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Growing misconception of technology: investigation of elementary students' recognition of and reasoning about technological artifacts

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Abstract Knowledge of technology is an educational goal of science education. A primary way of increasing technology literacy in a society is to develop students' conception of technology starting from their elementary school years. However, there is a lack of research on student recognition of and reasoning about technology and technological artifacts. In this respect, the purpose of this study was to determine elementary school students' recognition of and reasoning about technological artifacts. In line with this purpose, a survey was conducted with 239 elementary school students from Turkey. For the analysis of the quantitative data collected, independent sample *t* test, one-way ANOVA and descriptive statistics were used. For the analysis of the qualitative data, content analysis was used. The results revealed that the students' recognition of and reasoning about technological artifacts were not wrong yet not efficient. In addition, it was also found out that the students' technology recognition differed depending on the socioeconomic levels of their schools in relation to digital divide and on their parents' educational backgrounds. When the students' views were examined, it was seen that electricity was a requirement for anything to be regarded as technology. Suggestions were put forward for researchers, teachers as well as for parents regarding students' understanding of technology.

Keywords Recognition of technology · Reasoning about technology · Technology education · Elementary students · Digital divide

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Introduction

We are in a technological revolution, which has caused nation-states, corporations, and individuals to become more technology-driven, technology-supported, and technology-dependent (Paau 2001). Technology is one of the most important supporters of education and training in the 21st century, and knowledge of technology is an educational goal (DiGironimo 2011). Kids today are saturated by technology in different levels in accordance with their Socio-Economic Status (SES): from television to the Internet, from video games to mobile games, and from camcorders to personal computers (Hutchby and Moran-Ellis 2001).

With the rapid development and extensive integration to education, technology is now referred to as computer equipment, software and other electronic devices, and technology integration is known as use of this equipment in classrooms (Davies 2011). However, this approach has certain limitations because technology, as an object, could not only be electronic but mechanical as well or could be a creation process and human practice. It is also possible to see this deficiency in technology conception.

The ability to recognize technological objects and reasoning about technological artifacts is a prerequisite to the development of improved technological and scientific explanation (Sutopo and Waldrip 2013). Despite science education literature clearly shows that knowledge of technology is an educational goal; there is still a lack of research on students' recognition of and reasoning about the technology phenomenon (Thorsteinsson and Olafsson 2015).

Related literature

In related literature, there is a limited amount of research which generally investigates the understandings of different audiences regarding technology (Griffiths and Heath 1996; Levinson et al. 1997; Twyford and Jarvinen 2000; Rose et al. 2004; Volk and Dugger 2005) and which specifically examines elementary school students' understanding regarding the concept of technology (Davis et al. 2002; Cunningham et al. 2005; Aydin 2011; Thorsteinsson and Olafsson 2015). In related literature, there are also studies conducted to examine students' understanding regarding design, technology, and technical information (Bennett 1996; Gustafson et al. 1998; Levinson et al. 1997; Twyford and Jarvinen 2000). In all these studies, several suggestions were put forward for teachers, teacher trainers, and curriculum developers. However, the number of studies directly examining elementary school students' recognition of and reasoning about technological artifacts is limited in related literature.

One study carried out by Jarvis and Rennie (1998) was conducted with 315 British children and 745 Western Australian children. The results of the study suggested that the stages of developing an inclusive concept of technology are mainly chronological, but the rates vary with individuals depending on a number of inter-related factors including home and school influence. Volk and Dugger (2005) aimed at determining the technology-related views of people from USA and Hong Kong. According to the results obtained, more than half of the participants reported that the word of technology primarily reminded them of the computer. Other things most frequently mentioned by the participants were being advanced and electronic.

A conceptually detailed study carried out by DiGironimo (2011) aimed at developing a conceptual framework for the nature of technology thorough review of the literature on scientific and technological literacy, the philosophy of technology, and the history of technology. In this study, five dimensions of knowledge characterize the nature of technology as follows:

- technology as artefacts,
- technology as a creation process,
- technology as human practice,
- history of technology and
- current role of technology in society.

In a study conducted by Davis et al. (2002), the purpose was to determine elementary school students' understanding regarding certain technologies. A total of 92 elementary school students participated in the study. The students were shown a model of bridge and interviewed regarding this model. As a result of data analysis conducted following a comprehensive interview schedule, it was seen that the elementary school students viewed technology considering primarily its structure and shape and secondarily whether it was human-made or not. Depending on the results of the study, several suggestions were put forward for the course of design and technology as well as for teacher training.

One other study carried out by Cunningham et al. (2005) aimed at determining elementary school students' conception regarding engineering and technology. In line with this purpose, two different questionnaires developed separately for the concepts of technology and engineering were used. In this respect, the study was conducted with 504 elementary school students. The results of the study revealed that the students focused on construction, machines and tools regarding engineering. This result demonstrated that the students primarily considered the quality of work rather than the type of that work. It was also seen regarding the concept of technology that the students associated this concept frequently with energy and electricity.

In another study, Aydın (2011) aimed at revealing elementary school 6th, 7th and 8th grade students' views about what technology is. In the study carried out with 121 students in the Fall Term of the academic year of 2010–2011, the participants were given an A4-size empty paper and asked to draw their thoughts about technology on that paper. The students were not provided with any time restriction for drawing. Each student's drawing was evaluated using a graded scoring scale. The results revealed that most of the students regarded technology as advanced technologies; that they always regarded electronic devices as technology; and that there was no difference between the students in terms of their grades.

In order to explore students' technological understanding and reasoning at the ages of 11 and 13, Thorsteinsson and Olafsson (2015) conducted research in Icelandic schools during the 2013–2014 school year. The research data were collected using a questionnaire distributed to three elementary schools. According to the results of the study, boys answered 57.0 % of the questions correctly, while girls answered 53.3 % of the questions correctly. Significant differences were found between the students in terms of gender. The reason for this could be different social expectations for boys and for girls.

Ritzhaupt et al. (2013) investigated the differences in students' information and communication technology literacy based on SES, ethnicity, and gender. From 13 school districts, 5990 students across the state of Florida participated in the research. The results revealed a digital divide between low and high SES schools. Similarly, Hohlfeld et al. (2008) examined the digital divide in K-12 public schools in Florida. The results of the study demonstrated significant differences between high and low SES schools in terms of access to software, use of software and the level of technology support. The results of this research provide evidence for the existence of the digital divide among schools in different SES level. Cooper (2006) examined the evidence for the digital divide based on gender in line with the results of studies published in the past 20 years. According to the results of the study, females are at a disadvantage when compared to men about computers or computer-assisted software. Also, the results revealed that the digital divide affects people of all ages.

As can be seen, the number of studies examining elementary school students' technology recognition and reasoning is limited in related literature. The need for further research to investigate elementary school students' technology understanding was also mentioned in several studies (Lewis 1999; Davis et al. 2002; Cunningham et al. 2005; Mawson 2010; Aydın 2011). DiGironimo (2011) stated that although science education literature shows that knowledge of the nature of technology is an educational goal; there is a lack of research on student conceptions and reasoning about the nature of technology.

One of the best ways of supporting an accurate understanding of technology in a society is to develop students' technology conception starting from elementary school level (Cunningham et al. 2005). For this, students should not only be made aware of current technologies and of its basic purposes but also be able to recognize, reason and put these technologies into practice (Davies 2011). This makes it necessary to determine elementary school students' recognition of and reasoning about technology, to reveal the related deficiencies and to overcome these deficiencies.

Purpose

The purpose of this study was to determine elementary school students' recognition of and reasoning about technological artifacts. In line with this purpose, the following research questions were directed:

1. How successful are elementary school students in recognizing which of the given examples is technological artifact and which of them is not?
2. Do elementary school students' scores regarding recognition of a technological artifact among the given examples differ significantly with respect to;
    a. their schools,
    b. their grades,
    c. their gender,
    d. their parents' educational backgrounds and,
    e. availability of Internet access at home?
3. What are elementary school students' reasoning about technological artifacts?

Limitations

There were several limitations to the present study. This study was limited to information technology classes, to 239 elementary school fifth-grade and sixth-grade students from two different elementary schools, and to the Elementary School Students Technology Survey. Considering these limitations, suggestions for future research were provided in the section of "Conclusions and Suggestions".

Methods

This part presents the research participants, the data collection tool, data collection process and data analysis.

Participants

The participants of the present study were 239 elementary school fifth-grade and sixth-grade students from two different elementary schools with different SES in the city of Eskişehir in 2014. The reason why the participants in the study were selected among fifth-grade and sixth-grade students was that elementary school students are introduced to the course of science education and information technologies for the first time when they become fifth-grade students. Table 1 demonstrates the demographic backgrounds of the students participating in this study.

When the demographic backgrounds of the students participating in the study were examined, it was seen that most of them (71 %) were sixth-grade students; that the number of female students and that of male students were almost the same; and that their parents had high levels of educational backgrounds. In addition, it was seen that most of the participants had Internet access at home (74.1 %). Depending on the data presented in Table 1, it could be stated that the parents of the participating elementary school students had high levels of educational backgrounds and that the participants had high levels of technological opportunities.

Table 1 Demographic backgrounds of the elementary school students

Demographic background	Frequency (*f*)	Percentage (%)
School		
School A	108	45.2
School B	131	54.8
Grade		
5th Grade	69	28.9
6th Grade	170	71.1
Gender (*4 students did not mark their gender in the questionnaire*)		
Female	115	48.1
Male	120	50.2
Parents' educational background (*highest education level of parents*)		
Elementary school	60	25.1
High school	75	31.4
University	104	43.5
Availability of internet access at home		
Yes	177	74.1
No	62	25.9

Data collection tool

In line with the research purposes, the "Elementary School Students Technology Survey" was used to determine the elementary school fifth grade and sixth grade students' recognition of technological artifacts. This questionnaire was developed within the scope of the study. For the validity and reliability of the questionnaire, expert were asked for their views, and a pilot application was conducted. The initial form of the questionnaire was presented to 8 experts (four Information Technology teachers and four academicians studying on the use of education technologies in elementary schools) for their views regarding the face validity and content validity of the questionnaire. Taking the experts' views and the cognitive level of the target audience into account, examples of concrete technology were added to the survey, and abstract methodological examples were avoided. Also, in line with the experts' views, the open-ended question in the second part of the questionnaire was simplified to make it more comprehensible to the participants.

In order to determine the non-functioning aspects of the questionnaire form as well as its comprehensibility, it was piloted with a total of 10 students, five of whom were fifth-grade students and the other five of whom were sixth-grade students. As a result of this pilot application, images with a larger size and higher resolution were added to the choices in the first part of the questionnaire. In this way, the questionnaire form was finalized prior to the application.

The survey was made up of two parts. The first part included eight examples of technology as artifact (factory, book, scissors, house, bridge, television, telephone, and shoe) and four examples which were not examples of technology as artifact (tree, flower, rain and bird). The choices were given with their images and prepared in sizes appropriate to the target audience. The second part of the survey included an open-end question to determine the students' reasoning about technological artifacts.

Data collection process

Within the scope of the study, the survey was applied in two different schools located in different SES districts of the city of Eskişehir. For the application, the written consent of the Provincial Directorate for National Education and those of the school administrators were taken. The survey was conducted in the course of Information Technologies by two teachers of this course, who were previously trained on the application of the questionnaire. The training lasted approximately 20 min for both teachers. During the training, the two teachers were informed about things to consider in the application process of the questionnaire, about the questions likely to be directed by the students and about the fact that they could not help the students fill in the questionnaire form except for the demographic information section found in the questionnaire. For the choice regarding parents' educational background found in the section of demographic information, the students were asked to respond considering their parent who had the highest level of education.

Data analysis

The first part of the questionnaire included a total of 12 choices, eight of which were examples of technology and four of which were not. The choices were given in random order. Each of the correct choices found in this part was assigned 10 points, and the students received a technology score ranging from the lowest score of 0 to the highest score of 80. The incorrect choices were not assigned a score because it was seen that only one

Table 2 Descriptive statistics regarding the students' recognition of technology scores

Dependent variables	N	$\bar{X}$	Ss	Skewness	Kurtosis
Recognition of technology scores	239	39.41	18.80	.885	−.237

student had marked the wrong choices. The responses of this student were not included in data analysis as s/he had marked all the choices and avoided responding to the second part of the questionnaire.

For the analysis of the quantitative data, independent samples *t* test, one-way ANOVA and parametric tests were applied. For ANOVA, in order to determine which groups caused the significant difference, Bonferoni test, one of the most common post hoc (multiple comparison) tests, was used. Besides the parametric tests, such descriptive statistics as percentages (%), mean scores ($\bar{X}$) and frequencies (*f*) were used as well. Table 2 presents the descriptive statistics regarding the elementary school students' technology scores.

For the normal distribution of data, the skewness and kurtosis coefficients were examined. Huck (2008) states that there will be no problem with the data set in terms of normal distribution when the skewness coefficient of a distribution ranges between −1.0 and +1.0 and the kurtosis coefficient between −1.0 and +2.0. As can be seen in Table 1, the skewness and kurtosis coefficients of the students' scores were in the range of normal distribution.

The qualitative data obtained via the open-ended question found in the second part of the questionnaire were analyzed with the thematic analysis method. Thematic analysis is defined as a method applied to determine, analyze and report the themes within the data set (Braun and Clarke 2006). According to Liamputtong (2009), in thematic analysis, the researcher can reveal themes within the data set by establishing relationships between the basic categories and sub-categories. In addition, direct quotations regarding the themes were made from the students' views. For the direct quotations, the students' real names were not used; instead, codes were produced for this purpose. The codes were formed as follows: school (S1, S2), grade (G5, G6) and a random number for each student (ranging between 1 and 239). For example, the code of S2G523 referred to a fifth-grade student with number 23 at school B.

As appropriate to content analysis, the data collected from the participants were coded, and the themes were revealed via the coded data. In order to determine the reliability of coding, two experts from the field of Computer Education and Instructional Technologies were asked for their views. The researchers and the field experts did coding on the data independently of one another and formed the themes. The themes formed by the researchers and by the field experts were compared. According to the formula below put forward by Miles et al. (2013), the reliability of the coding was calculated as .97.

$$P = \text{Consensus}/(\text{Dissensus} + \text{Consensus})$$

As the reliability value was found higher than 70, the data collected were thought to be reliable. Lastly, the findings obtained via the research data were presented and interpreted.

Findings

In this section, the findings obtained in the study are presented under three headings based on the research questions.

How successful are elementary school students in recognizing which of the given examples is technological artifact and which of them is not?

When the elementary school students' responses to the first part of the survey for elementary school students' recognition of technological artifacts were examined, it was seen that the mean scores ($\bar{X} = 39{,}41$) were almost equal to the mean value of 40. This result demonstrates that the students had a moderate level of success in recognition of technological artifacts. The pie chart in Fig. 1 below demonstrates which of the given choices, and to what extent, the elementary school students regarded as technological artifact.

As can be seen in Fig. 1, among the multiple choices, the elementary school students marked the flower, rain, tree and bird with the lowest rate in response to the question of "Which of the following is an example of technology?" It was seen that all these four choices, which were not examples of technological artifact, were marked by the same student. On the other hand, it was seen that all the 239 students marked the choice of "telephone" and that 234 students marked "television". In addition, of all the students, 68 % of them marked the choice of "factory", and 44 % of them marked "bridge". It was a striking result that the rate of students marking the choices of "book", "scissors", "house" and "shoe", which were given as examples of technological artifact, was not higher than 30 %.

Do elementary school students' scores regarding recognition of a technological artifact among the given examples differ significantly with respect to their demographics backgrounds?

For the purpose of determining whether the elementary school students' scores differed depending on their schools, grades, gender, parents' educational backgrounds and

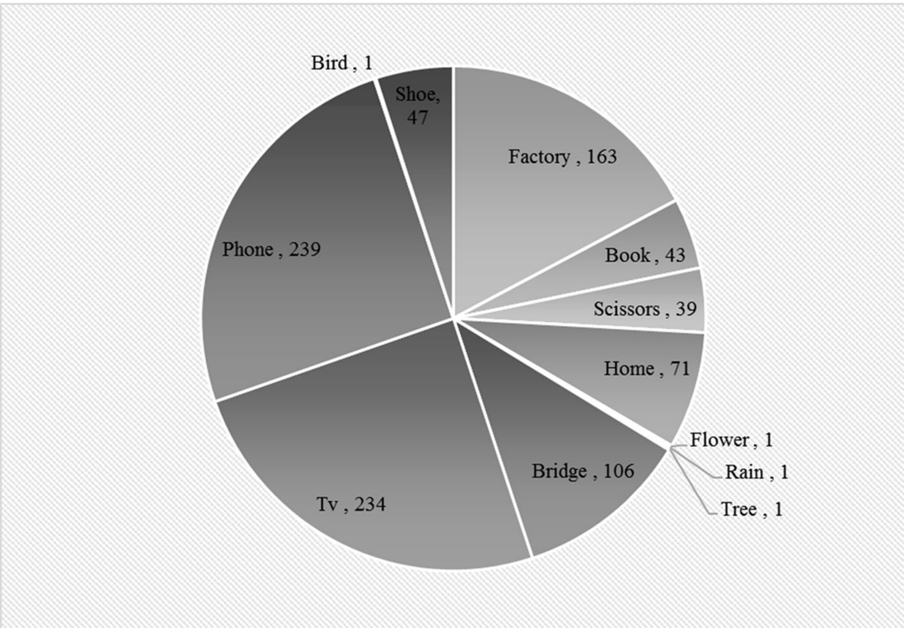


Fig. 1 Examples of technological artifacts

availability of Internet access at home, the parametric tests of independent samples *t* test and one-way ANOVA were applied. In order to determine whether there was a significant difference between the elementary school students' scores with respect to their schools, grades, gender and availability of Internet access at home, independent samples *t* test was run. For this purpose, the results of the analysis conducted are presented in Table 3 below.

The results of the independent paired samples *t* test revealed that the elementary school students' technology scores demonstrated a significant difference only with respect to their schools [$t_{(239)} = 3.665$, $p < .05$]. On the other hand, the elementary school students' technology scores did not differ significantly depending on their grades, gender and availability of Internet connection at home. The results also revealed that the technology scores of the students attending school B ($\bar{X} = 43.36$) were higher than those of the students attending school A at the significance level of $p < .001$. This result shows that the students attending school B had better recognition of technology as artifacts. The reason could be the fact that the SES at school B or the quality of education given in that school was high. Table 4 presents the educational backgrounds of the parents of the students as well as the availability of Internet access at home with respect to the schools.

When Table 4 is examined, it is seen that there were great differences between the educational backgrounds of the parents of the students and availability of Internet access at home with respect to the schools. The rate of parents who graduated from a university was 12 % for school A, while it was 69.5 % for school B. Similarly, 47.2 % of the students attending school A had Internet access at home; on the other hand, 96.2 % of those attending school B had access to the Internet at home. This result supports the SES difference between the two schools involved in the present study.

Table 3 Independent paired samples *t* test results regarding the elementary school students' recognition of technology scores with respect to their schools

	Groups	N	$\bar{X}$	Ss	t	*p* (two-way)
School	School A	108	34.63	15.67	−3.665	.0003*
	School B	131	43.36	20.25		
Grade	5th Grade	69	40.00	19.327	.306	.760
	6th Grade	170	39.18	18.635		
Gender	Female	115	37.65	17.688	−1.207	.229
	Male	120	40.58	19.459		
Internet connection at home	Yes	177	40.23	19.127	1.129	.260
	No	62	37.10	17.777		

* Significant difference at $p < .001$

Table 4 Educational backgrounds of the parents of the students and the availability of Internet access at home with respect to the schools

School	Parents' educational backgrounds			Internet access at home	
	Elementary school (%)	High school (%)	University (%)	Yes (%)	No (%)
School A	46.3	41.7	12.0	47.2	52.8
School B	7.6	22.9	69.5	96.2	3.8

In order to determine whether the scores of the elementary school students differed significantly depending on their parents' educational backgrounds, independent one-way ANOVA test was applied. Table 5 presents the one-way ANOVA results regarding the students' technology scores with respect to their parents' educational backgrounds.

The results presented in Table 5 demonstrate that the significance level was lower than .05 ($p = .002$). Accordingly, the elementary school students' scores differed significantly with respect to their parents' educational backgrounds. For the purpose of determining which groups caused this significant difference, Bonferroni test, one the most appropriate post hoc (multiple comparison) tests, was conducted. Table 6 below presents the multiple comparison test results.

When Table 6 is examined, it is seen that there was no significant difference between the scores of the students whose parents were graduates of elementary school and those of the students whose parents were graduates of high school. As can be understood from the fact that the increasing difference between the mean scores was higher at the bottom of the column of mean difference in Table 6, there was a significant difference between the scores of the students whose parents were graduates of high school and those of the students whose parents were graduates of university ($p = .18 < .05$) as well as between the scores of the students whose parents were graduates of elementary school and those of the students whose parents were graduates of university ($p = .005 < .05$). Table 7 presents the students' scores with respect to their parents' educational backgrounds.

Table 5 One-way ANOVA results regarding the students' recognition of technology scores with respect to their parents' educational backgrounds

Demographic background	Sd	Mean squares (MS)	F	*p*
Parents' educational background				
Between groups	2	2193.765	6.493	.002*
Within group	236	337.841		
Total	238			

* Significant difference at $p < .05$

Table 6 ANOVA multiple comparison test results regarding the students' recognition of technology scores with respect to their parents' educational backgrounds

Groups	Mean difference	*p* (two tailed)	Significant difference
Elementary school–high school	−1.86667	1.00	No
High school–university	−7.69744	.018	Yes
Elementary school–university	−9.56410	.005	Yes

Table 7 Students' recognition of technology scores with respect to their parents' educational backgrounds

Groups	N	$\bar{X}$	Ss
Elementary school	60	34.6667	15.34536
High school	75	36.5333	16.96525
University	104	44.2308	20.79452
Total	239	39.4142	18.79992

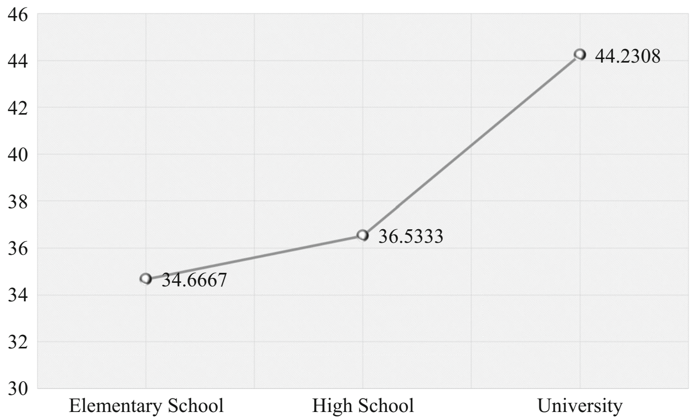


Fig. 2 Students' scores with respect to their parents' educational backgrounds

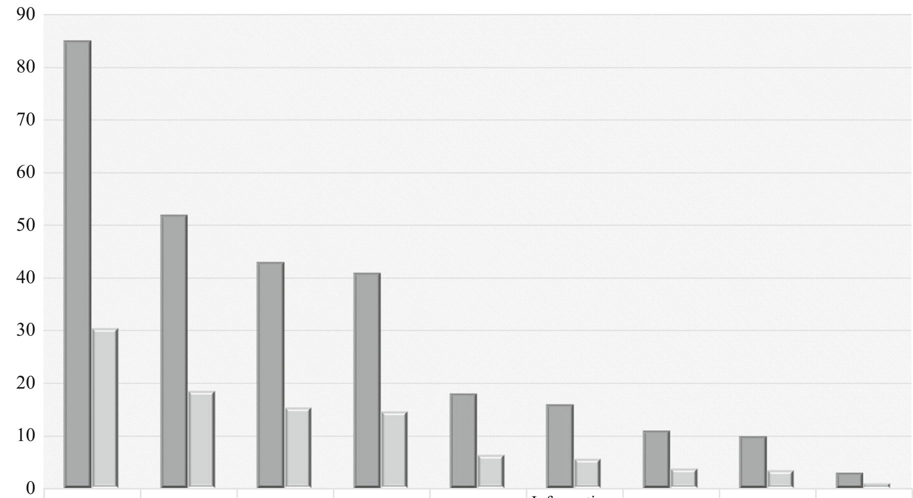
When the students' scores were examined with respect to their parents' educational backgrounds, it was seen that the mean scores of the students whose parents were graduates of university were higher than not only those of the students whose parents were graduates of high school but also those of the students whose parents were graduates of elementary school. This result suggests that the significant difference revealed as a result of the ANOVA test was in favor of the students whose parents were graduates of university. Figure 2 presents the elementary school students' scores with respect to their parents' educational backgrounds.

As can be seen in Fig. 2, the students whose parents were graduates of elementary school and those whose parents were graduates of high school had similar mean scores, while the students whose parents were graduates of university had fairly high mean scores. Depending on these findings, it could be stated that the elementary school students' recognition of technology as artifact developed as their parents' education level increased.

What are elementary school students' reasoning about technological artifacts?

The elementary school students' views about what made them decide something as technology or not (reasoning) were determined with the open-ended question found in the second part of the survey. The qualitative data collected were coded as appropriate to thematic content analysis, and the themes were determined via the coded data. In thematic analysis, the inductive analysis method, one of content analysis methods, was used. In the study, only one student did not respond to the open-ended question. In addition, there were 18 students who responded to the open-ended question, yet their responses did not belong to any theme. Thus, 19 students were not included in the process of determining the themes. As a result, the themes were determined based on the views of a total of 220 students. In some cases, the views of a single student revealed more than one theme. The themes determined and the related frequencies are presented in Fig. 3.

As can be seen in Fig. 3, the students' responses to the question of "What makes something technology?" were grouped under nine main themes. It was strikingly revealed that of all the 220 students, 85 of them associated technology with electricity. In addition, it was seen that the students decided something as technology by considering whether it facilitated life (18.6 %); whether it was human-made (15.4 %); whether it was advanced



	Electricity	Facilitation of Life	Human Made	Advanced	Motion	Information-Communication	Material	Innovation	Radiation
f	85	52	43	41	18	16	11	10	3
%	30.5	18.6	15.4	14.7	6.5	5.7	3.9	3.6	1.1

Fig. 3 Themes of students' reasoning for technological artifacts

(14.7 %); and whether it moved or not (6.5 %). Some of the students reported that they were able to decide something as technology by taking its information-communication features (5.7 %) and its material (3.9 %) into account as well as by considering whether it was an innovation (3.6 %) and whether it emitted radiation or not (1.1).

The open-ended question directed to the elementary school students also questioned their reasoning about the nature of technology. In order to decide something as technology or not, it is initially necessary to determine what is technology and what features it has. In the present study, the students' responses to this question mostly revealed that they tried to define technology and that they discussed what technology is. Among the themes determined, the most frequent feature was electricity. Table 8 presents direct quotations from the students' views about each theme.

When the direct quotations from the students' views were examined, it was seen that electricity was a requirement for anything to be regarded as technology and that a non-electrical thing could not be considered to be technology. In addition, it was found that the students also emphasized electronic devices and energy generally under the theme of electricity. Besides the theme of electricity, in the second place, the elementary school students mentioned the benefits of technology under such themes as "facilitating life", "human-made" and "advanced". When the elementary school students' views and the related direct quotations regarding the theme of "human-made" were examined, it was seen that they mentioned such features of things as natural and non-natural. According to the views of the student, coded as S2G5-33, technology did not exist in nature yet was invented with the help of things found in nature. Among the themes determined, only regarding the theme of "radiation" did the elementary school students report negative views. In addition, it was striking that this theme was formed based on the views of only three students. One of the students, coded S2G6-203, pointed out that technology emitted radiation and that it was dangerous for human health.

Table 8 Direct quotations and related themes of students' reasoning for technological artifacts

Theme	Direct quotation
Electrical	"…an electrical thing is technology, but a non-electrical one can not be regarded as technology …" S1G6-54 "…if a thing involves electrical current or if it runs on electric, then that thing is considered to be technology …" S1G6-74 "…when I see that it includes electrical current (electric, battery and such things)…" S2G6-97 "…if it is running on electricity or if it is chargeable, then that thing is technology…" S2G6-122 "…if it involves electric use, it is technology…" S2G5-13
Facilitating life	"…if a device is beneficial for us, then it is technology. For example, the washing machine helps us in our daily lives …" S1G5-22 "I can understand whether a thing is technology or not by recognizing whether it facilitates my life and helps me in daily life." S2G6-7 "…if it facilitates human life, it is technology …" S2G5-80
Human-made	"…a material produced by humankind to facilitate life …" S2G6-18 "…beneficial things invented and developed by people …" S2G5-127 "Things not existing in nature but invented with things found in nature." S2G6-33
Advanced	"It should be advanced if it is a technological device. So I try to see if it is advanced or not …" S1G5-45 "We can learn it if it is advanced or not. A thing is technology if it is advanced. For example, television, telephone …" S2G6-88
Motion	"When I see it moving, I can understand if it is technology or not. For example, sewing machine moves." S2G5-4
Information-communication	"…does it give us information? Or does it connect to the Internet? With these questions, I can understand if it is technology …" S1G6-191
Material	"…if something includes technological materials, then I can understand that it is technology. If it includes such technological things as iron, copper and nail …" S1G6-191
New	"…I try to see if it is new or not. If it didn't exist in the past but is present now, then I think it is technology …" S2G5-166
Radiation	"…technological devices emit radiation. Too much radiation is dangerous for our health. For example, if we watch television too much or watch it from a close distance for a long time, then our eye-sight deteriorates …" S2G6-203 "…devices emitting radiation are technological …" S2G6-215

Discussion

The results demonstrated that the elementary school students participating in the study were moderately successful in determining whether a thing was technology or not. However, the fact that only one of the students marked the choices which were not examples of technology suggested that the elementary school students did not have wrong recognition of technology as artifact. Besides this, it was also striking that the students regarded telephone and television most as examples of technology and least as shoe, scissors and book among the correct choices. The reason could be the fact that the current electronic technologies have rapidly spread throughout our daily lives and that these devices are already regarded by the society as technology. Also carrying out research in information technology courses might have led to this result.

The results obtained from *t* tests revealed that the students' recognitions differed depending only on their schools. This finding is similar to that of another study carried out by Aydın (2011), who reported that there is no difference regarding the concept of technology with respect to students' grades. However, this finding is different from that of a study conducted by Thorsteinsson and Olafsson (2015), who reported that "Significant differences were found between the sexes". The reason for the differences between schools could be the fact that the schools had different SES and digital divide. Therefore, the educational backgrounds of the parents of the participants and the availability of Internet access at home were compared with respect to the students' schools. This comparison revealed that the schools which accommodated students with higher levels of scores had higher percentages in terms of both availability of Internet access at home and parents' educational backgrounds. This result shows the levels of the digital divide in schools. The result is also parallel to the results of another related study (Hohlfeld et al. 2008; Ritzhaupt et al. 2013) which reported that "There are significant differences between high and low SES schools in terms of technology literacy". Also, students' recognition of technological artifacts was compared with respect to their parents' educational backgrounds. The results revealed a significant difference between the groups in favor of the students whose parents were graduates of university.

The qualitative results demonstrated that the students decided something as technology or not by taking such aspects into account as running on electricity, facilitating life, being human-made, being advanced, motion, information-communication, material, being new and emitting radiation, respectively. This finding is parallel to the finding obtained in another study conducted by DiGironimo (2011), who reported that there were no students who regarded technology as a human practice or as a creation process. On the other hand, this finding is different from that of a study carried out by Davis et al. (2002), who reported that "elementary school students regard technology mostly considering the material it is made of, its structure and whether it is human-made or not." Jones and Moreland (2003) reached important results in their study regarding elementary school students' understanding of the nature of technology. Accordingly, elementary school students can first understand the difference between the artificial and natural worlds at early ages, then recognize the variety of technology and finally give meaning to the negative and positive aspects of technology as well as the changes in technology at later ages. This approach is supported with the themes obtained via the qualitative data in the present study. Thus, the theme of "human-made" refers to the difference between the artificial and natural worlds; the themes of "motion", "innovation" and "information-communication" refer to the variety of technology; and the themes of "advanced" and "radiation" refer to the changes in technology and its negative and positive aspects.

In the study, the theme of "electrical" was found prominent. The direct quotations revealed that the students considered the electricity compulsory for anything to be regarded as technology and that they believed a non-electrical thing could not be technology. This finding obtained is consistent not only with the finding of a study carried out by Cunningham et al. (2005), who reported that most students associate technology with energy and electricity but also with the finding of another study conducted by Aydın (2011), who pointed out that students mostly consider technology to be advanced technologies and that they regard electronic devices in their daily lives as technology. According to de Vries (2005), at early ages, people cannot recognize the negative aspects of technology because they focus only on its positive aspects. This view is parallel to the finding obtained in the present study that the views of only three students constituted the theme of radiation, which was a negative aspect of technology.

Conclusions and suggestions

Based on the research findings obtained, it could be stated in general that the elementary school students regarded technology as devices running on electricity, invented by people to facilitate life, advanced, moving, new, allowing information-communication, made up of materials, constantly renovated and emitting radiation. Considering the students' success in determining which of the given examples of technology was technology, it is possible to say that students' recognition of technology as artifact was not wrong but insufficient in terms of current electronic devices. In other words, most of the students referred to technology as advanced electronic devices. In addition, the fact that the students did not mark the non-technological choices of flower, tree, rain and bird demonstrated that their recognition of technology was not problematic and that the students were capable of distinguishing between the nature and technology.

The results of the statistical tests revealed that the recognition success scores of the elementary school students differed with respect to their schools and their parents' educational backgrounds. These findings revealed that the students attending a school with a higher SES level had better technology recognition. Significant differences between high and low SES schools in terms of recognition of technological artifacts can be evaluated as evidence of a digital divide in Eskişehir elementary schools. Besides this, it was seen that the students' technology recognition differed significantly in relation to their parents' educational backgrounds. The multiple comparison test results demonstrated that the technological recognition of the students whose parents were graduates of university were better than those of the students whose parents were graduates of elementary school or high school. According to this finding, the educational backgrounds of parents constitute an important factor for the development of their children's technology recognition. According to Cooper (2006) digital divide affects people of all ages and across international boundaries.

In the study, the elementary school students tended to recognize technological artifacts by taking such themes into account mostly as "electrical", "facilitating life", "human-made" and "advanced", respectively. Among the nine themes, only the theme of "radiation" referred to the negative aspect of technology. This theme was determined via the views of only three students. This result demonstrates that the elementary school students participating in the present study focused more on the positive aspects of technology and that they did not pay much attention to its negative sides. However, it is necessary for students to perceive technology as a whole activity involving negative aspects not just as a product, a process or a way of application (Williams 2000).

The results of this research show that technology is referred to as electronic devices like the software and hardware required by the computer and mobile devices and as other electronic devices like television. This situation poses an important recognition and reasoning-related problem experienced not only by elementary school students but also by the society in general. Even in secondary school, students are unable to distinguish between the engineering process and the scientific process (Carey et al. 1989). According to Davies (2011), technology integration is regarded as use of electronic equipment by teachers in classrooms. Also Thorsteinsson and Olafsson (2015) underline the need for early emphasis on technological knowledge. This will allow training teachers who can both provide students with guidance in terms of technology literacy and help them develop correct concepts of technology.

In future, more comprehensive studies could be designed to determine the technological understanding of students as well as of teachers. Research can be conducted to determine the related deficiencies in the curricula applied in education faculties as well as to investigate how to overcome such deficiencies. The present study revealed that students' recognition of technological artifacts is seriously influenced by their parents' educational backgrounds and by the SES level of schools. Future studies could investigate digital divide in Turkish elementary schools, K12 schools, high schools, colleges and universities as well. For the purpose of determining children's understanding of technology as well as the changes in their understanding in time, comprehensive studies could be designed with younger and older children.

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