Cypriot Journal of Educational Sciences

Volume 13, Issue 2, (2018) 506-515

www.cjes.eu

How do technological and physical conditions affect science courses?

Ulas Kubat*, Department of Mathematics and Science Education, Faculty of Education, Mugla Sitki Kocaman University, Mugla, Turkey.

Suggested Citation:
Kubat, U. (2018). How do technological and physical conditions affect science courses?. *Cypriot Journal of Educational Science, 13*(2), 506–515.

Received date October 11, 2017; revised date February 05, 2018; accepted date June 01, 2018.
Selection and peer review under responsibility of Prof Dr. Huseyin Uzunboylu, Near East University.

Abstract

The aim of this research is to examine the adequacy of tools and teaching materials as well as physical and technological conditions in science classes according to the views of science teachers. To this end, qualitative research methods are designed according to phenomenological design. The sample of the research consists of 16 science teachers working in the academic year of 2017–2018 in Mugla province. Semi-structured interview techniques were used to analyze the collected data using descriptive analysis. According to research findings, most of the interviewed teachers stated that class size is appropriate. Teachers have emphasized that there are deficiencies in physical and technological conditions. Especially in some schools, it has been discovered that there are no labs, computers or Internet and interactive whiteboards. It was also determined that the teachers had classroom arrangement as a conventional fixed row arrangement for desks. There is little place in the learning-teaching process for posters, banners, and models.

Keywords: Science, physical and technological conditions, tools.

* ADDRESS FOR CORRESPONDENCE: **Ulas Kubat**, Department of Mathematics and Science Education, Faculty of Education, Mugla Sitki Kocman University, Mugla, Turkey. ***E-mail:*** ulaskubat@mu.edu.tr / **Tel.:** +90 252 211 10 00

1. Introduction

The classroom is the one place where learning and teaching processes often takes place. Therefore, it is one of the primary tasks of the teacher to plan, create and enrich learning environment in which all teaching activities are carried out. When teachers plan activities, they make a number of decisions about the organization of the physical environment of the classroom. Therefore, the class should be organized to accommodate various teaching activities in the best possible way. Effective use of technology can help teachers achieve their teaching goals on time. It can facilitate easier learning through a visually and audibly stimulating environment. In the teaching and learning process, up-to-date technological tools and equipment help teachers to effectively deliver course material and students to achieve course objectives. Using efficient technology in the classroom is imperative for teachers. A teacher faces two important limitations when designing a learning environment: the mental capacities of the students and the limitations resulting from the physical environment (Driver, 1988).

The use of technological tools and instruments in education contributes immensely to the preparation of effective course material. By using technology, different kinds of teaching materials can be prepared to appeal to more sense organs of students. Teaching material prepared according to the needs of the learners can create an indispensable hands-on learning environment. In order for the learning process to be efficient, it is not enough to use only technological tools. In addition to this, the teacher should be very well aware of teaching method principles, classroom management, communication, child development, individual differences of students and preparation of course material. This creates a rich learning environment for students.

The use of computers by teachers in the school has now become very common. Many computer programs are used for purposes such as drawing, graphics and problem solving. Computers are effective learning tools that will appeal to a variety of learning skills and speeds to make learning resources more accessible to students (Einarson, 2001). Even today, interactive whiteboards are made available to many teachers. In addition to traditional tools such as pencil, board and notebook, today's technological tools such as computers are used in the learning process. It is very important for the senses to participate in learning. Technology-based tools and materials are indispensable to sensory-based learning. Some computer programs help teachers and students learn various audio and visual informations in the form of photographs, videos, sounds, animations, music, text and graphics.

Today, most of the people use Internet in their daily life. As a result, Internet has become invaluable in the learning environment, enabling social, cognitive and technological learning that enriches the teaching process. For the preparation presentations and projects, accessing the desired information and communication, Internet is widely used in classrooms and schools. So, the teacher's duty is to use the technological tools and materials suited to individual differences of students and incorporate learning strategies that appeal to students' preferred learning process. This way, we can help students to adapt to and advance by contemporary amenities.

In summary, the effectiveness of technology depends on the teacher's ability to integrate it well into the teaching process. The use of technology in the class can be summarized as follows (Ogle & Beers, 2009):

- increases motivation and interest of the learner
- develops reading and writing skills
- improves imagination, critical thinking and problem solving skills
- supports individual differences
- provides multiple learning environments by addressing many sensory organs.

The physical conditions of the school are very important for the implementation of curriculum. In the science classes, the condition and availability of laboratories and equipment are important for the envisaged activities and achievements of the curriculum (Dogan, 2010). In science classes, laboratories are environments in which learners gain first-hand experience and learn concepts and theories through experiments. Laboratories are an integral part of science education in terms of students' reasoning, critical thinking, problem-solving skills and positive attitude towards science. Supporting the theoretical science course with experiments helps students to understand concepts, facts and theories more concretely. The subjects of science courses usually include abstract and complex concepts. For this reason, concrete and visual materials are used in laboratories in science lessons with abstract concepts. In this context, concepts that are abstract for students are transformed into more concrete and more easily understood topics (Heywood, 2002). The abstract and complex concepts in the science course provide students with the opportunity to learn hands-on in the laboratory. Thus, students develop a positive attitude toward science by linking theoretical knowledge with everyday life (Brown & Atkins, 1997). When the literature on laboratory use in science lessons is examined, it has been observed that the science laboratory's effectiveness in increasing academic success and attitude towards science education has been investigated (Chiappetta & Collette, 1989; Freedman, 1997; Hofstein, Mullisnavon, Kipnis & Naaman, 2005).

1.1. Purpose of the study

The aim of this research is to examine the adequacy of tools and teaching materials as well as physical and technological conditions in science classes according to the views of science teachers. The answers to the following research questions have been sought for this purpose.

i. What are the class sizes in science classrooms?
ii. What are the physical and technological conditions in science classrooms?
iii. Are the tools and teaching materials used in science classes efficient for current learning standards?

2. Method

2.1. Research model

Qualitative research methods are used according to the phenomenological design. The main aim of the qualitative research is to obtain more detailed information. The findings of the qualitative research are quite descriptive. The reflection of the researcher's learning about the phenomenon is enriched by the explanations about the participants and activities. In order to support the findings of the research, citations from the documents, field notes and sections from participant interviews are used. These citations add to the explanatory nature of the study (Merriam, 2009). The results of using interviews, observations, field notes and open-ended questions as data collection tools aiming at deep and detailed study of events in qualitative research are more directly explained by statistical reports (Johnson & Christensen, 2012). Detailed and in-depth realistic results are presented since the natural environments in which the events and phenomena take place in the qualitative research are used as a source of information (Gurbuz & Sahin, 2014). In this research, class size, physical and technological conditions, tools and teaching materials have been investigated in depth in the science courses according to the views of science teachers. Appropriate sampling method was used in the research.

2.2. Working group

A total of 16 teachers in Mugla province were chosen, and maximum diversity sampling method was used for purposeful sampling methods. The purposeful sampling method is useful in explaining

facts and events in many cases (Yildirim & Simsek, 2013). In the purposeful sampling method, the researcher chooses a subgroup that represents the universe. In qualitative research, the size of a sample cannot reach a large sample size as in quantitative research. For this reason, in the purposeful sampling method, the researcher himself/herself decides on the subjects to be selected and chooses the samples most suitable for the purpose of the research.

2.3. Data collection tools

The semi-structured interview form was developed by the researcher as data collection tools after the relevant literature review. In the semi-structured interview technique, the nature of qualitative research is that the researcher hardly interrupts the participant even if he or she gets off of the subject. However, the questions asked about the research topic are determined before the interview. If necessary, additional questions can be used for more detail during the interview. Occasionally, participants are allowed a limited amount of time to leave these questions during the interview (Gurbuz & Sahin, 2014).

Sixteen science teachers were interviewed for 10 minutes each, and interviews were recorded with a voice recorder. Semi-structured interview forms were used in interviews. The opinions of the four science faculty members were taken as expert opinions, and two science teachers were interviewed on whether the questions were understandable and the answers were appropriate for the research questions. At the end of this process, the scope of the interview form was re-examined and adjusted and prepared for implementation.

The data obtained using the semi-structured interview form was coded by the investigator and another science instructor, and the agreement percentage between the coders was calculated as 91.43%. For this purpose, the reliability formula of Miles and Huberman (1994) was used. Over 70% of the reliability calculations are considered reliable for research (Miles & Huberman, 1994). In this context, the results obtained in the percentage of compliance in this study are considered reliable for the research. The participating science teachers are coded as T1, T2, T3 ... T16. In this coding, T1 is the first teacher, and T8 is the eighth teacher.

According to Table 1, the majority of the teachers who participated in the interview were in age range of 36–40, 41–42 and 46+. As a year of seniority, teachers have more (21–25) and 26+ seniority.

Table 1. Demographic characteristics of the working group

	Frequency	Percentage
Gender		
Female	8	50.0
Male	8	50.0
Age		
21–25	—	—
26–30	1	6.3
31–35	2	13.0
36–40	4	25.0
41–42	5	30.7
46+	4	25.0
Experience		
1–5	—	—
6–10	2	13.0
11–15	3	18.5
16–20	3	18.5
21–25	4	25.0

26+	4	25.0
Graduated school		
Undergraduate	10	62.5
Masters	6	37.5
Graduated faculty		
Faculty of Education	12	75.0
Faculty of Science	4	25.0

3. Findings

3.1. Findings of science teachers' responses to the question 'Is classroom size appropriate in the science class?'

The code and frequencies of the responses to the question 'Is class size appropriate in the science classroom?' directed to the teachers are shown in Table 2.

Table 2. Codes for class size in the science class

Codes	Frequency	Teachers
Class size		
Class size appropriate	10	T1,T4,T5,T6,T8,T9,T10,T11,T12,T13
The class size is very crowded	4	T2,T7,T14,T16
Crowd Classroom Issues	3	T7,T14,T16
In service training for Classroom Management	2	T14,T16

Teachers have expressed their views in the following way:

'The class size is appropriate. Classroom in our school is not crowded, fairly fit for teaching. Usually our classes are around 18 people, so classroom are not crowded. Extremely convenient' (T4).

'We are very fortunate to have a small class size. Because classrooms are not crowded in this school. Lessons are handled comfortably even in a classroom with 24 students. We can make experiments in groups as long as the classroom is suitable. Our students can do even individual experiments on their own' (T8).

'Since the class is crowded, I cannot spare enough time for each student. Sometimes I cannot control the class. There is no such thing as learning. In this case, the only thing on my mind is to keep the class under control. This makes me nervous and put me under stress as a teacher' (T14).

3.2. Findings of science teachers' responses to the question 'How are the technological and physical conditions in science classes?'

The code and frequencies of the answers to the question 'How are the technological and physical conditions in the science class' directed to the teachers are shown in Table 3.

Table 3. Codes for technological and physical conditions in the science class

Codes	Frequency	Teachers
Technological conditions		
Internet and computer available	6	T1,T2,T3,T5,T8,T14
No Internet and projection	4	T4,T10,T13,T15
Technological conditions suitable	4	T2,T5,T6,T14
No computer	4	T4,T10,T12,T15
No interactive white board	3	T2,T12,T16
Physical conditions		

Desks in sequence	8	T2,T3;T5,T7,T8,T9,T12,T14
Test materials insufficient	4	T2,T8,T12,T10
Physical deficiency in the laboratory	4	T2,T7,T8,T12
No lab	1	T4

Teachers expressed their views on this issue as follows:

'Classes in the school are not designed to be used as laboratories. We cannot place lab supplies in classrooms. There are many tables, but there is not enough space when we put the lab tables in the classrooms. We're trying to make our best, but we cannot accommodate students in the lab. So, either we cannot do the experiments, or we cannot get the desired benefit from the experiments' (T11).

'I do not have a problem with the amount of tables and chairs in the lab, but these are not enough for experiments. There are many deficiencies in terms of test materials. When we try to make experiments, we need a lot of materials, but we find only half of it. This is causing great problems. For these reasons, sometimes there are experiments that we cannot do. We have to change the experiment we want to do. We have to do another experiment with the sufficient materials' (T14).

3.3. Findings about the answers given by the teachers in the question 'What are the tools and teaching materials used in the learning-teaching process?'

The codes and frequencies of the responses to the question 'What are the tools and teaching materials used in the learning-teaching process' directed to the teachers are shown in Table 4.

Table 4: Codes for tools and teaching materials used in the learning-teaching process in the science class

Codes	Frequency	Teachers
Tools and Teaching Materials Used		
Laboratory test materials	8	T1,T3,T5,T6,T11,T13,T15,T16
Ready programs from the Internet	6	T3,T5,T6,T7,T11,T16
Cheap easy-to-obtain materials	5	T2,T7,T13,T14,T16
Textbooks	5	T1,T6,T10,T14,T15
Notebooks	5	T1,T2,T3,T5,T14
Materials prepared for the class	4	T8,T12,T14,T16
Banners	4	T4,T7,T9,T11
Interactive Whiteboard	3	T3,T7,T14
Models	3	T5,T12,T15
Posters	3	T6,T9,T10
Video	2	T1,T6
Printers	2	T2,T14

Teachers have expressed their views in the following way:

'We are using experimental materials in the lab. I use materials that are very easily found in the neighbourhood. It is very important for the students to learn by doing. From this point of view, science is closely related to everyday life. The more we embody concepts in science, the better for children. Because the child does not forget what he/she sees and does himself/herself' (T7).

> 'We are trying to incorporate the technology as much as possible to class. We use some ready-made programs. As an example, there are ready programs like Vitamin. We use them quite often' (T10).
>
> 'We're trying to use posters and banners as much as we can. For example, we are trying to use the models to show the internal organs of the teeth, skeleton, body according to the subject. Thus, students can touch them and learn more easily by seeing them' (T5).

4. Conclusion and discussion

Today, although science and technology are developing very rapidly, education is not reflected too much. There is a lack of technological infrastructure of the school, and especially some of the teachers who have worked over 20 years do not have the necessary skills to use this technology. The pervasiveness of Internet and the computer in our lives began in the early 2000s in Turkey. For this reason, teachers with over 20 years of service tend to maintain habits of pre-computer eras. Teachers who cannot adapt to this change are a big problem for science education. Research reveals that teachers do not have sufficient knowledge about contemporary methods and their use in practice, and present tools, materials, computer deficiencies and crowded classes. The inadequacy of the school infrastructure is seen as a major problem in practice (Arslan, Avci & Iyibil, 2008). When we look at the results of the research, we can positively evaluate that the majority of interviewed teachers stated that class size is not crowded. However, some classes are still crowded. It is a necessity for classes to be not crowded for an effective interaction environment within the classroom, and for student participation. Class size should carry the following characteristics (Guven & Karatas, 2004):

- Class size should be 25–30 in order to provide class control
- The number of students is small, the classroom should be extensive and students should be able to feel comfortable
- To avoid distraction, class size should not be crowded in classrooms.

According to research findings, it can be said that there are problems in communication between students and teachers in crowded classrooms. Because the class is crowded, the teacher will not have enough time for each individual student. It is an obstacle to make a plan considering the individual differences of the students. Therefore, this situation will adversely affect students' academic success. The crowded class size may also cause problems in terms of class management. In particular, teachers can experience problems in effective use of time during the lesson and in prevention of the negative behaviours. Moreover, the crowded class size affects the group activities and make hard to monitor the responsibilities of each student participating in the group. Similar to the research findings, there was a significant relationship between teacher quality, classroom availability and student achievement. In this context, when the number of students exceeds 18 in a class, the result is that the student's success has decreased and the quality of the teacher has also influenced the student's achievement (Ferguson, 1991).

The number of students in the class, light, heat, cleanliness, class harmony, well ventilation of the class, and order of rows and column arrangement constitute the physical environment. The most traditional form in the class is desk sequencing. The traditional seating arrangement is not suitable for classroom discussions and group work because students look at a single direction. According to the results of the research, half of the interviewed teachers (eight) stated that the seats were fixed in sequence with the floor. This is not appropriate for objectives, methods and techniques used in the learning-teaching process. However, circle, semicircle and U-shaped classroom arrangements are advantageous for face-to-face communication for students and teachers. Such arrangements make it easier for teachers to apply teaching methods and techniques that they use and also allow students and teachers to easily communicate face-to-face with each other.

In order for knowledge to be permanent, it is necessary for science teachers to use technology effectively, as well as to use visually appealing materials such as banners and posters in the learning-teaching process. Besides, posters and auxiliary resources, models can be very effective in schools and science lessons. But the models, banners and posters that develop visuality have been used very little in the direction of research findings. There are many objects that can be used for learning teaching in the surrounding area. For example, in the teaching of simple mathematical operations such as addition and subtraction, objects such as apples, beans, etc., provide a concrete and permanent learning to students. Using a plastic kidney or heart model to show the inner structure of the human heart or kidney also helps students in learning. Particularly, because science lessons are intertwined with real life, they can be too large or too expensive to bring real goods to the classroom environment. For example, instead of what students might not see in real life, atom and molecule models, and planets' models that provide the opportunity to learn these objects in the classroom environment. In this case, the use of visual materials such as models, banners, or schemes is more practical and useful in terms of the learning-teaching process. At this stage, as the object represented by the model is not as real as possible, either in colour and shape, the models can lead to misperceptions. Therefore, shapes and colours that differ from the actual object represented by the model should not be used. Of the 16 science teachers interviewed, only three indicated that they used banners and models or posters. According to research findings, some teachers are not sufficient in preparing and using materials.

In the learning-teaching process, computers can be used in many situations such as planning, preparing the teaching materials, accessing Internet and sending electronic mail. In other words, the use of materials such as writing, animation, sound, graphics and video with the help of computer and Internet provides rich learning environments for students. According to research findings, some of the interviewed teachers stated that they did not have computer and Internet access. In this case, we can say that the lessons are mostly handled with traditional teaching materials. Whereas in traditional education, with books as the primary source of information, Internet and computer have increased the accessibility of information, as is available from libraries and research institutions. This situation changes the concept of richer time and space from visual point of view so that information can be transported at the desired time or place. Therefore, the lack of computer and Internet constitutes a great obstacle to the exchange of information among learners in learning environments and the exchange of information between teacher and student. The findings of the research are similar to those of other researches in terms of the technological infrastructure and technical support in the schools (Altun & Ates, 2008; Copper, 2004; Onal, 2013).

The use of interactive whiteboards in the classroom engages many sensory organs by providing visual, auditory and tactile learning opportunities. In this context, teachers have the opportunity to make versatile lessons through the interactive whiteboard. In addition, the course is recorded for the students missing the lesson. Interactive whiteboard provides easy archiving for content reuse (Reedy, 2008). Although technological conditions have improved so much, some science teachers have pointed out that they are not using the interactive whiteboards. The positive effect of the use of interactive whiteboard in the motivation of students has been revealed in many researches (Hall & Higgins, 2005; Martin, 2007; Schmid, 2006; Schroeder, 2007; Wood & Ashfield, 2008). In spite of all this positive effect, the use of interactive whiteboard in science lessons is very limited. It can be said that not only the technological conditions are insufficient but also some teachers do not have enough skills to use this technology.

5. Recommendations

The classroom must be arranged to be a maximum of 15–20 considering international criteria. For those students with learning disabilities, the size of the class is a very positive feature. Classroom management should not be crowded in terms of allocating sufficient time for each student to remove the particularly negative behaviour problems directed towards classroom management. In-service

training programs should be organized for teachers on the effects of class presence. It should be practically taught to teachers how to solve problems that may arise in crowded classes in in-service trainings.

According to the findings of the research, it has been revealed that some science laboratories are not sufficient. The absence of a laboratory indicates that there are problems in performing the experiments. For this reason, laboratory deficiencies should be eliminated and missing equipment should be renewed in accordance with technological developments.

Classroom layout is not just physical arrangement, but classroom communication is important for interaction. In this context, the classroom seating arrangement should be arranged in such a way as to provide for effective communication between teachers and students. In addition, the classroom communication environment should provide active participation of learners in the learning process.

Teachers as planners and practitioners of education should create a rich learning environment by applying technological developments to the class. Teachers should ensure that the students achieve the targeted achievements using appropriate technology and materials. In addition, practical in-service training courses should be organized for teachers to learn the use of technological tools.

References

Altun, E. & Ates, A. (2008). The problems and future concerns of computer and instructional technologies preservice teachers. *Elementary Education Online, 7*(3), 680–692.

Arslan, A. S., Avci, N. & Iyibil, U. (2008). Physics prospective teachers' perception levels concerning alternative evaluations methods. *Dicle University Journal of Ziya Gokalp Education Faculty, 11*, 115–128.

Brown, G. & Atkins, M. (1997). *Effective teaching in higher education*. London, UK: Routledge.

Copper, E. (2004). *Teachers perspectives on the implementation of the Ontario elementary school science curriculum* (Unpublished master's thesis). University of Lakehead, Thunder Bay, Ontario, Canada.

Chiappetta, E. L. & Collette, A. T. (1989). *Science instractron in the middle and secondary schools*. Merrill Publishing Company.

Dogan, Y. (2010). The problems encountered during the implementation of science and technology curriculum. *Yuzuncu Yil University: Journal of Education Faculty, 7*(1), 86–106.

Driver, R. (1988). Constructivist approach to curriculum development. In P. Fensham (Ed.), *Developments and dilemmas in science education*. London, UK: Falmer Press.

Einarson, M. (2001). A comparative study of personal, disciplinary and organizational influences on undergraduate faculty use of teaching methods that promote active student involvement in learning (Doctoral dissertation). University of Michigan, Ann Arbor.

Ferguson, R. F. (1991). Paying for public education: new evidence on how and why money matters. *Harvard Journal on Legislation, 28*(2), 465–498.

Gurbuz, S & Sahin, F. (2014). *Research methods in social sciences. Philosophy—Method—Analysis*. Ankara, Turkey: Seckin Publisher.

Guven, B. & Karatas, I. (2004). Middle school mathematics teacher trainees classroom designs. *Elementary Education Online, 3*(1), 25–34.

Hall, I. & Higgins, S. (2005). Primary school students' perceptions of interactive whiteboards. *Journal of Computer Assisted Learning, 21*(2), 102–117.

Heywood, D. (2002). The place of analogies in science education. *Cambridge Journal of Education, 32*(2), 64–75.

Johnson, B. & Christensen, L. (2012). *Educational research quantitaive, qualitative, and mixed approaches* (4th ed.). Sage Publication.

Martin, S. (2007). Interactive whiteboards and talking books: a new approach to teaching children to write? *Literacy, 41*(1), 26–34.

Merriam, S. B. (2009). *Qualitative research. A guide to design and implementation*. John Wiley.

Miles, M. B. & Huberman, A. M. (1994). *An expanded sourcebook qualitative data analysis*. Thousand Oaks, CA: Sage Publications.

Ogle, D. & Beers, J. W. (2009). *Engaging in the language arts: exploring the power of language*. Boston, MA: Allyn & Bacon.

Onal, N. S. (2013). *Teachers' views related to the acquisition of science-technology-society-environment in the curriculum of the primary education science and technology lesson* (Sample file of Isparta; unpublished master's thesis). Mehmet Akif Ersoy University, Institute of Educational Science, Burdur, Turkey.

Reedy, G. B. (2008). Powerpoint, interactive whiteboards, and the visual culture of technology in schools. *Technology, Pedagogy and Education, 17*, 143–162.

Schmid, E. (2006). Investigating the use of interactive whiteboard technology in the English language classroom through the lens of a critical theory of technology. *Computer Assisted Language Learning, 19*(1), 47–62.

Schroeder, R. (2007). Active learning with interactive whiteboards: a literature review and a case study for college freshmen. *Communications in Information Literacy, 1*(2), 64–73.

Wood, R. & Ashfield, J. (2008). The use of the interactive whiteboard for creative teaching and learning in literacy and mathematics: a case study. *British Journal of Educational Technology, 39*(1), 84–96.

Yildirim, A. & Hasan, S. (2013). *Qualitative research methods in the social sciences* (9th ed.). Seckin Publisher.