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EDITORIAL

Look Forward 2023

Longjun Zhou

Jiangsu Second Normal University, Nanjing 211200, Jiangsu, China

"An investment in knowledge pays the best interest."
–Benjamin Franklin

THE year of 2022 was an extremely difficult year. In 2022, we have experienced a succession of challenges: The world has become more volatile because of escalated geopolitical conflicts, the deteriorated global security, and the aggravated division of camps; the global economic growth has slowed down, and most of the world's major economies have been in the downturn trajectory; people's production and life have been severely affected by food, energy, inflation, supply chain crises; the global temperature continued to rise and reached a new high by 2022 which was 1.15 ℃ above the average temperature before the industrial revolution; the COVID-19 epidemic has been plaguing the world, threatening people's health and life. However, hard times will pass, as they always do. As Romain Rolland stated, "there should be two lights in everyone's heart: the light of hope and the light of courage; with them, we will not be afraid of the deepest darkness and most fierce storms at sea," with perseverance and determination, we have started a new year.

To *SIEF*, the year of 2022 was a special year. In the past year, the journal published over 20% more articles than the previous year and yielded an increasing number of views and downloads. It focused on world education issues and encouraged in-depth discussions on topics of common concern. The viewpoints of the published articles have drawn wide attention of readers, experts and scholars. For example, articles like *The Impact of Extracurricular Tutoring Time Investment on Academic Performance of Secondary School Students: An Empirical Analysis Based on PISA 2015 Data of Four Provincial Administrative Regions in China* (Song & Xue, 2022) and *The Relationship between Middle School Students' Learning Environment Perceptions and Achievement Goals* (Kahraman, 2022) in Science provoked extensive interest and discussions. We would like to take this opportunity to extend our sincere gratitude to all our contributors and readers whose trust, support, and encouragement have been a driving force for the development of the journal.

In the New Year, we will make further endeavor to provide an open, inclusive, objective, and scientific platform of academic exchanges for our global peers in the fields of education and teaching. From January 2023, the publication frequency of SIEF will be changed from bimonthly to monthly to increase the number of articles published to meet the needs of global educational researchers to publish their research results. At the same time, SIEF will carry on with its strict criteria for submission acceptance. It will focus on issues relevant to education development, such as the high-quality development of education, educational technology, educational equity, classroom teaching reform, teacher professional development, school-family-community collaboration, rural education and more. We hereby welcome educational researchers across the world to join us in the research and debate on these issues. We also look forward to readers from all over the world paying continuous attention to this journal and giving us your valuable feedback so that we can make further improvement.

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Song, H., & Xue, H. (2022). The impact of extracurricular tutoring time investment on academic performance of secondary school students: An empirical analysis based on PISA2015 data of four provincial administrative regions in china. *Science Insights Education Frontiers*, 11(2):1551-1565. DOI: https://doi.org/10.15354/sief.22.or052

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***Conflict of Interests**: None.*

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COMMENTARY

How to Help Special Education Students?

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"Good behavior is the last refuge of mediocrity."
—Henry S. Haskins

ACCORDING to UNICEF's report, there are approximately 240 million disabled children in the world. They are typically in a disadvantaged position in terms of health, education, and safety, compared with their normal peers (UNICEF, 2021). By the end of 2018, there were 1045038 registered disabled kids aged 0-14 in China, accounting for roughly 3% of the total population with impairments (Chen, 2020). Such a huge number involves millions of families, who deserve the concern and support of the whole society.

Globally, due to a lack of complete nursing system, disabled children have become chronic burdens, both financially and mentally, to their families, especially to their parents. The long-term, strenuous nursing exhausts parents' energy to the extent that the whole family cannot operate properly, which profoundly affects other family members and increases conflicts among them. Social discriminations against disabled children and their families have intensified their sense of exclusion from the community. Consequently, helplessness and fear of the unpredictable future further worsen the stress and anxiety of this special cohort. Therefore, schools and communities should provide them with professional support and attendance service to relieve their pressure.

Education and nursing for disabled children are not only a social issue, but also entail the protection of their right to education. Considering the crucial role of early basic education in the whole education system and its exceptional significance to the growth of disabled children, improving basic special education should be attached more importance in order to enhance the well-being of disabled children and maintain the harmony and stability of society. For example, the United States, one of the countries with highly-developed education, has been pushing for early education service for disabled children over the past few decades by enacting a series of pertinent laws such as Education for All Handicapped Children Act (1975), the Public Law 99-457 (1986), and Individuals with Disabilities Education Act (1990) (He, 2012).

Unquestionably, disabled children are the most vulnerable among all disadvantaged groups. Their right to education is one of the key indicators to measure the overall education equity of the country. The government intervention in the early education of disabled children can drive the education departments at all levels to contribute more to the development of special education. After years of experiment and practice, China has established a special education system encompassing special education schools, special education classes in regular schools, and inclusive education. Special education schools, including schools for the visually impaired, hearing-impaired, and mentally handicapped, have created curricula with their own characteristics based on the nation's uniform curriculum plan, course standards, and textbooks such that every disabled child can receive an education matching their ability and interest, get the most suitable school placement and attain essential skills to integrate into society (Shi, 2011).

There is a considerable proportion of visually impaired kids among all disabled children. As a result of their isolation from the outside world and their negative impact on their families, most of them have a strong sense of inferiority and low expectations of academic attainments. Books and written language are the major media in the traditional education. It is difficult for visually impaired students with limited reading ability to conduct long-time learning using paper media. Digital technologies have inspired the education community to seek for more effective educational strategies for this special group. For example, online audio books can serve as an ideal alternative with their advantages of being mobile and convenient in reading, since visually impaired children have no difficulty in acquiring information through hearing; it converts written texts into audio ones, which allow students with visual impairment to learn at any time and in any places. This can significantly enhance their interest in and devotion to learning (Zhang, 2011).

Besides, visually impaired students can utilize their sense of touch to augment learning results. *Barrier-Free Science Education for Visually Impaired Students: An Activity for Life Cycle in Plants* in this issue (Keleş et al., 2023) is a study on how to support visually impaired students in the Science course by using tactile materials and technical tools. In the research, a lesson plan was designed and implemented to help visually impaired 3rd grade students in an inclusive class with their study on the subject of life cycle of plants; Depending on touchable materials, teachers objectified abstract scientific concepts to offer these disadvantaged students equal opportunities to succeed in science learning. We hope that this study will spark more discussion on teaching strategies to facilitate special education for disabled children.

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ORIGINAL ARTICLE

Barrier-Free Science Education for Visually Impaired Students: An Activity for Life Cycle in Plants

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***Abstract**: This research aims to design and apply a lesson plan to satisfy 3rd-grade inclusive education students' individual learning needs on the subject of plant life cycle, and to develop three instruction materials based on this lesson plan. In the first stage of this three-staged research, visually impaired students' individual learning needs were determined by conducting workshops with science teachers, elementary school teachers, and special education teachers. Then, the learning outcomes of science education programs were determined. In the second stage, teaching materials suitable for students' personal characteristics were designed by the teachers after assessing the students' needs. Visually impaired students also participated in the process of developing the educational material. In the last stage, students were taught according to the lesson plan with the materials prepared according to the 5E learning model. After the lessons, data were collected through semi-structured interview forms to determine the students' opinions on the lessons and materials. Descriptive analysis was used to analyze the qualitative data obtained. The research results showed that the teaching material responded to the needs of the students and contributed positively to their conceptual learning.*

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Doi: 10.15354/sief.23.or082

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Keywords: *5E Instructional Model, Plant Life Cycle, Science Education, Visually Impaired Students*

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Conflict of Interests: *None*

Introduction

THE limitations of sight cause the students to encounter a lot of problems in access to basic education. Visually impaired students (partially sighted, blind) have difficulty accessing especially such lessons as science in which the visual content is intense in quantity (Jones et al. 2012). Previous research shows that visually impaired students have difficulty in learning subjects of science education where visual elements and abstract concepts are emphasized (Kalaycı 2001; Okcu, Yazıcı, & Sözbilir 2016), and they have less competence on the basic concepts than their sighted peers (Darrah 2013; Kolitsky 2014). For this reason, visually impaired students need different teaching strategies (Weems, 1977; Ataman 2012; Harshman, Bretz, & Yezierski 2013; Atila 2017; Okçu & Sözbilir 2017; Yalçın & Kamalı Arslantaş 2020) and different teaching materials (Atila 2017; Sahin & Yorek 2009; Yalçın 2020; Yalçın & Kamalı Arslantaş 2020) than their sighted peers. Teaching techniques and strategies that respond to individual characteristics and learning channels (sight, hearing, and touch) should be chosen for satisfying the needs of visually impaired students. Also, science concepts should be materialized as much as possible with suitable activities and materials (Cavkaytar & Diken 2012; Dion, Hoffman, & Matter 2000).

Tools such as a barometer, embossed thermometer, experiment tools with Braille labels, human figures, three-dimensional materials and models, three dimensional cells and DNA models, or tactile anatomy atlas should be procured for visually impaired students for their science lessons. Moreover, producing tactile drawings, using hot silicone to draw figures on Braille paper (Supalo 2005), embossed rulers or assistant technological devices (Kumar, Ramasamy, & Stefanich 2001), forming tactile models, preparing embossed maps (Sahin & Yorek 2009), animals and plants, models of organs such as heart, kidney, or stomach, human and animal skeletons, and all other devices adjusted for the visually impaired students can be helpful in science lessons (Köseler 2012; Yazıcı, Gül, & Sözbilir 2016; Zorluoğlu & Sözbilir 2016). For partially sighted students, it is advised to use physical objects and materials designed with large fonts and contrasting colors (Altunay Arslantekin 2018; Yalçın 2020). Also, assistant technological devices (3D Printer, 3D Pen, screen readers, magnifiers, etc.) are used effectively in both the visually impaired and partially sighted students' access to the lessons (Aslan 2016).

Previous research suggests the effectiveness of course materials prepared according to the needs of visually impaired students. For example, Zorluoğlu and Sözbilir (2017) designed materials suitable for the needs of visually impaired students in learning, and applied them on teaching the concept of intensity, Kızılaslan and Sözbilir (2017) on teaching heat and temperature, Lewis and Bodner (2013) and Boyd-Kimball (2012) on teaching chemistry, Smothers and Goldston (2010) on phase transition, Yazıcı and Sözbilir (2020) on teaching the concepts of the respiratory system, Supalo and Kennedy (2014) on the topics of organic chemistry, Gupta and Singh (1998) on the subject of heat exchange and temperature measurement, and Yazıcı and Sözbilir (2020) on support and movement system. All of the researches reported that visually impaired students had similar learning characteristics with their sighted peers when materials were developed in a way that could appeal to their learning channels.

This research aimed to design and apply a lesson plan that responds to the needs of visually impaired 3rd grade students in an inclusive class for individual learning on the subject of the plant life cycle in science lesson, and to develop three teaching materials within this lesson plan in order to enable the access of visually impaired students to science lessons and to help with the difficulties they experience.

The Activity

Lesson

Grade level: 3
Lesson time: Three 45-min periods recommended.

Purpose

At the end of the course, it is aimed to achieve the following objectives;

- The students monitor the growth of a plant for a certain period of time.
- The students explain the phases of a plant's life cycle.
- The students record the results of a plant's life cycle.

Safety

The use of cutting tools should be under the guidance of the teacher.

Procedure

The 5E Instructional model was used to plan the research lesson. The teacher was a facilitator, guiding the student through questions, investigations, experiences, and research. The 5E Instructional Model can be used to design a science lesson, and is based upon cognitive psychology, constructivist-learning theory, and best practices in science teaching (Bybee & Landes 1990). The cycle consists of cognitive stages of learning that comprise engage, explore, explain, elaborate, and evaluate. The 5E instruction model was developed originally for the Universal Design for Learning (UDL). UDL is an approach to teaching aimed at meeting the needs of every student in a classroom that helps give all students an equal opportunity to succeed. At its core, UDL means that a teacher designs learning experiences to remove any barriers to learning and give all students equal opportunities to succeed. UDL suggests giving students more than one way to interact with the activity material and to understand why they should learn what they're learning (Morin 2014).

The fundamental principles paid attention to in the research while developing/adjusting the teaching materials for the students' needs are listed below,

- Materials should be relevant to the learning outcomes.
- Materials should be prepared in a way that helps students objectify abstract concepts.
- All of the materials should be prepared in visual and tactile formats. So, the materials should address more than one learning channel while they are being prepared.
- The writings on the materials should be in large fonts for partially sighted students and in Braille format for visually impaired students.
- Especially for the visually impaired students, materials that are tacitly distinguishable should be used (e.g., foam or sand).
- During the development process, color and background contrast for partially sighted students should be a priority.
- High (e.g., 3D Printer) and low (e.g., Braille tablet) technological tools that have highly been preferred for visually impaired students' access to knowledge in recent years should be made use of during the process.

5E Instructional model lesson plan and the development process of teaching materials in this study is detailed below.

Engage

At this stage, students are made to read the story below (Braille, large font) that would attract their attention to the topic. Students are then asked to answer questions related to the story. At the beginning of the lesson, students are expected to realize the living things and inanimate objects around them and establish a relationship between their life cycle and everyday life.

> *Ece goes to her grandmother's village with her family every summer. Sunflower fields capture her attention as they approach the village. The yellow color of the sunflowers looks fabulous. Her dad tells her that another name for sunflower is day viewer. The birds and colorful butterflies flying over the sunflower fields*

look incredibly beautiful. When her dad asks Ece if she knows "the sunflowers follow the Sun," Ece gets surprised and grows curious. On the road, her dad gives her this information. Many people may think of plants as inanimate since they do not move. Actually, plants are alive, and they can move to a certain extent. The sunflowers that follow the Sun during the day are the best example of this phenomenon. The flowers of sunflowers move from the east to the west by following the Sun during the day. At night, they move in the opposite direction and go back to their position in the morning. This daily movement is observed in the developing sunflowers, and it ceases when they become ripe. Ece is very surprised when she hears this information, and she starts to think about the properties of living things. She also thinks if she has seen non-living things on the road. The stream in their village, fruit trees, mountains, bird nests, her grandfather's cows, etc. Ece's mind is thoroughly confused.

- -What are the living and non-living beings in the story?
- -Can living and non-living beings have common properties?
- -What are the properties of living beings?
- -What are the properties of non-living beings?
- -How does the life cycle of sunflower begin?
- -How do you think a seed becomes a plant?

Explore

In this stage, a course material named "Plant Life Cycle Calendar" is prepared by considering sighted, partially sighted, and visually impaired students' learning channels. Below are the materials and the development process for the course material named "Plant Life Cycle Calendar".

Used Materials: Cardboard, metal ring, colored construction paper and felt, glue, Braille tablet, nail, printer, utility knife

Development Process: 5 cardboards are cut in A5 size. On the first cardboard, a figure representing the seed is made from construction paper and felt. On the second and third cardboard, figures representing germination are made of construction paper and felt. A round plant on the fourth cardboard is prepared from construction paper and felt, and a mature plant on the fifth one. Then the internal mechanism of the cardboard desk calendar is prepared. The cardboards are conjoined; we open two holes on their top and pass the metal rings from these holes. The cycles' names are written on acetate paper in Braille with large fonts, and they are glued on the appropriate places on top

Figure 1. Steps by Teachers in Developing the Material.

of each cardboard. Photos of the steps for the development of teaching materials are shown below (**Figure 1; Figure 2).**

The Application of the Material: Each student gets to examine the calendar. It is examined holistically by the visually impaired student. Next, the student is informed about it. Then, the student is asked to study the calendar pages one by one by touch/look. It is necessary to give elaborate descriptions while informing the students after they examine the calendar. Afterward, visually impaired students should be made to touch the calendar while it is being exhibited to sighted students. The current situation is discussed through question-answer technique.

Explain

The students are informed about plant life cycle in this stage. Then, within an extent that is appropriate for the students' age group and their capacity of observing their surroundings, they are told that the plants have a life cycle like the other living things, and that a plant's life cycle begins with pollination. They are also informed about the insects' role in pollination, and further phases of this life cycle such as insemination, zygote, embryo development, growth and a mature plant. Phases start with the seed for this age group.

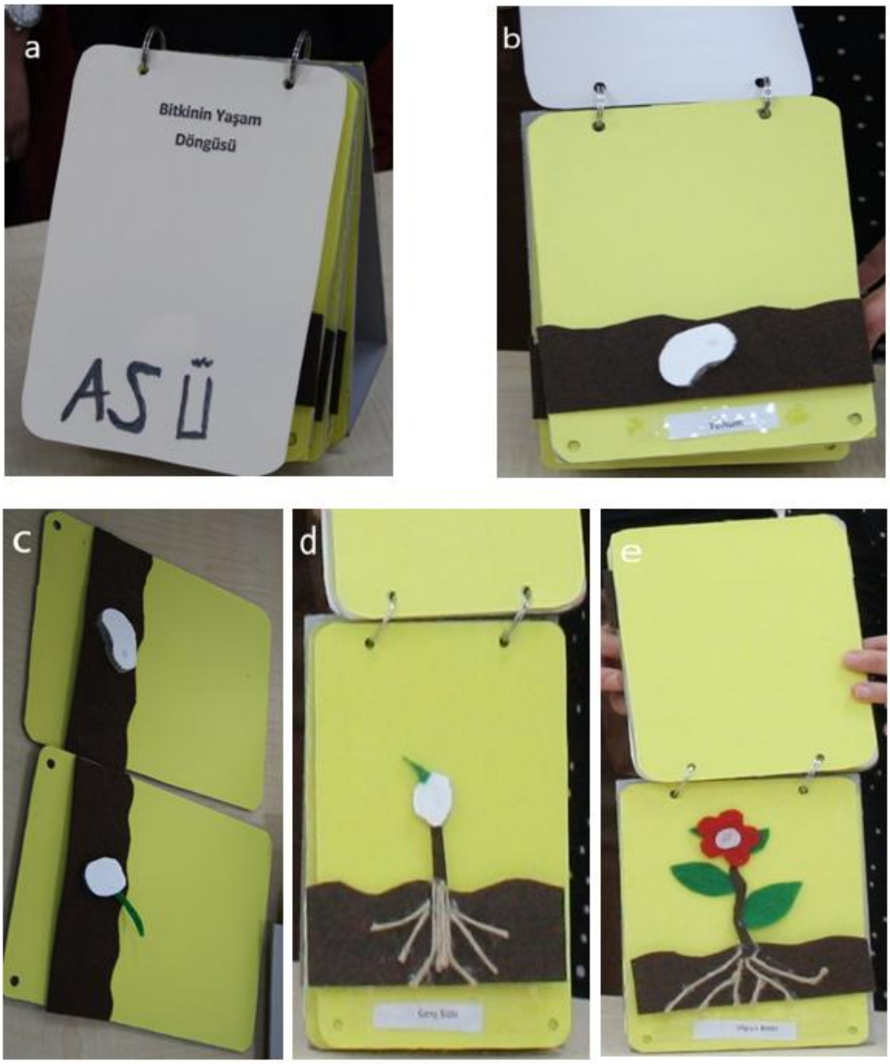

Figure 2. Calendar Pages for the Life Cycle of the Plant.

Elaborate

At this stage, students are informed about the design of the 'Plants Grow' material below. It aims to deepen the students' knowledge which they acquired during the lesson. The stages of this activity are presented below.

Figure 3. Preparation Stages of the “Plants Grow” Material by the Teachers.

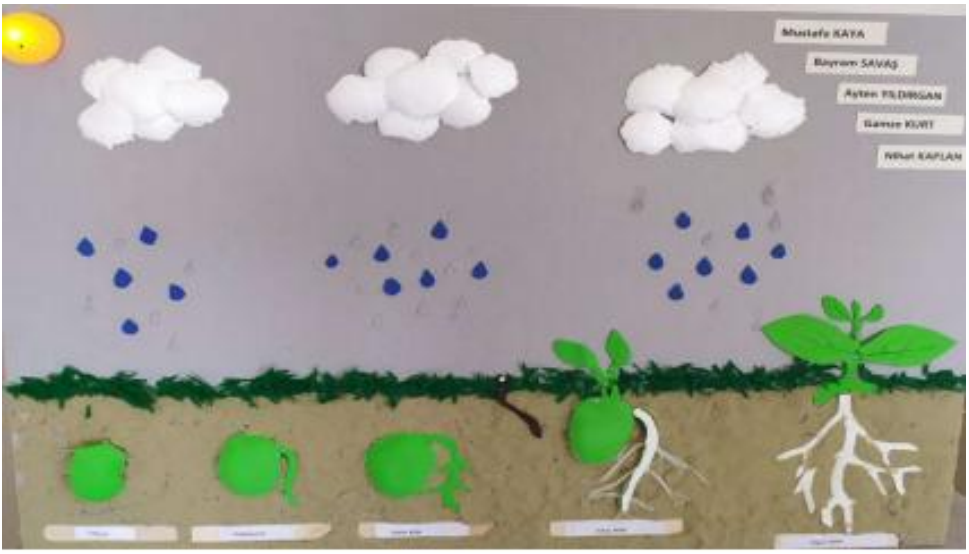

Figure 4. "Plants Grow" Material.

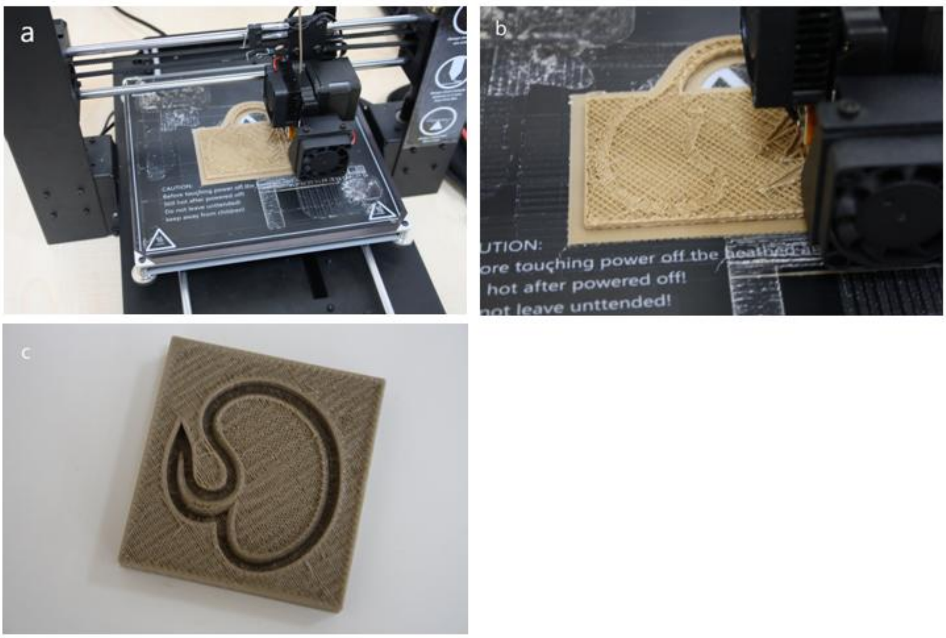

Figure 5. Steps of 3D Printing of Teaching Materials.

Used Materials: Cardboard, foam/cotton, sand/soil, green construction paper and felt, white construction *paper*, glue, hot silicone and silicone gun, transparent glue, blue ink, ping pong ball, connection wires, socket, battery, light bulb.

Development Process: The soil is glued on the bottom of the cardboard. On the top, clouds made of foam are glued to an appropriate place. Raindrops made of transparent glue and blue ink are positioned below the clouds. Above the soil, grass made of felt is glued. Figures representing each phase of the plant's growth process are made from colored construction papers and glued above the grass. The figures made from colored construction paper are stuffed with cotton and glued. The visuals about the plant's life cycle are glued on the cardboard. Under each figure narrating the process of plant growth, the phase's name is written in Braille and large font format and glued. Photos of the steps for the development of teaching materials are shown below (**Figure 3; Figure 4**).

The Material's Application: The visually impaired student is made to examine the material holistically at first. Then, the student is made to touch every object in the material. The student is informed about what the object the student is touching/looking at represents.

Evaluation

Materials comprising each phase of the bean plant's life cycle printed by a 3D printer are distributed to the students. The students are asked to examine these materials. Then, the teacher hands over the students one of the materials representing plant life cycle and makes them touch it, and asks them to tell which phase of the cycle (seed, germination, young plant, etc.) the material represents. The teacher evaluates the students' knowledge about the topic by initiating an in-class discussion. Photos of the steps for the development of teaching 3D materials are shown below (**Figure 5; Figure 6**).

"Life Cycle" activity that can be seen below is practiced together with the students in class. Their lack of knowledge about the topic is eliminated. As seen in the visual, the cycle can be printed on a Swell paper and be embossed by using a Piaf machine.

Activity's Name: Life Cycle

Like all other living things, plants also have a life cycle. Below is given the tomato plant's life cycle (**Figure 7**). Fill in the boxes with the name of the event realizing in each phase

On the visual above (**Figure 8**), an example is provided in the Braille format in order to show the names of the phases in the plant's life cycle.

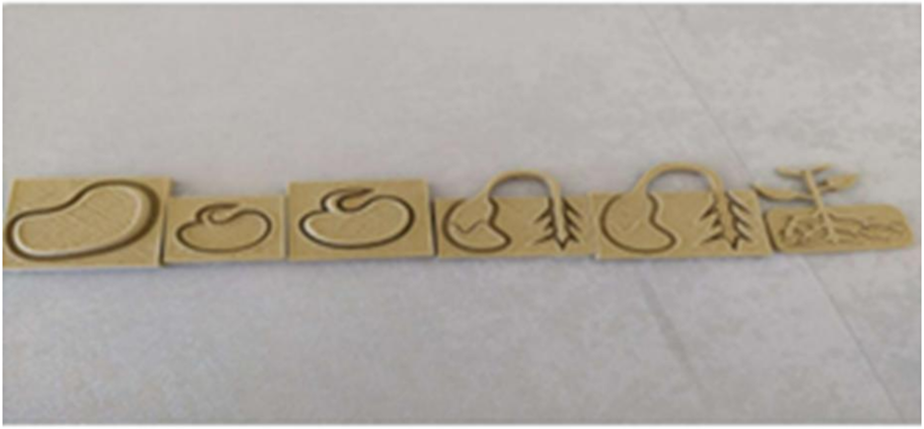

Figure 6. 3D Model of the Plant's Life Cycle.

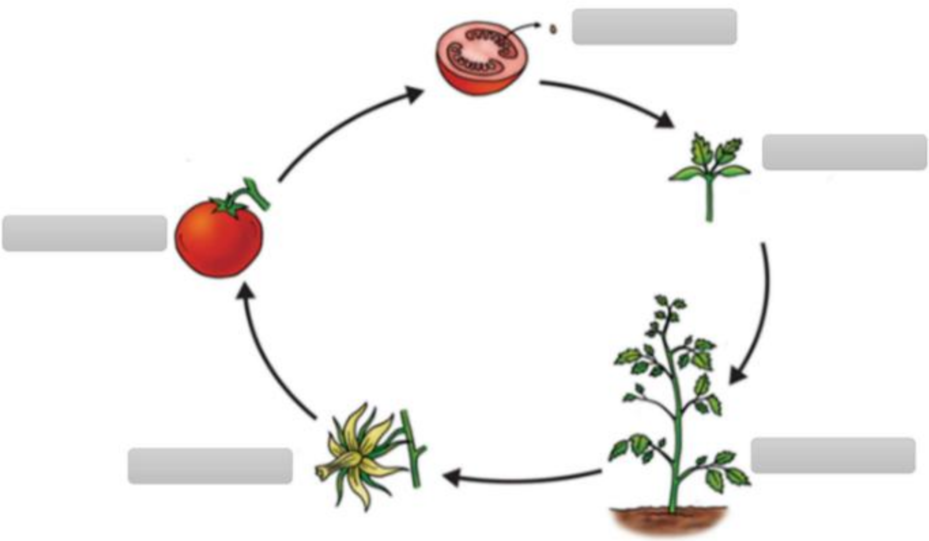

Figure 7. Tomato Plant'S Life Cycle.

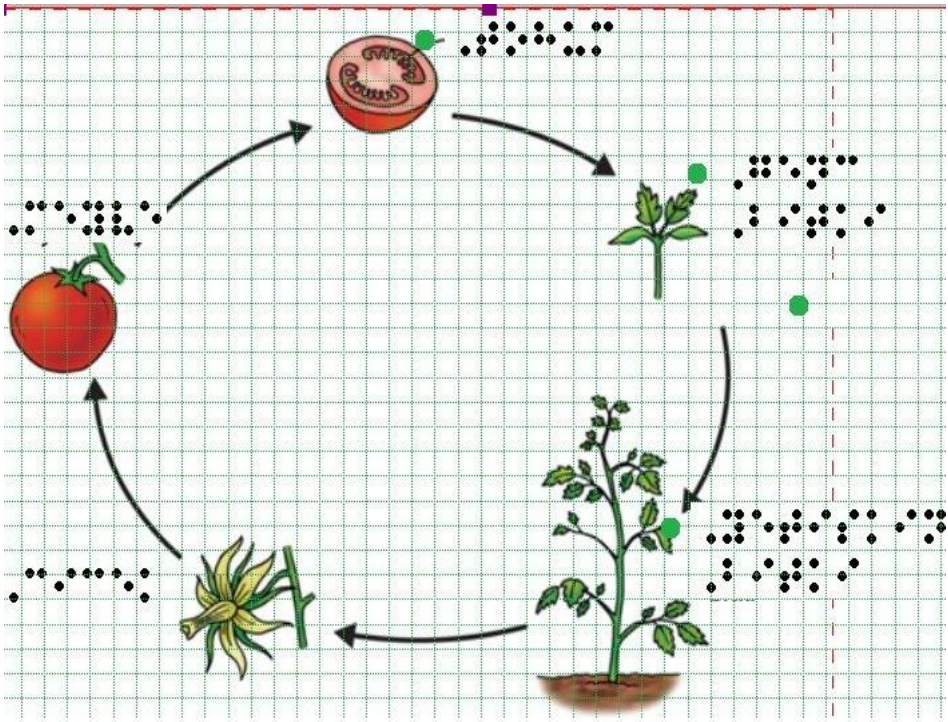

Figure 8: The Names of the Stages of the Plant's Life Cycle, Written in Barille Format.

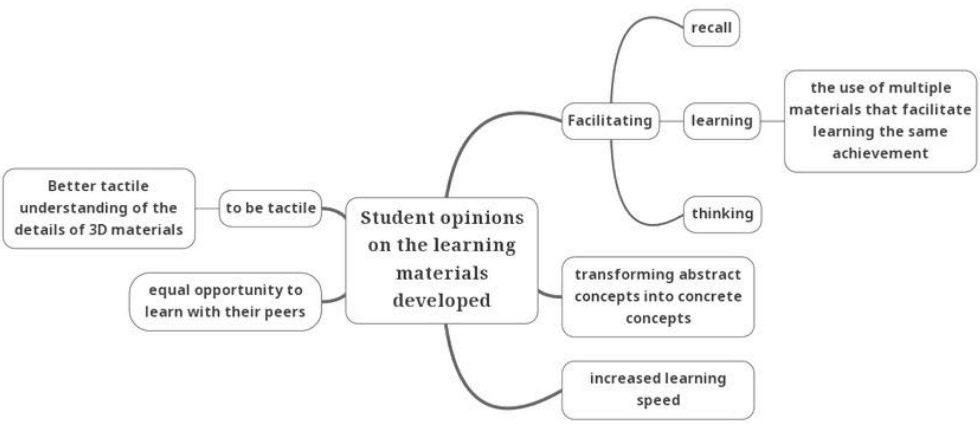

Figure 9: Mind Map of Student Opinions.

Reflection and Implications for Teaching and Learning

The activities and teaching materials developed in this article were developed within the scope of the Barrier-Free Science Teaching Project supported by the Sabancı Foundation. The teaching materials and activities developed in the project were prepared in order to enable students studying in inclusive classrooms to learn science concepts better. In the related project, inclusive classroom teachers, science teachers and special education teachers and visually impaired students worked together in the development of teaching materials. In the province where the research was conducted, the number of visually impaired students studying in the inclusion class is limited. The project was carried out during the Covid 19 pandemic period. For this reason, the opinions of two visually impaired students studying in the inclusive classroom, who actively participated in the development of the teaching materials (in the pilot phase and in the application process), were consulted.

In this research, a lesson plan that responds to the needs of 3rd grade visually impaired students in an inclusive class for individual learning on the subject of the plant's life cycle in science lesson was designed and applied, and three models were developed based on this lesson plan. A teaching session with two visually impaired students was administered after this stage. Students were made to use the developed teaching materials. Then, a semi-structured interview form, composed of six open-ended questions, was used to collect the students' opinions on the lesson plan and materials. The students' responses to the open-ended questions were coded and presented as S1 and S2.

It is necessary to use more than one material in order to achieve the learning outcomes. Teaching should be rich in materials, especially to objectify abstract concepts for visually impaired students.

S1 stated: "*Teaching in this way was fluent, efficient, and clear. The existence of more than one material, the preparation of tactile materials, and the presentation of detailed information in an order were effective for me*."

It is observed that if the concepts of science were taught with these processes from the beginning of the pre-school period, the visually impaired students would have a better basic knowledge level on which new knowledge can be developed better. According to the 5E learning model, which is one of the constructivist approaches, students construct new knowledge based on their prior knowledge. S1: "*I would definitely learn much better, and I would have a sound background. It would be easier to keep in mind, recall, and learn. I was able to learn such concepts as earthquake, landforms, formation of the continents much easier*." S2: "*I could also learn* *about pyramids and old buildings with these materials."* With these statements, the students expressed that visually impaired students will have a better basic knowledge level.

Research findings in the literature show that visually impaired students have limited exposure to course materials and materials suitable for their needs in concept learning (Bargerhuff, 2013; Yazıcı & Sözbilir, 2020). It is necessary to design audio, tactile, large font or Braille documents suitable for the needs of visually impaired students and to include all these materials in classroom activities (Yazıcı, Gül, Sözbilir, Çakmaka & Aslan, 2021). If this need is met, visually impaired students can learn the concepts in science and other visual lessons better, and their incomplete and erroneous learning can be prevented.

The use of assistant technologies in the education of visually impaired students is accelerating. Using technological tools in teaching materials is just as important as teaching the students how to use these tools in their access to the materials. Students S1 and S2 stated: "*I liked both the materials made by our teacher and those printed by 3D printer. Even the smallest details were there in the printed material*." The students stated that the use of technology would increase their learning pace.

This finding shows that visually impaired students are aware of assistive technological tools, which are accepted as a facilitating tool in accessing information. Studies in the literature state that assistive technological tools are an important element that facilitates both the academic and daily lives of visually impaired students (Aslan, 2016; Yalcin & Kamali Arslantas, 2020; Yalçın & Altunay, 2021; Thurlow, Johnstone, Timmons & Altman, 2009). Therefore, especially the courses where visual content is intensive, the use of assistive technological tools in all courses and extracurricular activities is expected to be widespread.

The difference in the textures of materials used in the development of tactile materials increases their discernibility. For example, S1 stated: "*The seed's germination is explained by sand, and another by construction paper. I did not confuse the topics; recalling and learning became easier*."

The teacher's use of concrete materials while teaching the topics during class enables the students to have an answer for their questions by themselves. For example, S1 stated: "The topic is explained as well as the material is used. It eliminates the question concerning how the seed germinates."

Inclusive education supports equal opportunity for all individuals. But in Turkey, the difficulties experienced in educational support services of inclusion and teachers' lack of knowledge on inclusion prevent equal opportunity in education. For example, S2 states: "*We are learning what our sighted peers actually learned in the 3rd grade in the 5th grade. With this type of materials, we could have learned concurrently with our sighted peers at an earlier stage*."

As a matter of fact, studies in the literature have reported that preparing materials suitable for students' own learning channels facilitates their learning processes (Kızılaslan & Sözbilir, 2017; Okcu & Sözbilir, 2016; Yalçın, 2022). In a study conducted by Yalçın (2022), the opinions of students, teachers and families about tactile materials prepared for visually impaired students to be used in science lessons were determined. As a result of the study, it was seen that all three groups stated that the materials prepared would have a positive effect on the learning processes of the students.

In the mind map below (Figure 9), the views of the visually impaired students participating in the research on the 5E learning model developed within the scope of this project and the teaching materials developed are presented as a whole.

Considering the data collected from the responses (as shown in Figure 9), findings of this research put forward the importance of using teaching materials and lessons planned according to 5E learning model through objectifying the abstract information in the education of visually impaired students, increasing their learning pace, facilitating thinking, increasing permanence, compensating for the missing prior knowledge, and equal learning opportunity with their peers.

Studies show that the 5E method within the scope of the constructivist approach is also an effective method that can be used to improve science literacy (Ayvacı & Bakırcı, 2012; Dikici, Türker & Özdemir, 2010). Therefore, although these findings obtained from students were obtained from a limited number of visually impaired students, it is thought that they will shed light on educators in teaching science concepts to students with special needs.

Conclusion

Visually impaired students are in a disadvantaged position in terms of access to lessons such as science, which is intense in visuals and includes abstract concepts, due to their limitations in seeing. It is, therefore, necessary to teach with materials that can objectify the abstract concepts in order to obviate visually impaired students' difficulties in learning science and to help them learn the concepts. In other words, it is necessary to make use of audial, tactile, and visual material proper to the learning channels of visually impaired students, to use effective learning strategies in a class environment, and to make specific arrangements in a setting suitable for the student's needs in inclusive classrooms. Lastly, the use of assistant technological tools to adjust the materials and preparation of course books according to the students' needs is critical for students' access to lessons.

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APPENDIX I

Interview Questions

1. *What was your favorite material in this work? Why is that?*
2. *Have you had any new information you haven't learned in the past but learned while using these materials?*
3. *Do you like the teaching and lecture according to the 5E learning model? Why is that?*
4. *What kind of differences do you think would be about your own learning if all your lessons were taught in this way and such materials were used?*
5. *Would you suggest that we do lessons with your friends who are visually impaired with these kinds of materials? Why is that?*
6. *Do you have any different suggestions regarding the study, especially the materials?*

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ORIGINAL ARTICLE

Evaluation of Parents’ Views on An Early Childhood Science Program Including Activities in Out-of-School Learning Environments

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***Abstract**: Young children’s instinctive curiosity is essential in early childhood science education. Efficacious science education is associated with the characteristics of a qualified science program and an effective learning environment. The out-of-school learning environments make it easier to achieve the aims of science education in early childhood with their opportunities and advantages. This single case study aimed to reveal the views of the parents of children aged 60-72 months who participated in an early childhood science program that included science activities in out-of-school learning environments, in the classroom, and at home. The Program, which included parent involvement activities in the classroom, out-of-school learning environments and at home, was implemented for seven weeks. After completing all activities of the Program, the data obtained from the interviews with the parents were analyzed. The findings showed that parents were interested in science and supported their children regarding science subjects, spent time at home on science activities, and visited out-of-school learning environments with their children. It was determined that the out-of-school learning activities of the Program contributed a lot to the child, and the studies of parent involvement at home contributed variously for both the child and the parents. The Program was effective as a whole and parents requested its implementation throughout the school year. Based on these findings, in this research, we discussed the importance of frequently including science activities in out-of-school learning environments and classroom activities in early childhood and the parents’ involvement in the science education process as valuable stakeholders.*

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Introduction

"WHAT is science?" There is no doubt that there is no single answer to this question. Paulu and Martin (1992) have defined science as observing what's happening, predicting what might happen, testing predictions, and trying to make sense of our observations. Science is a "body of knowledge" or a "body of facts" associated with particular disciplines such as biology, physics, chemistry, geology, astronomy, psychology, information and communication technology, and so on) (Johnston, 2005, p.10-11). Science involves the process of trial, error and retries (Paulu & Martin, 1992), and this process brings about discoveries. Therefore, science is a process of research, discovery and understanding (Uludağ & Erkan, 2020). Uludağ and Erkan (2020) defined science as acquiring knowledge about the world by using the innate sense of curiosity, discovery and learning, and the ways of reaching knowledge (p.3).

Science is an exciting topic that attracts young children. Because children like to know how things are, and science encourages them to test how things work. Science, which is highly related to other fields, provides recognition and understanding of the world (Kelly, 2015). Young children's curiosity about their daily lives and the world around them improves scientific concepts, knowledge, skills and attitudes. The equal development of these scientific concepts, knowledge, skills and attitudes is essential for children not to develop alternative conceptions or misconceptions and positive scientific attitudes (Johnston, 2005).

Science Education in Early Childhood

The aim of science education in early childhood is to improve children's knowledge of the world and to help them learn the methods to be used in discovering, evaluating, reviewing and communicating this information, and to nurture, enrich and sustain their natural interest in scientific knowledge (Klahr et al., 2011). In early childhood, science education should provide active participation of children in the process with a qualified program, enable hands-on experiences, be child-centered, develop a positive attitude towards science, include knowledge and skills that will form the basis for better understanding of scientific concepts and future science learning, enable acquiring knowledge and getting to know the world by using sensory organs, and develop science process skills (Conezio & French, 2002; Hachey & Butler, 2009; Mantzicopoulos et al., 2008; O'Connor & Rosicka, 2020; Pattison & Dierking, 2019).

There are three main content areas of science education in early childhood: life sciences, physical sciences, earth and space sciences (Charlesworth & Lind, 2013; Lester, 2007). Children need to understand and use these areas, focusing on science events, concepts, principles, theories and models (National Research Council [NRC], 1996). Today, engineering, technology and science applications are also included in the content (NRC, 2012). Characteristics, biology and ecosystems of living organisms in children in the context of life sciences; properties of matter, sound, motion and energy in the context of physical sciences; In the content of earth and space sciences, it is aimed to structure the concepts of the Earth's place in the universe and its systems, and the effects of human activities on these systems (Vermont Early Learning Standards, 2015). A qualified science program and an effective learning environment have a fundamental role in achieving the goals of early childhood science education and in helping children learn science content.

Out-of-School Learning Environment

The themes and key issues of 21st-century skills, emphasized in this century, are built on four support systems, one of which is "learning environments" (Partnership for 21st Century Learning, 2019). It is known that appropriate learning environments positively affect child development (Özbay-Karlıdağ, 2021). Learning experiences of young children are best realized in environments where they can use all their senses (Kostelnik et al., 2014). The out-of-school learning environments (OSLE) appeal to children's senses and stimulate them.

Museums, botanical gardens, zoos, science centers and aquariums are OSLE and associating activities in these environments with the curriculum and achieving learning outcomes is defined as out-of-school learning (Laçin-Şimşek & Öztuna-Kaplan, 2022). OSLE start with the school garden and spread towards the immediate environment (Loxley et al., 2010). Using these environments in science education is interesting for children, increases learning motivation, develops scientific and social skills, develops positive attitudes towards science, and makes learning in the classroom permanent and meaningful (Öcal & Uludağ, 2022; Guardino et al., 2019). Therefore, parents' use of these environments is as important as teachers' use of these environments. Because one of the essential stakeholders in qualified science education is parents.

Parent's Role in Science Education

Young children's first informal science experiences occur in their interaction with their parents (Crowley et al., 2001). Parents may not have a strong science infrastructure to experience science with their children, but there are many opportunities to learn science in everyday life. For example, how long it takes for a rose to bloom fully, to monitor and record changes in the Moon, to monitor/track a kitten's growth, to make cakes together, etc. (Paulu &

Martin, 1992). These informal experiences can also be transformed into a more planned process with home-based and school-based parent involvement activities when the child starts school.

Parent involvement refers to parents' activities to support children's education (Camarero-Figuerola et al., 2020). Parent involvement is discussed in two groups as participating in school and home activities (Martinez, 2015). Parent involvement in science education is strongly recommended (The National Science Teachers Association [NSTA], 1994). Parents encourage the daily use of their children's science concepts and process skills, helping them develop the skills necessary for success. NSTA (1994) recommends that parents give the child time to do science, listen to and talk to the child's questions, not avoid saying what they don't know, and be eager to seek answers to questions. Parents should also encourage the school to do science activities and explore OSLE such as museums, airports and recycling centers with the child.

Aim of the Research

The current research aimed to reveal the views of parents of children who participated in an early childhood science program that included science activities in OSLE, in the classroom, and at home. The following research questions (RQ) were addressed with the study;

RQ1. Are parents interested in science, and how does the child answer questions about science?
RQ2. Do parents do science activities at home with child and visiting science-related OSLE?
RQ3. According to the parents, what are the contributions of science-related OSLE to the child?
RQ4. What are the parents' views on the contribution of the Program's activities in OSLE and parent involvement at home?
RQ5. According to the parents, what are the Program's contributions as a whole to child?
RQ6. What are the parents' interest in the Program and the reasons for their interest?

Method

Research Model

The research is a descriptive case study and has a holistic single-case design. Descriptive case studies deal with the "how" of a situation. The holistic single case design covers a single unit of analysis (such as individual, organization, and program) and is used to investigate unique situations and topics that have not been studied before (Yin, 2018). This research is about describing the effects of a specific program.

Study Group

The research included the parents of 27 children aged 60-72 months who attended an official kindergarten and participated in the Program (mother: 18, father: 9). The demographic characteristics of the parents were as follows: 41% of their mothers and 60% of their fathers were between the ages of 35-40. 74% of mothers and 66% of fathers had bachelor's degree. 37% of mothers and 48% of fathers were self-employed.

In the selection of the school where the Program was applied, the physical facilities of the school, the willingness of the school administration, parents and classroom teachers to participate in the research, and the absence of children in any other research during the time period in which the research will be conducted were taken into consideration. In addition, since science activities were carried out in both classroom and OSLE, it was considered that the school was in the city center for ease of transportation and more effective use of time. In order to carry out science activities in the school garden, security measures were taken (being surrounded by fences etc.) and the choice was made among the schools, the ground of which were not covered with asphalt, with a garden with trees, soil and green areas.

Content and Implementation of the Program

The Program was prepared by the researchers in line with expert views to support the science process skills of children aged 60-72 months (Uludağ & Erkan, in press). The Program consists of science activities in the classroom and OSLE and parent involvement activities at home. In the Program, which includes large and small group activities, there are 36 activities in total, 21 in the classroom and 15 in OSLE. Based on the constructivist and science process approach, the Program has seven gains and 24 indicators for observing, comparing, classifying, measuring, data recording/communicating, inferring and predicting skills. The Program includes life sciences, physical sciences, earth and space sciences. The Program's table of specifications is presented in **Table 1** (Uludağ & Erkan, in press).

The Program's activities in the classroom and OSLE (Aquarium, Insect Festival School (IFS), Natural History Museum, Planetarium, Science Center, Veterinary Anatomy Museum, school garden) were carried out by the researcher for seven weeks, three days a week, in the classroom (Photograph 1-2) for 45-50 minutes each, and OSLE for 2-3 hours once a week (Photograph 3-8, taken by the researchers). In the evaluations made at

Table 1. The Program's Table of Specifications.

Wk	Activity No	Content Area	Environments	Observing	Comparing	Classifying	Measuring	Data recording/ communicating	Inferring	Predicting
1	1	LS	Classroom	*	*					
	2	LS-PS	Classroom	*	*	*				
	3	LS-PS	Classroom	*	*	*			*	
	4-5	LS-PS	Science Center	*	*			*	*	*
2	6-7	PS	School Garden Classroom	**	**	*		**		
	8	PS	Classroom	*				*	*	
	9	PS	Classroom			*		*		
	10-11	PS	Veterinary Anatomy Museum	*	*			*	*	*
3	12	LS-PS	Classroom		*		*		*	*
	13	LS-PS	Classroom						*	*
	14	PS	Classroom			*	*			*
	15	PS	Aquarium	*	*	*		*		*
4	16	LS-PS	Classroom		*	*			*	*
	17	ESS	Classroom				*		*	*
	18	PS-ESS	Classroom			*	*		*	
	19-20	LS-PS-ESS	Natural History Museum	*	*			*	*	
5	21	LS-ESS	Classroom	*			*	*		*
	22	PS-ESS	Classroom		*				*	*
	23	PS	Classroom	*					*	*
	24-25	LS-PS	Science Center	*	*		*		*	*
6	26	PS-ESS	Classroom				*	*		*
	27-28	LS-ESS	School Garden-Classroom	**		*			*	
	29	LS-ESS	Classroom			*	*	*		
	30-31	LS	IFS	*	*	*	*		*	*
7	32	ESS	Classroom				*		*	*
	33	ESS	Classroom	*				*	*	*
	34	PS	Classroom			*	*	*		
	35-36	PS-ESS	Planetarium	*					*	*

***Shows the scientific process skills related to the activity in the school garden (LS=Life Sciences, PS=Physical Sciences, ESS=Earth and Space Sciences)*

the end of the Program, it was determined that the Program positively affected children's science process skills (Uludağ & Erkan, in press).

Within the scope of the Program, complementary worksheets prepared for the activities of the children during the week were delivered to the parents by the teacher every Friday. These worksheets included activities

Photograph 1. Classifing of Seashells.
Photograph 2. Recognize Non-Standard Measurement Tools.
Photograph 3-4. Museum of Veterinary Anatomy - Examination of Frozen Samples.
Photograph 5. Science Center-Milk Experiments Workshop (Structure of Milk).
Photograph 6. Natural History Museum- Examination of the Cave Model.
Photograph 7-8. Aquarium-Various Marine Animals and Snake Observations.

to reinforce children's learning in the OSLE they visited and carried out activities in the relevant week, activities to support science process skills, and information notes about the OSLE to be visited the following week. These worksheets aimed to increase the effect by repeating and reinforcing children's knowledge and involving parents in the process. Parents did the activities on the worksheets with child and delivered the worksheets to the teacher on the first school day of each week. For example, in the worksheets, there were tasks such as chatting with children about the out-of-school learn-

Picture 1. A Drawing of the Aquarium Activities.

Child: "This is the tunnel we passed through, the stingrays were passing over us, here are they, I saw the biggest stingray, I saw their eyes, this is the crocodile I drew. I never thought I'd see a real crocodile (Laughs). It was moving very slowly, and I drew it here as moving slowly."

Picture 2. A Drawing of the Activities of the Natural History Museum.

Child: "I drew the jaguar that we saw, this is the cave that we entered, the voices echo in the cave, that is the flying dinosaur, they are no longer alive, that's the tree trunk that we saw. We know the age of the trees from these lines. I also saw the fossils; I drew them all differently because there were slightly different ones."

ing environment in which the activity was carried out in the relevant week, asking children thought-provoking questions, asking children to draw the objects/events they saw in the out-of-school learning environment and to explain their observations through these drawings (**Picture 1-2**), doing activities that support science process skills (comparing and sorting the cards showing the life cycle of the chick, chatting about similar and different characteristics of family members, conducting simple experiments and noting the processes with the child's expressions, etc.). These worksheets from the parents were filed in separate folders for each child, thus ensuring that the tasks were performed.

The data were obtained through interviews using an open-ended questionnaire prepared by the researchers. In the first part of the form, questions about the parents' age, parent type (father-mother), education level and profession were included; in the second part, questions about whether the parent is interested in science, the status of children's answering science questions, the status of carrying out science activities with the child and visiting OSLE, and their views about the contributions of science-related OSLE to the child were included. The questions in the second part aimed to determine the parents' views on science and on performing science activities with their children; thus, it was aimed to obtain preliminary information for the answers to the questions in the third part. In the third part, questions were asked to determine their views on the Program's activities in OSLE, parent involvement activities at home, their contributions in terms of children and the request for implementation. The average duration of the interviews was 40 minutes.

Data Collection

The data were obtained immediately after the completion of the Program's activities. Necessary ethical and official permissions were obtained before data collection. Participants were told that participation in the research was voluntary and that they had the right to withdraw at any time. Confidentiality and anonymity were guaranteed. Some of the interviews were conducted face-to-face, and the researchers noted the answers given in writing. It was determined that some parents could not participate in the face-to-face interview due to reasons such as their work life, the presence of another child/ other children in need of home care, and the lack of transportation to school. In this case, the data collection tool was delivered to the parents by the teacher in printed form, and phone calls were made to willing parents.

Data Analysis

The data were analyzed using content analysis techniques. The content analysis aims to reach concepts and relationships that explain the collected data, and similar data are gathered and interpreted within the framework of specific concepts and themes (Çepni, 2014). In this respect, the data were first read within the predetermined framework in the research. As a unit of analysis, words were used, codings were made according to the concepts extracted from the data, and direct quotations that could be used in the meantime were also noted. Then, the similarities and differences between the codes were reviewed, and the themes were obtained. The data organized in this way were supported by direct quotations. Two researchers carried out the analysis process independently, and the formula (reliability=number of agreements/total number of agreements + disagreements) was used to reveal the coder reliability (Miles & Huberman, 1994, p.64). As a result of the calculation, the percentage of agreement between the coders was determined as 91%. It is recommended that the inter-coder reliability rate should be 90% and above (Miles & Huberman, 1994). Codes assigned to parents for use in reporting data and direct quotations were presented in the findings.

Findings

Parent's Interest in Science and Answering the Child's Science Questions

According to the findings obtained within the scope of RQ1, all parents stated that they were interested in science and tried to clearly and understandably answer the child's questions about science. However, some of the parents stated that they investigated the answer of the question with the child (n=8), some tried to explain the answer to the child's question with examples and practices (n=6), and some parents stated that they encouraged the child to ask more questions (n=2). (n= the number of participants). The samples of parents' quotes follow:

> *Parent 1: "I am interested in science. I am happy when I see my child's desire to learn something. I explain it to him/her in a way that he/she can understand and make him/her understand by giving examples."*

> *Parent 3: "I'm interested in science. Because I'm a chemist, my daughter knows university life very well. We're going to the lab with him, and he knows how to experiment. Since I work at home, he has an interest in science subjects. I explain his questions in the most detailed way and explain them with practices; we spend time together this way."*

Performing Science Activities at Home with Child and Visiting Science-Related OSLE

According to the findings obtained within the scope of RQ2, some of the parents stated that they did science activities at home with their child (n = 17), while some of the others stated that they could not do science activities at home with their children because of lack of time (n = 5) and some of them stated that they did not know what to do (n = 2). Three parents stated that they did not do science activities with their children. However, they only did science activities at home with children within the scope of the Program's parent involvement activities. The samples of parents' quotes follow:

> *Parent 9: "Yes, sometimes we do. For example, we studied how the seed became a plant. We planted seeds in the pots, growing flowers, parsley and onions. We examined them."*

> *Parent 4: "No (we can't do the activity). Because we are working very hard and we do not have time."*

Twenty-four parents said they visited their children's science-related OSLE. The OSLE that parents visit with the child were the zoo (f = 15), the greenhouse/botanical garden (f = 8), the aquarium (f = 5), the science center (f = 3), the science museum (f = 2), the natural history museum (f = 2) and nature (f = 2). Three parents stated that they could not make such visits due to their busy working life [f = Frequency of code in data (raw count)].

The Contribution of Science-Related OSLE to Child

According to the findings obtained within the scope of RQ3, the codes and frequencies related to the contribution of science-related OSLE to child are presented in **Table 2**.

According to **Table 2**, parents thought that OSLE mostly aroused curiosity in children and led them to explore. The samples of parents' quotes follow:

> *Parent 27: "We visited many museums, science museums, botanical gardens and zoos. My son mostly asked why and how questions in these places we visited. Many things attracted his attention, and he remembered the information even after a long time."*

Table 2. The Contribution of Science-Related OSLE to Child.

Environment	Code	*f**
Zoo/Aquarium	Arousing curiosity	10
	Raising awareness for animal protection	7
	Leading to discovery	3
	Helping to overcome the animal phobia	2
	Providing a permanent learning opportunity	2
Greenhouse/Botanical garden	Leading to discovery	4
	Ensuring that child learns about plants	4
Science center/Science museum	Arousing curiosity	3
	Providing concrete learning opportunity	2
Natural history museum	Leading to discovery and research	2
	Providing a permanent learning opportunity	2

**: Frequency of code in data (raw count)*

Table 3. The Contributions of the Program's Activities in OSLE.

Theme	Code	*f**
Learning process	Awakening the desire to learn	21
	Making the learning process enjoyable	10
	Providing new learning	4
	Ensuring that learning is permanent	2
	Making children want to go to school	2
Development of science process skills	Developing communication skills	12
	Improving observing skills	8
	Improving comparing skills	2
	Developing predicting skills	4
	Developing inferring skills	4
Science learning	Increasing interest in science/science subjects	12
	Increasing the use of scientific terms and descriptions	4
	Arousing interest in OSLE	2
Development	Helping to reduce animal phobia	3
	Increasing love for animal	2
	Increasing self-confidence	2

**: Frequency of code in data (raw count)*

Parent 24: "We went to the zoo and aquarium. This place allowed him to get to know animals and overcome his fear of animals a little bit. He began to wonder how the animals were fed and how they were born."

The Contributions of the Program's Activities in OSLE and about Parent Involvement at Home

According to the findings obtained within the scope of RQ4, the themes, codes and frequencies obtained from the views on the contribution of the Program's activities in OSLE to children are presented in **Table 3**.

According to **Table 3**, the activities of the Program in OSLE contribute mostly to the children's learning process. In addition, the parents stated that the activities improved science process skills, increased their interest in science-related subjects and positively affected their development. The samples of parents' quotes follow:

> *Parent 5: "He describes all events in detail. That his hair flew electrically at the Science Center, he made experiments with vinegar, everything. All the activities and trips made him go to school excitedly. He studies everything he sees more and more in detail now. He establishes cause-effect relationships. "*

> *Parent 10: "He returned very happy from all his trips. When he came home, he gave detailed information about the events he had experienced that day. He fondly described the fish in the aquarium, the skeletons in the natural (historical) museum, and so on. He has started to make more observations; he is examining his surroundings in more detail. He also wants scientific explanations for any event. He thinks the word science is very important. It's certainly easier for him to learn that way."*

The contributions of the Program's activities about parent involvement at home were grouped into two groups for child and parent. The themes, codes and frequencies obtained from the views are presented in **Table 4**.

According to **Table 4**, the learning process is first in the category of contributions for children. In this theme, it is seen that parents think that their children enjoy working with them and learning the Program worksheets at home and that this practice is educational and instructive for children. However, some parents stated that their children started to be curious about science and their interest increased. Some contributions are improving children's self-confidence and strengthening their communication skills. In addition, parents stated that the worksheets of the Program guided them in carrying out science activities with children at home. The samples of parents' quotes follow:

Table 4. The Contributions of the Program's Activities About Parent Involvement at Home.

	Theme	Code	f*
For Children	Learning process	That it is enjoyable	15
		Being educational/instructive	11
		Reinforcing learning	3
		Improving vocabulary	1
	Science	Increasing curiosity/interest in science/science subjects	8
	Improvement	Increasing self-confidence	2
		Strengthening communication skills	2
For Parents	Counselling	Providing counselling in carrying out science activities	5
		Offering the opportunity to follow up on the development of children	2
	Interaction	Facilitating communication with children	3
		Providing the opportunity to get to know children	2

**: Frequency of code in data (raw count)*

Table 5. The Contributions of the Program as A Whole to Child.

Theme	Code	f*
Science learning	Willing to learn about the science	18
	Using scientific terms and making scientific explanations	5
	Asking more questions on various science topics	5
	Requesting science materials from the parents	2
	Awakening the desire to be a scientist in children	2
Learning process	Willingness to research and discovery	11
	Enjoying the learning process	7
	Permanent learning	5
	Willing to share learned information	2
	Starting to like the school	1
Development of science process skills	Developing communication skills	7
	Developing observation skills	3
	Developing inference skills	3

**: Frequency of code in data (raw count)*

Parent 9: "As soon as he comes from school, he asks about these activities. –Mom, let's see what's going on- (on the worksheets). –Let's do it, he says. He's started to be interested in everything. When the activities are over, he says, "Any more"? So we started *to do other experiments, activities, and research information from the internet."*

Parent 12: "I think it reinforces everything he has learned and more within the Program. He talks about it all the time. He started talking more about science at home. He shared what he saw and learned through these activities (on the worksheet). These events have been a guide also for me. I have learned what my child can understand and learn."

The Contributions of the Program as A Whole to Child

According to the findings obtained within the scope of RQ5, the themes, codes and frequencies related to the contribution of the Program as a whole to the child, according to parents' views, are presented in **Table 5**.

According to **Table 5**, parents think that the curriculum contributes mainly to the child in science learning; at the same time, it contributes variously to the development of the learning process and science process skills. The samples of parents' quotes follow:

Parent 11: "He says he loves science. His attention and interest in his environment increased. He's questioning everything now. He asks us why-how everything he sees is done, he wants to learn more, and he is very happy."

Parent 8: "My child has become a child who wants to experiment thanks to the Program. He's also waiting for a scientific explanation for every incident. He thinks the word science is very important. While watching cartoons at home, I observed that he started to choose those content that includes experiments and describes animals. And the questions he asks amaze me. Planets, day and night formation, germination of seeds, the natural life of insects... He explains many subjects in his own words and tries to teach us. He also wants to know what he doesn't know."

Parent 27: "His curiosity for science has increased, and he wants to be a scientist. Actually, he always said he wanted to be a painter. He questions the before and after of every event that happens around him. He began to look for a reason as to why this had happened. He draws pictures of how it rains. He tells the lava of volcanos. He excitedly describes the science activities we do at home to our family elders as a discovery, which makes us very happy. This is spectacular."

Parents' Interest in the Program and the Reasons for Interest According to the findings obtained within the scope of RQ6, the implementation period of the Program is seven weeks. However, all of the parents demanded that the content of the Program be applied for one academic year. Because according to parents, the Program is a program that is fun/instructive (f = 10), effective/successful (f = 7), efficient/useful (f = 4), enjoyable/entertaining (f = 4), engaging (f = 3), different (f = 3), allows parent involvement (f = 3), supports the development of the child (f = 2), is loved by children and is wanted to continue (f = 2). The samples of parents' quotes follow:

> *Parent 13: "I want it to continue. So does my daughter. He says he wants to learn more and see new places."*
>
> *Parent 26: "I really want it to continue throughout the year. At the beginning of this year, my daughter and I made a list of places to visit. Places visited under this Program were also on our list, and there were even more. This work seems like a miracle to us. I think it supports his development, and he asked us for a telescope as a gift on his birthday. We were very surprised."*
>
> *Parent 4: "(The Program) It should continue until the year ends. I think this training is very useful. I would love for my child to be interested in science. I think this training is the first step for him. So we did things with our child that we never thought we would do because of the busy schedule. We spent time with him. My son learned new things, and I think it was very effective."*

Discussion

As a result of the research, it was determined that all parents were interested in science, and they tried to answer the child's questions about science clearly and understandably. The answers to the questions that were unknown by some parents were investigated together with children, the answer to the child's question was tried to be explained with examples and practices, and the child was encouraged to ask more questions. Accordingly, it can be said that parents find it essential to encounter science-related issues at an early age and have a positive approach to encouraging the child to learn. Kıldan and Pektaş (2009) determined that preschool teachers think parents are essential in encouraging the child's curiosity about science-related issues. Parents play a critical role in their children's observation, discovery and research of the world they live in (Zucker et al., 2021, p.3). However, the enthusiasm and courage of the parents can ignite the child's interest in science

(Paulu & Martin, 1992). Aktamis et al. (2008) concluded in their research that parents' interest in science helps children grasp the importance of science in daily life.

It has been determined that many parents do various science activities with their children at home; however, a few cannot do such activities due to a lack of time and not knowing what to do. Some parents stated that they only did science activities within the scope of the Program's activities about parent involvement at home with the child. Accordingly, it can be said that some situations prevent the realization of parent-child interaction in science, and the Program plays a mediating role in performing science activities at home. In the research conducted by Erkan et al. (2016), it was determined that reasons such as lack of time, intensity of working life, intensity of housework, lack of pedagogical knowledge are the factors that prevent home-based parent involvement of parents whose children attend early childhood education institutions. Directing parents to parent involvement activities, the teacher's guide for parents, and planning home-based participation are also important parts of the education process. According to Mumpini et al.'s (2021) research, parents already have a proper understanding of early childhood science learning and can theoretically support the child.

Most parents stated that they visited OSLE with the child. The most important of these environments are the zoo, greenhouse/botanical garden and aquarium. Some parents point to busy work life as why these environments cannot be visited. Science and technology museums, anatomy museums, history museums, science centers, science camps, planetariums, aquariums, national parks, zoos, botanical gardens, school gardens, farms, nature centers (lake, river etc.), industrial establishments, hospitals, post offices, digital environments, cinema and theatres, historical open areas, libraries, educational environments of non-governmental organizations, camps conducted within a specific program are OSLE (Cabello & Ferk Savec, 2018; Çolakoğlu, 2019; Eshach, 2007; Laçin-Şimşek, 2020; Republic of Türkiye Ministry of National Education, 2019; Walsh & Straits, 2014). Although it is pleasing for parents to visit these environments with their children, it is seen that one of the reasons for not being able to participate in science activities at home is the intense work life and, accordingly, not being able to spare time. However, it is a fact that parents' good planning of the balance and time management between their work lives and the needs of their children plays an essential role in the child's development.

Parents explained the contribution of OSLE for children, mostly through the zoo and aquarium, and stated that OSLE arouse children's curiosity and lead them to explore. In the research of İnce and Akcanca (2021), parents stated that using OSLE in early childhood education provides many advantages for children's cognitive, affective, social and life skills. Ramey-

Gassert (1997) states that environments such as science centers, museums, and zoos provide motivational, engaging, enjoyable, and non-threatening, hands-on opportunities.

According to the parents, the Program's activities in OSLE contribute various contributions to children in terms of the learning process, development of science process skills, and science learning and development. At this point, we would like to mention the importance of the planning and implementation process, one of the most critical dimensions of the activities to be carried out in OSLE with preschool children. It can be predicted that taking children out of school will raise parents' concerns. İnce and Akcanca (2021) determined that parents whose children continue early childhood education experience various concerns about possible accidents and hazards in out-of-school activities, high-class size, the structure of the OSLE and how to meet the needs of the child. Uludağ (2021) determined that preschool teachers face parent-based problems such as concerns about their children's safety and health problems, negative attitudes towards their children's participation in activities, finding these activities unnecessary, and not wanting to pay transportation and entrance fees. Fear and anxiety about out-of-school activities are essential obstacles to realising these activities (Dillon et al., 2006). However, a good planning process and appropriate practices in this direction will reduce parents' anxiety and ensure active use of the environment. As a matter of fact, in the current research, parents were the supporters of the process and stated the contribution of the activities.

It is obvious that the use of OSLE in science education in early childhood is related to the perspectives of teachers and parents in these environments. Teachers may be shy about carrying out activities in these environments due to environmental opportunities, security problems, parental problems and problems related to themselves (lack of knowledge and experience, etc.) (Uludağ, 2021). However, it is known that parents do not prefer these environments for reasons such as costly use and security problems (İnce & Akcanca, 2021; Uludağ, 2017). Each preschool setting will have its unique possibilities and constraints for using science as a context for early childhood learning. However, small actions by both preschool teachers and parents can make a big difference in highlighting the joy and curiosity of science (Raven & Wenner, 2022).

Parents stated that the Program's activities parent involvement at home contribute to the child and themselves. Parents are an indispensable part of early childhood education. However, parent involvement in early childhood education is an important opportunity for children to learn. Powell et al. (2010) found that parent involvement in early childhood education contributes to children's academic, cognitive and social development. In addition, parent involvement is also effective in developing children's self-esteem and self-efficacy skills (Graham & Kankpi, 2020; Mishra, 2012).

Parent involvement in science education positively affects children's science achievement and attitudes towards science (Fleer & Rillero, 1999; Reinhart et al., 2016). According to Güler and Hazır Bıkmaz (2002), preschool teachers think that cooperation with the family is essential for effective science education and that the child should be given some responsibilities at home. In line with this finding, it is seen that the Program is a science program that contributes to both children and parents with the dimension of parent involvement at home. It is known that many science programs/projects are implemented in various countries related to science education in early childhood and parent involvement plays an essential role in them. Preschool Pathways to Science, ScienceStart! are among these programs. Kefi (2020) states that parent involvement is one of the most important strategies of early childhood science education programs. Therefore, it is clear that the Program's parent involvement activities at home play an essential role in the success of the Program. However, it can be said that parents' interest in science is also effective in the success of the Program. Sahin-Cakır and Uludag (2022) determined that parents' perceptions about science and participation in science activities in early childhood were positive.

According to the parents, the program as a whole contributed to the child's science learning, the development of the learning process, and science process skills. It is known that OSLE has many benefits for K-12 children (Anderson et al., 2000; Armağan, 2015; Attisano, 2021; Balçın & Yavuz-Topaloğlu, 2019; Bamberger & Tal, 2008; Bozdoğan & Kavcı, 2016; Dağal & Bayındır, 2016; DeMarie, 2001; Dohn, 2011; Erten & Taşçi, 2016; Erentay, 2013; Gerber et al., 2001; Hoisington et al., 2010; Li, 2022; Neill, 2008; Sobel et al., 2022; Okur-Berberoglu et. al., 2013; Toprakkaya, 2016; Uludağ & Erkan, in press; Ürey & Çepni, 2014). Civelek and Özyılmaz-Akamca (2018) determined that preschool education supported with outdoor activities improves the science process skills of preschool children and that children find the activities enjoyable. However, the Program, which is a seven-week program, has been a program with its content that all the parents demanded to be implemented for an academic year. The reason for this request was explained as the Program being enjoyable/instructive, effective/successful, beneficial/useful, entertaining/enjoyable, engaging, different, enabling parent involvement, supporting the child's development and being loved and desired by children to continue. Accordingly, it is possible to say that the Program serves its purpose.

Conclusion and Recommendations

According to the research results, parents are interested in science and try to answer their child's questions about science clearly and understandably. They usually spare time for science activities with children at home and visit various OSLE with children. It has been determined that these environments arouse curiosity in children and lead them to explore. The Program's activities carried out in OSLE contribute to children's learning process, science process skills, science learning and development, and the Program's parent involvement studies have various contributions for both children and parents, the Program generally contributes to children in terms of science learning, learning process and science process skills. In addition, due to its many positive features, parents wanted the Program to be applied throughout the entire academic year.

Early childhood science education is essential for children to know and understand the world, develop science process skills, and form the basis of further science learning. Considering that young children need concrete materials, effective learning environments and real hands-on experiences for learning, the active use of OSLE also gains importance. To achieve science acquisitions in early childhood education, activities in OSLE, which are suitable for learning science and performing science activities, should also be included as classroom activities. Based on this result, we suggest that the use of this and similar content science programs should be widespread and that the active use of OSLE should be included in early childhood education policies. We also suggest making cooperation to benefit from OSLE with systematic and planned practices in early childhood science education to support parent involvement in early childhood science education.

Limitations

The research has a limitation. The analysis is based on the experiences of parents whose children participated in the Program and who are also a part of parent involvement and their observations of changes/development in their child. In future studies, studies can be conducted to determine the contribution of this Program to science learning in later years (for example, primary school). It is possible to research with larger working groups. Mixed method studies can be designed to compare results. Parents' views could be addressed in terms of various variables, but these were not the aim of this research. This research aimed to reveal the effects of a program based on using OSLE in science education with parents' evaluations. All the results are considered an opportunity to construct subsequent relevant research on the importance of using OSLE in early childhood science education.

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ORIGINAL ARTICLE

The Development of Mathematical Model Consciousness in Junior Secondary Students: A Lesson Study of the Instruction of Congruent Triangles

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Abstract*: The Compulsory Education Course Standards for Mathematics 2022 have highlighted the educational objectives of junior secondary mathematics by emphasizing the development of mathematical competence and practical learning. Model consciousness, as one of the fundamental mathematical competencies to be developed at the junior secondary level, can facilitate students' comprehension of the universal application of mathematics. Teachers of mathematics in junior high school should construct effective classroom activities based on the cognitive qualities of their students in order to enhance their mathematical model consciousness and comprehension of the substance of mathematics knowledge. This paper is a lesson study of the education of Congruent Triangles, and its purpose is to investigate strategies for fostering mathematical model consciousness among junior high school pupils.*

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Background and Objectives

ACCORDING to the *Compulsory Education Course Standards for Mathematics 2022* (henceforth referred to as the New Course Standards), the junior secondary level core mathematical competencies include abstract thinking, computing skills, geometric intuition, spatial thinking, reasoning ability, data consciousness, model consciousness, application awareness, and innovation disposition (Ministry of Education, 2022). Computing abilities, geometric intuition, spatial thinking, and data awareness serve as the basis for training abstract thought and reasoning ability, which are required for the development of model consciousness. The model consciousness of students contributes to their comprehension of the universality of mathematical application, hence enhancing their application consciousness and innovative disposition. Therefore, model awareness becomes an essential component of students' mathematical competence.

The New Course Standards define mathematical model consciousness as students' understanding of applying mathematical models to solve issues and connecting math knowledge to actualities through mathematical modelling. Junior high school students should develop an understanding of the fundamental process of mathematical modelling, the ability to abstract mathematical subjects from real-world or specific situations, and the ability to use mathematical symbols to establish equations, inequalities, functions, etc. to represent quantitative relationships and the reasoning process in mathematical inquiry. Mathematical modelling is also valuable for theme-based multidisciplinary education (Ministry of Education, 2022).

Shi (2016) argued that the purpose of mathematics education is to equip students with the skills necessary to view the real world from a mathematical viewpoint, investigate it using mathematical methods, and communicate it using mathematical terms. A mathematical model can also be referred to as mathematical language. We discover in our teaching practice that due to their incapacity to build mathematical models during the learning process, a sizable portion of students struggle when applying their knowledge of mathematics to evaluate and solve particular situations. Therefore, developing students' awareness of mathematical models is essential for the general growth of their fundamental mathematical skills.

This lesson study on the instruction of "Congruent Triangles" has the following goals: (i) to arouse teachers' interest in developing student mathematical model consciousness and to investigate how to promote it through effective design of classroom activities; (ii) to improve students' learning processes to maximize their engagement and to search for strategies to incorporate assessment of student mathematical modelling thought into classroom evaluation.

Teaching Design

Learning Contents

Geometric measures, geometric characteristics, and geometric relations are the three parts of the study of geometry at the compulsory education level (which includes primary and junior secondary schools). The study of geometric relationships includes the section on congruent triangles. The unit on triangles comes before this part. A study of the relationship between two triangles takes the place of the study of a single triangle at this point. The most fundamental and prevalent congruent shapes in the physical universe are congruent triangles. Students have previously studied the ideas of a line segment, an angle, a parallel line, and a triangle. This lesson introduces the new topic and serves as the first lesson in the unit on the congruence of triangles. In order to prepare them for further study of this topic, students learn the definition and characteristics of congruent triangles through concrete examples in this lesson. They also create the mathematical model of congruent triangles.

Learning Situations

- *Students' Prior Relevant Experiences:* Students in the eighth grade have a basic concept of plane and space geometry as well as a beginning comprehension of the characteristics of polygons and circles. They have also mastered straight lines, rays, line segments, angles, and parallel lines. Students are capable of mathematical thinking such as analogies and have the fundamental skills of geometric analysis and proof.
- *Knowledge to Be Learned*: Congruent shapes and triangles.
- *Projected Learning Difficulty*: How to establish triangle congruence by rational and deductive reasoning.
- *Individual Disparities*: Student variations in symbol consciousness, observation and induction skills, and other skills.

Teaching Focuses

- *Key Points*: The concepts of congruent triangles and congruent shapes; reasoning and calculation based on congruent triangle properties
- *Teaching Challenges*: The study of corresponding relations in congruent triangles; the development of a mathematical model for congruent triangles.
- *Instruction Strategies*: Students' capacity to recognize geometric figures will be improved. Students will also develop a mathematical model consciousness in the process of analyzing and solving problems. Finally,

students will be made aware of the reciprocal translation between figures and symbols.

Lesson Implementation

The First Experiment in Class A: Focusing on the Holistic Mastery of Knowledge

The Objectives of the Lesson Design

To help students build the mathematical model of congruent triangles, it is important to give them the tools to abstract the idea of congruent triangles from everyday life, recognize corresponding relationships in congruent triangles, represent their properties with symbols, and calculate their sides and angles using geometric analysis.

Classroom Processes

i. The Introductory Situation

- Students were instructed to study the following four pairs of images and record their characteristics.

Students can recognize that the two pictures in each pair correspond.

- This technique aimed to prompt students' consideration on geometric congruence by using familiar imagery from daily life.

ii. Interpretation of Learning Objectives

- To comprehend the concept of congruent triangles and their corresponding relationships through the observation of actual examples; to investigate the properties of congruent triangles through analogies with general congruent figures and use the properties to calculate the degree of angles and the length of line segments; to hypothesize the methods for determining the congruence of two triangles with the aid of teaching aids.

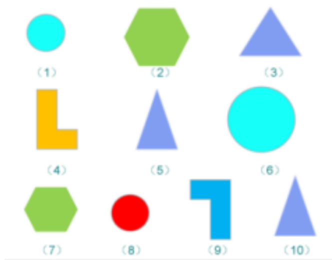
- The objective of this procedure is to assist students in comprehending the inquiry procedure and fundamental concepts of this course.

iii. *Conceptual Comprehension*

- The interaction between the teacher and students:

  The teacher: "How should geometric congruency be defined in mathematics?"
  Students: "Identical in size and shape."
  The teacher: "Give some examples from your personal surroundings."
  Students: "Classroom windows, doors, etc."

Instant assessment: Identify congruent figures among the following shapes,

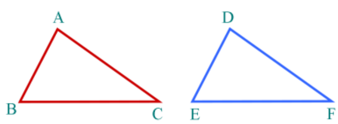


- The purpose of this method is to allow students to abstract geometric congruence from physical examples and recognize the application of mathematics to real-life situations; and to assess students' understanding of the notion of geometric congruence.

iv. *The Inquiry of the Properties of Congruent Triangles*

- Step One

The teacher stacked two sheets of different colored cardboard and cut two congruent triangles from them.



The teacher: After a sequence of movements of the two models, ask students to discuss the relationships between the two figures.
Students: "They are congruent because they can coincide."

The teacher: demonstrate the symbol "≌" that denotes geometric congruence ("∽" means the same shape, "=" means the same size).

- Step Two

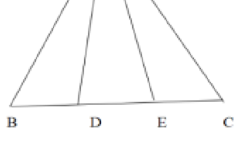
  The teacher: Make the two models coincide to direct students to explore the traits of sides and angles in congruent triangles and their correspondent relations.
  Students: Identify the vertices, sides, and angles that correspond in congruent triangles by aligning the two models.
  The teacher: Instruct students to consider the properties of congruent triangles.
  Students: After group discussion, identify the relationships between the two sets of sides and angles and use symbols to express their attributes.

- The purpose of this process is to help students obtain the concept of congruent triangles through the analogy of general congruent shapes and to perceive the mathematical research process of transitioning from generality to particularity; to guide students in discovering the corresponding relationships in congruent triangles through overlapping, observation, and other activities; and to express the properties of congruent triangles in symbolic language.

v. *The Application of the Properties of congruent triangles*

- The explanation of an example question:

  As shown in the figure, △ABE ≌ △ACD is known,
  (1). If BE = 6, DE = 2, find the length of BC.
  (2). If ∠BAC = 75°, ∠BAD = 30°, calculate the degree of ∠DAE.



- The goal of this procedure is to explain how to apply the properties of congruent triangles to problem solving using the example question, based on students' prior understanding of the sum and difference of line segments, and to emphasize the usual steps for addressing the question.

vi. Knowledge Transfer

- Speculating on the criteria for determining if two triangles are congruent.

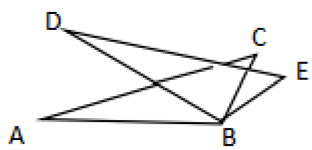
The teacher: "What to consider while determining triangle congruence?"
Students: "Equal sides and angles."
The teacher: "What are the necessary conditions?"
Students: Make personal guesses freely.

- The goal of this procedure is to provide students the chance to visualize the material covered across the entire unit and make connections between concepts.

vii. In-class Assessment

- The exercise.

As shown in the figure, △ ABC and △ DBE are congruent triangles, so there are ( ) pairs of equal angles in the figure.
A.1, B. 2, C. 3, D. 4



- The goal of this procedure is to assess the lesson's effectiveness by asking a question that is appropriate for students' average cognitive abilities.

An Evaluation of the Instruction Results

i. Using concrete examples, students were able to grasp the idea of geometric congruence, although the initial situation did not spark their interest in acquiring additional information.
ii. With the aid of teaching aids, students could use characteristics of generic congruent figures to comprehend the idea of congruent triangles and explain the corresponding relationships between congruent

triangles. The idea of a mathematical model of congruent triangles has not been formed, yet pupils were not proficient enough in using the properties of congruent triangles to solve problems.

iii. The knowledge transfer approach helped students understand the subject as a whole, but it has to be enhanced to better raise students' awareness of mathematical models.

The Second Experiment in Class B: Constructing a New Framework by Analogy Based on Students' Prior Knowledge

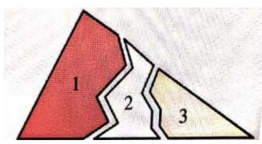
The Objectives of the Lesson Design

To modify classroom activities in response to problems encountered in the first experiment; to plan a more intriguing introduction to pique students' curiosity; to associate the corresponding relations between general congruent figures with those between the elements (vertexes, sides, and angles) in congruent triangles; to hypothesize the process of studying geometric figures, including congruent triangles, in analogy with that of studying parallel lines and triangles; and to construct the mathematical model of congruent triangles.

Classroom Processes

(i) The Introductory Situation

- Student X shatters a triangular piece of glass into three pieces, and he now needs to go to the glass shop to obtain an equivalent piece.



- The objective of this procedure is to prompt students to consider the question, "What does 'an identical piece of glass' mean?" and "How can it be expressed mathematically?"

(ii) Interpretation of Learning Objectives

- To abstract congruent shapes from physical examples and identify the corresponding relationships between them; to apply knowledge about general congruent shapes to the study of the relationships between the basic elements of congruent triangles; to use prior knowledge of parallel line analysis to project the process of analyzing the congruence of triangles.

- The objective of this procedure is to assist students in comprehending the inquiry procedure and fundamental concepts of this course.

(iii) Conceptual Comprehension

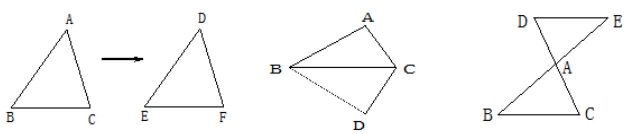
- To abstract the mathematical concept of geometric congruence, students needed to see the following images in pairs and identify those that could coincide.

Students perceived the qualities of geometric congruence by comparing the size and shape of two congruent figures; to expand their grasp of the idea, they were asked to provide more instances of congruent shapes in everyday life.

- The objective of this procedure is to enable students to abstract the mathematical model of geometric congruence from real examples and get an initial understanding of the features of congruent figures.

(iv) The Inquiry of the Properties of Congruent Triangles

- The teacher cut multiple pairs of congruent triangles from two pieces of different colored cardboard and performed the following actions: *translating △ ABC along line BC to obtain △ DEF; flipping △ ABC along BC to obtain △ DBC; rotating △ ABC by 180° around point A to obtain △ AED.*



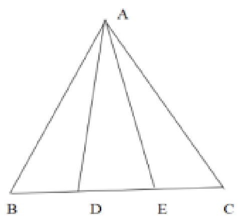
With reference to the definition of congruent figures and the characteristics of the figures before and after the movements, students compared the description of congruent triangles with their own words; using symbols to represent the congruence of triangles and summarizing the properties of congruent triangles, they identified the corresponding equal sides and angles between triangles after translation, flipping, and rotation; they then applied the properties of congruent triangles to analyze relations of sides and angles in more complex figures.

- The objective of this procedure is to help students understand the concept of congruent triangles by analogy with general congruent shapes; to understand that the resulting figures and the original figures are congruent after movements such as translation, rotation, and flipping; to understand the relationships between the corresponding vertexes, sides, and angles in congruent triangles with the aid of the aforementioned movements; and to represent the properties of congruent triangles.

(v) The Application of the Properties of Congruent Triangles

- An explanation of an example question:

As shown in the figure, △ ABE ≌ △ ACD is known,
(1). If BE=6, DE=2, find the length of BC.
(2). If ∠ BAC=75 °, ∠ BAD=30 °, calculate the degree of ∠ DAE.



- The objective of this procedure is to explain how to apply the properties of congruent triangles to problem solving using the example question, based on students' past understanding of the sum and difference of line segments, and to emphasize the usual problem-solving steps.

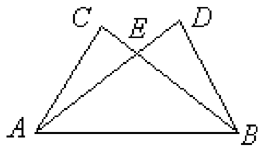
(vi) Knowledge Transfer

- Examine the process of learning parallel lines and compare it to the process of studying geometric shapes such as congruent triangles.
- The objective of this procedure is to teach students about the interconnectedness and integrity of mathematics, as well as to understand the process of geometrical study - from definition to property determination, deduction, and application - and to use the mathematical model to analyze and solve problems.

(vii) In-class Assessment

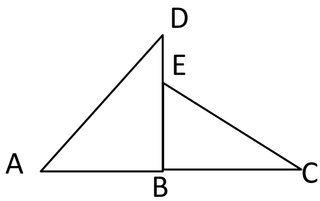
- The basic exercise:

As shown in the figure, △ ABC ≌ △ BAD, AC and BD are corresponding sides, AC=8cm, AD=10cm, DE=CE=2cm, then the length of BE is ( ).
A. 8cm B. 10cm C. 2cm D. Undeterminable



- The exercise with a higher-level of difficulty:

As shown in the figure, △ABD ≌ △EBC, AB=3cm, BC=4.5cm
(1). Find the length of DE.
(2). Determine the relation between AC and BD and explain the reason.



- The goal of this procedure is to stratify the in-class assessment according to students' academic levels.

An Evaluation of Instruction Results

- In this experiment, students were exposed to the topic through a real-world incident, which was more effective in sparking their interest in addressing problems with mathematical answers.
- Common figure movements such as translation, rotation, and inversion were incorporated into the study of the definition and properties of congruent triangles to aid students in establishing the mathematical model of congruent triangles and learning to determine the corresponding relations in more complex configurations via figure movements. However, this strategy was ineffective for kids with inadequate spatial vision skills. Therefore, it needs additional development.

- In the context of knowledge transfer, the similarity between the relationships between two straight lines and those between two figures was advantageous to students' perceptions of mathematics' interconnection and integrity, but had no influence on their awareness of mathematical models. It can be used as a supplement during the summary phase.

The Third Experiment in Class C: Using Revised Learning Activities to Foster Mathematical Model Consciousness in Students

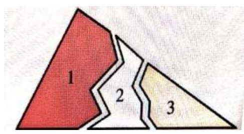
The Objectives of the Lesson Design

Revisions are made to classroom activities in response to obstacles encountered in the first two experiments. To achieve the goal of developing their mathematical model consciousness, students are required to make their own models of congruent triangles to better perceive the corresponding relations between them; to find common configurations of congruent triangles through movements of models; to understand the properties of congruent triangles by establishing mathematical models using physical models; and to apply the properties of congruent triangles to the calculus.

Classroom Processes

i. The Introductory Situation

- Student X shattered a triangular piece of glass into three pieces; he must now visit a glass shop to obtain a replacement.



- The objective of this procedure is to prompt students to consider the question, "What does 'an identical piece of glass' mean?" and "How can it be expressed mathematically?"

ii. Interpretation of Learning Objectives

- To be able to take the idea of geometric congruence from physical objects, relate the definitions and features of congruent figures and triangles, and figure out if two figures are congruent; to use self-made models to find the matching sides and angles in congruent triangles and to learn how to use the matching relationships to find the unknown length of a side or degree of an angle; to figure out the sides and angles of congruent triangles by moving self-made models in ways like translation, rotation, and flipping, and to use the properties of congruent triangles to figure out the sides and angles.

- The goal of this process is to help students understand the inquiry procedure and what the main points of this lesson are.

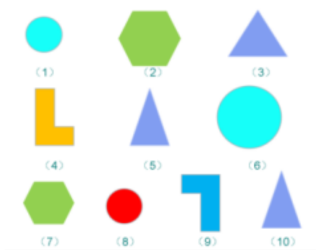
iii. *The Perception of Physical Examples*

- Raising questions: What do the four pairs of images have in common? Can the images in each pair coincide if they are overlapped properly? What are the shape and size relationships between the two images in each pair?

How can the third set of images be made to coincide? The instructor utilized the software Easinote5 to illustrate that the two images can coincide after being rotated to convince pupils that figures can coincide through a variety of motions.

Students were invited to provide further instances of coincident plane geometric forms. In addition, students needed to construct models of two congruent triangles on their own, based on their knowledge of generic congruent figures, and to explain how they did so in order to strengthen their understanding of the idea.

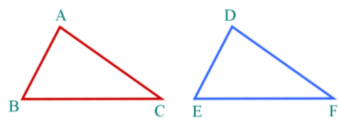
Identify congruent forms among the figures shown below and summarize the criteria for determining congruent figures.



- The goal of this procedure is to enable students to abstract congruent geometric shapes from real-world objects and to recognize their application in the actual world; to strengthen students' grasp of the congruence of figures, compare the fourth pair of images, which consists of two images of the same shape but different size, with the others; to construct models of congruent triangles to assess their knowledge of the idea and for the use in the succeeding classroom activities; to self-assess their ability to distinguish between congruent and non-congruent figures.

iv. The Inquiry of the Properties of Congruent Triangles

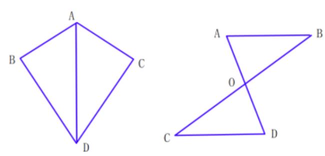
- Raising the question: What relationships exist between the sides and angles of the two triangles that are congruent?



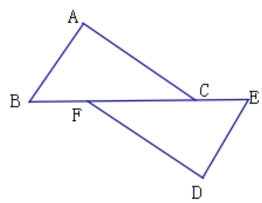
Students aligned the models in their hands and identified the vertices, sides, and angles in the two triangles that corresponded.

What are the relationships between the sides and angles of congruent triangles, as defined by the definition? Use mathematical symbols to represent congruent triangle qualities.

Students were instructed to place the two congruent triangle models in their hands according to the graph below and determine the relevant sides and angles.



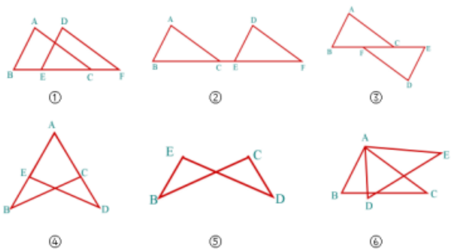
- Self-assessment: in the following figure, △ABC ≌ △DEF, write the equal sides and angles of the two triangles,



- Further consideration: identify the equal line segments and angles in this picture and explain why; how many moves are required to align the two triangles?
- The objective of this procedure is to help students understand the idea of congruent triangles by comparing them to other shapes that are also congruent; to find the matching relationships in congruent triangles, describe their properties, and show them with mathematical symbols; to learn that two figures can be the same by moving in the same way, using models they made themselves; to use physical models to figure out the mathematical model of congruent triangles; to improve the ability to think by answering questions that get progressively harder.

v. *The Construction of Mathematical Model of Congruent Triangles*

- First, put the two models of congruent triangles next to each other. Then, use translation, rotation, and flipping to make new shapes. Try to draw the patterns that have changed.



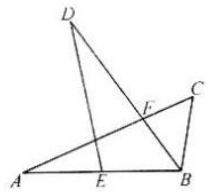
Observe the configurations of group members' models and practice identifying corresponding sides and angles.
Display all student-created patterns and identify their relevant relationships without the use of physical models.

- The objective of this procedure is to increase students' understanding of mathematical models by having them arrange physical models and hone their geometric intuition through the manipulation of figures.

vi. *The Application of the Properties of Congruent Triangles*

- An explanation of the example question:

As shown in the figure, it is known that △ ABC ≌ △ DEB; point E is on AB; AC and BD intersect at point F; AB = 6, BC = 3, ∠C=55°, ∠D=25°.
(1). Find the length of AE.
(2). Calculate the degree of ∠AED.



- This approach is intended to inform students of the standard symbols for reasoning, facilitate their transition from physical model-based analysis to spatial representation without actual models, and cultivate an awareness of mathematical models.

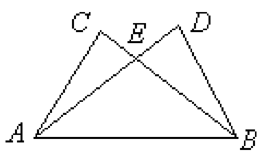
vii. The Lesson Summary

- Analyze the procedure for learning parallel lines and that for studying geometric forms, especially congruent triangles.
- The objective of this procedure is to make an analogy between the relationship of two straight lines and that of two figures to perceive the interconnectedness and integrity of mathematics; to comprehend the path of geometrical figure study – a process from definition to property determination, deduction, and application, incorporating the mathematical model into problem analysis and solution.

viii. Homework

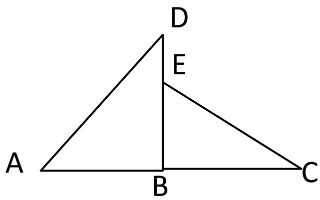
- The basic exercise:

As shown in the figure, △ ABC ≌ △ BAD, AC and BD are corresponding sides, AC=8cm, AD=10cm, DE=CE=2cm, then the length of BE is ( ).
A. 8cm B. 10cm C. 2cm D. Undeterminable

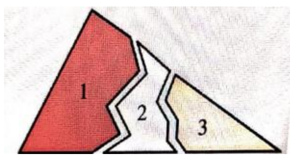


- The exercise with a higher level of difficulty:

  As shown in the figure, △ABD ≌ △EBC, AB=3cm, BC=4.5cm
  (1). Find the length of DE.
  (2). Determine the relation between AC and BD and explain the reason.



- The exercise for mathematical competence training:
  Student X shattered a triangle of glass into three pieces. He must now go to the glass shop to obtain an identical one. Which of the three bits should he keep? Try it with cardboard and scissors, and then give him some suggestions. Give your reasoning.



- The objective of this procedure is to differentiate homework assignments based on students' academic levels and to foster the development of their mathematical skills.

An Evaluation of the Instruction Results

i. The design of an introductory circumstance can effectively stimulate students' initiative in learning and encourage them to combine math studies with real-world experience. It was also reiterated in the final homework assignment.
ii. The formation of mathematical model consciousness was explicitly stressed in the classroom processes of "Inquiry of the Properties of Congruent Triangles" and "Construction of Mathematical Model of Congruent Triangles". To meet the cognitive qualities of pupils, progressive modes of inquiry have been devised, and questions with more openness have been prepared.
iii. Students were extremely engaged in model creation, model organization, and spatial visualization. Their past knowledge of figure move-

ments (translation, rotation, and flipping) aided in the analysis of typical configurations of congruent triangles.

iv. The findings of the self-assessment revealed that the majority of students had increased their awareness of mathematical models, allowing them to precisely identify the corresponding linkages between congruent triangles and use their properties to solve problems.

v. All classroom activities were concentrated on the students. Students could freely share their thoughts and confidently present the results of group research as significant actors in the session.

A Comparison of the Three Experiments

Figures 1 and 2 show students' engagement in class and how many students used mathematical models in each of the three experiments. They show that optimizing learning activities can make a big difference in how much students participate in class and how many of them can use the mathematical model of congruent triangles on their own in class.

Teachers' Reflections

The design of classroom activities is essential to the development of mathematical model consciousness among students. The growth of students' understanding of mathematical models is contingent upon their involvement in learning activities on a voluntary basis. Consideration must be given to students' past knowledge, cognitive qualities, and life experiences while planning classroom activities. Students are more willing to comprehend, discover, and investigate mathematical subjects when their dynamic thinking is fully activated. Second, a well-designed learning exercise can inspire students' inquisitiveness. Exploratory classroom activities can dramatically increase students' mathematical model awareness. In the third experiment, students engaged in a comprehensive investigation of the process of constructing the mathematical model of congruent triangles through model creation, model layout, and group cooperation, among other activities. Students became the discoverers and explorers of knowledge through this process. Thirdly, a learning task followed by self-reflection promotes model consciousness among students. The summary following each exercise, the exchange of results, and group conversations all help to the formation of knowledge linkages.

Findings of the Lesson Study

The Mathematical Modelling Process

Mathematical modelling ability is the capability to abstract mathematical questions from real-world circumstances, to portray them using mathematic-

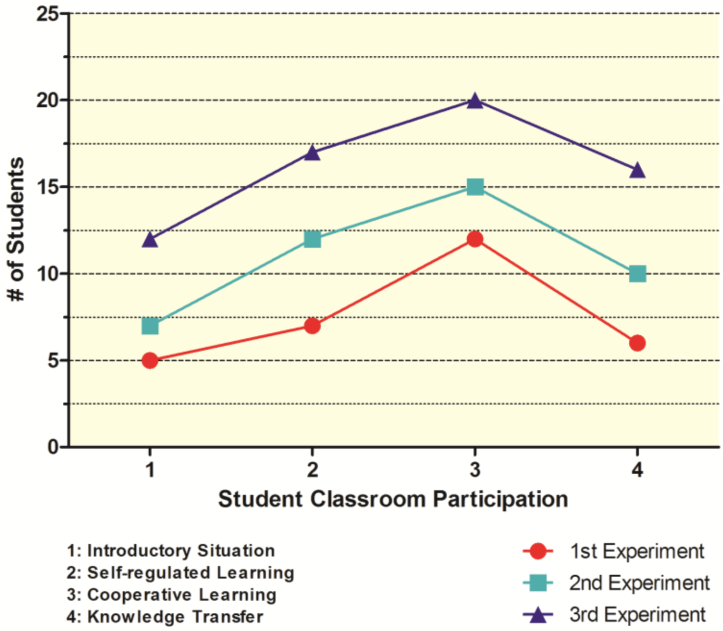


Figure 1. Student Classroom Participation.

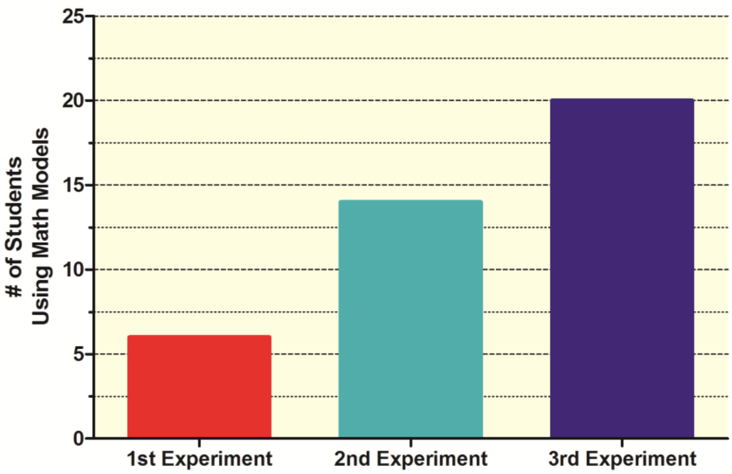


Figure 2. Numbers of Students Using Mathematical Models.

cal language, and to discover solutions through the building of mathematical models. Generally speaking, a mathematical modelling procedure consists of the following steps: discovering the problem, posing questions, evaluating the problem, developing the model, locating and confirming the solution, optimizing the model, and resolving the problem. Mathematical model consciousness, which is the mental disposition of solving real-world issues through the application of mathematical knowledge, has long been a driving factor in the evolution of mathematics.

Strategies for Cultivating Mathematical Model Consciousness

Comprehend Mathematical Models in Specific Situations

The setting of an appropriate scenario is helpful to achieving educational goals. Even though mathematical knowledge is derived from real-world experience, real-world events must often be correctly understood prior to classroom application. The instructor should pay close attention to the creation of situations that correspond with textbook content, students' learning conditions, and teaching approaches. They do not need to be complex, but they must facilitate students' comprehension of mathematical models.

Emphasize the Application of Mathematical Models in Classroom Activities

Mathematical models bridge the gap between mathematics and reality. Mathematical modelling training should not only teach students important concepts and principles, but also increase their understanding of how to apply applicable mathematical models to problem solving. Exploratory learning activities are extremely beneficial in promoting student mathematical competencies, particularly mathematical model consciousness (Yang, 2022).

Improve Mathematical Modelling Ability through Reflections

Using mind-mapping, the teacher can encourage students to review the process of mathematical modelling and reinforce their model consciousness through associations, reflections, and knowledge transfer during the final step of class summary. As a result, students are able to develop effective learning strategies and gain expertise in mathematical modelling, so laying a solid foundation for the subsequent study of more advanced math concepts (Li, 2022).

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ORIGINAL ARTICLE

Examination of the Views of Science Teachers Trained in a Project on Socioscientific Issues

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***Abstract**: Socioscientific issues (SSIs) have a scientific basis, have a dilemma in their nature and are often discussed under political and social influences. Teachers perceive SSIs as a difficult subject to teach. This project was carried out to guide teachers in overcoming this difficulty and to enable them to include practices that they can adapt more easily to their lessons. The purpose of the current study is to evaluate the views of science teachers on the teaching of SSIs and the project carried out within the scope of a funding project for teaching SSIs. The study was designed according to a single-group pre-test post-test experimental design. The study group the study comprises teachers from different branches of science (15 middle school science teachers, four biology teachers, three physics teachers and two chemistry teachers) from various provinces of Türkiye. As the data collection tools of the study, the Project Participation Form, the Scale of Views on Teaching Socioscientific Issues, the Know-Want-Learn Form and the Project Evaluation Form were used. Quantitative and qualitative data analysis methods were used together in the evaluation of the data. Because of the study, the implemented project activities contributed to the development of the participants' views on the teaching of SSIs and caused a positive development in their views on the project. Suggestions were made considering the results of the project so that guidance could be provided for teachers and teacher educators.*

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Introduction

"SOCIOSCIENTIFIC issues (SSIs) are up-to-date scientific issues that closely affect societies and their lives (Sadler, 2004). In other words, these issues include situations where there is a dilemma, no clear answer, and where decisions may depend on individual values (Zeidler et al., 2009). Nuclear power plants, nanotechnology, global climate change, cloning, stem cell applications, genetically modified organisms and vaccine studies can be given as examples of SSIs. The importance of SSIs in science education comes from there being an important component in the development of scientific literacy (Ke et al., 2021; Zeidler, 2014). Therefore, every science teacher who educates scientifically literate individuals should know the methods/techniques used in the teaching of SSIs in their lessons and have sufficient knowledge in the evaluation of students' SSI knowledge.

SSIs, which are in science curricula in many countries to ensure scientific literacy, were started to be included in the Middle School Science Curriculum (Ministry of National Education of Türkiye [MoNET], 2013a), Physics Curriculum (MoNET, 2013b) and Biology Curriculum (MoNET, 2013d), which were prepared in Türkiye in 2013. It has been seen that there has been an increasing interest in SSIs since then (Tekin et al., 2016). As in the Science Curriculum (MoNET, 2018a) developed in 2018, socioscientific objectives were also included in secondary curricula. The subjects covered by these objectives can be summarized as follows: thermal insulation, global climate change, solar cells (MoNET, 2018b), acid rain, convenience foods, fossil fuels (MoNET, 2018c), viruses, biodiversity, organ transplantation, biotechnology, cloning, agricultural applications (MoNET, 2018d), environmental issues, alternative energy sources, nanotechnology (MoNET, 2018b; MoNET, 2018c; MoNET, 2018d). As it can be seen, science teachers frequently encounter SSIs in their lessons starting from secondary education. According to Levinson (2013), one of the main dilemmas in teaching SSIs is whether SSIs addressed in curricula in schools have real-world counterparts. According to Zeidler et al. (2011), SSIs can be applied formally outside the school and formally learned at school. However, teachers who want to encourage their students to question SSIs, to argue, to reason and to make informed scientific decisions by using lesson plans are expected to act as a moderator, not as a provider of scientific knowledge. In this connection, teachers can make improvements in their pedagogical content knowledge (PCK) possible by using SSIs in their lesson plans. Minken et al. (2021) stated that because of five months of training, teachers developed PCK components related to SSIs by using lesson plans, but that they had difficulties balancing the social and scientific aspects of SSIs. Here, PCK has an important place in the teaching of SSIs in the curriculum. For this, Lee (2016) cre-

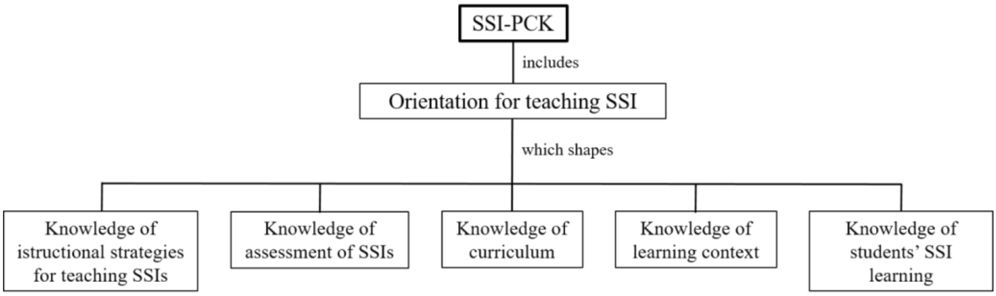

Figure 1. SSI-PCK Components and Relationships (Lee, 2016).

ated a map showing the SSI-PCK components and the relationships between them (**Figure 1**).

According to this map, SSI-PCK can be formed by shaping the information of students about teaching strategies, evaluation, curriculum, learning content and students' learning of SSIs for teaching SSIs. Activities suggested by Macalalag et al. (2020) made this content more understandable. Accordingly, discussing on SSIs, creating a lesson plan, planning prior knowledge expected from students, hands-on activities and evaluation of the lesson all support the efficient teaching of SSIs (Macalalag et al., 2020).

In order for teachers and pre-service teachers to be more closely interested in SSIs, to focus on these issues in their teaching and to develop their self-efficacy in this regard, these issues should be included in university education (Top ̧ çu et al., 2014). Not only pre-service teachers but also teachers need in-service training to improve their knowledge and skills on these issues (Top ̧ çu et al., 2014). However, in the study by Uluçınar Sağır and Dolunay (2021), pre-service teachers stated that they do not consider themselves be competent in the teaching of SSIs. They attributed their incompetence to the fact that the education they received was insufficient in teaching these issues and that they did not conduct individual research on these issues. Similarly, Evagorou and Puig Mauriz (2017) stated that both pre-service and in-service teachers have difficulties integrating the social aspects of science into teaching. Kokolaki and Stavrou (2022) stated that this situation is associated with teachers' limited content knowledge of SSIs (lack of knowledge about non-scientific aspects of the issues such as social, political and moral dimensions), lack of knowledge about scientific knowledge (inability to interpret scientific evidence and ambiguities) and limited knowledge of SSI teaching practices and evaluation strategies. When the renewed Council of Higher Education (CEH) Teacher Training Undergraduate Programs (CEH, 2018) is examined, it is seen that there is no required course related to SSIs in science, physics, chemistry and biology teaching undergraduate programs.

However, these issues are included in the content of two elective courses offered in the Science Education Undergraduate Program and in one elective course in the Physics Teaching Undergraduate Program. Therefore, both pre-service teachers and teachers need in-service training to improve their knowledge and skills on these issues. Project studies based on teacher education can open an important door that includes activities that will guide them in this context. This necessity led the researcher of the current study to conduct a teacher education project with the content of SSIs.

When the projects involving teacher education are examined, it is seen that TÜBİTAK (The Scientific and Technological Research Council of Türkiye) funded science-society projects have been conducted on various subjects in recent years. Projects with the content of SSIs are seen to be focused on the areas that will contribute to the teaching of these issues (i.e. Identification and Comparison of Scientific Thinking Habits Using Socioscientific Issues), that will address local SSIs (i.e. Energy Resources in our Paradise Province of Muğla, Journey to Socioscientific Issues, Argumentation of Socioscientific Issues in the Eastern Black Sea Region, Konya Plains Project [KPP] Region Science Teachers are Learning Socioscientific Issues with Interactive Activities), where one of these issues comes to the fore (i.e. Recognizing the Energy Resources of the Future with the Architects of the Future, Teachers of the Future, Biotechnology as the Technology of the Future, Bridge from School to Society, Nanotechnology Clubs). Among these projects, the project titled "KPP Region Science Teachers Learn Socioscientific Issues with Interactive Activities" is the first project coordinated by the researcher in the current project. These projects have provided guidance to the research in the creation of the current project. However, in most of these projects, it is seen that only some objectives addressed in different fields of science are included. The current study is more comprehensive in terms of including the objectives of both secondary school science lessons and secondary school physics-chemistry-biology lessons, and the use of various teaching methods/techniques in teaching SSIs. The objectives addressed with the activities conducted within the project are given in detail in the methods section.

In teaching SSIs, many studies are focused on argumentation (Capkinoglu et al., 2020; Dawson & Carson, 2020; Namdar & Shen, 2016), dilemmas (Rydberg et al., 2017), reasoning (Cian, 2020; Karahan & Roehrig, 2017; Ozturk & Yilmaz -Tuzun, 2017), critical thinking (Gul & Akcay, 2020) and decision making strategies (Altmeyer & Dreesmann, 2021; Dauer et al., 2017; Sutter et al., 2019; Yapıcıoğlu & Aycan, 2018). From these studies, Capkinoglu et al. (2020) evaluated the 10-week argumentation process of students in their study of local environmental SSIs. Because of their study, they concluded that the quality of argumentation of each group varied depending on the data sources and SSI context. For example, while hydroelectric power plants was a challenging issue for the groups participating in the study, the researchers found that high-quality arguments were made on issues such as artificial lakes and base stations. In another study, Chan (2020) informed teachers about different approaches to teaching SSIs depending on the issue and emphasized that students should be introduced to many SSIs. In another study, Gul and Akcay (2020), using a model based on SSIs, examined the change in pre-service teachers' critical thinking skills and tendencies in relation to the issue of climate change. Because of their studies, they concluded that the applied model increased the critical thinking tendencies of pre-service teachers. Yapıcıoğlu and Aycan (2018) examined the effects of teaching activities related to nuclear power plants on the decisions, positions and informal reasoning of pre-service teachers. In their study, they concluded that the pre-service teachers had decided that no nuclear power plant should be established. Another result related to the current study is that the pre-service teachers stated that the activities used led them to change their position. Therefore, the use of various teaching techniques in different SSIs is effective in the quality of argumentation, critical thinking tendency and changing decisions.

When the relevant literature is reviewed, it is seen that not including SSIs in the renewed teacher training undergraduate programs and their not having being introduced to SSIs before starting their professional career result in their having difficulty in creating the course content. The importance of teaching SSIs effectively by using various teaching methods/techniques in in-class activities, and therefore the need of teachers for these methods/techniques, created the current study. When the role of science-society projects in teacher education is considered, it is important to support science with out-of-school studies and teaching science in formal settings. In the studies conducted, it has been seen that the projects and research are mostly aimed at middle school students or teachers. It is seen as an important necessity to increase the number of studies on teaching SSIs in different branches of science starting from middle school by including physics, chemistry and biology teachers in the study. In this respect, it is valuable to ensure information sharing by referring to SSIs with the participation of teachers from almost every region of Türkiye, with both theoretical and practical training. Therefore, through this project, the following purpose was determined in accordance to create SSI awareness in teachers from different branches of science through interactive activities, their learning the nature and characteristics of SSIs, choosing activities to do so and including applications that they can use more easily in their lessons.

The purpose of the current study is to evaluate the views of science teachers about the teaching of SSIs and about the project carried out within the scope of a TUBITAK funding project that includes a teacher training program for teaching SSIs. To this end, the following questions were determined as the research questions:

- *Did any changes occur in the views of science teachers about the teaching of SSIs after the project?*
- *Did any changes occur in the views of science teachers about the project after the completion of the project?*

Materials and Methods

Research Design

The current study was designed using a single-group pre-test post-test experimental design, which is one of the quantitative research methods. The single-group pre-test post-test experimental design is based on the measurement of the dependent variable through the administration of scales as a pre-test before the intervention and as a post-test after the completion of the intervention (Büyüköztürk et al., 2008). In this study, the Project Participation Form, the Scale of Views on Teaching Socioscientific Issues and the Know and Want stages of the Know-Want-Learn Form were administered as a pre-test, while the Scale of Views on Teaching Socioscientific Issues, the Want stage of the Know-Want-Learn Form and the Project Evaluation Form were applied as a post-test.

Participants

The study group of the current research comprises 24 teachers from different branches of science and from different provinces of Türkiye. Demographic information of the participating teachers is given in **Table 1**.

As shown in **Table 1**, the numbers of female teachers (n = 13) and male teachers (n = 11) participating in the project are similar to each other. More than half of the participating teachers are doing/have done their postgraduate degrees (n = 15). The teaching experiences of the participating teachers are as follows; 6–10 years (n = 8), 0–5 years (n = 5), 11–15 years (n = 4), 21 years and more (n = 4) and 16–20 years (n = 3). More than half of the teachers participating in the project are teachers from the branch of science (n = 15). Almost half of the teachers were from the Central Anatolian Region (n = 10). After the Central Anatolian Region, the Marmara Region (n = 6) had the highest number of participants. The lowest participation was from the Black Sea Region (n = 1) and there was no participation from the Eastern Anatolian Region. All the teachers participating in the project declared that they had not been involved in a project related to SSIs before.

Research Instruments

Table 1. Demographic Information of the Participating Teachers.

Characteristic		N	%
Gender	Female	13	54.2
	Male	11	45.8
Educational degree	Undergraduate	8	33.3
	Postgraduate	15	62.5
	Doctorate	1	4.2
Teaching experience	0–5 years	5	20.8
	6–10 years	8	33.3
	11–15 years	4	16.7
	16–20 years	3	12.5
	21 years and beyond	4	16.7
Branches	Science teachers	15	62.5
	Physics teachers	3	12.5
	Chemistry teachers	2	8.3
	Biology teachers	4	16.7
Region	Marmara	6	25.0
	Aegean	2	8.3
	Mediterranean	2	8.3
	Central Anatolia	10	41.7
	Black Sea	1	4.2
	South-eastern Anatolia	3	12.5
Participation in the previous project	Yes	0	0.0
	No	24	100.0

The Project Participation Form, the Scale of Views on Teaching Socioscientific Issues, the Know-Want-Learn Form and the Project Evaluation Form were used as data collection tools in the current research. Detailed information about the data collection tools used in the study is given below.

Project Participation Form

This form was used during the science teachers' process of application to the project. The form consists of demographic information and project participation application sections. The application section was created by the researcher to obtain information about the teachers' expectations from the project and methods-techniques they use in their lessons. In the study, the section of expectations from the project of this form was used as a pre-test in accordance with the research questions.

The Scale of Views on Teaching Socioscientific Issues

Table 2. Distribution of Activities, Aims and Learning Outcomes in Science Curricula.

Activity Title	Aim	Learning outcome*
Introduction to Socioscientific Issues	Introducing teachers to socioscientific issues and establishing their place in the context of science-society	Teachers were introduced to socioscientific issues in the science curriculum.
Which Socioscientific and Decision-making Criteria	To raise awareness among teachers about socioscientific issues, their history, their place in the curriculum and criteria for decision-making about these issues. To introduce different methods and techniques used in teaching these issues to teachers	F.6.4.3.4. Discusses the importance of thermal insulation in buildings in terms of family and country economy and effective use of resources. F.6.4.4.2. Discusses the effects of the use of different types of fuels for heating purposes on humans and the environment. F.8.7.3.4. They Generates ideas about the advantages and disadvantages of power plants. F.8.7.3.5. Discusses the importance of conscious and efficient use of electrical energy in terms of family and the national economy. 9.5.4.3. Designs for insulating the living space for energy saving. 12.6.2.5. Designs a system that facilitates daily life and uses solar cells.
Preparing a Lesson Plan according to the 5E Learning Model: Vaccines	To enable teachers to acquire the ability to prepare a lesson plan using the 5E Learning Model and to prepare a sample lesson plan suitable for the 5E Learning Model related to vaccines as a socioscientific issue	F.8.2.5.1. Relates genetic engineering and biotechnology. (Examples of breeding, vaccination, gene transfer, cloning, gene therapy are emphasized) F.8.2.5.2. We Discusses the dilemmas created within the scope of biotechnological applications and the beneficial and harmful aspects of these applications to humanity.
Turkey's Policy on GMO Foods	Implementing a sample SBK-based Jigsaw activity for teachers	F.8.2.5.3. Predicts what future genetic engineering and biotechnology applications might be. 12.1.2.4. We evaluated the effects of genetic engineering and biotechnology applications on human life.
Nanoscience Nanotechnology Education: I'm Designing a Nanobiosensor!	Teachers' discovery of the basic components for the use of nanoparticles, in biosensor technology, which is a nanotechnological application and increasingly involved in our daily lives	12.4.4.1. Evaluates developments in nanotechnology in terms of their effects on science, society, technology, environment and economy.
Our Space Trash	Discussing the pollution in the world based on critical thinking skills	F.7.1.1.2. We express the causes of space pollution and predict the possible consequences of this pollution.
Designing an Activity on Socioscientific Issues in the Ihlara Valley	Designing an activity involving socioscientific issues in the Ihlara Valley	F.5.6.1.2. discusses the factors that threaten biodiversity based on research data. 9.5.4.5. Develops a project for measures to be taken against global warming. 12.4.1.1. We offered solutions to reduce the harmful effects of fossil fuels on the environment.

**: Numbering such as "F.6, F.8" indicate middle school level learning outcomes, and numberings such as "9, 12" indicate high school-level learning outcomes.*

This scale was used to determine the views of the participating teachers about the teaching of SSIs. The 5-point Likert-type scale, adapted by Kara (2012) from the study by Lee et al. (2006), consists of 20 items and three sub-dimensions: Views on the necessity of SSIs in the content of the program (9 items, Cronbach alpha = 0.72); Views on the factors hindering the teaching of SSIs (7 items, Cronbach alpha = 0.78) and Belief in the personal efficacy of teaching SSIs (4 items, Cronbach alpha = 0.67). In this study, the Cronbach's alpha value of the scale was found to be 0.79 for the pre-test and 0.71 for the post-test. The scale was administered using paper and pencil in two stages as pre-test and post-test.

Know-Want-Learn (KWL) Form

It was used to determine what information the participating teachers had and what information they needed about the project subject before the project and what information they learned after the project. The form consists of three sections. Among these sections, the "Know" and "Want" sections were administered before the activities and the "Learn" section was administered after the activities.

Project Evaluation Forms

This was used to determine the participants' views about the project activities and the project at the end of the project. This form consists of two sections: "Evaluation of Activities," where the contents of the activities and the project team (project coordinator, experts, trainers and guides) are evaluated and "Additional Services," where the location of the activities, transportation service, accommodation services, and catering services are evaluated. In this study, the "Evaluation of Activities" section of this form was used as a post-test in accordance with the research questions. For reliability, this form was submitted to the review of three experts in the field of science education, who have studied on SSIs and their teaching, and it was finalized with 100% agreement (Miles & Huberman, 1994).

Pilot Study and Processes

In this study, the project in which the research data were collected was created as the continuation of the first project conducted on science teachers in the KPP region in 2020. Therefore, the project conducted in 2020 can be considered a pilot study for this study. According to the first project (Tekin, 2022) of the first author, a significant increase was observed in the examples given by the science teachers in the KPP region for SSIs after being involved in activities. Additionally, it was concluded that teachers generally had positive views about the project process and project services. Based on these results, the content of the project was enriched by adding new activities in this study. Furthermore, the most important feature of the current study that makes it different from the first project was the inclusion of physics, chemistry and biology teachers from all geographical regions of Türkiye in the study group, as well as middle school science teachers. Additionally, the project team (project coordinator, experts and guides) checked the time required for the activities, the usefulness of the materials to be used and the use of the places of activities.

The data collection process includes a pre-project activity period, during-project activity period and post-project activity period. In the pre-project activities period, the Project Participation Form was sent to receive the applications from teachers from different branches of science via Google Forms. After the determination of the teachers who would participate in the project, on the first day of the project, the Scale of Views on Teaching Socioscientific Issues and the Know and Want sections of the Know-Want-Learn Form were administered to the teachers as a pre-test. The project activity process was started with drama activities. After the interaction of the teachers was ensured, activities with the content of SSIs were carried out. **Table 2** shows some activities, their aims and the distribution of these activities across the objectives in the science curricula (MoNET, 2018a; MoNET, 2018b; MoNET, 2018c; MoNET, 2018d).

According to **Table 2**, some activities conducted during the project process can be summarized as follows: "Introduction to socioscientific issues" focused on the features of SSIs, "Preparing a lesson plan according to the 5E learning model: Vaccines," "Which socioscientific and decision-making criteria" aiming at the use of SSIs in the decision-making process, "Designing an activity related to SSIs in Ihlara Valley" related to the implementation of SSIs in out-of-school learning environments. Additionally, "Instructional SSI selection and teacher action research," which includes the methods/techniques used in teaching SSIs and will help teachers in their selection of SSIs, "How to evaluate an argument?" focused on the evaluation during the argumentation process, "Socioscientific reasoning and its evaluation" grounded in the reasoning process, "Blood transfusion timeline," which establishes the connection of SSIs with the nature of science and "Trade game," which establishes the connection between SSIs and sustainable development were also other activities included in the project. After these activities, the project team divided the teachers into groups and they asked them to create lesson plans with SSIs content and evaluated these lesson plans. After the activities and evaluations were completed, the Scale of Views on Teaching Socioscientific Issues, the Learn section of the Know-Want-Learn Form and the project evaluation form were administered as a post-test.

Data Analysis

Quantitative data obtained from the Scale of Views on Teaching Socioscientific Issues were analyzed with the SPSS 19.0 statistical program. Shapiro Wilk test was used to check the assumption of normality in the analysis of the data. The test results showed normal values for the pre-test and post-test ($p > 0.05$) p and that the skewness and kurtosis coefficients took the values between -1.50 and +1.50 recommended for social sciences (Tabachnik & Fidell, 2013). Therefore, data showed a normal distribution. Accordingly, paired samples t-test was used in the analysis of the Scale of Views on Teaching Socioscientific Issues since it was administered to the science teachers as a pre-test and post-test in the project. Qualitative data obtained from the Project Participation Form, Know-Want-Learn Form and Project Evaluation Form were analyzed according to descriptive analysis. While the descriptive analysis was performed, it was ensured that the project coordinator and project experts made comparisons by using independent coding. After the comparison, using the formula suggested by Miles and Huberman (1994), the percentage of agreement was calculated to be 90%. According to the rate suggested by Miles and Huberman (1994), it was concluded that the reliability was at an acceptable level.

Ethics

This research was approved be in compliance with ethical principles by the Human Research Ethics Committee of Aksaray University (Ethical Approval No: 2021/05-40). For confidentiality, information is not included here. Additionally, the personal information of the teachers participating in the study was kept confidential and the data collected from the project were used only for research purposes.

Findings

In this section, the findings related to the science teachers' views on the teaching of SSIs and the project carried out are presented to answer the research questions.

Findings related to the Science Teachers' Views on the Teaching of SSIs

The statistical information derived from the participants' views on the teaching of SSIs is given in **Table 3**.

As shown in **Table 3**, there is a difference of 5.25 points between the pre-test (Mean = 82.04) and post-test scores ((Mean = 87.29) of the participants' views on the teaching of SSIs because of the one-week project active-

Table 3. Comparison of Pre-Test and Post-Test Scores of Participant Teachers' Views on Teaching Socioscientific Issues with Paired Sample T-Test.

Variable		N	Mean	SD	df	t	p
VTSSI	Pre-test	24	82.04	8.02	23	-3.00	0.006
	Post-test	24	87.29	5.99			

Table 4. Distribution of the Answers Given by the Participant Teachers about Their Expectations from The Project.

Expectations of the Project	f	%
Learning in-class activities for SSIs	14	26.92
To gain a different perspective	7	13.46
Raising the awareness of students	7	13.46
Providing professional development	5	9.62
Providing academically development	4	7.69
Arouse students' curiosity	4	7.69
Guiding students	3	5.77
Share the learned information from this project with society	2	3.85
Learning new developments	2	3.85
Developing students' citizenship skills	2	3.85
Get project experience	1	1.92
Developing a project	1	1.92

Table 5. Answers to the Question "What Do You Know about the Project and Its Subjects?"

What Do I know? (K-Know)	f	%
Examples of socioscientific issues	12	37.50
Features of socioscientific issues	8	25.00
Methods/techniques for teaching socioscientific issues	4	12.50
Preparing a lesson plan with the content of socioscientific issues	4	12.50
Impact of socioscientific issues of society	3	9.38
Science-society interaction	3	9.38
Instructional difficulty of socioscientific issues	1	3.13

ties. This difference was found to be statistically significant because of the t-test ($t_{(23)} = -3.0$; $p < 0.05$). Considering these results, implemented project activities contributed to the development of the participants in terms of their views on the teaching of SSIs.

Findings related to the Science Teachers' Views on the Project

The data obtained from the Project Participation Form, the Know-Want-Learn Form and the Project Evaluation Form were evaluated together to obtain the findings regarding the views of the science teachers about the project. According to the answers given by the science teachers in the project participation form, the findings regarding their expectations from the project are shown in **Table 4**.

As shown in **Table 4**, what is expected by the science teachers from the project is to learn in-class activities for SSIs (f = 14), to gain a different perspective (f = 7) and to raise awareness in students (f = 7). Some excerpts related to the teachers' expectations from the project are given below:

> *"I think that I will improve myself in SSI teaching as there will be practice-based activities. In this context, I think that I will gain more competence and that I can transfer this to my classroom practices. Also, I like to improve myself academically." (T1)*

> *"I want to increase the students' scientific curiosity. I have been involved in many projects before. I find interacting with students through projects valuable for their development and that of mine." (T13)*

> *"The most important feature of science is that it must be based on provable and repeatable data. My expectations from this project are to be more productive in science for the children of my country by learning from the right people what the contribution of socioscientific issues to teaching is." (T15)*

> *"I believe that there will be experiences that I can learn from this project to raise awareness of socioscientific issues (vaccines, organ donation, nuclear energy, stem cells, space pollution, global climate change, GMOs, etc.) that we touch upon in our lessons from time to time, to arouse students' curiosity and to attract students' attention and to use methods and techniques that are unusual for them." (T18)*

> *"To provide a classroom environment where my students can express themselves more easily with different activities." (T24)*

Table 6. Answers to the Question "What Do You Want to Learn about the Project and Its Subjects?"

What do I want? (W-Want)	f	%
Activities for teaching socioscientific issues	12	21.82
Exercises of socioscientific issues in the course	7	12.73
Conveying socioscientific issues to students	6	10.91
Preparing material for socioscientific issues	3	5.45
Active processing of lessons on socioscientific issues	3	5.45
Integration of socioscientific issues with science	3	5.45
Ensuring environmental awareness in students	3	5.45
To raise social awareness in students	2	3.64
Promoting an interest in socioscientific issues	2	3.64
Arousing students' curiosity	2	3.64
Providing professional development	2	3.64
Obtaining content knowledge	2	3.64
Sharing project content with colleagues	1	1.82
Developing different perspectives for students	1	1.82
To learn about the current developments in socioscientific issues	1	1.82
Preparing lesson plans about socioscientific issues	1	1.82
To make the issues permanent	1	1.82
To learn about the features of socioscientific issues	1	1.82
To learn about the relationships of socioscientific issues with other fields	1	1.82
Evaluation of students' competencies in socioscientific issues	1	1.82

The answers provided by the science teachers about what they knew about the project content and activity topics before the project is classified in **Table 5**.

As shown in **Table 5**, the teachers participating in the project stated that they knew about the examples of SSIs (f = 12), features of SSIs (f = 8), preparing lesson plans with SSIs (f = 4), and methods and techniques used in teaching SSIs (f = 4). Sample excerpts about their knowledge before the project are given below:

> *"…Generally, the argumentation method is used in the teaching of these issues. It has gained increasing popularity recently. Issues such as nuclear energy and organ donation can be given as examples of socioscientific issues." (T24)*

> *"Regarding the project, I know that the formation of socioscientific issues is scientifically based and their results are social. I know that the activities will be based on interaction rather than classical teaching." (T19)*

> *“A project that deals with issues such as vaccines, global warming, sustainable development, and issues that affect all living things in the world.” (T4)*

> *“I know what socioscientific issues are dealt with in the project. However, I learned about some activities to be conducted or developed in relation to these issues of social media. I am not fully aware of their contents.” (T17)*

The answers through which the teachers stated what information they needed while participating in the project are classified in **Table 6**.

According to **Table 6**, the science teachers stated that they most wanted to learn about the activities that can be used in the teaching of these issues (f = 12), classroom implementation of SSIs (f = 7) and how to convey SSIs to students (f = 6). Below are given sample excerpts about what teachers want to learn about the project and its subjects:

> *“I want to increase my experience and knowledge about the transfer of socioscientific issues to students in an activity-based way that will arouse their curiosity students.” (T6)*

> *“I want to know what I can use in classroom activities. I want to know how I can increase the students’ interest.” (T19)*

> *“I want to compensate for my incomplete knowledge and eliminate my misconceptions about socioscientific issues and convey the correct information to my students. I want to produce activities to make these issues more interesting (for students). I have participated in this project to achieve my goals.” (T4)*

> *“I want to implement these activities through the active participation of students in classroom environments where students can be instructed in such a way as to accomplish the objectives set in the science curriculum. I want to offer students the opportunity to learn by doing rather than conveying raw knowledge. I want to learn from the project content how to make lessons more enjoyable and not monotonous.” (T17)*

The answers through which the teachers stated what they learned after participating in the project are classified in **Table 7**.

As shown in **Table 7**, the science teachers stated that they most learned about the methods/techniques to be used in the teaching of these issues (f = 39), examples of these issues (f = 11) and the features of SSIs (f = 9) from the project and activity topics. Among the methods-techniques to be used in the teaching of SSIs, teaching SSIs with Web 2.0 tools (f = 10), using argumentation in the teaching of SSIs (f = 8) and using action research in

Table 7. Answers to the Question "What Did You Learn About the Project and Its Subjects?"

What I Learned? (L-Learn)	f	%
Methods/techniques for teaching socioscientific issues	39	39.00
Examples of socioscientific issues	11	11.00
Features of socioscientific issues	9	9.00
Activities on socioscientific issues	6	6.00
Preparing a lesson plan with the content of socioscientific issues	5	5.00
Differences between socioscientific issues and other topics	4	4.00
Dimensions of socioscientific issues	3	3.00
Edges of socioscientific issues	3	3.00
Socioscientific issues in out-of-school learning environments	3	3.00
Decision making on socioscientific issues	3	3.00
Recognizing incomplete information about socioscientific issues	2	2.00
The aim of socioscientific issues	2	2.00
Awareness of socioscientific issues	2	2.00
Integration of socioscientific issues into science lessons	2	2.00
Content knowledge	2	2.00
Importance of socioscientific issues	2	2.00
Socioscientific issues-nature of science connection	1	1.00
Human-environment interaction	1	1.00
Evaluation of students in courses on socioscientific issues	1	1.00
Clarification of existing conceptual confusions	1	1.00
Effective classroom management	1	1.00

Table 8. Answers from Participant Teachers about "Evaluation of Activities" in the Project Evaluation Form.

Characteristics	Contributed		Not Contributed	
	n	%	n	%
Learn socioscientific issues	24	100.00	-	-
To learn about the features of socioscientific issues	24	100.00	-	-
To teach socioscientific issues	24	100.00	-	-
To evaluate socioscientific issues	24	100.00	-	-

the teaching of SSIs (f = 6) come to the fore. Below are given sample excerpts about what the teachers learned about the project and issues:

> *"I learned which subjects are socioscientific by nature. I learned how to convey socioscientific issues to our students and what*

> *kind of activities to conduct. I learned how to teach subjects of nanotechnology within the scope of socioscientific issues. I learned about Web 2.0 tools, how to prepare puzzles and how to use them in lessons. I learned that when discussing socioscientific issues, a definite conclusion cannot be reached." (T13)*

> *"I learned many methods and techniques to be used in the teaching of SSIs in the classroom. I was delighted to be informed about Web-based applications in particular. I learned about subjects such as argumentation, Web 2.0-based applications such as crossword lab, and how to create a discussion environment in the classroom." (T2)*

> *"I learned what socioscientific issues are, how we can transfer socioscientific issues to our lessons, the usage areas of Web 2.0 tools and that socioscientific issues cannot be fully answered, and clear judgments cannot be reached." (T21)*

> *"I learned the different aspects of SSIs specified in the project, what kind of activities I will do in the teaching of SSIs, how students will be evaluated before, during and after the teaching of SSIs." (T9)*

According to the answers given by the teachers to the project evaluation form, the findings regarding the evaluation of the activities are shown in **Table 8**.

As shown in **Table 8**, all of the science teachers stated that the project contributed to the learning of SSIs (n = 24), the learning of the features of SSIs (n = 24), the teaching of SSIs (n = 24) and evaluation of SSIs (n = 24). Below are given sample excerpts from the answers of the teachers about the evaluation of activities:

> *"We covered the dimensions of SSIs in depth through the activities." (T7)*

> *"The definition of socioscientific issue is rooted in my mind, I can now distinguish which issues are socioscientific and which are not." (T24)*

> *"Because I learned and heard the term 'socioscientif issues' for the first time in this project." (T4)*

> *"Teaching through the presentation of arguments and counter-arguments caused me to learn the features of socioscientific issues." (T10)*

> *"It made me think that there is no single right answer, that it should be handled impartially and that we are maximally affected by the individual-society-environment interaction." (T17)*

Results

The following results were obtained in the current study, which consisted of the results of a TÜBİTAK funding project based on teacher education, which was carried out using interactive activities, and which investigated the views of science teachers on the teaching of SSIs and the project.

This project activity contributed to the development of the participants in terms of their views on the teaching of SSIs. Additionally, it is seen that the expectations of the participating teachers from the project are to learn in-class activities for the teaching of SSIs, to gain a different perspective and to raise awareness among students. Additionally, the teachers stated that they knew the examples and features of SSIs before the project, and that they wanted to learn the activities and classroom practices to be used in the teaching of these issues and in their transfer to students. Accordingly, it is seen that the teachers knew the features and examples of SSIs before the project and they needed to learn the methods/techniques to be used in the teaching of SSIs. After the project, they stated that they learned the methods/techniques to be used in the teaching of SSIs, their examples and features. The fact that many examples of methods/techniques to be used in the teaching of SSIs were shown by the participating teachers after the project is an indication that the project led to a positive change in the views of the teachers. Additionally, all the teachers stated that the project contributed to the learning and teaching of SSIs, learning and evaluation of the features of SSIs. Therefore, the project activities carried out were effective in the development of the teachers' views on the project.

Discussion

In this section, discussion and conclusions for the research are given on the basis of the above-mentioned results. The implemented project activities contributed to the development of the science teachers' views on the teaching of SSIs. It is useful to remind again that the project conducted here was a one-week intensive activity process. In the literature, there are similar studies. Wu et al. (2022) conducted a study on pre-service science teachers and in this study they developed a short-term teaching module to develop the pre-service teachers' competence in teaching SSIs. In this module, the researchers adopted a two-week process that includes pre-service teachers discussing teaching topics with each other, reviewing the topics with a science education expert, and experiencing practices with in-service training. Because of their study, they concluded that both the pre-service teachers' self-efficacy beliefs about teaching SSIs and their pedagogical content knowledge levels improved. This study supports the effectiveness of the project activities discussed in the current study in terms of achieving a positive development in a short time. In another study, Leung (2022) implemented a 12-week teacher training program for pre-service science teachers. Leung (2022) stated that there was a shift toward the view that these issues should be taught, as the pre-service teachers, who stated that SSIs are excluded in science education, experienced SSI teaching in this process. Similarly, Karahan (2022) researched the experiences and comments of pre-service science teachers in the design and implementation processes of SSI-based teaching. In the study, it was concluded that the views, ideas and practices of the pre-service teachers were transformed and changed during this process. The progress made in this process demonstrates the importance of practice/activity supported SSI teaching. From another viewpoint, to integrate these issues into science teaching in classrooms through practices, they should be presented to pre-service teachers and teacher education starting from the university. Borgerding and Dagistan (2018) stated that although pre-service teachers were willing to participate during methods to be used in teaching these issues, they confused SSIs with subjects that were rejected by society (for example, evolution). As in the project discussed here, collaborations on these issues in a practice-oriented environment in the community of teachers with similar scientific knowledge can help overcome such misconceptions. However, Sibic and Topcu (2020) in their study on pre-service science teachers stated that pre-service teachers' self-efficacy beliefs in dealing with these subjects in real classroom environments are not at a sufficient level. Similarly, Aydın and Karışan (2021) stated that science teachers do not have enough knowledge about SSIs and they can define these issues only superficially. The fact that both pre-service teachers and teachers do not have sufficient knowledge to teach these issues demonstrates the importance of determining their needs in this regard. Although the number of studies conducted with the participation of science teachers and pre-service science teachers is higher, it is possible to come across studies in the field of secondary education. However, they are few. Compared to the curricula of secondary education physics, chemistry and biology, SSI-related objectives are given more space in the science curriculum (Et & Gömleksiz, 2021). Therefore, the acquaintance of secondary school teachers on these issues may be lower. Including physics, chemistry and biology teachers and science teachers in the projects provided an opportunity to improve their views, perceptions, or teaching motivations on these issues. When the above-mentioned studies are compared with the results of the current project, the importance of practice-based education for all science fields is revealed once more. Owens et al. (2021) stated that in addition to the need for teachers to develop content knowledge in their classrooms and the methods/techniques that should be used while teaching these subjects, there is also a need for classroom environments that contextualize learning and teaching and enable students to address the subject from multiple perspectives. Therefore, it is seen that there is a need for studies on how teachers implement these practices in their classrooms. Thus, it can be suggested to investigate the practices that teachers include in their classrooms longitudinally. Additionally, depending on the result obtained from the current study, it can be suggested that science teachers be included in larger-scale programs where they can evaluate themselves about teaching SSIs. As it is known, these projects are carried out with teachers who apply and participate voluntarily. Therefore, the initial motivation of the teachers participating in the project may have been high. In this connection, a holistic teaching package based on SSI that will appeal to all teachers can be created by examining the classroom practices of other teachers who both participate and do not participate in these projects.

TÜBİTAK funding projects are very supportive studies in presenting interactive activities for the professional development of teachers. From this perspective, the teachers' views on the project developed positively. The participating teachers stated at the beginning of the project that they had expectations and desires to learn the activities to be used in the teaching of SSIs. After the project, the teachers' expressing that they learned the methods/techniques to be used in the teaching of SSIs may be an indicator of positive development. Additionally, the fact that the teachers used the methods/techniques in their examples after the project proves that the project was effective. The statements of the participants about the project contributed to the learning and teaching of SSIs supported this result. Numerous TÜBİTAK funding projects involving teacher training have been carried out. In many studies, it has been seen that there are positive developments about the issue addressed and the project carried out (Aşkım Kurt et al., 2019; Fettahlıoğlu, 2019; Karakoç Topal, 2022; Sapsaglam & Kaya, 2022; Yoloğlu & Uçar, 2015). For example, Aşkım Kurt et al. (2019) in their study on Web 2.0 tools concluded that the teachers used Web 2.0 tools more after the project and they used these tools more easily in in-class activities. They also stated that the participants were satisfied with the training given. Similar results are also supported in the study of Karakoç Topal (2022). Karakoç Topal (2022) stated that the activities carried out were found enjoyable by the participants, that the activities aimed at creating products were liked more and that their awareness of the issue was increased. As mentioned above, there is no doubt that these projects are carried out with teachers who are aware of the subjects and willingly participate in the project. Participants are included in the study by focusing only on these activities, away from all work and daily life stresses. Moreover, it is normal for them to share their views with teachers from their fields and agree on a common point, and reason for the subjects covered. Therefore, it can be seen as an expected result that the participants will gain the highest level of benefit in their field. The important point here may be to increase this knowledge sharing and to encourage all teachers. By using the results obtained from these projects, it can be ensured both to share information among colleagues and to increase the professional development of teachers in their own fields by developing projects as research teachers.

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REVIEW

Parental Involvement in Senior Pupils' Learning in the Context of the Implementation of China's Double Reduction Policy

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Abstract: *Parental involvement in learning, entertainment, emotion, and daily care is crucial to the growth and development of children. Due to the increasing significance of educational attainment in China, parental involvement in child learning is receiving ever-increasing weight and is now the most prevalent of the four aspects. In the wake of the implementation of the Double Reduction Policy, family education has encountered new obstacles, resulting in a shift in parental involvement in education. In the framework of policy execution, the learning involvement of parents of senior students merits special consideration, as they are burdened with the upcoming enrollment in secondary school. The objective of this essay is to describe the current state of parental involvement in learning under the new policy and investigate the causes of existing problems. Also presented are suggestions for enhancing the effectiveness of parental involvement in child study.*

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PARENTAL influence has a significant impact on all aspects of a child's development. The scholastic and professional success of children can be effectively predicted by parental participation. It can be broken down into four categories: education, amusement, emotion, and everyday care (Feng, 2011). The amount of parental learning involvement has far exceeded any other sort of parental engagement as a result of the growing significance of educational attainment. Unfair parental participation in children's education reflects the routine of home education and high levels of worry about children's academic achievement.

Opinions on Further Reducing the Burden of Homework and Off-Campus Training for Compulsory Education Students, also known as the "*Double Reduction Policy*," were released in July 2021. They say that students' homework loads must be controlled according to their educational phases and that after-school training institutions cannot hold "subject-based" training programs on national holidays, weekends, or during the winter and summer breaks (Ministry of Education, 2021). As a result, children spend more time with their parents after school. In order for their children to succeed in the competitive world of education, parents, particularly those of senior students (those in the fifth and sixth grades), know that home education must take on more responsibility. This article makes an effort to pinpoint issues with existing parental involvement in senior students' learning, such as insufficient time commitment, a limited scope, low efficacy, increased parent-child conflicts, and heightened parental concern; to investigate the causes of the current problems; and to offer proposals for enhancing the efficiency of parental learning involvement, such as developing democratic and egalitarian home environments, increasing parental educational beliefs, enhancing home-school and home-community collaboration, and changing the system of educational evaluation.

The Status Quo of Parental Learning Involvement in the Education of Senior Pupils

Inadequate Time Input

Conflict of Interests*: None*

Parents who are involved in their children's learning do things like help them review lessons and make learning plans, look over their homework, and so on. The goal is to improve the quality of their homework and make sure they do other family-based learning tasks (Feng, 2011). In a survey conducted by Ye et al. (2022), more than 85.4% of parents of primary school students claimed that they lacked the time to assist their children with schoolwork, while 3.5% said they had never been active in their children's education. An assessment of the implementation consequences of the Double Reduction policy revealed that 24.3% of students were unable to complete tasks at school and had to do them at home; the bulk of these students were high school seniors (Nin & Yang, 2022). Therefore, despite the fact that the implementation of the Double Reduction policy has significantly reduced the workload of students, the amount of homework assigned to senior pupils remains substantial. Consequently, the majority of senior-level primary school students continue to finish their assignments at home.

Self-regulation in learning refers to a student's capacity to autonomously do homework, formulate learning plans, and manage learning time. Despite the fact that senior students have developed greater self-control than their junior counterparts, their self-regulation power is still restricted, necessitating parental engagement in their academic concerns along with their requirement to complete coursework at home. Involvement of parents in their children's education serves as a monitoring mechanism that not only improves children's learning efficacy but also aids in the formation of healthy learning habits.

Low Quality of Parental Involvement

Under the Double Reduction policy, the academic burden of students has been significantly reduced due to the regulation of homework and off-campus tutoring services. At the same time, it imposes new duties on parents, who must now assume greater responsibility for the after-school education of their children. However, many parents lack the expertise and experience necessary for educating children and view their engagement in their children's education as only checking homework. Parents may assist their children with homework they are unable to complete (Zhang, 2022) or provide them with additional exercises to complete after they have completed their teachers' assignments. According to these parents, homework is only a form of labor that keeps their children occupied or quiet (Dewey, 2004), which violates the Double Reduction Policy's goal. When homework consists of repetitive and overly practical tasks, it loses its actual value. Meaningful homework should consist of independent and exploratory tasks outside of classroom instruction (Luo & Meng, 2021). Children can only benefit from the Double Reduction policy if they are assigned exciting, colorful homework rather than tedious writing assignments.

For some parents, being involved in their children's education simply means being present when they are learning at home (Li, 2022). Parents may focus on surfing their cell phones or other "essential" tasks while observing their children complete their schoolwork. The parents' interactions with their children are ineffective. Instead of negligent parental participation, children actually need high-quality parental interaction. Deep child-parent communications are just as crucial for senior pupils who have reached a certain level of abstract-logical reasoning as parental support for their schooling. The first and most significant role models for children are their parents. The interests, perspectives, and values of parents have a direct or indirect impact on how children's characters develop (Hong & Ran, 2000).

Intensifying Parent-Child Conflicts Due to Educational Anxieties

Alfred Adler's Separation of Tasks theory says that everyone has their own tasks to focus on and shouldn't get in the way of others'. This theory can help avoid problems in relationships between people. The "mixture of tasks" can also make it hard for parents and children to get along (Li, 2022). For example, one of the most important goals for senior elementary school students is to work hard and get into the best secondary school possible. If parents see this as their job, they may get in the way of their kids' education by giving them too many activities after school and having too high standards for them. They might get angry if the kids do not do what they want. Still, the kids cannot make big changes overnight just because their parents are putting pressure on them, and eventually the parent-child relationships get worse over time.

The *2017 Annual Report on New Types of Education Supplies* revealed that 48.3% of primary and secondary school students participated in off-campus supplemental tutoring, with each participant spending an average of over 5,000 CNY (Wang, 2018). According to the *White Paper on Chinese Family Educational Consumption*, in 2017, approximately half of all household expenditures in China were allocated to family education. These statistics reflect parental concerns regarding their children's education. They are so concerned about their children's academic ranks that they rely heavily on advanced instruction from off-campus tutoring firms. The Double Reduction program has alleviated some of the public's educational concerns (Yu & Yao, 2021). However, as noted previously in this article, the reduction of homework for senior pupils is limited; their parents must continue to devote considerable time to monitoring their studies. In addition, the policy requires offline training institutions to conclude tutoring by 8:30 p.m. on school days.

Parents must cram all after-school tutoring for their children into the window between the schools' and training institutions' closing times. This completely exhausts senior pupils, diminishes their self-motivation, and heightens their defiance, which in turn increases parents' anxiety.

A Lack of Comprehensive Home-School Collaboration

The Double Reduction policy highlights the importance of optimizing home-school partnerships in order to improve school education (Ministry of Education, 2021). Other national education policies emphasize the necessity of home-school collaboration. "More is less." The lowering of student academic burden does not imply that teachers and parents can relax their educational obligations; rather, it needs more scientific and systematic home-school contact in order to holistically improve educational efficacy.

Home-school communication in China, on the other hand, is typically cantered on student academic progress. Parents would seek assistance from teachers only when their children were having academic difficulties or when they needed to consult teachers about their children's middle school enrollment; teachers would contact parents only when their child fell behind in academic performance. Topics such as kids' spiritual pursuits and emotional needs are rarely addressed in parent-teacher dialogue. Such contact is limited and has minimal bearing on students' overall development.

Causes of Problems with Learning Involvement of Senior Pupils' Parents

Parents' Outdated Educational Beliefs

In China, parents with traditional educational beliefs often see schools as the primary actors in their children's education. Ye, Fang, and Zhang (2022) discovered that 62.7% of parents polled were unaware that their actions may have a significant impact on their children, instead arguing that schools and teachers should bear complete responsibility for their children's education. When faced with increased educational involution, parents resorted to off-campus additional tutoring to help their children succeed in the rat race. Approximately 95% of parents of compulsory education students expect their children to attend university or higher education (Wang, 2021). When they believe that family education is incapable of promoting children's academic success, they can only turn to external resources for assistance, and the limited availability of such services makes them even more concerned. That is why the implementation of the Double Reduction policy heightened their concerns, as the children's after-school education was now in their hands.

Parents' lack of educational capacity is the result of outdated educational concepts. First, the majority of parents of senior pupils link involvement in their children's education with the supervision of homework. They are unable to identify relevant teaching approaches that match the features of children. Second, they lack sufficient information regarding child development. Senior primary school students are going through profound physical and mental changes as they shift from childhood to adolescence. In the absence of educational expertise, parents are prone to approach their children in early adolescence as little children, which frequently provokes a rebellious mindset in the adolescents. Thirdly, parents may have poor communication abilities. Frequently, parents are unable to communicate effectively with their children and transmit their feelings, opinions, and desires, resulting in confrontations with their children.

Parents frequently prioritize their kids' academic success and intellectual prowess over the most crucial concerns, such as their physical and mental health, moral development, and character building, because they lack a reasonable knowledge of how kids grow and develop. When parents place unreasonable academic success expectations on their children, it demonstrates that they are unaware of the unique characteristics and variances that exist among people.

A Paucity of High-Quality Educational Resources

The battle for admission to renowned secondary schools is mostly due to a lack of high-quality educational resources. The physical facilities and supportive environment of a school are among its educational conditions. The term "soft school environments" refers to the conditions that educated people perceive in the dynamic process of education, which, to some extent, have more significant effects on student educational outcomes. School physical facilities include teaching infrastructure, equipment, recreational facilities, and more (Wang, 2021). Even though China's universalization and balanced development of compulsory education have mostly eliminated geographic inequities in school facilities, shortages of teachers continue to have a substantial impact on education and teaching quality. That explains why senior pupils' parents worry about their children's education.

Incomplete Educational Evaluation Standards

The goal of the 2020 publication of the Overall Plan for Deepening the Reform of Educational Evaluation in the New Era was to advance the reform of student educational evaluation to support comprehensive moral, intellectual, physical, aesthetic, and social development of students (State Council, 2020). Exam results continue to be the dominant factor in the evaluation of students' educational outcomes in reality, though. Although the Double Reduction policy is intended to lessen the amount of homework and off-campus training students must complete, senior pupils who are anxious about approaching secondary school enrollment are unable to take advantage of it because of the assessment's emphasis on exams. As a result, tutoring at training institutions gives way to one-on-one private instruction; students receive more supplemental instruction materials, making up for the decreased amount of homework. It can be challenging for parents to strike a balance between their children's academic performance and their physical and mental health in test-ability-oriented education (Yu & Yao, 2021). In this case, exam results and the struggle for spots in elite middle schools become the main sources of worry for parents of senior primary school students.

Suggestions for Improving Parental Involvement in Senior Pupils' Learning in the Context of the Double Reduction Policy Implementation

Creating a Democratic Home Atmosphere to Improve the Effectiveness of Parental Involvement

The goal of the Double Reduction policy is not to promote a laissez-faire approach to student learning but rather to restore students' rest time and eliminate repetitive, pointless exercises, and to maximize the learning results of children, parental participation must be improved.

Some Chinese parents are unable to treat their children with equality and respect due to the influence of an ancient authoritarian society. They would most likely utilize their parental authority to force their children to obey. In terms of child learning, parents may impose their own standards on their children, such as asking them to do extra exercises and tailoring learning plans to their own preferences.

Children pursue two essential psychological needs: a sense of belonging and self-worth (Nelsen, 2016). Senior students often have a greater desire for attention and support from their parents than their junior counterparts. Parents should endeavor to understand more about child psychology, develop their parenting skills, and learn to listen to their children. Parents can reduce their own educational anxiety while also creating a motivating environment for their children by focusing on improving their competency rather than exam results. When parents and children have an equitable connection, children feel more relaxed at home, and doing schoolwork is no longer a daily chore. Equal dialogue and rational communication might encourage senior students of a vulnerable age to be more open with their parents, allowing the latter to provide appropriate support.

Upgrading Parents' Educational Ideas to Reduce Parent-Child Conflicts

The "side effect" of the Double Reduction policy is that parents of senior primary school students are more anxious. In light of this strategy, parents may attempt to fill the gap by creating after-school learning programs for their children if they are concerned about how the reduced academic workload may affect their children's test scores. Early adolescent kids often become resistant to their parents' over involvement in their education, which exacerbates problems between parents and their kids. Parents should adopt more scientific educational principles in order to make their engagement acceptable to children.

The transition from primary to secondary education should not be seen by parents as a final and conclusive event, but rather as one of many stages in their child's life. Parental participation is a sustained endeavor. The parent-child relationship suffers when instant results are overemphasized. Parents should also refrain from placing unreasonably high expectations on their kids' academic performance. Children have a variety of skills and abilities. Overly demanding standards for a child's academic success can make them feel burdened and under strain. Given their abilities, the learning objective chosen for the child must be feasible, challenging, and applicable. Children get a huge boost in self-efficacy when they achieve tough but attainable goals, and the cooperative efforts of the children and their parents in meeting the challenge also offer opportunities for parent-child emotional engagement.

Strengthening Home-school and Home-community Collaboration to Bolster Parents' Educational Competence

The main objective of the Double Reduction policy is to support students' overall development, which calls for parents to have high levels of educational competency. Parents with poor educational skills find it difficult to select effective teaching methods and, as a result, are unable to produce high-quality parental involvement in their children's education. Additionally, the primary source of parents' educational worry is a lack of educational competency (Yu & Yao, 2021). So, parent education efforts should be increased in communities and schools.

Schools should encourage parents to use internet resources like "parent classrooms" and "family microlectures." For the purpose of maximizing parents' educational goals, assumptions, and practices, teachers can organize specialized parent meetings where they can provide parents with advice on home education and scientifically supported child-education strategies. Additionally, parents might freely take part in their children's extracurricular activities. Schools are now obligated to provide after-school services in the afternoon as a result of the policy's release. When parents are available during the service period, they can help schools plan after-school programs for kids. This is a great chance for parents to spend time with their kids and foster stronger emotional connections. This can be used as a good illustration of how parents can positively influence their children's learning.

Parents who require assistance might also receive home education counselling from the community. Parents should work with competent professionals to identify issues with their family's education and come up with remedies (Yuan, 2009). As a result, parents who have never received formal training in child education can gain some basic knowledge of the subject, develop better communication skills, and increase the impact of their involvement in the learning of their children. In addition to child learning, professional guidelines can be expanded to include emotional and psychological problems.

Accelerating the Reform of Educational Evaluation and Expanding the Forms of Parental Learning Involvement

The skewed educational evaluation system based on academic results is to blame for the existing one-sided parental learning involvement. Senior students need to work extremely hard or even engage in advanced learning to achieve good marks and get accepted into exclusive secondary schools as a result of the rising educational competition. As a result, parents' efforts have been focused on supervising homework and improving their children's exam scores. This phenomenon runs counter to the idea of the Double Reduction program, which seeks to increase students' overall competencies while reducing the amount of work they have to do after school.

Currently, teachers are in charge of evaluating students. The evaluation of pupils' performance is based on the teachers' grades. This restriction should be overcome through a new paradigm for educational evaluation that includes feedback from numerous sources, including parents and peers. A thorough evaluation strategy might inspire parents to become more involved in their children's education and to focus on things other than homework and tests.

Conclusion

It is necessary to look more closely at the impacts of the Double Reduction policy. However, it has a significant impact on learning when parents of senior primary school students are involved. Undoubtedly, the changing environment has presented parents with new challenges regarding their children's education. Parents must adopt scientific perspectives on education, pay attention to their emotional interactions with children, and foster egalitarian, peaceful home environments if they want to increase the success of their efforts to support their children's learning. It is essential for schools and communities to offer qualified assistance to parents to improve their educational competency in order to ensure responsible parental involvement. Additionally, the elements of parental participation may benefit from the reform of the school evaluation system. In order to carry out the goals of the Double Reduction policy and support children's healthy development, more study is required to investigate how to enhance parental involvement in their children's education.

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