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Examining secondary students' perceptions of the technology-based learning and teaching in science courses

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Abstract

The aim of this research is to examine the perceptions of technology-based learning and teaching in the science courses of secondary school students. This research sample is made up of 396 students studying in the eighth grade of seven secondary schools in the center of Kars, Turkey. This research includes a case study design. As a data collection tool, an important technical drawing is used in the literature of science education to reveal the mental approaches of individuals against facts and events. Data are analysed through drawing analysis. This research reveals three key conclusions. First, it is understood that the perception of students in the eighth grade of secondary schools for the use of technology in existing science courses is largely composed of smart boards. Second, it is understood that the technological systems that students demand in science courses should be designed specifically in a way that they can use independently. Third, it has shown that smart boards among the technological systems are largely in the grip of science teachers, but students are not able to use these technological systems adequately in the courses.

Keywords: Science courses, secondary school students, technology-based teaching, drawing analysis.

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1. Introduction

In today's world, technology has become the most important phenomenon that affects every moment of life. However, individuals of all ages mostly feel the impact of technology in the field of education. The emphasis on technology in the field of education corresponds to a conceptualisation on the basis of student, teacher and pedagogy. This structure refers to a teaching purpose that takes the student to the centre and where technological tools and systems suitable for the area and content can be selected and used correctly. Nowadays, the vast majority of students adapt to technological tools and systems (computers, tablets, mobile phones, digital vehicles, internet etc.) before they reach school age. Moreover, students have access to a lot of information through technology before they reach the school age. They still desire a technology-compliant education system in order to add to the information they learn through technology at every moment of their lives when they start school (Ciampa, 2014; Garba, Yusuf & Busthami, 2015; Nurullina, Muraviyov, Martyanova, & Yarmakeev, 2018; Shanmugam & Balakrishnan, 2019).

Especially in the field of science education, the suitability of technology significantly shapes teaching and learning practices. Therefore, technology has become an important factor in diversifying teaching activities in science education, enabling them to make courses more understandable, funny and interesting. Science is one of the fields where students have difficulty learning. Many students faced with the complexity of the field of science at school age lose their learning motivation. In this context, technology is seen as an important source of motivation for students to overcome the complexity and difficulty of learning science (Granito & Chernobilsky, 2012; Shanmugam & Balakrishnan, 2019; Sin, Talib & Norishah, 2013). With the use of technological tools and systems in education, the science teaching culture in the classrooms is also undergoing a significant change. Moreover, the use of technological tools and systems in the teaching of science is seen as a new channel that makes it easier for students to meaningfully structure and learn information (Nikou & Economides, 2016).

According to Miller (2003), technology is a cognitive tool that helps students learn and increase their learning capacity, along with learning theories applied in classrooms in today's conditions. Technologically advanced learning environments give students more qualified learning opportunities without space and time restrictions (Eristi, Sisman & Yildirim, 2008). Therefore, technology provides important opportunities for students to develop learning environments where they participate more effectively in teaching (Falloon, 2019; Fernandez-Lopez, Rodriguez-Fortiz, Rodriguez-Almendros & Martinez-Segura, 2013).

In today's technology age, the vision for technology integration in classrooms continues to be researched and examined. The majority of relevant literature covers studies exploring the impact of technology-assisted education in science (Malone, Schunn & Schuchardt, 2018; Mills, Tomas & Lewthwaite, 2019; Schreyer-Bennethum & Albright, 2011; Taleyarkhan, Dasgupta, Garcia & Magana, 2018; Zhai, Li & Chen, 2019). However, there is a limited number of studies that examine the perceptions of technology-based learning and teaching that students encounter in science courses (So, Chen & Wan, 2019; Yeh, Tsai, Tsai & Chang, 2019). Moreover, it is still unclear how students see the use of technology in today's science classes.

In research studies, students' perceptions of technology-based science learning and teaching are mainly obtained through traditional research approaches, such as interviews or surveys. However, using a drawing-based approach to determine the perceptions of technology-based science learning and teaching is an important advantage for students to exhibit their mental structures for a phenomenon they cannot express in many words (Yeh et al., 2019). Using this approach allows students to feel less pressure on a study (Brown & Wang, 2013). In addition, students can freely express their perceptions of technology-based science learning and teaching without being affected by pre-designed categories as in the traditional survey method (Funkhouser & Mouza, 2013). In particular, drawing-based research can provide a significant advantage in terms of revealing how virtual technology-assisted science learning and teaching perception and the perception of science learning and teaching, which is ideal for students in the course, can differentiate. Therefore, examining the perception of students for technology-assisted education in science through drawings can make significant contributions to developing effective technology-based teaching approaches that will allow students to better understand science issues and in determining students' learning needs.

1.1. Technology-assisted science education

The important tools and digital resources, such as computers, digital resources, mobile technologies, internet, web, multimedia and hypermedia, animation, simulation, gaming, wiki, training software, video etc., are defined as today's educational technologies (Fernandes, Rodrigues & Ferreira, 2019). New opportunities depending on the developments in technology arise in order to be used for educational purposes. These technologies provide students with a flexible learning way by eliminating geographical boundaries and breaking the boundaries of learning (Ozdamli & Cavus, 2011).

The use of these technologies in science courses becomes inevitable (Ozdener & Demirci, 2019). This requires the planning of more effective science programmes that include technology for programme preparers and teachers. Therefore, in science education, it is necessary to think a lot about the best practices of technology at the moment. In particular, the fact that technology is at the centre of in-class teaching in subjects such as physics and chemistry allows students to understand the nature of complex information in these areas. Moreover, they allow students to visualise subjects, processes or ideas that are difficult to experience and are abstract in many subjects in science (Gerjets, Imhof, Kuhl, Pfeiffer, Scheiter & Gemballa, 2010).

Technology is getting more and more attention in the field of science education, and more and more technology-based learning tools are included in teaching for students to learn meaningfully (Zhang, 2014). Although the world's educational policies make great efforts to position technology at the centre of contemporary education, their use in educational environments has many challenges (Athanassios, 2010). In particular, the classrooms where technology support is not provided and the inability of the teachers using technology in teaching are our biggest challenges (Badia & Iglesias, 2019). Research shows that many teacher education graduates feel unprepared to use technology to support student learning in the transition to teaching (Ottenbreit-Leftwich, Glazewski, Newby & Ertmer, 2010).

1.2. The purpose and situation problem of research

The aim of this research is to examine the perceptions of students in the eighth grade of secondary school regarding technology-assisted learning and teaching in science courses. Within the scope of this research, the perceptions of the technology used in science courses are expressed through drawings. In this context, the questions that are answered in this research are:

1. How are the students' drawings a representation of their perceptions of technology-assisted learning and teaching in science courses?
2. How are the drawings that represent students' perceptions of technological tools and systems used for learning and teaching in science courses?
3. How are the drawings of technology-assisted learning and teaching perceptions that students demand in science courses?

2. Method

This research is a case study created to determine the perceptions of students studying in the eighth grade of secondary schools in the centre of Kars Province in eastern Turkey about technology-based learning and teaching in science courses. The case study is based on examination in a specific time pattern in relation to a case (Merriam, 2002; Yin, 2009).

2.1. The sample of research

The convenience and purposive sampling methods are used in this study. In this context, the students studying in the eighth grade of seven secondary schools in the centre of the province in eastern Turkey are chosen as a convenience sample. Although four secondary schools are located in the city centre, they are not included in the sample of the research because they are considered as far away from the centre. A total of 478 students have been sent drawing forms of the technology-based perception of science learning and teaching through 14 science teachers in seven secondary schools in total. However, the drawings of 396 students in total constitute the sample of this study, since some of the forms are not filled and some of the teachers have not participated in this research.

2.2. Data collection and data collection tools

The data collection process includes the fall semester of the 2019–2020 academic year. The data were obtained on the basis of the drawing method. The technique representing objects, events, ideas or concepts is defined by using drawings, lines, symbols, labels or text (Tsai, Yeh & Chang, 2017; Yeh et al., 2019). It can be said that the drawings are the right tools for students to conceptualise their images and their mental model, to determine their knowledge and opinions about a subject (Hamdiyati, Sudargo, Fitriani & Rachmatullah, 2018; Oren & Ormanci, 2014). The advantages of using the drawing as a research approach are an efficient and less stressful type of research that does not require participants to speak or write extensively (Brown & Wang, 2013; Hsieh & Tsai, 2017; 2018; Wang & Tsai, 2012). In addition, participants of this study can accurately reflect their true experiences in any subject through drawing (Xiao & Carless, 2013).

Drawing-based research technique represents a trend that begins with Draw-AScientist-Test in the science education literature (Chambers, 1983; Mead & Metraux, 1957). In this context, the research data are collected with the 'drawing form' prepared to determine the perceptions of technology-based learning and teaching of secondary school students. The literature has been thoroughly studied while preparing this form, and the recent study examining students' technology-based learning perceptions through drawing in science by Yeh et al. (2019) provides the inspiration for preparing the drawing form of this study. This form consists of brief information about the content of the research and two drawing sections. The necessary explanations have been made by the researcher to the science teachers who will apply this form. In this context, it is stated that students can paint the drawings in different colours and label them with words. In the first drawing section of the form, they are asked to draw only their understanding of the use of technology in science courses. In the second drawing section, they are asked to create drawings that could represent the technology-supported learning and teaching understandings they demand from science classes.

The data of this research cover a two-week process that includes the delivery and collection of drawing forms from schools. The drawing forms are delivered to all secondary schools included in this sample within the same day. These forms are delivered to science teachers who attend class directly in all schools. Nine science teachers in four secondary schools delivered the forms they collected in the same week during the process of the return of the forms. However, five science teachers in three secondary schools submitted the forms they collected to the researcher within the second week. In relation to the application of drawing forms to students, all teachers indicated to the researcher that they want these drawing forms to be filled out of class and in out-of-school time by their students. The data collection process is summarised in Figure 1.

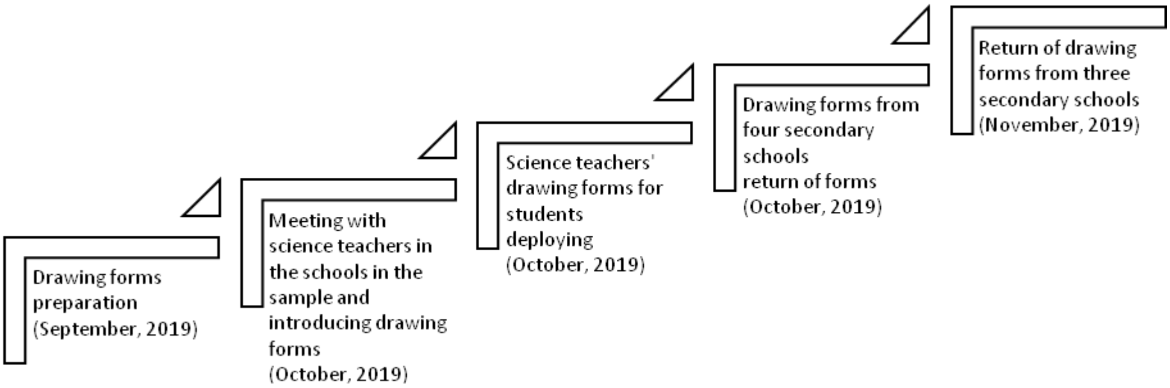


Figure 1. The data collection process

2.3. Analysis of data

The document analysis method is used to analyse the data obtained from the research. In this context, student's drawings are analysed with qualitative analysis techniques using both descriptive and content analysis techniques. The research data were described by using the percentage and were presented by converting them into a chart. Three main themes have been identified to analyse the data.

These are:

1. The perception of technological tools and systems used and want to be used in science courses.
2. The perception of technology-based learning and teaching in the current science courses that students attend.
3. The perception of technology-based learning and teaching that students demand in science courses.

The first theme contains a total of 20 technological tools and system codes uncovered by examining the technology-based science education literature. For this first theme, the technological tools and systems that stand out in all drawings collected from students are descriptively analysed. However, the codes for the other two themes are uncovered through content analysis of student drawings. In this context, four codes are set for the second theme with regard to the technology-based learning and teaching in the current science education, and nine codes are set for the third theme with regard to the students' perception on technology-based learning and teaching that the students demand. In order to ensure the analysis reliability of data based on student drawings, both the researcher and an instructor who works on technology-based education in the field of science education for the first theme evaluated 48 randomly selected students' drawings before starting the entire analysis. The average consistency in the depiction of these two independent evaluators according to 20 codes is found to be approximately 83%. The fact that the percentage of compliance between encoders is more than 80% is an important sign that reliability is achieved (Miles & Huberman, 1994).

3. Findings

The findings of this study are presented under three main headings. These are: the students' perception about technological tools and systems, their perception about the current technology-based learning and teaching in science courses and their perception about the technology-based learning and teaching that they demand in science courses.

3.1. Findings on drawings representing the perceptions of technological tools and systems used in the learning and teaching in students' science courses

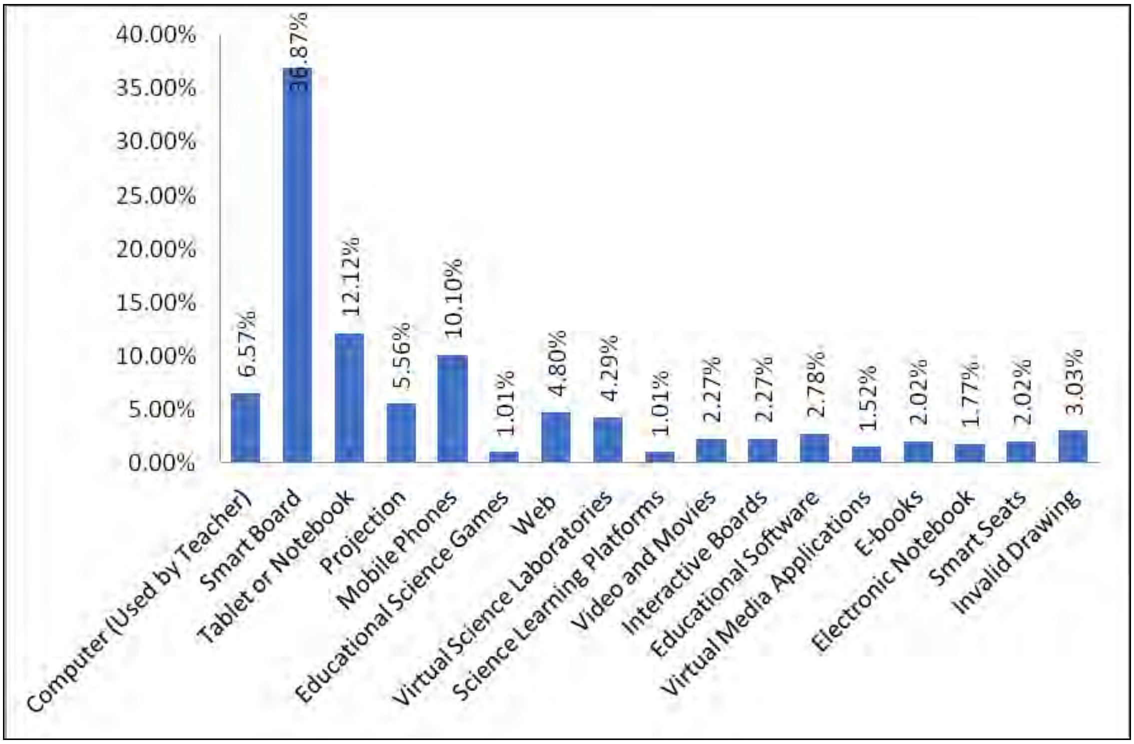
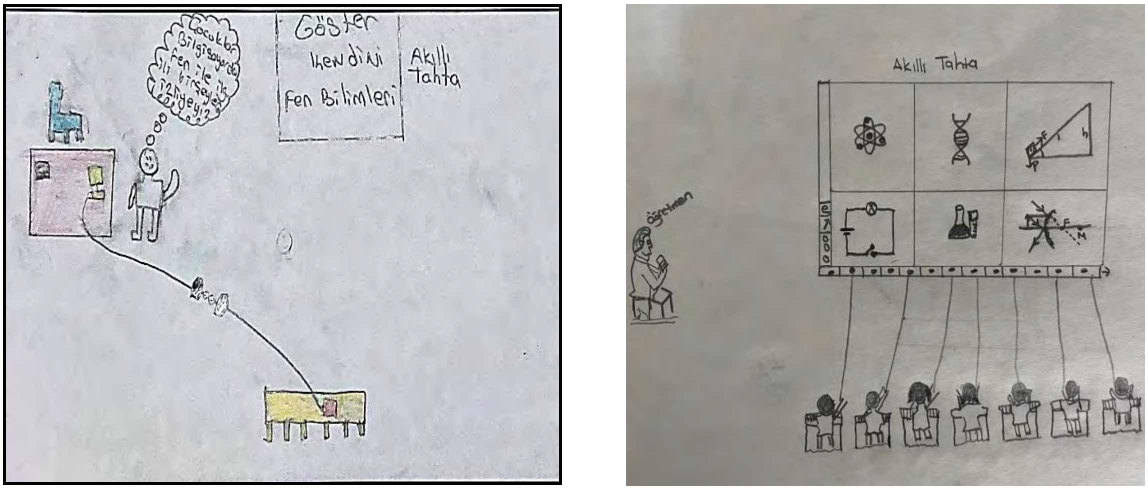


Chart 1. Findings on drawings representing the perceptions of technological tools and systems used in the learning and teaching of students' science courses

When Chart 1 is examined, it is understood that smart boards (36.87%) within the technological tools or systems are mostly reflected in the student drawings. Moreover, it is seen that the use of tablet and notebook (12.12%) and mobile phone (10.10%) stands out in the students' drawings compared to the other technological tools and systems. However, it is understood that the teacher's computer (6.57%), projection (5.56%), the use of web (4.80%) and the use of a virtual science lab (4.29%) significantly appear in the drawings of the students. Nevertheless, it is seen that technological systems such as animation, simulation, online science education practices and wiki applications that are significantly featured in the literature are not included in the students' drawings. In addition, it is also understood that the percentage of the students' invalid drawings that do not include technological tools and systems is 3.03%. These findings show that secondary school students have significantly diversified their drawings in terms of technological tools and systems used or want to be used in science courses.

The examples related to the drawings of secondary school students on the perception of technological tools and systems used in science courses are shown in Figure 2.



Drawing of student #47 | Drawing of student #83

Figure 2. Examples of the students' drawings related to technological tools and systems used in science courses

3.2. Findings on the drawings representing technology-based learning and teaching in the current science courses

The findings on the drawings representing the perception of the eighth-grade students about their technology-based education in the current science courses are shown in Chart 2.

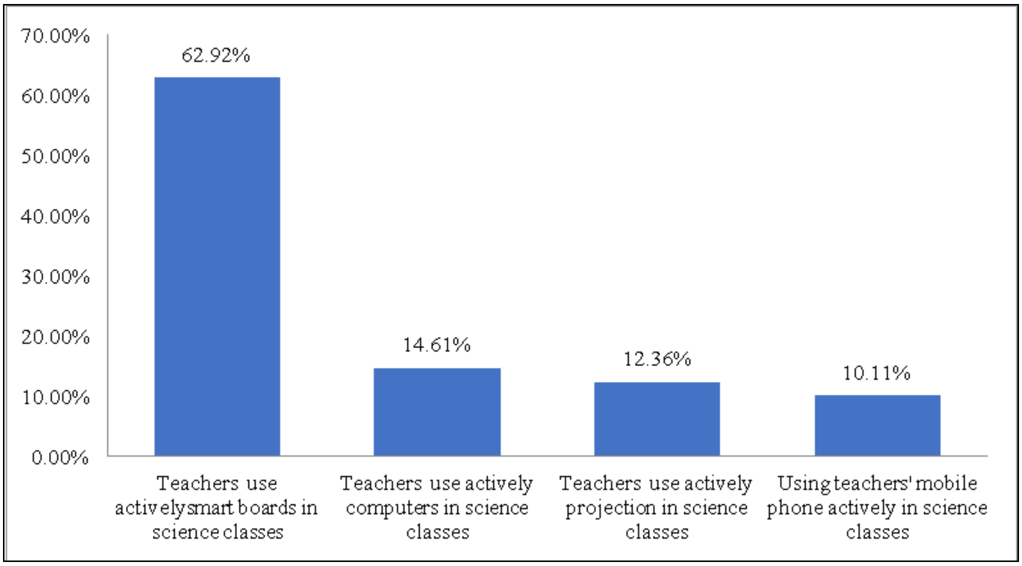
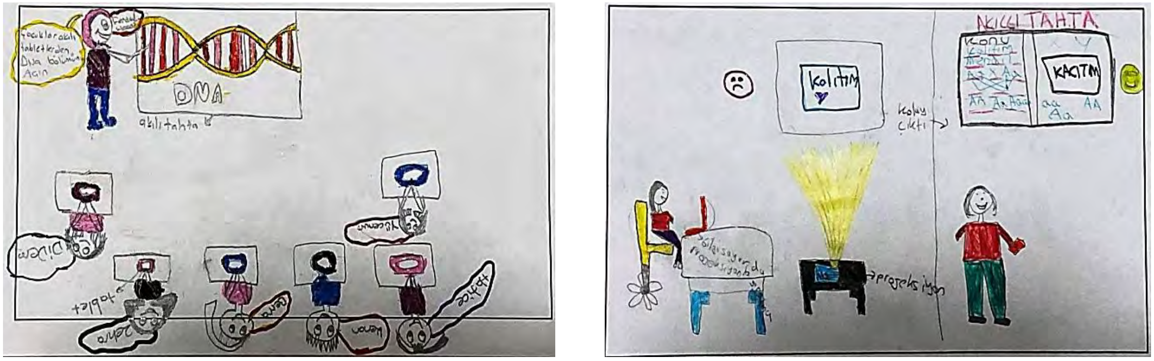


Chart 2. Findings on drawings representing students' perceptions of technology-based learning and teaching in current science courses

When Chart 2 is examined, it is understood that the secondary school students' perception on technology-based education in the current science courses is teacher centred. It is seen that technological tools and systems controlled by the teacher become prominent in the current science courses. Moreover, it appears that the smart boards (62.92%) are substantially used by the teachers as a technology-based tool while teaching science. However, the fact that the teacher uses his/her own personal computer (14.61%) is perceived as another technology-based teaching approach by students. Also, it is seen that projection-based teaching (12.36%) and the use of mobile phone (10.11%), which are preferred by teachers at similar proportions, stand out in the students' drawings. According to these results, it is clear that the technology-based teaching approach in the current science courses is largely shaped by teachers and the students are poor at using technology in the science courses.

The examples about the secondary school students' drawings related to the technology-based learning and teaching used in the current science courses are depicted in Figure 3.



Drawing of student#11 Drawing of student#124

Figure 3. The examples about the students' technology-based learning and teaching approach in the current science courses

3.3. Findings on the drawings representing the students' technology-based learning and teaching approach that they demand in the science courses

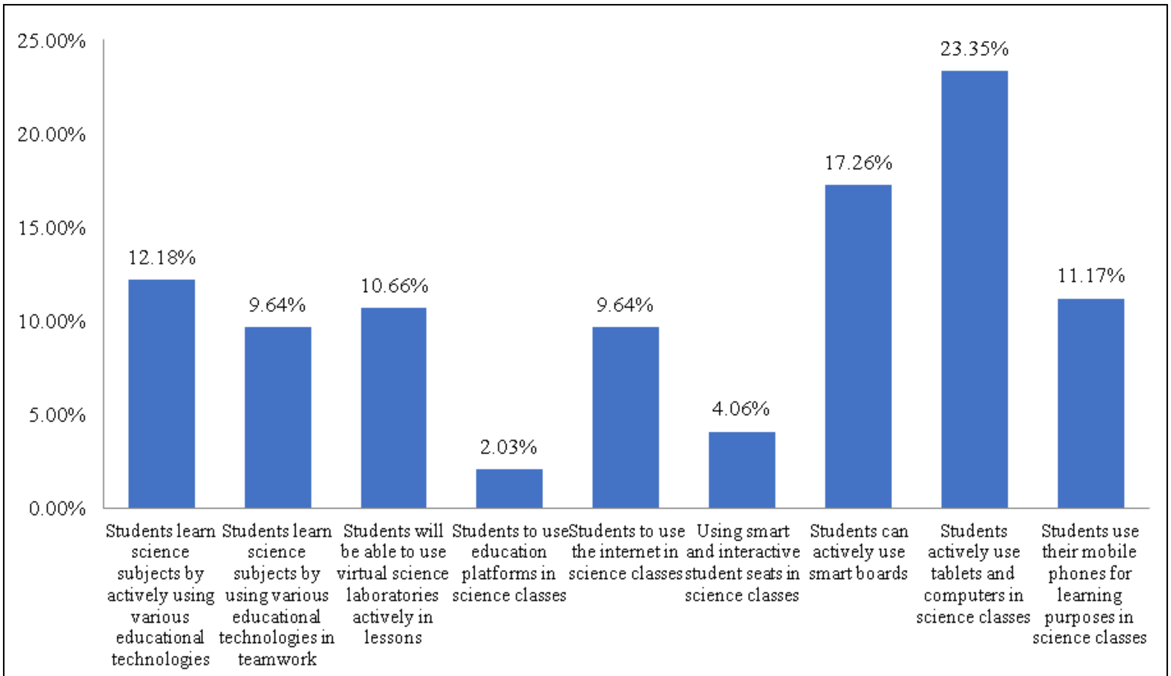
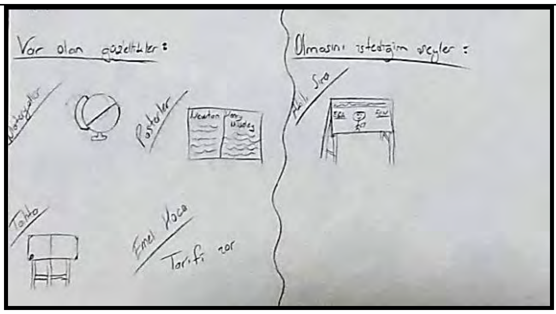


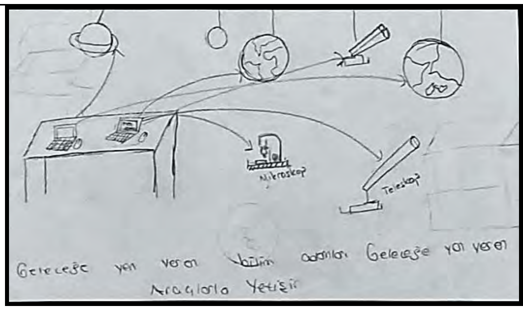
Chart 3. Findings on the drawings representing the students' technology-based learning and teaching approach that they demand in the science courses

When Chart 3 is examined, the students reflect through their drawings that technology-based learning they demand in the secondary school students' science courses should have a content in which students will actively use their computers and tablets (23.35%) to a large extent. On the one hand, the students substantially reflect through their drawings that they themselves want to actively use the smart boards in the science courses (17.26%). In addition, it is understood that the students reflect through their drawings that they demand an educational environment (12.18%) in which they themselves actively use various technological tools. On the other hand, it is understood from their drawings that virtual science labs (10.66%) are wanted to be used by the students in courses. Moreover, it is seen that the students want to use their mobile phones for the purpose of learning (11.17%) in the science courses. These findings show that in science courses students want a technological support to actively learn science subjects by using various technological tools and systems instead of a limited technology support that the teacher is at the centre of technology use.

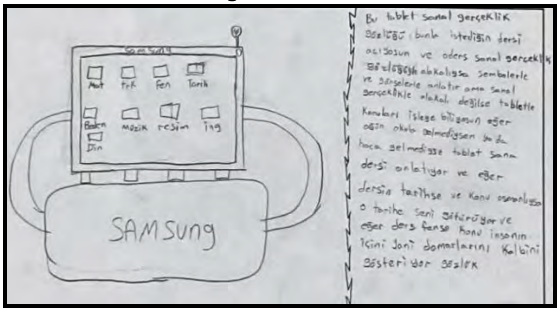
The examples of drawings related to the secondary school students' technology-based learning approach they demand in the science courses are shown in Figure 4.



Drawing of student#117

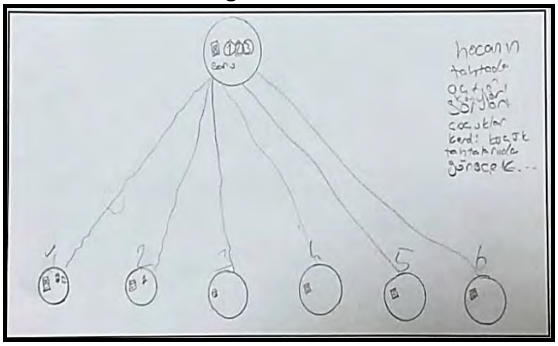


Drawing of student#184

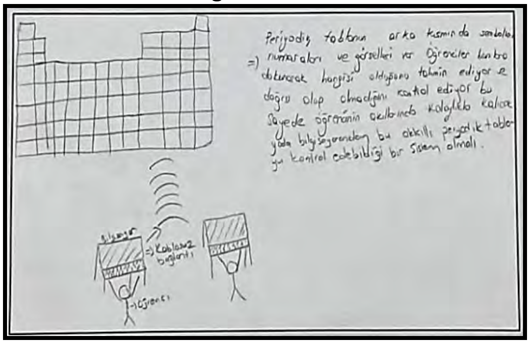


Drawing of student#135

Drawing of student#222



Drawing of student#301



Drawing of student#312

Figure 4. Examples of drawing examples on the students' technology-based learning and teaching perception that students demand in science courses

4. Discussion and conclusion

The eighth-grade secondary school students' perceptions about technology-based learning and teaching are examined in the science courses in this research. Student drawings are used as a new technique apart from traditional data collection techniques, such as interviews and surveys. In this context, students reflect their perceptions about technology-based learning and teaching related to science courses through drawings. Three results have emerged from drawings representing students' understanding about technology-based science learning and teaching.

The first is the students' perceptions about the technological tools and systems used and desired to be used in science courses. It is seen that the students' approach concerning technological tools and systems focuses substantially on the smart boards. It is also understood that tablets, notebooks and mobile phones are also significantly prominent in student drawings. In addition to these technological tools, it is understood that the new educational technologies (educational software such as simulation, animation and mobile applications) which take an important place in the science education literature are not reflected in student drawings. The result of this research shows that diversity related to technological tools is provided at the secondary school level, whereas technological software applications are minutely used in science courses. When the relevant literature is examined, it can be said that the results of various studies show a significant parallelism with the result of this research (Li, Garza, Keicher & Popov, 2019; Mellati & Khademi, 2019).

The second result refers to the secondary school students' perception on technology-based education in the current science courses is teacher-centred and the students' interactions with technology are weak. Student drawings indicate that teachers are constantly controlling smart boards, and that students' interactions with these technologies remain weak in the courses. This result supports the results of various researches in the relevant literature (Shaheen & Watulak, 2019; Zhai et al., 2019).

The third result of this research points out that the secondary school students' perceptions on technology-supported learning that they demand in science classes should have a plan in which they can actively use technological tools and practices. The result of this study can be said to have a significant parallelism with the relevant literature (Ankiewicz, 2018; Blau, Shamir-Inbal, & Avdiel, 2020; Ioannou, Georgiou, Ioannou & Johnson-Glenberg, 2019).

5. Recommendations

These results of this study show that the approach of technology-based teaching in secondary school science courses should be re-planned to be student-centred by teachers. In this context, science teachers should prepare to guide students' technology-based learning. Therefore, it can be said that with vocational development programmes teachers need studies to understand how students can actively use effective technologies in secondary school science courses. In addition, new courses combined with field courses in science teacher preparation programmes should be added to teach how prospective teachers can use technology more effectively in science courses in the future.

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