www.ijres.net

Teachers' Effective Use of Time in Scientific Inquiry Lessons

Onur Bektaş
Mugla Sıtkı Koçman University, Turkey

Ayşe Oğuz Ünver
Mugla Sıtkı Koçman University, Turkey

To cite this article:

Bektas, O., & Oguz Unver, A. (2022). Teachers' effective use of time in scientific inquiry lessons. *International Journal of Research in Education and Science (IJRES), 8*(4), 647-661. https://doi.org/10.46328/ijres.2918

IJRES International Journal of Research in Education and Science
2022, Vol. 8, No. 4, 647-661 https://doi.org/10.46328/ijres.2918

Teachers' Effective Use of Time in Scientific Inquiry Lessons

Onur Bektaş, Ayşe Oğuz Ünver

Article Info

Article History

Received:
15 February 2022
Accepted:
05 September 2022

Keywords

Effective use of time
Scientific inquiry
Classroom videos
Instructional time
Preschool teachers

Abstract

This study was aimed to calculate teachers' effective use of time in scientific inquiry lessons. The research was designed as a case study. The study group of the research consists of 5 pre-school teachers determined by the convenient sampling method. Before the study, the participants were taken in-service training program on scientific inquiry. A timetable, developed by the researchers, was used as a data collection tool. The tool consists of two main themes, "academic time" which has three sub-themes, and "non-academic time". The academic time definition for this research is the process of scientific inquiry interventions that are consist of "building on ideas", "supporting investigation", and "supporting analysis and conclusion" sub-themes. Teachers' classroom videos were the data source of the research. Each video was analyzed in terms of the timetable by the authors. Results of the study stated that the teacher, who uses too much time in one process of the scientific inquiry, could not take enough time to the other processes. In conclusion, teachers need development in the effective use of time in their classrooms. For future studies, it is suggested that mentors' observation and feedback will contribute to the teachers' use of effective time in their scientific inquiry lessons.

Introduction

Teaching is a difficult profession that requires serious preparation and effort to prepare and plan the activities to be carried out in the classroom (Moore, 2001). Teaching is a planned and purposeful by nature and it needs to address the needs of the students. The act of teaching is done by adhering to certain plans; therefore, planning is vital for efficient teaching (Jacobsen, Kauchac & Dulaney 1985). The teachers plan for their classes in advance, teach the lesson in line with this plan, and finally, evaluate the class. Therefore, in evaluating the effectiveness of teaching, the pre-class, the in-class, and the post-class phases should be taken into consideration (Moore, 2001).

The main subject of focus of this study is teachers' use of time during science activities. It is imperative to determine the conditions and situations that cause teachers to have difficulty or lose time in implementing the fundamentals of scientific inquiry in science lessons. Even in well-thought-out classes, teachers may be unable to carry out the designed activities efficiently. The common perception among teachers is that scientific inquiry-related activities take up a lot of time (Campbell, Zhang, & Neilson, 2011; Cheung, 2007). Many teachers complain about being unable to carry out their activities during class, and one of the prominent underlying limitations is argued to be the constraint of time (Jones, Gott, & Jarman, 2000; Staer, Goodrom, & Hackling 1998). Deficiencies in curriculum planning may lead to the inability to spare enough time for all stages of scientific inquiry (Akuma & Callaghan, 2018). In inquiry based activities, students require additional time to plan their own experiments, collect and data, and reach a conclusion (Cheung, 2007). Accordingly, while planning inquiry-based activities, teachers need to dedicate enough time for students to hypothesize, and collect and analyze data. The knowledge, skill, and experience levels of teachers are bound to affect the plans they make.

In order to ensure the professional development of teachers and enable them to improve their skills, the Ministry of National Education of Turkey provides in-service training during seminar periods. Although in-service training programs are considered a standard procedure, European Commission Eurydice analyzes and the OECD report show that the participation of Turkish teachers in professional development programs is limited (European Commission, 2018; Organization for Economic Cooperation and Development [OECD], 2009). The effectiveness of such training programs are diminished as the same programs are offered to all teachers intermittently and without taking into consideration their personal traits, strengths and weaknesses, and in a way that the teachers are the learners rather than contributors (Oguz Unver et al., 2021). It is necessary to provide teachers with support and opportunities to improve continuously (Taitelbaum et al., 2008). It will be wishful thinking to believe that teachers who cannot improve themselves sufficiently can instruct students in a neoteric and internationally-agreed-upon manner. The PISA (Programme for International Student Assessment) and TIMSS (Trends in International Mathematics and Science Study) test scores can be used to extract evaluations on the issue. Accordingly, the Turkish students' science scores in PISA held in 2018 (MEB, 2019; OECD, 2019) and TIMSS held in 2019 (Mullis, et al., 2020) in comparison with students from different countries are presented in Table 1.

Table 1. Comparison of Turkish Students' PISA (2018) and TIMSS (2019) Science and Mathematics Scores with Students from Other Countries

	TIMSS				PISA	
	4th Grade Science Scores		8th Grade Science Scores		15-year-olds' Science	
	Rank	Points	Rank	Points	Rank	Points
Turkey	**19**	**526**	**15**	**515**	**39**	**468**
B-S-J-Z (China)	-	-	-	-	1	590
Singapore	1	595	1	608	2	551
Macau (China)	-	-	-	-	3	554
Hong Kong	15	531	17	505	9	517
Taiwan	5	558	2	574	10	516
South Korea	2	588	4	561	7	519
Russia	3	567	5	543	33	478
Japan	4	562	3	570	5	529
Finland	6	555	6	543	6	522
US	9	539	11	522	18	502
TIMSS Scale Midpoint	**-**	**500**	**-**	**500**	**-**	**-**
PISA Scale Average	**-**	**-**	**-**	**-**	**-**	**458**

It is seen that Turkish students received above-average science scores both in PISA and TIMSS. The improvement in science literacy competencies, namely explaining phenomena scientifically, evaluating and designing scientific enquiry, and interpreting data and evidence scientifically (MEB, 2019), should be a sustained one. Improving teachers' competencies through in-service training program will affect the way they design in-class activities. In-service training success is contingent upon whether the training is on an area teachers need to develop themselves and whether it is compatible with the relevant curriculum (Capps, Crawford & Constas, 2012). The failure to determine teachers' scientific inquiry-related needs is a significant problem undermining the implementation of a research and inquiry-based curriculum (MEB, 2018). Accordingly, it is imperative to promote teachers' strengths and provide them with support in eliminating their weaknesses.

The main purpose of this study is to examine teachers' use of time in science classes. It was observed that teachers commonly think that inquiry-based in-class activities take too much time (Deters, 2005). There is a need to examine scientific inquiry techniques in terms of time management and detect the problematic variables. Classes are systems encompassing many variables such as the teacher, students, classroom, curriculum, time management, etc. Here, the teaching environment should be directly observed variable by variable, and how time is managed during inquiry-based activities should be determined. Detecting the issues in time management during such activities requires a thorough approach. Literature review showed that the variable of scientific inquiry that challenges teachers the most is time management. Therefore, it is necessary to analyze how teachers utilize the average 40-minute class period. The study will contribute to the literature in terms of the evaluation of teachers' use of time in science lessons, which will potentially be of great use in designing in-service training programs.

Method

The qualitative case study method was adopted in this study. According to Merriam (2009), the case study method helps to examine from a holistic perspective variable such as environment, individual, process, or event related to single or multiple situations. In cases where the case study method is adopted, the case as well as its scope should be clearly defined (Creswell & Plano Clark, 2017). The case examined in this study is teachers' time management in science classes where they perform scientific inquiry-related in-class activities.

Participants

The study group consists of five science teachers working in a school in Western Anatolia. The participants were selected using the convenience sampling method, one of the purposeful sampling methods. The convenience sampling method can be preferred in cases where it is difficult to select the study group with random or systematic non-random techniques (Fraenkel, Wallen & Hyun, 2012). The convenience sampling method offers significant advantages to researchers in terms of time and implementation (Leedy & Ormrod, 2005). Among the participation criteria were having at least 5 years of professional teaching experience, having taught a science class, and currently instructing a science class. Participation to the study was voluntary. The participant teachers are known to have received training on inquiry-based science education and STEM education.

Data Collection

The data collection of the research was carried out in parallel with the in-service training process. Data were collected in the form of video recordings. Action cameras were provided to teachers to enable them to film their lectures in high quality. As such, one class video of each teacher was analyzed in terms of use of time. The researchers assumed the role of observers during data collection.

After the data collection stage, each teacher participated in a two-stage in-service mentoring program. In order to examine how teachers used time during their classes before participating in the study, videos were from the first stage of the study were analyzed. The participants filmed their classes both before and after taking place in the mentioned mentorship program. As the aim was to examine the usual flow of the class, the researchers had not interfered with participants' choice of teaching venue. Each participant filmed itself delivering lecture to a classroom to which they have been assigned before. Teachers covered their subjects in classrooms, laboratories, or in another venue they found appropriate. Thus, it was possible to analyze the classes in a holistic manner by taking into account all variables.

The video recordings of the classes were stored by the codes assigned to the participants, in addition to their dates and the stage from which they are. The researchers watched the class video recordings and used the scale they had developed to analyze the change in the time allocated by teachers for the stages of scientific inquiry after the in-service training the latter received.

Data Analysis

The video recordings were analyzed using the scale developed by the researchers. The analysis was made to assess whether teachers sufficiently utilized scientific inquiry in their classes. Accordingly, it was examined whether the three stages of scientific inquiry were completed within the class period. The analysis variables are were time allocated for the stages of scientific inquiry, the percentage weights of the durations of the said stages, and the teacher behaviors and practices that caused loss of time.

The "Time Scale for Scientific Inquiry Classroom" (see Annex) was used by the researcher during the analysis of the video recordings. This scale consists of two dimensions, namely "academic time" and "non-academic time". "Academic time" refers to the periods of time when the teacher or students are actively performing scientific inquiry activities. Academic timeframe AB 7. Academic time, with reference to the booklet of the EU's Fibonacci Project (Borda Carulla, 2012), has been determined to include the stages of ‘building on pupils’ ideas’, ‘supporting pupils’ own investigations’, and ‘supporting analysis and conclusions. Here, whether teachers ask their students questions that encourages the latter to use their previous experiences is associated with building on ideas; the ability of teachers to encourage students to perform scientific inquiry by forming hypotheses, making predictions, testing their predictions, and obtaining data through observation and measurements is associated with supporting pupils’ own investigations; and students communicating the results of their inquiries, making evidence-based inferences, and discussing their findings is associated with supporting analysis and conclusions. Non-academic time, on the other hand, is defined as the periods of time during the course when neither the teacher nor the students are engaged in teaching and learning activities. This period includes portions of the class such as chatter between students, as well as teacher taking attendance and handing out and arranging class materials. The developed scale was used to examine whether the stages of scientific inquiry were completed during the class, and if yes, how much time was allocated for them and whether the they were carried out sequentially, as well as time losses. Each stage of scientific inquiry was evaluated in terms of duration (in minutes and seconds), the share within the entire duration of the class, and the employed scientific inquiry method.

Validity and Reliability of the Scale

Various methods can be used to ensure internal and external validity in qualitative research. Among these methods are prolonged involvement, member checking, and peer debriefing (Holloway & Wheeler, 1996). In order to ensure the internal validity of this study, field experts were consulted. In order to ensure the validity of the study, the opinions of relevant experts on the prepared scale were consulted. The scale was finalized after four revisions were made in line with the opinions of the consulted experts. In order to ensure external validity of the study, the environment in which the study was carried out and the participant profiles were introduced. The fit index was calculated based on the data obtained from the videos analyzed by the researchers. One of the methods used to determine the agreement between the findings of multiple researchers on a situation is to calculate the agreement between raters (IRR-Inter Rater Reliability). Aiken (2000) defines interrater reliability as the degree of consistency between the scores calculated by two or more researchers in a given measurement. The inter-rater reliability formula proposed by Miles and Huberman (1994) was used to determine the interrater reliability. The IRR value was calculated to be over 82%; an IRR value of 70% and above indicates that the measurement tool is suitable to be used in a study.

Results

The participants of the study teach at the same level of education. The participants' years of professional experience, the level of education at which they teach, and the subject of the class that was video recorded are given in Table 2.

Table 2. Participants' Years of Professional Experience and The Subject of the Video Recorded Class

Teacher	Years of Experience	Level of Teaching	Course Subject
Aslı	14	Kindergarten	Buoyancy
Elif	7	Kindergarten	Buoyancy
Handan	20	Kindergarten	Buoyancy
Oyku	17	Kindergarten	Buoyancy
Ozge	19	Kindergarten	Dissolution

Table 2 shows that all participants have more than 5 years of teaching experience. The subjects of the video-recorded classes were determined to be buoyancy and dissolution. The durations of the class videos analyzed by the researchers are given in Figure 1.

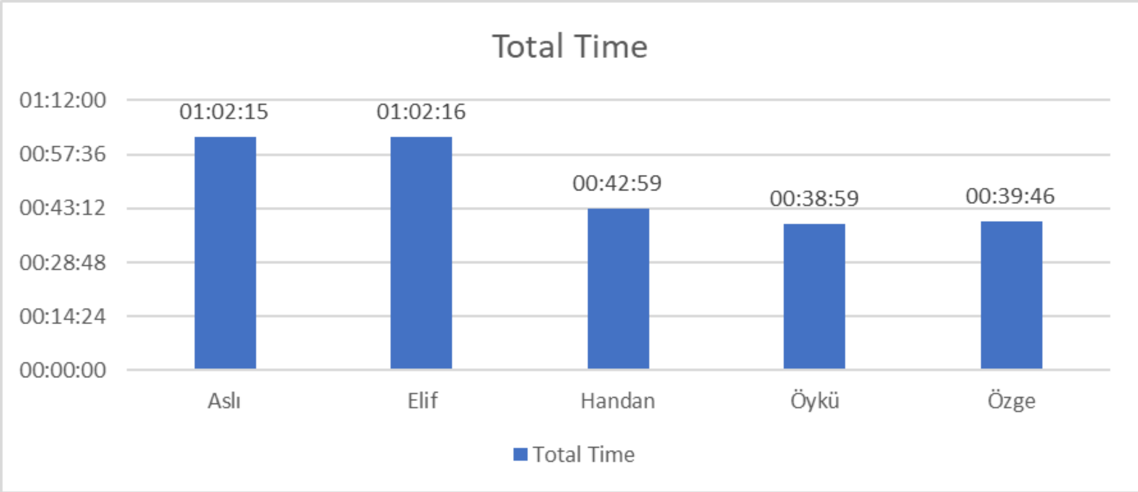

Figure 1. Comparison of the Durations of the Video-Recorded Classes

Figure 1 shows that there is a difference between the time teachers can allocate to scientific inquiry activities. As the course durations of the participants are different, the time allocated for the three stages of scientific inquiry was taken into account in terms of minutes and seconds. For example, if the class duration of a teacher is 1 hour, 2 minutes, and 16 seconds, this duration was taken into consideration as 62 minutes and 16 seconds, and percentages of the time teachers allocated for scientific inquiry activities were calculated accordingly. The comparison of the percentages of the class duration allocated by teachers for the stages of scientific inquiry is given in Figure 2.

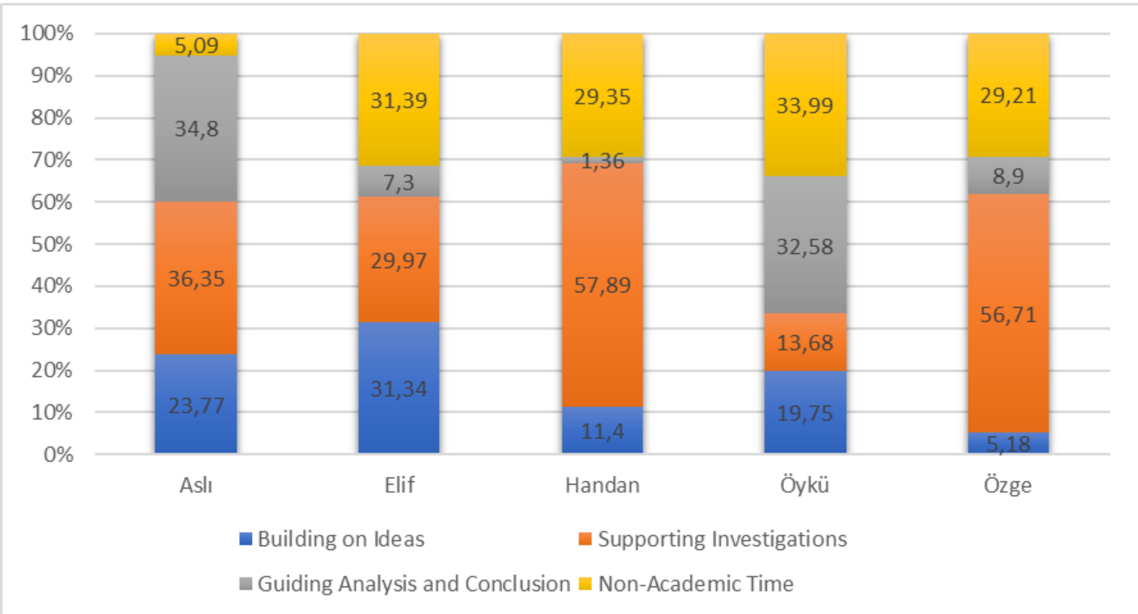

Figure 2. The Percentages of the Class Duration Allocated by Teachers for the Stages of Scientific Inquiry

Figure 2 shows that the participants dedicated differing periods of time to the three stages of scientific inquiry. It can be seen that the time allocated for the 'building on ideas' stage was the longest in Elif's class, in which 62% of the class duration was allocated for this purpose, while Ozge only dedicated 10% of the class duration for it.

The time allocated for supporting pupils' own investigations was the longest in Handan's class, in which 82% of the class duration was allocated for this purpose, while Oyku only dedicated 22% of the class duration for supporting pupils' investigations. Finally, as for the supporting analysis and conclusions, Oyku dedicated the longest time with 37% of the class duration while the shortest time was allocated by Handan with 1%. It can be observed that Handan did not spare enough time for supporting analysis and conclusions.

The teachers are seen to have spared differing periods of time for building on ideas, supporting pupils' investigations, and supporting analysis and conclusions. Generally, as the 'supporting pupils' investigations' stage is the one in which students are the most active both mentally and physically, the longest time should be allocated for this stage. However, allocating more time for this stage than necessary may hinder allocating the required time for other stages. How Handan managed the course can be shown as an example to this case. Handan, who allocated 82% of the course duration for the supporting pupils' investigations, could not spare enough time for the 'supporting analysis and conclusions' stage and completed the course without being able to proceed to it. On the other hand, it is seen that Aslı and Ozge have managed their courses in a more balanced manner, allocating similar portions of the class to different stages. It can be seen that Oyku and Elif did not allocate enough time for the 'supporting pupils' investigations' stage.

According to Figure 2, Aslı allocated 23.77% of the course duration for building on ideas, 34.8% for supporting pupils' investigations, and 36.5% for supporting analysis and conclusions; 5.09% was of the course duration was non-academic time. The column chart demonstrates that Aslı allocated course time evenly among the three stages of scientific inquiry. It was seen that at the 'building on ideas' stage, which covered 23.77% of the course, Aslı asked questions related to daily life that encouraged the students to use their previous experiences. In this stage, almost all students shared their ideas. The 'supporting pupils' investigations stage' was the longest scientific inquiry stage, taking up 36.35% of the course duration. It was seen that at this stage, students designed their own experiments and recorded their observations on the worksheets distributed by the teacher. The use of varied materials by the teacher, Aslı, was seen to expand the scope of observation and enrich the course. It can be argued that the fact that Aslı prepared course material in advance helped to use the course period efficiently. At the 'supporting analysis and conclusions' stage, the students' predictions and observations were compared. Lastly, Aslı utilized the drama method in the evaluation of the course.

According to Figure 2, Elif allocated 31.34% of the course duration for building on ideas, 29.97% for supporting pupils' investigations, and 7.3% for supporting analysis and conclusions. It was seen that in Elif's class, the non-academic time corresponds to 31.39% of the course duration, which was more than any other portion of the class period. Elif asked questions that encouraged the students to use their previous experiences, and almost all students answered these questions. However, it was seen that Elif was significantly late in proceeding to the 'building on ideas' stage. In scientific inquiry applications, sufficient time should be allocated for students to test their predictions and make observations. It was observed that Elif asking disconnected questions during the 'building on ideas' stage occasionally caused the class to derail. This hindered the allocation of sufficient time to the other stages of scientific inquiry.

According to Figure 2, Handan allocated 11.7% of the course duration for building on ideas, 57.89% for supporting pupils’ investigations, and 1.36% for supporting analysis and conclusions, in addition to the non-academic time, which corresponds to 29.35% of the class duration. The observer notes show that Handan allocated sufficient time for the ‘building on ideas’ stage, that students were asked questions that encouraged them to use their previous experiences, and that she attentively listened to the answers of the students. However, this teacher was observed to have lost time while preparing and distributing worksheets to the students at the ‘supporting pupils’ investigations’ stage. The main reason behind this loss of time was that the said materials were not prepared for distribution in advance. Despite this loss of time, Handan was able to allocate enough time for the students to design their experiments and make predictions and observations. However, this hindered the allocation of sufficient time for the 'supporting analysis and conclusions' stage. Handan, therefore, could only spare 35 seconds to the last stage before it was time for a break, which meant that scientific inquiry could not completely performed.

According to Figure 2, Elif allocated 19.75% of the course duration for building on ideas, 13.68% for supporting pupils’ investigations, and 32.58% for supporting analysis and conclusions, in addition to the non-academic time, which corresponds to 33.99% of the class duration. The column chart shows that in Oyku 's class, non-academic time was longer than all other stages. Although the teacher sending students to wash their hands as a part of COVID-19 measures and preparing the course material in the meantime can be regarded as a loss of time, the fact that the teacher quickly distributed the course materials to the students in the next stage can be argued to have partially compensated the lost time. Oyku allocated 32.58% of the course duration to the ' supporting analysis and conclusions' stage, where students discussed and compared their predictions and observations. The teacher encouraging the students who made incorrect predictions by saying "all contributions are valuable" was a remarkable and admirable detail.

According to Figure 2, Ozge allocated 5.18% of the course duration for building on ideas, 56.71% for supporting pupils’ investigations, and 8.9% for supporting analysis and conclusions, in addition to the non-academic time, which corresponds to 29.21% of the class duration. Ozge was able to complete all stages of scientific inquiry, and the stage to which she allocated the longest time was the 'supporting pupils’ investigations', where students carried out experiments and made observations. It was observed that Ozge was not very well at either associating the subject with daily life or encouraging students to compare their predictions and observations at the 'building on ideas' stage.

So, because spending too much time at a given stage of scientific inquiry consequently decreases the time allocated for other stages, the teachers cannot completely cover the subject in the duration of the class. The balance between the times allocated for the three stages of scientific inquiry directly affects the efficiency of the act of inquiry itself. Therefore, time-sensitive course planning is essential for teachers to be able to complete all three stages of scientific inquiry within the course period.

Findings on the Stages of Scientific Inquiry

In the second part of the rubric developed by the researcher, analysis was conducted in order to find out which stages of scientific inquiry were utilized in the video recorded science lessons. It is known that the teachers received scientific inquiry training before participating in the study. Accordingly, it was observed that this training helped teachers to follow a suitable pattern in encouraging students to perform scientific inquiry. Findings of the analysis regarding the stages of scientific inquiry that teachers utilized in their classes are given in Table 3.

Table 3. Stages of Scientific Inquiry Utilized by Participants in their Video-Recorded Classes

	Building on Ideas	Supporting Investigation	Supporting Analysis and Conclusions
Aslı	✓	✓	✓
Elif	✓	✓	✓
Handan	✓	✓	X
Oyku	✓	✓	✓
Ozge	✓	✓	✓

Table 3 shows that Aslı, Elif, Oyku, and Ozge utilized all three stages of scientific inquiry in their classes. However, as the class period ended before being able to the ' supporting analysis and conclusions' stage, Hande could not utilize all three stages of scientific inquiry. Therefore, this stage was construed as "uncomplete" for Hande's class. So, it has been concluded that teachers usually possess the necessary knowledge on scientific inquiry and its stages; however, they may have time management problems while putting this knowledge to use during classes, which clearly demonstrates the importance of planning in utilizing scientific inquiry.

Findings on the Sequency of the Stages of Scientific Inquiry

Here, findings obtained from the Time Scale for Scientific Inquiry Classroom on the sequency of the stages of scientific inquiry have been presented. In this section, the sequence in which teachers utilized the stages of scientific inquiry, namely building on ideas, supporting investigations, and supporting analysis and conclusions, during class has been analyzed vis-a-vis the course duration expressed in minutes.

The findings of the study show that the periods of time allocated by teachers for the three stages of scientific inquiry, as well as their periods of preparation, preferred method of teaching, and evaluation processes, vary. It was seen that the differences in the times allocated for different stages of scientific inquiry affected the efficiency of these stages. Nevertheless, 4 out of 5 participants were able to complete all stages of scientific inquiry in their classes. No similarities were observed between the times allocated by the participants to the different stages of scientific inquiry. Also, it was observed that the length of the non-academic time within the class period negatively affected the timely completion of the stages of scientific inquiry. Although the training teachers received on utilizing scientific inquiry in their classes seems to have been useful, it was seen that they also need training on time management.

Discussion

In the study, the class videos filmed by the participant teachers were analyzed using the scale developed by the researcher. When literature on scientific inquiry is reviewed, it was observed that the main challenge teachers face in terms of planning scientific inquiry activities for their classes is the constraint of time (Jones, Gott, & Jarman, 2000; Mumba, Banda & Chabalengula, 2015; Staer et al., 1998). This situation is also valid for classes that are held in laboratories (Booth, 2001). The findings of this study show that teachers are usually able to complete the stages of scientific inquiry in their classes, but they have issues regarding time management. It has been observed that although the participants are known to have received in-service training on the utilization of scientific inquiry in their classes, time allocation is not a part of their class preparation. Consequently, teachers who spend a lot of time at one stage of scientific inquiry need to compensate the loss of time by allocating less time than needed to the other stages. The findings of this study are found to be similar to the findings of the studies in the literature.

It is known that scientific inquiry encourages learning in students with different levels of academic success and from different backgrounds (Cuevas, Lee, Hart, & Deaktor, 2005; Palincsar & Brown, 1992). Scientific inquiry is an efficient way to learn and teach science (Anderson, 2002). There is evidence in the literature that scientific inquiry helps students to understand and interpret science concepts (O'Neill & Polman, 2004). It was seen in the video recordings examined as a part of the study that scientific inquiry encouraged students to actively contribute and express themselves. Another point that is worth mentioning is that scientific inquiry provided ease for the teacher as well. The information and skills gained through scientific inquiry, as well as the excitement of comparing experiments and observations, are factors that ensure knowledge retention in students. In light of the findings of the study on student participation and behaviors, it has been concluded that scientific inquiry is an effective way of science teaching. This conclusion indicates a parallelism between the findings of this study and the relevant studies in the literature.

Conclusion

In addition to the problems they have with the allocation of time, teachers are also found to have difficulties with planning and managing scientific inquiry activities. This is thought to have an impact on teachers' use of time. The sequency of the stages of scientific inquiry affects the time teachers allocate to these stages. It has been seen in this study that pre-class preparation by teachers can prevent the loss of time during the class. It has been revealed that teachers should take measures to minimize non-academic time in order to use the academic time effectively during class. In conclusion, the practice of scientific inquiry in science classes should be carried out in a way to allocate sufficient time to each stage. Although it poses certain difficulties to teachers, it is an undeniable fact that scientific inquiry is an effective approach in science education, because humans, by nature, are more prone to learning through scientific inquiry than any other approach.

Recommendations

Similar studies can be carried out with a focus on different subjects and levels of education. Accordingly, the scale developed by the researcher for this study can be adapted in accordance with the subject and level of education focused on in the study. Thus, the strengths and weaknesses of teachers in terms of efficient use of time can be investigated more comprehensively; professional development programs can be developed accordingly.

Acknowledgements

This study is based upon work supported by The Scientific and Technological Research Council of Turkey, 1001-Scientific Technological Research Project Support Program under Grant 220K080 entitled "Designing and Evaluation of the Effectiveness of Scientific Inquiry Supported Online Mentoring (e-scaffolding) in In-service Teacher Training" and presented at the International Conference on Education in Mathematics, Science, and Technology (ICEMST 2022), March 24–27, 2022, Antalya, Turkey.

References

Aiken, L. R. (2000). *Psychological testing and assessment*. Allyn and Bacon.

Akuma, F. V., & Callaghan, R. (2018). A systematic review characterizing and clarifying intrinsic teaching challenges linked to inquiry-based practical work. *Journal of Research in Science Teaching, 56*(5), 619-648. doi: https://doi.org/10.1002/tea.21516

Anderson, R. D. (2002). Reforming science teaching: What research says about inquiry. *Journal of Science Teacher Education, 13*(1), 1-12. https://doi.org/10.1023/A:1015171124982

Bergman G., Borda Carulla S., Ergazaki M., Harlen W., Kotul'áková K., Pascucci A., Schoultz J., Transetti C., & Zoldozova K. (2012). *Tools for enhancing inquiry in science education tools for enhancing inquiry in science education.* Montrouge, France: Fibonacci Project. Retrived from http://fibonacci-project.eu/

Booth, G. (2001). Is inquiry the answer? *The Science Teacher, 68*(7), 57-59.

Campbell, T., Zhang, D., & Neilson, D. (2011). Model based inquiry in the high school physics classroom: An exploratory study of implementation and outcomes. *Journal of Science Education and Technology, 20*(3), 258–269. https://doi.org/10.1007/s10956-010-9251-6

Capps, D., Crawford, B., & Constas, M. (2012). A review of empirical literature on inquiry professional development: Alignment with best practices and a critique of the findings. *Journal of Science Teacher Education*, *23*(3), 291-318. doi: https://doi.org/10.1007/s10972-012-9275-2

Cheung, D. (2007). Facilitating chemistry teachers to implement inquiry-based laboratory work. *International Journal of Science and Mathematics Education, 6*(1), 107–130. https://doi.org/10.1007/s10763-007-9102-y

Creswell, J. W., & Plano Clark, V. L. (2017). *Designing and conducting mixed methods research* (2nd ed.). Sage Publications.

Cuevas, P., Lee, O., Hart, J., & Deaktor, R. (2005). Improving science inquiry with elementary students of diverse backgrounds. *Journal of Research in Science Teaching, 42*(3), 337-357. https://doi.org/10.1002/tea.20053

Deters, K. M. (2005). Student opinions regarding inquiry-based labs. *Journal of Chemical Education, 82*(8), 1178–1180. https://doi.org/10.1021/ed082p1178

European Commission. (2018). *Teaching Careers in Europe: Access, Progression and Support.* Eurydice Report. Publications Office of the European Union. Retrived from https://eacea.ec.europa.eu/national-policies/eurydice/content/teaching-careers-europe-access-progression-and-support_en

Fraenkel, J. R., Wallen, N. E., & Hyun, H. H. (2012). *How to design and evaluate research in education* (8th ed.).

McGraw-Hill.

Holloway, I., & Wheeler, S. (1996). *Qualitative research for nurses.* Blackwell Science Ltd.

Jacobsen, D., Eggen, P., Kauchac, D., & Dulaney, C. (1985). *Methods for teaching: A skills approach.* Charles E. Merrill.

Jones, M. E., Gott, R., & Jarman, R. (2000). Investigations as part of the key stage 4 science curriculum in Northern Ireland. *Evaluation and Research in Education, 14*(1), 23–37. https://doi.org/10.1080/09500790008666959

Leedy, P. D., & Ormrod, J. E. (2005). *Practical research: Planing and design* (8th ed.). Pearson Education International.

Merriam, S. B., & Tisdell, E. J. (2009). Qualitative data analysis. In S. B. Merriam (Eds.) *Qualitative research: A guide to design and implementation* (pp. 169–207). Jossey-Bass.

Miles, M., & Huberman, M. (1994). *Qualitative data analysis: An expanded sourcebook.* (2nd ed.). Sage Publishing.

Millî Eğitim Bakanlığı (2019). *PISA 2018 Turkey initial report.* Accessed at http://www.meb.gov.tr/meb_iys_dosyalar/2019_12/03105347_PISA_2018_Turkiye_On_Raporu.pdf

Moore, K. D. (2001). *Classroom teaching skills* (5th ed.). McGraw Hill.

Mullis, I. V. S., Martin, M. O., Foy, P., Kelly, D. L., & Fishbein, B. (2020). *TIMSS 2019 International Results in Mathematics and Science.* Retrieved from Boston College, TIMSS & PIRLS International Study Center.

Mumba, F., Banda, A., & Chabalengula, V. M. (2015). Chemistry teachers perceived benefits and challenges of inquiry-based instruction in inclusive chemistry classrooms. *Science Education International, 26*(1), 180-194.

O'Neill, D. K., & Polman, J. L. (2004). Why educate "little scientists?" Examining the potential of practice-based scientific literacy. *Teaching Journal of Research in Science, 41*(3), 234-266. https://doi.org/10.1002/tea.20001

Oguz Unver, A., Arabacioglu, S., Okulu, H. Z., Senler, B., Muslu, N., ve Ozdem Yılmaz, Y. (2021). Hizmet İçi Öğretmen Eğitiminde Bilimsel Sorgulama Destekli Çevrim İçi Mentorluk (e-scaffolding) Modelinin Tasarlanması ve Etkililiğinin Değerlendirilmesi, 14. Ulusal Fen Bilimleri Ve Matematik Eğitimi Kongresi.

Organisation for Economic Cooperation and Development. (2009). *Creating effective teaching and learning environments: First results from TALIS.* OECD Publishing. Retrived from http://www.oecd.org/education/school/43023606.pdf

Organisation for Economic Cooperation and Development. (2019). *PISA 2018 combined executive summaries.* OECD Publishing. Retrived from https://www.oecd.org/pisa/Combined_Executive_Summaries_PISA_2018.pdf

Palincsar, A. S., & Brown, A. L. (1992). Fostering literacy learning in supportive contexts. *Journal of Learning Disabilities, 25*(4), 211-225. https://doi.org/10.1177/002221949202500402

Staer, H., Goodrum, D., & Hackling, M. (1998). High school laboratory work in Western Australia: Openness to inquiry. *Research in Science Education, 28*(2), 219–228. https://doi.org/10.1007/BF02462906

Taitelbaum, D., Mamlok-Naaman, R., Carmeli, M., & Hofstein, A. (2008). Evidence for teachers' change while participating in a continuous professional development program and implementing the inquiry approach in the chemistry laboratory. *International Journal of Science Education*, *30*(5), 593-617. doi: 10.1080/095006 90701854840

Author Information

Onur Bektaş	Ayşe Oğuz Ünver
https://orcid.org/0000-0002-7735-5649	https://orcid.org/0000-0003-2938-5269
Mugla Sıtkı Koçman University	Mugla Sıtkı Koçman University
Mugla Sıtkı Koçman University Menteşe/MUGLA	Mugla Sıtkı Koçman University Menteşe/MUGLA
Turkey	Turkey
Contact e-mail: *bektas.onurr@gmail.com*	

Annex. Time Scale for Scientific Inquiry Classroom

This scale has been developed to monitor the time teachers allocate for the stages of scientific inquiry in their classes. The scale also measures whether the teachers utilize the stages of scientific inquiry sequentially or not.

The Stages to be Followed in Scientific Inquiry Activities

Building on Ideas At this stage, the teacher is expected to propose a theoretical framework and take steps to encourage students come up with ideas about the subject. Accordingly, the teacher needs to elaborate on the relevant basic concepts, provide an interdisciplinary perspective, and associate the subject with daily life while creating the theoretical framework. In the 'building on ideas' stage, the teacher is expected to stimulate students' sense of curiosity, enroucage students to use their existing knowledge and experiences, help students to understand the nature of science, and use supporting materials (board, worksheet, etc.).

Supporting Investigations: At this stage, the teacher is expected to support students in designing their own research. This stage is where the students make predictions, establish hypotheses, and make observations to design experiments of their own. The teacher is expected to assist students in recording the data on the changes they notice in their experiments.

Supporting Analysis and Conclusions: At this stage, the teacher is expected to encourage students to think about the evidence obtained from the experiments. This is the stage where students compare the results of their experiments, discuss their predictions and observations, examine how their ideas changed from before to after the experiment, and try to develop different perspectives. The teacher is expected to guide the students in these processes.

Non-Academic Time: Refers to the period of time when neither the teacher nor the students are engaged in academic activities. The communication between the teacher and the students have been observed to weaken during this period. At this stage, the students are not engaged in class activities; sometimes even turmoil can be observed in non-academic time. Students' discussion within or between groups is not regarded as non-academic time.

IDENTIFYING INFORMATION

Teacher's first and last name:
Video code:
Video analysis date:
School name:
The name of the course:
Subject covered in the course:
Grade:
Number of students:
The observer's first and last name:

Total Time:		**Academic Time**			**Non-Academic Time**
Time Interval (min:s-min:s)	**Duration (s)**	**Building on Ideas**	**Supporting Investigation**	**Supporting Analysis and Conclusions**	
Total					