers simultaneously, or it can be done by the same researcher at different times (Çelik, Başer Baykal, & Kılıç Memur, 2020).

Interview forms collected and transcribed by the researcher (deciphering audio recordings) were analyzed twice at different times, and coding reliability (correspondence percentage) was calculated for each item. The correspondence percentage formula was used to calculate the coding reliability. According to Yıldırım and Şimşek (2013), the percentage of correspondence is the ratio of the number of items agreed by the observers or evaluators to the total number of assessments or observations. It is stated that the ratio should be at least 70%. Qualitative data were then tabulated by calculating frequency and percentage.

Results

In this section, the data obtained from the semi-structured interview form applied to 10 science teachers are given. Below are the findings including the interview questions and the frequencies and percentages of the answers given.

Research Results of Questions 1. Do you have an idea about the meanings of the pictograms below? What could be the danger statement or the precautions to be taken with this symbol?

Participants were asked to state their views on the danger statement to be indicated with the given symbol and the explanations for the precautions to be taken. The answers given by the pre-service teachers to first question were examined and tabulated and given in Table 2.

Table 2.
Views on Pictogram Definitions and Percentage Values for the Obtained Categories

Pictogram code	Pictogram	Categories	Frequency (*f*)	Percentage (%)
1a		It means that it is an oxidizer	5	45.4
		It means it is a flammable substance.	2	18.2
		It can be an oxidizer or flammable	2	18.2
		I have no idea about this pictogram.	1	9.1
		Reacts on contact with oxygen.	1	9.1
				100

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1b		It means that it is an explosive material	7	58.3
		Frangible material	2	16.7
		I have no idea about this pictogram.	2	16.7
		It means that it is a penetrating cutter material	1	8.3
				100
1c		It means that it is an oxidizer	6	42.8
		It means it is a flammable substance.	4	28.6
		It can be an oxidizer or flammable	2	14.2
		It means that it is an explosive material	1	7.2
		It means that it is an incendiary material	1	7.2
				100
1d		It means that it has fatal dangerous substance	4	33.4
		It identifies toxic substance	3	25
		It identifies Hazards substance	2	16.7
		It identifies Harmful substances	1	8.3
		It identifies the materials to be careful about	1	8.3
		I have no idea about this pictogram.	1	8.3
				100
1e		I have no idea about this pictogram.	3	25
		I have an idea but not sure about it	2	16.7
		It can be a kind of hazardous material	2	16.7
		It identifies the materials to be careful about	2	16.7
		Radiation-containing substance	2	16.7
		It identifies the materials that can have dangerous risks	1	8.2
				100
1f		It signifies a corrosive substance with irritating properties	9	75

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		It identifies the materials that can be harmful for the environment	1	8.33
		It identifies the materials that can be acidic	1	8.33
		It identifies the materials that can be harmful for the soil	1	8.33
				100
1g		It identifies the materials that can be harmful for the environment	7	58.4
		It identifies the materials that can be harmful for the soil	2	16.7
		I have an idea but not sure about it	1	8.3
		It identifies the materials that can be harmful for the living beings	1	8.3
		It identifies the materials that can be harmful for the water	1	8.3
1h		I'm seeing it for the first time and no idea about it	7	70
		It identifies a substance that can cause respiratory problems	2	20
		It identifies a substance not to be swallowed	1	10
1ı		I'm seeing it for the first time and no idea about it	9	90
		I cannot remember this pictogram	1	10

According to Table 1, the correspondence percentage of first sub question (1a) data was calculated as 83.4% and classified under 5 categories. It is seen that pre-service science teachers expressed an opinion that for the pictogram used to denote oxidizer substances, 45.4% could be an oxidizer substance, 18.2% a flammable substance, and 18.2% an oxidizer or flammable substance. It was stated that 9.1% of the participants did not know about the oxidizing pictogram. It is understood that 9.1% of the participants stated that the pictogram would react in contact with oxygen.

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A total of 4 categories were obtained for the 1-b coded pictogram, which was used to express substances that could cause explosion as a result of heating, the correspondence percentage of which was calculated as 80%.

In this pictogram definition, the participants stated that the pictogram signifies an explosive material with the percentage of 58.3. In addition, 16.7% of participants explain it as a usage for breakable materials, and 16.7 percentage of them stated that they have no idea about this pictogram. And lasty 8.3% of the participants expressed their opinions about the pictogram in the category of penetrating cutter material

The pictogram with the code 1c uses for signifying explosives, self-reactive, and organic peroxides grouped into 5 categories with the 83.4% correspondence percentage. Regarding the 1c coded pictogram, 42.8% of the participants expressed an opinion as flammable substance, while 28.6% stated that the pictogram expresses oxidizer substances. In addition, it is noteworthy that 14.2% of the participants stated that the pictogram can be an oxidizer or flammable. However, 7.2% of the participants expressed their views as explosive material and 7.2% as incendiary material.

The pictogram with the code 1d identifies acutely toxic or fatal substances grouped into 6 categories with the 85.7 % correspondence percentage. According to the results obtained, 33.4% of the participants expressed an opinion as a fatal dangerous substance, 25% as a toxic substance, and 16.7% as a hazard substance. The rate of those who expressed their opinions about the pictogram as harmful substances and substances to be careful in usage is 8.3%. In addition, the rate of the participants who stated that they have no idea about the pictogram is 8.3%.

The pictogram with the code 1e refers to less serious health hazards such as skin irritancy / sensitization grouped into 6 categories with the %85.7 correspondence percentage. While 25% of the participants state that they have no idea about this pictogram, 16.7% of the participants state that they have an idea but not sure about it. It is understood that 16.7% of the pre-service teachers think that the pictogram respectively can be a kind of hazardous material, a material that needs attention and a radiation-containing substance. And lastly the participants stated that the pictogram identifies the materials that can have dangerous risks with the percentage of 8.2.

The pictogram with the code 1f uses to signify corrosives grouped into 5 categories with the %80 correspondence percentage. 75% of the participants state that the pictogram represents a corrosive substance with irritating properties. 8.33% of the participants expressed their opinions regarding the pictogram in the categories of harmful to environment, materials that can be acidic and materials that can be harmful for the soil, respectively.

The pictogram with the code 1g refers to environmental Toxins grouped into 5 categories with the 100% correspondence percentage. While 58.4% of the participants stated that the pictogram was used to express a substance harmful to environment, 16.7% stated that it was a harmful substance for the soil. However, 8.3% of the participants stated that they did not know exactly what the pictogram was. In addition, 8.3% of the participants think that the 1-g coded pictogram is a substance that harms living things and is harmful to water, respectively.

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The pictogram with the code 1h reflects serious longer term health hazards such as carcinogenicity and respiratory sensitization grouped into 3 categories with the 75% correspondence percentage. Regarding the pictogram, which is not among the old danger signs but included in the new labeling system, 70% of the participants stated that "I see it for the first time, I have no information". While 20% of the participants define the pictogram for the materials that may cause respiratory problems, 10% draw attention to the fact that it is used for materials that should not to be swallowed

The pictogram with the code 1ı means "contains gas under pressure" grouped into 2 categories with the 75% correspondence percentage. While 90% of the participants stated that they saw the pictogram included in the new labeling system for the first time and no idea about it, 10% of the participants stated that they could not remember the pictogram.

Research Results of Questions 2. The new chemical labeling process continues in our country. What do you think about the pictograms that are not included in the old symbols and added to the new labeling system?

Participants were asked to state their opinions about the pictograms that were not included in the old symbols and were added to the new labeling system. The answers given by the pre-service teachers to first question were examined and tabulated and given in Table 3.

Table 3.
Views on Pictograms Added to the New Labeling System and Percent Values for the Obtained Categories

Pictogram	Categories	Frequency (f)	Percentage (%)
	1h and 1ı coded pictograms have just been added.	4	40
	1h, 1ı and 1e coded pictograms have just been added	2	20
	1h, 1ı and 1d coded pictograms have just been added.	1	10
	1h, 1ı and 1a coded pictograms have just been added	1	10
	1h, 1ı ,1a and 1e coded pictograms have just been added	1	10
	I have no idea	1	10

In Table 3, the views of pre-service science teachers about the pictograms included in the new labeling system were examined. The correspondence percentage is %85.7 with 5 categories. According

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to the data obtained, 40% of the pre-service teachers stated that the 1h and 1ı coded pictograms were newly added, while 20% of them stated that the 1h, 1ı and 1e coded pictograms were newly added.

On the other hand, 10% of the pre-service teachers support the view that the 1h, 1ı and 1d coded pictograms have been newly added, while the other 10% state that the 1h, 1ı and 1a coded pictograms have been newly added.

In addition, 10% of the participants stated that the 1h, 1ı, 1a and 1e coded pictograms were newly added. The percentage of participants who state that they do not know what the pictograms included in the new system are is shown as 10%.

Research Results of Questions 3. What do you about the new chemical labelling system and possible reasons for adaptation a new labelling?

Participants were asked to state their opinions about the new chemical labelling system and possible reasons for adaptation a new labelling. The answers given by the pre-service teachers to first question were examined and tabulated and given in Table 4.

Table 4.
Views on new chemical labelling system with possible reasons for adaptation and Percentage Values for the Obtained Categories

Categories	Frequency (*f*)	Percentage (*%*)
The necessity of identifying newly discovered substances	5	35.7
Inability to adequately explain visual signs which being on the old labels	3	21.4
The need for a more common language	2	14.3
Failure to prevent laboratory accidents with old labels	2	14.3
Changes on technological conditions	2	14.3

Table 4 shows the views according to categories of pre-service science teachers about new chemical labelling system and possible reasons for adaptation. The correspondence percentage is %83.3 with 5 categories. According to the data obtained, 35.7% of the pre-service teacher's state that "it is necessary to be able to define newly discovered substances". On the other hand, 21.4% of the participants expressed their opinions in the category of " Inability to adequately explain visual signs which being on the old labels ".While 14.3% of the pre-service teachers expressed their views about the new chemical labelling system in the direction of " the need for a more common language ", 14.3% stated that " failure to prevent laboratory accidents with old labels ".In addition, the percentage of pre-service teachers who interpreted the reason for the need of an adaptation in the labeling system as "changes on technological conditions " is 14.3%.

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Research Results of Questions 4. What do you think should be included in a label that did not exist in the old system? What should be the definitions on a chemical label in the adopt system?

Participants were asked to state their views about the necessary definitions on the new chemical labels. The answers given by the participants to the 4. question was examined and tabulated and given in Table 5.

Table 5.
Views about the necessary definitions on the new chemical labels with the Percentage Values for the Obtained Categories

Categories	Frequency (*f*)	Percentage (*%*)
Hazard statement of the chemical	6	37.5
Instructions to be followed before use	4	25
Information about using of the chemical	4	25
Information on chemical storage conditions	2	12.5

In Table 5, the opinions of the pre-service science teachers the necessary definitions on the new chemical labels are given. The correspondence percentage is %80 with 4 categories. According to the data obtained, 37.5% of the pre-service teachers thought that the "hazard statement regarding the characteristics of the chemical" should be included, while 25% of them thought that there should be "instructions to be followed before use" on the label. The percentage of the participants who stated that the explanation titles on the new chemical label contain "information about the use of the chemical" is 25. In addition, the percentage of pre-service science teachers who stated that the newchemical label should contain information about chemical storage conditions is 12.

Research Results of Questions 5. Lugol Solution is not included in a special group. It is available in 200 mL bottles. It is harmful when it enters the body. It is not flammable and reactive. Safety: In case of eye and skin contact of the solution, it should be washed with plenty of water. Which pictogram or pictograms do you think should be included in the chemical label of Lugol's solution?

Participants were asked to state their views about the pictogram or pictograms that should be included in the chemical label of Lugol's solution. The answers given by the pre-service teachers to first question were examined and tabulated and given in Table 6.

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Table 6.
Views on the pictograms that should be on a chemical label and Percentage Values for the Obtained Categories

Pictogram	Categories	Frequency (f)	Percentage (%)
	1f coded pictogram must be included	9	36
	1 c coded pictogram must be included	5	20
	1e coded pictogram must be included	4	16
	1a coded pictogram must be included	3	12
	1g coded pictogram must be included	3	12
	1d coded pictogram must be included	1	4

In Table 6, views on what the pictogram or pictograms should be on the label of a chemical with known properties (Lugol solution) are expressed. The correspondence percentage is 100% with 6 categories. According to the data obtained, 36% of the pre-service teachers stated that pictograms should be included in the 1f, 20% 1c and 16% 1e coded pictograms. However, the percentage of pre-service teachers who stated that the pictogram with the code 1a and 1g should be included on the chemical label of Lugol's solution, respectively, is 12%. In addition, 4% of the pre-service teachers expressed their views on that the 1d coded pictogram should be included on the chemical label.

Research Results of Questions 6. Do you know which symbols in the old system correspond to the pictograms on the new chemical labels? Explain your answer using the symbols given below.

Participants were asked to state their opinions about the equivalents of the pictograms on the new chemical labels in the old system. The answers given by the pre-service teachers to 6. question was examined and tabulated and given in Table 7.

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Table 7.
Views on the equivalents of the pictograms on the new chemical labels in the old system and the Percentage Values for the Obtained Categories

Pictogram code	Old and New Labels	Frequency (f)	Percentage (%)
1a	 		
1b	 		
1c	 		
1d	 	10	100
1f	 		
1g	 		
1h	no equivalent in the old labeling system 		
1e	 	9	90
1ı	no equivalent in the old labeling system 		

In Table 7, the views of the pre-service science teachers regarding the pictograms on the new chemical labels in the old system are given. The correspondence percentage is %100 with 9 categories.

According to the data obtained, in the comparisons made on a total of 9 pictograms, 100% (all) of the pre-service teachers matched the 1a, 1b, 1c, 1d, 1f, 1g and 1h pictograms correctly. In addition, it is seen that the percentage of matching of the 1e and 1i coded pictograms is 90%.

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Discussion, Conclusion and Suggestions

In this section, the awareness in the adaptation process of changing chemical labeling system according to the views of the pre-service science teachers are explained.

Discussion on Research Questions 1.

In order to reveal the awareness of the pre-service teachers in the adaptation process, their views on pictogram definitions were expressed in the first question with the 9 sub questions.

It is understood that the majority of the pre-service science teachers (45.4%) gave correct answers to the pictogram with code 1a used to express oxidizing substances (Table 2). However, as it can be understood from the data obtained, the pre-service science teachers are confused in the using of definition flammable and oxidizer materials, and this confusion also emerges in the pictogram expressions.

The pictogram with code 1b uses for signifying explosives, self-reactive, and organic peroxides. It should also be kept away from sources of ignition. According to the data obtained, it is understood that the vast majority (58.3%) of the pre-service science teachers expressed the meaning of the Pictogram correctly (Table 2). However, some of the participants stated that the item could be defined as a breakable material based on the drawing on the pictogram. (%16.7). In addition, it is noteworthy that there are participants who expressed the opinion that the pictogram may belong to penetrating substances (%8.3). It is also seen that there are participants who say that they do not know about the chemical materials carrying this pictogram (%8.3) Nitrates, perchlorates and peroxides are reactive. Hydrogen peroxide (H_2O_2) is known as oxygenated water and Nitric acid (HNO_3) are examples of well-known reagents. From this point of view, it is predicted that participants who do not have sufficient knowledge about the pictogram may have problems with the safe usage of chemical materials bearing this pictogram.

The 1c coded pictogram can cause fire when heated and is easily flammable. It is stated that it should only be kept in its original container. The majority of the participants (%42.8) state that the pictogram is used for oxidizer materials. However, there are also participants (28.6%) who stated that the pictogram has the definition for flammables. This situation can be interpreted as the 1c coded pictogram is confused with the 1a coded pictogram. In addition, it can be stated that the participants who expressed their opinions that the pictogram could be a combustible or caustic substance could not make a clear distinction between 1a and 1c coded pictograms (%14.2). Another remarkable situation is that some of the pre-service teachers (7.2%) state that the 1-c coded pictogram is an explosive substance. In this case, it can be said that the pictogram with the code 1c is confused with the pictogram used for the explosive materials expressed with the code 1b. (%7.2) We can say that all products containing alcohol are flammable. Acetone, makeup remover materials, wet wipes, hair sprays, lemon cologne, air fresheners are easily flammable. Some of the combustibles that we use in our laboratory such as Ether, Ethyl alcohol, Phenol Phthalic Solution, Methylene Blue Solution, Alcohol. It can be understood predicted that participants who do not have sufficient knowledge about the pictogram may have problems with the safe usage of chemical materials bearing this pictogram.

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The pictogram with the code 1d identifies acutely toxic or fatal substances in case of swallowed. It is especially emphasized that nothing should be eaten or drunk during in use. The percentage of the participants who defined the pictogram in the most correct way, stating that it is a toxic substance, is 25%. When the views on the pictogram definition are examined, it is noteworthy that there are definitions with similar expressions such as deadly dangerous, dangerous, harmful and substance to be considered. Arsenic, mercury compounds, methanol are some of the chemicals that can classifying as toxins (DeMary, 2000). This situation can be interpreted in a way that the expression intended to be explained by the pictogram is largely understood by the participants.

The pictogram with the code 1e refers to less serious health hazards such as skin irritancy / sensitization. Persons working with chemical materials with this pictogram should not go out of the workplace with their contaminated clothes. The data obtained show that the rate of the participants (25%) who stated that they do not have knowledge about the definition of pictograms is in the top rank. In addition, there are similar opinions that the substances with the 1e coded pictogram may be dangerous, need attention or contain radiation (%16.7). The fact that the pictogram is identified with an exclamation mark makes it difficult to talk about a specific hazard class. Sodium carbonate (Na_2CO_3), Lugol Solution, Manganese Dioxide (MnO_2) are the chemical materials that can be counted in this group.

The 1f coded pictogram is used to denote corrosive substances that can cause serious eye damage. When working with chemicals with this pictogram, it is absolutely necessary to use protective glasses. The data obtained indicate that the vast majority (75%) of the pre-service science teachers expressed the meaning of the pictogram correctly (Table 2). The corrosives we use are divided into two as acids and bases which have been teaching in the unit of chemicals for secondary schools. In terms of all the pictograms in the research, it is understood that the 1f coded pictogram is most accurately expressed by the participants. In addition, other definitions made that the substance with this pictogram “harmful for the environment”, “can be acidic” and “can be harmful for the soil”, evaluated as correct explanations on a category basis, although the pictogram definition cannot be clearly expressed.

The 1g coded pictogram is used for substances that are toxic to aquatic organisms and have long-lasting effects. It is especially emphasized that the materials with this pictogram on the label should not be discharged into the environment. While the pre-service science teachers mostly (58.4%) stated that the chemicals with this pictogram are harmful to nature, it can be said that statements similar to this explanation are in the category class. Some of the participants used the expressions harmful to the soil (16.7%) or harmful to living things (16.7%) instead of using the expression harmful for the environment in general. This situation can be interpreted as the definition of the 1g coded pictogram is understood correctly. However, it is noteworthy that there are also (8.3%) participants who stated that they did not know exactly what the pictogram was.

The 1-h coded pictogram is used for allergy asthma symptoms or harmful substances that can cause breathing difficulties. When working with chemical materials bearing this pictogram, appropriate respiratory equipment should be used in poor ventilation conditions. The participants stated that they saw the 1h coded pictogram for the first time in a large proportion, which can be

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expressed as 70%. Based on the drawing on the pictogram, some of the participants stated that these pictograms are a substance that can cause respiratory problems (20%) and should not be swallowed (10%). It can be said that the definitions based on the data obtained are due to the fact that the 1h coded pictogram is not included in the old labeling system and is included in the new labeling system.

The pictogram with Code 1ı contains gas under pressure and may explode when heated. Chemicals bearing this pictogram label should not be left in sunlight and should be stored in a well-ventilated environment. When the opinions about the pictogram are examined, it can be said that the pre-service science teachers have not seen the 1ı coded pictogram before and therefore cannot define it. As with the views on the definition of the 1-h-coded pictogram, the 1-h-coded pictogram is among the markings that were not included in the old labeling system and included in the new labeling system. The inability of the participants to explain the definition of opinion may be due to the fact that the use of pictograms is new and not frequently used in applications yet.

Discussion on Research Questions 2.

Pre-service science teachers were asked to state their opinions about the pictograms that were not included in the old symbols and were added to the new labeling system. Safety signs, which were called symbols in the old labeling system, are explained under the name of pictograms in the new labels. In the old system, there were orange background and black colored symbolic drawings on the labels, while in the new pictograms there is a symbolic drawing in a red frame created in a diamond pattern with a white background. Among the pictograms presented to the Pre-service science teachers views, the 1h and 1ı coded pictograms are not included in the old system and are included in the new adaptation of labeling system. The 1-h pictogram reflects more serious long-term health hazards such as carcinogenicity and respiratory sensitization, while the pictogram coded with 1ı means that the material contains gas under pressure. Pre-service teachers made correct definitions about the newly added pictograms at a rate of 40%. The data obtained show that all of the pre-service teachers participating in the study included 1h and 1ı coded pictograms in their opinions.

However, it is noteworthy that some of the participants included Pictograms coded with 1e poisonous, coded 1d harmful and oxidizer coded with 1a pictograms along with the correct answers in their views. However, it is seen that there are participants who state that they do not have information about the pictograms included in the new adaptation system. The reason for this situation can be interpreted as the fact that the use of pictograms has not yet become widespread enough and the old labels continue in practical applications. Many countries have been started to adopt the system eventually (Roy, Markow & Kaufman, 2010). According to the country's chemical manufacturers' production, we will be much more familiar with the new system.

Discussion on Research Questions 3.

Pre-service science teachers view on reasons for the need of a new labeling system were examined. Pre-service teachers expressed the opinion (35.7%) that new regulations are needed in order to define newly discovered substances. At the same time, they pointed out that the old labels and visual events were not adequately matched (21.4%) However when the literature is examined,

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there is no information that old markings will cause any problems in terms of identifying newly discovered substances. But it can be said that, a new regulation on chemicals is being worked on in order to make laboratories safer in schools (Council of State Science Supervisors-CSSS, 2000). A new and up-to-date system has been created by taking into account the debates about the change in the labeling system of chemicals and the warnings made by the scientific community all over the world. The aim is to create a general and universal labeling system in schools, industries, chemical sectors and homes. The search for a more common language (14.3%), which is among the views expressed by pre-service teachers, stands out among the correct options.

Discussion on Research Questions 4.

Pre-service science teachers' views on the definitions in the new chemical label that did not exist in the old system were examined. Now there are 6 definitions created by the GHS-Globally Harmonized System (OSHA adopted this system in 2012 and revised its standard) and which are being tried to be accepted all over the world. On a chemical label, the product identification features, which provide information about the chemical identity of the substance, respectively, the pictogram, which is expressed as a visual representation of the danger, the keyword expressed as caution or danger according to the level of danger, the danger information that defines the hazard class of the chemical substance, the warning information that gives information about what to avoid when using the chemical and information such as the name, address and telephone number of the manufacturer company where the chemical was produced. According to the research data obtained, the participants stated that there should be a hazard statement (37.5%) regarding the chemical property, instructions to be followed before use (25), information about the use of the chemical (25%) and storage conditions (12.5%). It is noteworthy that the participants did not include the pictogram expression, the keyword, the hazard class and the manufacturer's information.

Discussion on Research Questions 5.

Pre-service science teachers were asked to state their views about the pictogram or pictograms that should be included in a chosen chemical label. Lugol solution, which is one of the chemicals frequently used in school laboratories by science teachers, was chosen as an example. After explaining the chemical properties of Lugol's solution, the opinions of the pre-service teachers about the pictogram that should be on the chemical label were examined. Lugol solution, which is not included in a special group, is available in 200 milliliter bottles (Stroud, Stallings, & Korbusieski, 2007). In the new labeling system, it is expressed with the pictogram used for harmful chemicals that may cause an allergic skin reaction, coded with 1e. It is seen that the participants expressed their opinions by choosing the correct pictogram at a low rate of 16%. Being able to read the labels of chemicals in school laboratories by correctly interpreting them can be effective in eliminating many risks.

Discussion on Research Questions 6.

In order to reveal the awareness of pre-service teachers in the process of adaptation to the new labeling system, their views on the symbols used in the old system for the pictograms on the new chemical labels were examined. Pre-service teachers were asked to see and match the hazard symbols

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and pictograms used in the old and new labels through a semi-structured interview form. According to the data obtained, it is seen that the pre-service teachers, who are expected to make a total of 9 matches, reached 100% correct answers for 7 matching (1a, 1b, 1c, 1d, 1f, 1g, 1h,). It is noteworthy that the accuracy rate for 2 matches (1e,1ı) is 90%. When the previously stated opinions about the pictograms are examined, it can be said that the pre-service science teachers have not seen the 1ı coded pictogram before and therefore cannot define it. Unfortunately, it can be said that the rate of the participants (25%) who stated that they did not have knowledge about the definition of the 1e coded pictogram ranked at the top. (Table 2). This situation is among the remarkable findings. Because the subject of chemicals is one of the topics covered in science curriculum at schools. According to MoNE 2018, at the 8th grade level, there is a section called acid and base reactions. It is seen that the definitions of acids and bases are included in the content. In addition, it is understood that where and for what purpose chemicals are used in daily life and their effects on nature and people are emphasized.

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