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A SCALE DEVELOPMENT STUDY FOR IDENTIFYING THE LEVELS OF KNOWLEDGE, PERCEPTION AND AWARENESS OF CHEMICAL HAZARD SYMBOLS

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Abstract. *The purpose of this study was to develop a scale to identify the levels of knowledge, perception and awareness of chemical hazard symbols of participants from a variety of backgrounds and ranging in age from 12 years to 40 and over. Experts were consulted for the contextual and the language validity of each item on the scale. In line with the opinions of the experts, the scale, consisting of a total of 25 items distributed under four sections, was applied to 462 participants of all age groups, so as to calculate the discrimination and difficulty indexes. In order to decide whether the third section of the scale is one-dimensional or two-dimensional, data obtained from the 13 multiple-choice questions constituting this section were examined using confirmatory factor analysis. Afterwards the items constituting the second and the third sections of the scale were tested in terms of their reliability. Finally, a useful scale of 24 items in four sections was prepared with tested validity and reliability.*

Key words: *awareness, confirmatory factor analysis, hazard symbols, perception, reliability, validity.*

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Introduction

Laboratories are described as secure environments with adequate experimental material where open-ended activities can be carried out, the rules to be followed are clearly defined; designed properly for both individual and co-operative studies of students (Lang, Wong & Fraser, 2005; Quek, Wong & Fraser, 2002).

The practices performed in laboratories are among the indispensable elements of science lessons (Hofstein & Lunetta, 2004; Hofstein, 2004). These practices aid students in better understanding abstract and complex subjects. They enhance students' scientific attitudes towards research and increase their motivation for science lessons. What is more, laboratory practices enable students to learn the safe use of chemicals. They gain the habit of using chemical tools in safety and attain experience in using these tools (Hofstein & Mamlok-Naaman, 2007).

Students may be exposed to chemicals at different levels of hazard in the laboratory practices of several natural sciences such as chemistry and biology. These chemicals might be organic or inorganic and may be encountered in solid, liquid or gaseous form. Moreover, these chemicals may be corrosive, explosive, irritant, flammable, harmful, oxidizing, toxic, environmentally harmful or radioactive.

Those who work in laboratories must therefore be aware of the hazards and risks associated with chemicals. They should be aware that, for instance, acids and bases that are ordinarily used in chemical laboratories are irritants. Upon contact with the eye, skin and respiratory organs, they have a burning effect. There are several chemicals used in laboratories that are easily flammable and pose threat of fire. On the other hand, there are explosive chemicals in a laboratory, as well. If released, some chemicals can have harmful effects on human beings and the environment.

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Even experienced individuals might be exposed to several hazards unless they follow certain precautions while working in the laboratories (Fivizzani, 2005). Chemicals are dangerous and risky. It should always be remembered that they are beneficial provided that they are used appropriately (Warhurts, 2006). In order not to be exposed to harmful effects in laboratories, good and regular planning is essential. Safety is therefore of prime importance in laboratory practices. Individuals must be informed about the risks of a laboratory environment and the necessary precautions must be taken (Banda & Sichilongo, 2006; Karapantsios et al., 2008; Pratt, 2002; Richards-Babb et al., 2010). Chemical accidents mostly occur due to the neglect of safety precautions or the absence of related precautionary symbols on the chemicals (Su & Hsu, 2008). So as to classify chemicals and draw users' attention, each chemical should be labelled with precautionary symbols indicating its features (Pratt, 2002). These symbols (flammable, corrosive, irritant, environmentally harmful, radioactive, oxidizing, toxic or harmful) include different colours and images and are designed to inform users about the features of the chemicals (Kan, 2007). Besides, the cleaning, cosmetic and stationery products, which are used in daily life, are also labelled with similar chemical hazard symbols.

These hazard and risk precautionary symbols must be known by everybody who enters the laboratory. Similarly, consumers of all ages should be aware of similar chemical hazard symbols which are placed on products for daily use. Knowing the meanings of these hazard symbols on chemicals aid the safe use of chemicals (Duffus & Worth, 2006).

Upon investigating the literature, one can see that several studies have been carried out to measure the awareness of individuals of chemical hazard symbols (e.g. Adane & Abeje, 2012; Anilan, 2010; Draman et al., 2010). When these studies are examined, it is seen that only students were preferred for sample groups. Nevertheless, most of the products used in daily life have similar chemical hazard symbols on them. Besides, as well as identifying the levels of students' knowledge and awareness of chemical hazard symbols, studies aimed at identifying their level of perception towards these chemical hazard symbols are also required. For such reasons, this study intends to develop a measurement tool, the validity and reliability tests of which have been done, to identify the levels of knowledge, perception and awareness of participants in all age groups.

The Purpose of the Study

Laboratory practices are among the integral parts of science subjects. There are several symbols on the chemicals that are used in laboratory experiments. Moreover, these symbols are used on cleaning, cosmetic and stationery products that are encountered in daily life mostly. Therefore the purpose of this study is to develop a scale with a completed reliability test will identify the participants' levels of knowledge, perceptions and awareness of the chemical hazard symbols.

Methodology of Research

Sample of the Study

Four experts were consulted to ensure the content validity of the scale items. Two Turkish language experts then evaluated the language and comprehensibility of each item of the scale. The sample of this investigation comprised an initial 47 undergraduate students that took part in the pilot study while writing the scale items. The scale was then applied to 462 people from all age groups and the data evaluated for validity and reliability. In order to determine whether measurement tool entitled *"A Scale for Identifying the Levels of Knowledge, Perception and Awareness of Chemical Hazard Symbols"* is really sensitive to the features to be intended to measure, the study was carried out with 462 participants in February and April, 2013.

The participants were selected through convenience sampling (Johnson & Christensen, 2004). A sample of the study was comprised of 293 females (63.4%) and 167 males (36.1%). 0.4% of the participants did not specify their gender. A detailed demographic information of the sample is given in Table 1.

Table 1. Demographic information about the sample of the study.

The age range			Profession			Marital status		
	N	%		N	%		N	%
19-24	206	44.6	Student	367	79.4	Single	392	84.8
16-18	106	22.9	Housewife	36	7.8	Married	61	13.2
12-15	63	13.6	The self-employed	13	2.8	Unspecified	9	1.9
25-30	29	6.3	Officer	9	1.9	**Number of child**		
40-over	37	8.0	Other	8	1.7		N	%
30-40	19	4.1	Unspecified	7	1.5	No	381	82.5
Unspecified	2	0.04	Engineer	6	1.3	2	34	7.4
Inhabitation			Worker	6	1.3	Unspecified	19	4.1
	N	%	Academic staff	5	1.1	3	13	2.8
Urban	380	82.3	Teacher	4	0.09	4-over	8	1.7
Rural	62	13.4	Doctor	1	0.02	1	7	1.5
Small town	17	3.7						
Unspecified	3	0.06						

As can be seen, the majority of the participants (79.4%) were students. Of these, 180 (39%) were undergraduate students, 98 (21.2%) were high school students, 46 (10%) were secondary school students, 39 (8.4%) were associate degree students and 4 (0.8%) were graduate students.

Development of the Scale

Formation of the item pool: Initially, the chemical hazard symbols commonly used by European Union member countries were specified by the researcher. These symbols were classified as corrosive, harmful, flammable, over-flammable, oxidizing, irritant, environmentally harmful, toxic, explosive or radioactive. Thereafter which of these symbols were placed on the products using in daily life was determined. At this part, 47 undergraduate students participating in the Elementary Science Teaching Undergraduate Program (ESTUP) of a university located in the Northwest of Turkey were put through pilot study. The students were asked to identify products with chemical hazard symbols in the cosmetics, cleaning and stationery departments of supermarkets. The products having bore chemical hazard symbols were photographed at very close distance by digital cameras. The photographed products were displayed in a General Chemistry Laboratory lesson. A brainstorming session was performed with the students to determine what kind of products were generally indicated with chemical hazard symbols such as those for irritant, harmful, environmentally harmful or corrosive.

Scale items were then prepared by the researcher in four-parts to investigate the levels of knowledge, perception and awareness of chemical hazard symbols of the participants. The first part involves the demographic information. The second part constitutes the first six questions of the scale. It includes questions that aim to identify levels of perception of chemical hazard symbols. To determine the degree of agreement with these expressions, a four point Likert type scale was used (4-High; 3-To a degree; 2-Slightly; 1-None). The third part of the scale comprises multiple-choice questions aimed at determining to what extend people are informed about what chemical hazard symbols mean and what people should notice while using these products. These questions were formed with a scenario which includes products with chemical hazard symbols generally consumed in daily life with illustrations. 9 of the questions at this part seek the answers of the questions "to what extend are people informed about the meanings of chemical hazard symbols?" while the remaining four were designed to help obtain the answers of the questions "what should people notice while using of these products?". Each of the 13 multiple-choice questions in this part were prepared in a way that they had four choices, one being the correct choice and other three being the distractive choices. The final six questions (questions 19-25) that constitute the last part of the scale were 'yes/

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no' type of questions. These questions were intended to determine whether chemical hazard symbols should be on the products of daily using and whether people should be informed about these symbols or not.

Content validity: Content validity is defined as the degree of measuring ability of a scale tool (Gullo, 2005). At this stage, experts determined the level of content reflection of each item of the scale. In this study, four subject matter experts evaluated the scale items. In accordance with expert opinions, necessary corrections were made.

Language validity: At this stage, 2 Turkish language experts evaluated whether the scale items were appropriate for Turkish grammar rules or not. Expressions causing incomprehensibility were corrected in accordance with expert opinions.

Item discrimination and difficulty index: The item difficulty index is used to determine the participants' ratio of answering each item correctly (Kaplan & Saccuzzo, 1997). This index may have values between 0 and 1. Item discrimination index, on the other hand, is the indicator of whether each scale item is capable of differentiating between the levels of knowledge of successful and unsuccessful students. It may have values between -1 and +1. Negative values are mean an undesired situation. The fact that the item discrimination index is close to 0 indicates that the item has been answered correctly by every participant. In this study, the item difficulty and discrimination indexes of 13 questions constituting the third part of the scale were calculated.

Factor analysis: Factor analysis is an integral element of scale development and adaptation studies. It is used for identifying the latent variables of the scale (Devellis, 2003). It possesses two types that are exploratory and confirmatory factor analysis (Decoster, 1998). Exploratory factor analysis aims to identify the underlying relationships between a relatively large set of variables into a few and meaningful factors. (Cokluk, Sekercioglu & Buyukozturk, 2012). Confirmatory factor analysis, on the other hand, is used to investigate the compliance of factors that are made from variables with real values. In this study, confirmatory factor analysis was used to determine whether the questions constituting the third part of the scale were one-dimensional or two-dimensional.

Reliability: Reliability is another main topic in psychological measurement, and it represents the degree of instrument consistency or stability (Carmines & Zeller, 1979). The reliability of a scale can be calculated in several ways. The coefficient for internal consistency of a scale can be calculated with split model, KR-20 and KR-21 models and Spearman-Brown formula. The internal consistency coefficients of the scale were calculated using KR-20 model and Cronbach-alpha values.

Results of Research

The reliability (internal consistency) of the scale was investigated using item analysis which based upon both sub-super group average difference and correlation. Item analysis based on sub-super group average difference and correlation were performed separately for the second and the third parts of the scale.

Item Analysis Based on Sub-Super Group Averages Difference

With the aim of identifying the discrimination of the scale items, the t values of the difference between the averages of the levels of knowledge, perception and awareness of chemical hazard symbols were calculated. To this end, the scores obtained from the scale applied to 462 participants were listed from the highest to the lowest separately for the second and the third parts of the scale. Sub and super groups were organized in a way that they constituted approximately 27% of the 462 participants that answered the scale questions. For the second part of the scale, sub and super groups included 115 participants each while they included 110 participants each for the third part. The analysis shown is presented in Table 2.

Table 2. The item averages, standard deviation and t values of 27% sub groups and 27% super groups of the scale.

Items	1: Sub 2: Super	N	Mean	SD	t	p
1	1	113	2.18	0.901	14.514	0.000
	2	115	3.61	0.539		
2	1	113	2.50	0.887	-7.723	0.000
	2	115	1.69	0.677		
3	1	112	2.09	0.683	15.260	0.000
	2	115	3.35	0.549		
4	1	112	1.29	0.563	21.128	0.000
	2	115	3.17	0.763		
5	1	113	1.76	0.747	21.612	0.000
	2	115	3.66	0.573		
6	1	113	1.83	0.705	22.422	0.000
	2	115	3.67	0.522		
7	1	105	0.27	0.444	-11.857	0.000
	2	110	0.89	0.313		
8	1	108	0.53	0.502	-7.106	0.000
	2	110	0.92	0.275		
9	1	110	0.75	0.438	-6.101	0.000
	2	110	1.00	0.000		
10	1	110	0.33	0.471	-9.895	0.000
	2	110	0.87	0.335		
11	1	109	0.61	0.491	-7.411	0.000
	2	110	0.97	0.164		
12	1	109	0.36	0.482	-5.149	0.000
	2	109	0.69	0.465		
13	1	102	0.46	0.501	-5.925	0.000
	2	109	0.83	0.381		
14	1	108	0.15	0.357	-9.902	0.000
	2	110	0.70	0.460		
15	1	109	0.54	0.501	-9.213	0.000
	2	110	0.99	0.095		
16	1	107	0.46	0.501	-9.487	0.000
	2	110	0.96	0.209		
17	1	108	0.67	0.474	-6.354	0.000
	2	110	0.97	0.164		
18	1	108	0.38	0.488	-10.942	0.000
	2	110	0.95	0.228		
19	1	109	0.40	0.491	-7.085	0.000
	2	110	0.82	0.388		

Table 3 shows the item-total correlation of the items included in the second and the third parts of the scale.

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Table 3. Item-total correlation of the scale items.

Item No	Item-total correlations (r)	Item No	Item-total correlations (r)	Item No	Item-total correlations (r)
Item 1	0.522	Item 7	0.326	Item 13	0.200
Item 2	Removed	Item 8	0.282	Item 14	0.290
Item 3	0.518	Item 9	0.442	Item 15	0.418
Item 4	0.582	Item 10	0.324	Item 16	0.401
Item 5	0.597	Item 11	0.433	Item 17	0.336
Item 6	0.648	Item 12	0.181	Item 18	0.445
				Item 19	0.272

As shown in Table 3, the second of the first six items identifying the level of perception of chemical hazard symbols was omitted because its item-total correlation was negative. It can be seen that the item-total correlation values of the remaining five items vary from 0.518 and 0.648. The table also shows that the item-total correlation values of the 13 items that identify the levels of knowledge and awareness of chemical hazard symbols (questions 7-19) vary from 0.181 and 0.445. At this part, item 12. was determined as not adequately distinctive, therefore it was considered for removal initially, however, after calculating the item difficulty and discrimination values, a decision regarding the item was made.

Item Difficulty and Discrimination Indexes

To determine the level of difficulty of the 13 multiple choice questions constituting the third part of the scale, the item difficulty and discrimination indexes of each question was calculated. The item difficulty and discrimination values are given in Table 4.

Table 4 reveals that all of the multiple-choice questions constituting the third part of the scale, except question 9 have a discrimination value of over 0.30, where these questions can be regarded as adequately distinctive. The most appropriate item difficulty level for multiple-choice questions with four options is 0.62 (Kaplan & Saccuzzo, 1997). Furthermore, an item difficulty index of nearly 0.50 and a discrimination index of over 0.20 is a desired situation. According to the item difficulty and discrimination indexes obtained from the questions it was seen that the easiest question was question 9 since it was answered correctly by 87% of the participants of the study. The most difficult question was question 14 since it was answered correctly by 42% of the participants. The item difficulty index values of a scale should be between 0.1 and 0.90 (Walsh & Betz, 2000). It was seen that the item difficulty indexes of the multiple-choice questions of the scale developed varied from 0.42 and 0.87. It was found that the average difficulty value of a total of 13 questions was 0.66 and the average discrimination value was 0.44. Accordingly, it is clear that the third part of the scale that includes the multiple-choice questions is slightly easier than moderate and they have various difficulty levels.

Table 4. The average difficulty and discrimination values of the multiple-choice questions of the scale.

Item No	Discrimination	Difficulty
Item 7	0.64	0.57
Item 8	0.40	0.72
Item 9	0.25	0.87
Item 10	0.55	0.60
Item 11	0.37	0.79
Item 12	0.33	0.52
Item 13	0.39	0.62

Item No	Discrimination	Difficulty
Item 14	0.55	0.42
Item 15	0.45	0.76
Item 16	0.51	0.70
Item 17	0.32	0.81
Item 18	0.57	0.66
Item 19	0.43	0.60

Factor Analysis

Of the 13 multiple-choice questions constituting the third part of the scale, 9 aimed at determining to what extend the meanings of chemical hazard symbols are known and 4 determining what should be noticed while consuming products with chemical hazard symbols. To this end, it was considered that multiple-choice questions could be made from two different sub-dimensions. In order to determine whether the third part of the scale developed, including the multiple-choice type of questions, had one-dimensional or two-dimensional structure, confirmatory factor analysis was used for both models. Thus, via a comparison of goodness of fit coefficients obtained from the two models, it was determined that which factor model would have a better fit. The findings of confirmatory factor analysis for the 13-item one dimensional model and 9 and 4-item two dimensional model are given in Table 5.

Table 5. The fit statistics for one dimensional and two dimensional model of the third part of the scale (N=462).

Model	χ^2	df	χ^2/df	GFI	AGFI	RMSEA	CFI	NFI	NNFI	RMR	SRMR
One dimensional	126.11	65	1.94	0.96	0.94	0.045	0.89	0.81	0.87	0.0096	0.048
Two dimensional	126.16	64	1.97	0.96	0.94	0.046	0.89	0.81	0.87	0.0096	0.048

After the confirmatory factor analyses, fit indexes were examined in order to find which of the two models had better fit to the data obtained. There are many fit indexes for the analyses of the Structural Equation Models (SEM). In this study, the most commonly used fit indexes are given. The ratio of χ^2- value is an important statistic within its own degree of freedom. The fact that this ratio is 3 or lower indicates a very good fit of the model to the data obtained (Loehlin, 2004). The fact that GFI, AGFI and CFI values are over 0.90 is accepted as a good fit. The fact that RMSEA value is below 0.03 means that the model proposed is perfectly fit the data obtained, if the value is below 0.05, there is a very good fit (Byrne, 1998; Kelloway, 1998). When Table 5 is examined, it can be seen that both one dimensional and two dimensional structure of the third part of the scale have very similar fit indexes that both have very good and perfect it. According to Cheung and Rensvold (2002), who reported on the necessary difference between RMSEA and CFI values to determine which of the two models has better compliance, a difference of 0.01 and higher between RMSEA and CFI values can be interpreted as a meaningful goodness of fit between two models (cited in Feyzioglu et al., 2012). Although the difference between the RMSEA values of one dimensional and two dimensional values is 0.01, there is no difference between CFI values. In light of this, the fit of the one dimensional model is better than that of the two dimensional one to the data obtained. Anyway, the fit of both models are good.

Reliability

In order to investigate the internal consistency of the 5 items constituting the second part and the 13 items constituting the third part of the scale identifying the levels of knowledge, perception and awareness of chemical hazard symbols, reliability coefficients were calculated. Accordingly, for the internal consistency of the 5 items that constitute the second part of the scale intented to identify the level of perception of chemical hazard symbols, the Cronbach-alpha value was calculated as 0.792. The internal consistency of the 13 items including the multiple-choice questions of the scale were calculated using the KR-20 formula since the difficulty indexes of the items were different

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from each other. The KR-20 reliability coefficient was calculated 0.66. These values are important evidence in terms of the fact that they reveal the integral consistence of the questions. Besides, according to Shum, O'Gorman and Myors (2006), the internal consistency coefficient for the multiple-choice questions having 0.66 is acceptable.

Explanatory Statistical Data

The 5 items constituting the second part of the scale were designed to identify the participants' level of perception of chemical hazard symbols. To determine whether the answers given by the participants to the items in this part caused a meaningful difference in terms of gender, age, profession, inhabitation, marital status and number of child, a one-way analysis of variance (ANOVA) was done. According to the results of (ANOVA), there is no meaningful difference between the groups. The means and standard deviations obtained from the answers of the participants to the items in this part in terms of gender, age, profession, inhabitation, marital status and number of child are given in Table 6.

Table 6. Value points according to gender, age, profession, inhabitation, marital status and number of child.

		N	Mean	SD
Gender	Female	293	13.58	3.35
	Male	166	13.02	3.50
	Total	459	13.37	3.41
The age range	12-15	63	14.03	3.46
	16-18	106	13.02	3.69
	19-24	205	13.36	3.02
	25-30	29	13.79	3.82
	30-40	19	14.42	3.11
	40-Over	37	12.24	4.07
	Total	459	13.35	3.41
Profession	Employee	49	13.85	3.54
	Housewives	36	12.25	4.22
	Secondary school	58	14.27	3.29
	High school	98	12.71	3.68
	Associate's degree	39	13.56	3.14
	Undergraduate	177	13.54	3.03
	Total	457	13.39	3.41
Inhabitation	Rural	62	13.12	3.23
	Small town	17	12.64	3.77
	Urban	379	13.43	3.42
	Total	458	13.36	3.41
Marital status	Married	61	12.86	4.15
	Single	391	13.49	3.28
	Total	452	13.40	3.41
Number of child	None	380	13.51	3.26
	There are child	62	12.77	4.01
	Total	442	13.40	3.38

Each of the multiple choice questions that constitute the third part of the scale were graded 1 for correct answer and 0 for incorrect answer in the achievement test. For this reason, as the points obtained from this test increase, it is understood that what chemical hazard symbols mean is known while the situation is reverse as the points decrease. In Table 7, the means and standard deviations obtained from answers of participants to the multiple-choice questions in the third part of the scale are given.

Table 7. Value points according to gender, age, profession, inhabitation, marital status and number of child.

		N	Mean	SD
Gender	Female	293	8.90	2.22
	Male	167	8.74	2.28
	Total	460	8.84	2.24
The age range	12-15	63	8.28	1.74
	16-18	106	9.05	2.12
	19-24	206	8.89	2.34
	25-30	29	9.79	2.00
	30-40	19	8.52	2.24
	40-Over	37	8.24	2.67
	Total	460	8.83	2.24
Profession	Employee	49	9.42	2.25
	Housewives	36	7.80	2.43
	Secondary school	58	8.27	1.83
	High school	98	9.16	1.96
	Associate's degree	39	8.35	2.05
	Undergraduate	178	8.99	2.42
	Total	458	8.83	2.25
Inhabitation	Rural	62	8.70	2.43
	Small town	17	7.52	2.87
	Urban	380	8.92	2.18
	Total	459	8.84	2.25
Marital status	Married	61	8.49	2.42
	Single	392	8.92	2.20
	Total	453	8.86	2.23
Number of child	No child	381	8.94	2.21
	There are child	62	8.17	2.51
	Total			

Table 8 shows the results of the one-way analysis of variance (ANOVA) performed to identify whether the scores of the participants obtained from the multiple choice questions of the third part of the scale made a meaningful difference in terms of gender, age, profession, inhabitation, marital status and number of child or not.

Table 8. One-way analysis of variance results.

	Source of variance	Sum of squares	df	Mean square	F	p
The age range	Between Groups	66.413	5	13.283	2.676	0.021
	Within Groups	2253.683	454	4.964		
	Total	2320.096	459			

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	Source of variance	Sum of squares	df	Mean square	F	p
Profession	Between Groups	97.462	5	19.492	3.968	0.002
	Within Groups	2220.582	452	4.913		
	Total	2318.044	457			
Inhabitation	Between Groups	32.910	2	16.455	3.265	0.039
	Within Groups	2297.796	456	5.039		
	Total	2330.706	458			
Number of child	Between Groups	31.622	1	31.622	6.181	0.013
	Within Groups	2255.999	441	5.116		
	Total	2287.621	442			

When Table 8 is examined, it is seen that there was a meaningful difference between the groups in terms of age group, profession, inhabitation and number of child. To identify between which groups there exist a meaningful difference, the Post Hoc test results were examined. It is obvious that from the averages of the correct answers of the multiple choice questions constituting the third part of the scale, there is a meaningful difference in favour of secondary school students of ages 12-15 and participants of 25-30 (p=0.032). Moreover, in terms of professions, among housewives and those who are employees separately (p=0.012), high school students (p=0.022) and undergraduate students (p=0.041), there is a significant meaningful difference to the detriment of housewives. On the other hand, meaningful differences in favour of urban people against small town people (p=0.034) and in favour of people with child against people without child (p=0.013) were detected.

The results of frequencies and percentages of participants answered by the yes/no type of questions in fourth part of the scale are given in Table 9.

Table 9. Frequencies and percentages of the fourth part.

	Item 20		Item 21		Item 22		Item 23		Item 24	
	N	%	N	%	N	%	N	%	N	%
Yes	428	92.6	399	86.4	122	26.4	115	24.9	157	34
No	32	6.9	61	13.2	335	72.5	340	73.6	300	64.9
Unspecified	2	.04	2	.04	5	1.1	7	1.5	5	1.1

It is seen that the ratio of participation in questions 20 and 21 having positive meaning for the necessity of using chemical hazard symbols and the benefits that can be obtained from using these symbols is high (See Table 9). Moreover, it is seen that those who reported whether they had been involved in an accident while using a product with a chemical hazard symbol and if they had, said *"if only I had known the meaning of the chemical hazard symbol"* constituted approximately one fourth of the participants. On the other hand, about two thirds of the participants expressed that they had never been informed about the chemical hazard symbols on the products that they use in their daily life. To the last question *"have you ever received any information about chemical hazard symbols? If you have, where?"* were not answered by 188 (40.6%) of the participants. This information was obtained by 114 (24.6%) from school; by 111 (24.0%) from the media; 80 (17.3%) from self-researching; 52 (11.2%) from friends, 38 (8.2%) from seminars and 26 (5.6%) from other sources.

Discussion and Recommendations

The scale was developed with the aim of identifying participants' levels of perceptions and awareness of chemical hazard symbols and whether they know what these symbols mean. The following steps were followed in scale development. Initially, the symbols commonly used in European Union countries found on the products that consumed in daily life were identified. Thereafter, products having these chemical hazard symbols were identified with the assistance of 47 undergraduate students studying in the first grade of the ESTUP of a university located in the Northwest of Turkey. They were asked to locate products with chemical hazard symbols in the cleaning, cosmetics and stationery departments of supermarkets. Then, close up images were obtained of these products using a digital camera. The photographs were then displayed in a General Chemical Laboratory lecture. Students then discussed on which products having various chemical hazard symbols were generally found in relation to them as being irritants, flammable, environmentally harmful or corrosive.

Later, scale items were developed by the researcher. While developing the multiple choice questions of the scale, scenario-type questions about products with chemical hazard symbols that are consumed in daily life were preferred. Expert opinions were received for the content validity and language validity of the scale. After a number of corrections in the scale items in accordance with expert opinions were made, a scale of a total of 25 items and with four parts was applied to a total of 462 participants. From the data obtained, item-total correlations, item difficulty and discrimination indexes of the items were calculated. To decide whether the multiple-choice questions constituting the third part of the scale was one dimensional or two dimensional, a factor analysis was carried out. Lastly, the reliability values of the scale were calculated.

The findings show that the scale developed has adequate physcometric features and it is decisive for individuals' levels of knowledge, perception and awareness of chemicals hazard symbols. The scale is useful in terms of determining whether students are sensitive to chemical hazard symbols placed on the chemicals used in laboratory practices which are integral parts of the science lessons. Students of all age groups (secondary school, high school, associate's degree, undergraduate or graduate) might be exposed to several hazards unless they follow certain precautions while working at laboratories (Fivizzani, 2005). Knowing the meanings of these hazard symbols on chemicals aid the safe use of chemicals (Duffus & Worth, 2006). As noted at the outset, this scale may serve as a useful tool for future researchers who are attempting to reveal students' levels of knowledge, perception and awareness of chemical hazard symbols. Also, the scale is well-organized, age and linguistically appropriate, and supported with pictures to make the items more understandable. Moreover, this scale can be used outside the laboratory to identify the level of knowing, perceiving and being aware of chemical hazard symbols which are on products consumed daily life.

Scale items were organized in a manner that used a comprehensible daily language, daily life scenarios in some questions and illustrations. Of the multiple-choice questions constituting the third part of the scale, the average difficulty index was found 0.66 and the average discrimination index was found 0.44. According to Kaplan and Saccuzzo (1997), this situation is ideal for multiple-choice questions with four options. Furthermore, the results of the factor analysis performed for the multiple-choice questions constituting the third part of the scale showed that the fit indexes and the internal consistency coefficients of the scale were at ideal level.

Even though the results found indicate that the scale is at a desired level in terms of structure, concept, language validity and physcometric features, they should be supported in studies conducted with larger samples groups and in different environments because the majority of the sample of this study is made up of students. In as much as the average difficulty and discrimination indexes of the scale are at ideal level, since the majority of the sample group is students, it may be regarded as a bit easy. It can be thought that the data obtained from a sample comprised of participants from all age and profession groups and living in different regions who participate at an equal level, would have much more appropriate values.

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Appendix 1

Scale of Identifying the Levels of Knowledge, Perception and Awareness of Chemical Hazard Symbols

Esteemed Participants;

This scale aims at determining your views on topics such as "how careful we are about the chemical hazard symbols that we frequently see on the daily products we consume (cleaning, cosmetics and stationery products), to what extend do we know what these symbols mean, whether we take notice of while consuming these products or not?" etc. Hoping that you will share your views on every single expression in the scale with us sincerely, we thank for your participation.

Demographic Information

1. Gender: ( ) Female ( ) Male

2. Age: ( ) 12-15 ( ) 16-18 ( ) 19-24 ( ) 25-30 ( ) 30-40 ( ) 40-Over

3. Professions:

( ) Student	( ) Teacher	( ) Housewife
( ) Worker	( ) Self-employed	( ) Doctor
( ) Lawyer	( ) Officer	( ) Health Staff
( ) Engineer	( ) Academic Staff	( ) Other:

4. Educational level:

( ) Illiterate	( ) Literate	( ) Primary school	( ) Secondary school
( ) High school	( ) Associate's degree	( ) Undergraduate	( ) Graduate

5. If you continue your education, specify your school/university/department/class: …………………… ……………………………………………………………………...

6. Inhabitation: ( ) Rural ( ) Small town ( ) Urban

7. Marital status: ( ) Married ( ) Single

8. Number of child: ( ) No ( ) 1 ( ) 2 ( ) 3 ( ) 4-over

SCALE QUESTIONS

1. To what extend do the hazard symbols that are attached to the products (cleaning, cosmetics and stationery products) are consumed daily life and whose images are given above draw your attention?

○ 4. High ○ 3. To a degree ○ 2. Slightly ○ 1. None

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2. To what extend do these hazard symbols attached to some of the products consumed in daily life concern you?
   ◯ 4. High ◯ 3. To a degree ◯ 2. Slightly ◯ 1. None

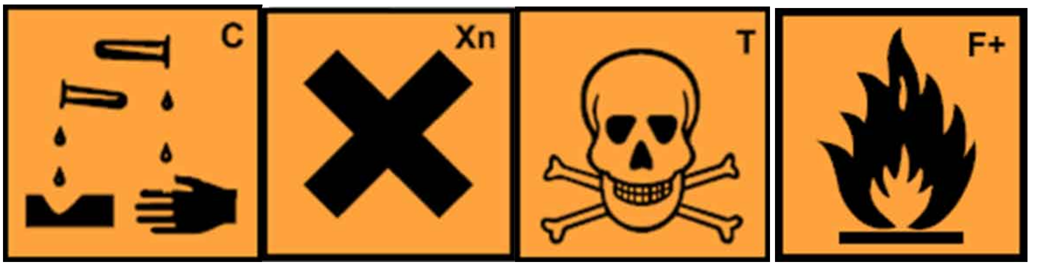
3. How much are you familiar with these hazard symbols attached to some materials consumed in daily life?
   ◯ 4. High ◯ 3. To a degree ◯ 2. Slightly ◯ 1. None

4. How much do you get curious and research about the meanings of these hazard symbols that are on some of the products consumed in daily life when you see them?
   ◯ 4. High ◯ 3. To a degree ◯ 2. Slightly ◯ 1. None

5. How much do you take precautions when consuming products with hazard symbols?
   ◯ 4. High ◯ 3. To a degree ◯ 2. Slightly ◯ 1. None

6. When using the products of the hazard symbols, how much do you pay attention how these products should be used?
   ◯ 4. High ◯ 3. To a degree ◯ 2. Slightly ◯ 1. None

7. Imagine you are at the cleaning products department of a market. Which one of the below is the precautionary symbol that is on the products such as laundry detergents and means ***"HARMFUL"***?



◯ A ◯ B ◯ C ◯ D

8. Ladies are generally neat about cleaning. They are exposed to the hazardous effects of dishwashing liquids while washing the dishes; bleaches while disinfecting the sink and tiles joint disinfectants while cleaning between the tiles. Using these throughout the day, which hazardous effects of these products are the ladies exposed to?

   ◯ A. Flammable ◯ B. Irritant ◯ C. Harmful ◯ D. Corrosive

9. Which one of the below is the symbol meaning "***FLAMMABLE***" that is on the shaving foam, used by men while shaving and acetone, used by women to remove their nail polishes?

◯ A ◯ B ◯ C ◯ D

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10. Which one of the below is the precautionary hazard symbol that is usually on the deodorants we use to remove the unwanted smell in the restrooms, sprays that we use to kill the insects and flies that sometimes inhabit our homes, fly repellents and pest repellents?

◯ A. Environmentally harmful ◯ B. Corrosive ◯ C. Radioactive ◯ D. Oxidizing

11. Lime water sometimes results in liming in tea pots. Most of use lime solvents for this. Which of the following do you think is the hazard symbol that means "***CORROSIVE***" found on the solvents used to remove the lime in the tea pots?

◯ A ◯ B ◯ C ◯ D

12. There are usually more than one hazard symbol on the packages of adhesives that the students use for various purposes and the correction fluids clerks use for correcting writing mistakes. Which of the below do you think offers the right couple of hazard symbol that should be on such products?

◯ A. Toxic-Radioactive ◯ B. Corrosive-Harmful
◯ C. Oxidizing- Environmentally harmful ◯ D. Flammable- Irritant

13. Fly repellents usually bear hazard symbols numbered 1, 2 and 3. Which of the below options are the meanings of these symbols given correctly?

	1	2	3
◯ A.	Corrosive	Environmentally harmful	Oxidizing
◯ B.	Environmentally harmful	Extremely flammable	Irritant
◯ C.	Explosive	Irritant	Toxic
◯ D.	Radioactive	Flammable	Harmful

14. The products that are labelled with the hazard symbol on the side are those that are explosive even if they do not contact with a flammable material and should be kept away from flammable materials. Which of the below gives the meaning of this symbol?

◯ A. Oxidizing ◯ B. Extremely flammable
◯ C. Irritant ◯ D. Toxic

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15. There are usually hazard symbols on air refresheners that are numbered 1, 2 and 3. Which option gives the correct meaning of these symbols?

	1	2	3
◯ A.	Explosive	Harmful	Environmentally harmful
◯ B.	Toxic	Flammable	Corrosive
◯ C.	Flammable	Toxic	Environmentally harmful
◯ D.	Irritant	Radioactive	Harmful

16. Let us imagine that you see the hazard symbol illustrated below on your deodorants and you know the meaning of that symbol. Which precaution would you take against this hazard symbol?

◯ A. I would shake before use.
◯ B. I would avoid exposing it to sunlight.
◯ C. I would not come close to with a flammable.
◯ D. I would keep it in a cool environment.

17. What feature of cleaning products such as laundry bleaches, spirit of salt and oil solvents makes it necessary to wear gloves while using these products?

◯ A. Flammable ◯ B. Irritant ◯ C. Toxic ◯ D. Explosive

18. Let us imagine that you see the hazard symbol illustrated in the side on fly repellents and insect killers and you know the meaning of that symbol. Which precaution would you take against this hazard symbol?

◯ A. I would use wearing gloves.
◯ B. I would avoid inhaling the product.
◯ C. I would shake before use.
◯ D. Considering the risk, I would prevent this kind of materials' contact with the soil and the environment.

19. Let us suppose that you know what the hazard symbol on the package of the lime solvent that you use to solve the lime in your tea pot. In this case, which of the following precautions would you take while cleaning your tea pot with lime solvent?

◯ A. I would avoid inhaling the steam produced while using the product.
◯ B. I would try not to use mixing with laundry bleaches and other such cleaners.
◯ C. After the solving has been finished, I would cleans the entire pot with plenty of water.
◯ D. All of the above

20. Do you think that some products that consumed in daily life should be labelled with these hazard symbols?
◯ 1. Yes ◯ 2. No

21. Do you think that if the meanings of these hazard symbols on the products consumed in daily life were known, the harms of these products on yourself and your environment would be much lower?
   ◯ 1. Yes ◯ 2. No

22. Consider your past life briefly. Have you ever been involved in an accident while using a product with a hazard symbol?
   ◯ 1. Yes ◯ 2. No

23. "Have you ever said afterwards "If I had learned the hazard symbols of those products before, I would not have had this accident"?
   ◯ 1. Yes ◯ 2. No

24. Has anybody informed you about these hazard symbols on some products that consumed in daily life?
   ◯ 1. Yes ◯ 2. No

25. If you have been informed about this topic previously, where have you received this information? (If you have not, do not answer this question, you may mark more than one option).
   ◯ From the media (TV, radio, newspapers, etc.,)
   ◯ From my friends
   ◯ From self-researching
   ◯ From seminars
   ◯ From school
   ◯ Other (Write where):

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