Original Article

IEEPJ Vol. 5, No. 2, 2023, 14-24

http://ieepj.hormozgan.ac.ir/

Iranian Evolutionary and Educational Psychology Journal

IEEPJ

Science Education in the Second Grade of Elementary School: A Research Synthesis

Zahra Bakrani Balani[3], Narges Keshtiaray[2]*, Hamid Azizi Malekabadi[3]

1- PhD Student, Department of Curriculum planning, Isfahan (Khorasgan) Branch, Islamic Azad University, Isfahan, Iran

2- Associate Professor, Department of Educational Science, Isfahan (Khorasgan) Branch, Islamic Azad University, Isfahan, Iran

3- Assistant Professor, Department of Physiology, Basic Dental Sciences, Islamic Azad University, Isfahan (Khorasgan) Branch, Isfahan, Iran

* Corresponding author's Email: keshtiaray@gmail.com

Abstract: The current research is qualitative research that was conducted using the synthesis research method based on the deductive model. The research environment in the synthesis phase included all citations in the range of 2008 to 2020 for the studies conducted in the field of experimental science education of the second grade in elementary school. Based on this, 40 sources were selected by purposive selection method. Stopping the sampling process was based on information saturation. Data collection was done using a survey in the research environment and based on the synthesis of experimental science education in the second grade of primary school. According to the findings of the research synthesis based on the deductive model, the environmental factors affecting experimental science education in the second grade of primary school include: support factors (family-oriented, school-oriented), extracurricular environment, socio-cultural environment, science curriculum design including goals (instructional, educational, motivational), content (knowledge, practical skills, challenging thinking), teaching strategies (group discussion, advance organizer, exploration, problem solving, learning assistants, laboratory, cognitive development, game-oriented, aesthetic), intra-school environment (independent, individual, deep, collaborative, exploratory), evaluation (evaluation tools, evaluation methods), learned skills (life skills, mental skills, social skills, thinking skills), science education approaches (teacher-centered, student-centered) and learning experiences (meaningful experiences and valuable experiences). The findings provide useful implications for science education in elementary school and can be used by elementary school teachers and parents for science education as well.

Keywords: Synthesis research, science education, elementary school

Introduction

Experimental science is one of the important subjects in elementary education, and today this field of primary education is witnessing significant developments, to the extent that the practical education of this subject has gained great importance, and educators and trainers are pursuing the application and deep learning of this subject (Strand-Cary & Klahr, 2008). Creating a transformation in past processes to achieve these goals is inevitable. In this regard, implementing innovative learning and teaching patterns is one of the important components of this transformation (Hug et al., 2005). Education in science and technology is one of the fundamental pillars of education and training, whose direct impact on the cultural, economic, political, social, and material and spiritual capital development of a society has been well established (Perignat & Katz-Buonincontro, 2019). With the recognition of the importance of science in determining the cultural, social, and economic position of a society, the importance of science education and its universalization is more evident. One of the most important achievements of

Article information: Received: 2022/03/2 | Accepted: 2022/06/15 | Published: 2023/06/1. https://doi.org/10.52547/ieepj.5.2.14

science education is the training of individuals with knowledge that enables them to think logically and make informed decisions (Harlen, 2005).

Since it can be expected that science education in elementary education prepares students for lifelong learning and, in other words, increases their ability to acquire scientific and technological literacy, learning experimental sciences, like other sciences, is considered an important matter because it is related to daily life and its importance has increased with advances in technology (Momeni Mehmoi et al., 2013).

The objectives of science education in secondary education have been expressed in a list format in various books and articles, and at first glance, there may be a slight difference between the lists of objectives, but upon careful examination, we will find that all the lists are close to each other in agreement, and their differences are mainly in how the objectives are explained. Science education in this period should help students become familiar with the surrounding environment and create a kind of awareness, interest, and curiosity about natural phenomena in the environment so that they can recognize nature, discover the laws governing it, and understand cause and effect relationships. This information includes four areas: a) human body and health (health sciences), b) living environment (biological sciences), c) non-living environment (earth sciences), and d) subjects related to matter and energy (physical sciences) (Bergmann & Sams, 2012).

On the one hand, science education in secondary education should create desirable attitudes and scientific attitudes in students that are desired by the education system of society. Among the attitudinal objectives of experimental science education, laboratory work can include things such as attention to the grandeur of the phenomena of creation and the grandeur of the Creator, willingness to cooperate, patience, honesty, understanding others, curiosity, environmental protection, creative thinking, and so on (Abolghasemi & Mohamadi, 2020).

So, teaching science requires creating insight and deep understanding of the world around us and laying the foundation for honoring the Creator through understanding the magnificence of creation. On the other hand, given the increasing dependence of various dimensions of human life on scientific and technological achievements, it is essential to provide scientific and technological literacy with a monotheistic perspective, which is the main approach of the general curriculum of experimental sciences (Amani Saribaglou et al., 2019). To achieve this literacy, students need to be placed in situations where they can link their knowledge, skills, and attitudes and reach competency. Topics such as gratitude, frugality, and helping others can be included in science education (Amani Saribaglou et al., 2019).

[DOR: 20.1001.1.25884395.2023.5.2.2.1]

[DOI: 10.61186/ieepj.5.2.14]

Traditional teaching methods are no longer responsive to students' needs, as these methods do not promote problem-solving skills, information use, collaboration, and understanding with each other. The increasing progress of technology has made traditional teaching methods inadequate (Tony, 2016). Despite some research that has been done in this area, there has been no comprehensive research on the synthesis of teaching science in the second elementary school cycle, and only relatively close subjects have been studied. For example, Abdolmaleki et al. (2021) compared the effects of guided play, free play, and direct instruction on first-grade students' learning in science. According to the findings of this research, modern teaching methods, especially exploratory and participatory methods accompanied by practical and laboratory activities, are used in science teaching is very effective. Brahuei Moghadam and Kahrazehi (2020) compared teaching methods in Iran and England and found that innovative teaching methods such as flipped teaching and exploration make science education more attractive. Ahmadabadi et al. (2021) investigated the effect of flipped teaching compared to co-teaching, exploration, and lecture methods on sixth-grade students' learning in science and found that flipped teaching and exploration make science education more attractive.

Science education introduces students to scientific laws that help them understand the workings of the universe. Through learning science, students develop curiosity, creativity, innovation, critical thinking, and logical reasoning. They must always seek answers to fundamental questions of why, what, and how, and these answers should be based on scientific and practical foundations, which means conducting experiments and experiences (Stinner et al., 2003). Practical activities are crucial for the advancement of experimental sciences. Laboratory work has opened many doors for researchers to discover new inventions and innovations. Therefore, practical and laboratory work plays a fundamental role in science education, particularly in the experimental science curriculum of the second elementary school cycle. In addition to familiarizing students with tools and methods used in science laboratories, practical work also strengthens and develops problem-solving skills. Based on it, this research aims to answer the question of how to synthesize science education in the second elementary school cycle.

Material and Methods

This research is a qualitative study that used the synthesis research method based on a standard model. The research environment in the synthesis phase included all reference texts (articles and books) in the range of 2008 to 2020 in the field of science education in the second elementary school cycle. Based on this, 40 sources were studied and reviewed in a purposive method, and the sampling process was stopped based on information saturation. It should be noted that the data collection tool was a library exploring method. For this purpose, content analysis was used to identify science education in the second elementary school cycle through extracting information from specialized articles and books. In the

[DOR: 20.1001.1.25884395.2023.5.2.2.1]
[DOI: 10.61186/ieepj.5.2.14]

textual description version, which is a form of archiving data collection, the maximum amount of information was recorded to have the most essential information available for data analysis and coding.

Results

The research environment in the synthesis phase, as shown in Appendix 1, included all reference texts in the range of 2008 to 2020 in the field of science education in the second elementary school cycle. Based on this, 40 sources were studied and reviewed in a targeted manner, and the sampling process was stopped based on information saturation. A summary of 15 sources is presented in Appendix 1 (table 1).

Based on the findings of the synthesis research, environmental factors affecting education include supportive factors (family-centered and school-centered), the out-of-school environment, the socio-cultural environment, science curriculum design, including goals (educational, developmental, motivational), content (knowledge-based, practical and skill-based, challenging and thinking-based), teaching strategies (group discussion, pre-organization, exploration, problem-solving, learner support, laboratory-based, cognitive development, game-based, aesthetic), the in-school environment (independent, individual, deep, collaborative, exploratory), assessment (assessment tools and methods), learned skills (life skills, mental skills, social skills, thinking skills), science teaching approaches (teacher-centered, student-centered), and learning experiences (meaningful and valuable experiences), which are presented in Figure 1.

Figure 1 presents the synthesis of science education in the second elementary school cycle. This model starts with broader external layers and moves towards the central and innermost layer. Environmental factors affecting education have a direct impact on science teaching approaches, which form a cohesive foundation for all aspects of science education, such as science curriculum design and learning experiences, and influence the outcomes and learned skills, which are the core of the model. In fact, all factors are interconnected and interact with each other to achieve the ultimate goal of science education, which is learned skills, and based on these learned skills, they shape and progress.

[DOR: 20.1001.1.25884395.2023.5.2.2.1]

[DOI: 10.61186/ieepj.5.2.14]

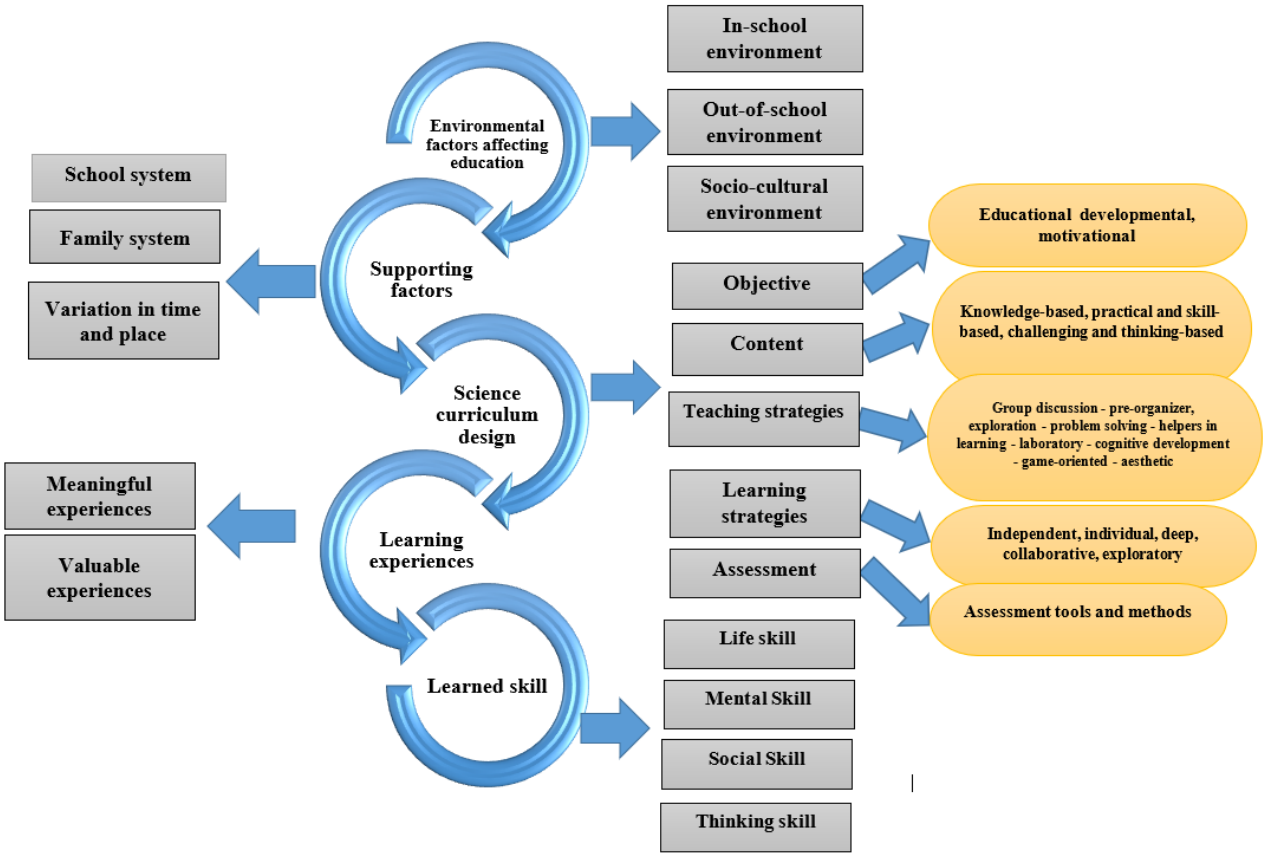

Fig. 1. Synthesis of science education

Discussion

The aim of this research is the synthesis of science education in the second elementary school cycle. Based on the findings of the synthesis research, environmental factors affecting education include supportive factors (family-centered, school-centered), the out-of-school environment, the socio-cultural environment, science curriculum design, including goals (educational, developmental, motivational), content (knowledge-based, practical and skill-based, challenging and thinking-based), teaching strategies (group discussion, pre-organization, exploration, problem-solving, learner support, laboratory-based, cognitive development, game-based, aesthetic), the in-school environment (independent, individual, deep, collaborative, exploratory), assessment (assessment tools and methods), learned skills (life skills, mental skills, social skills, thinking skills), science teaching approaches (teacher-centered, student-centered), and learning experiences (meaningful and valuable experiences).

The mentioned results are consistent with the findings of Abdolmaleki et al. (2021), Brahuei Moghadam and Kahrazehi (2020), and Ahmadabadi et al. (2021). In response to the above question, it can be said that nowadays one of the problems in science classes is the use of ineffective and traditional teaching

[DOR: 20.1001.1.25884395.2023.5.2.2.1]
[DOI: 10.61186/ieepj.5.2.14]

methods. Traditional methods are not responsive to the learners' needs and do not include problem-solving skills, information application, participation and collaboration, and understanding of each other. The increasing progress of technology in the world has led to traditional teaching methods no longer meeting the needs of students. In this regard, great efforts have been made to provide new and innovative methods based on the individual and social needs of students to cultivate their creativity and scientific production and open new windows in the field of science and technology for them (Mirdrikvandi, 2016). These conditions have challenged educators and teachers on how to best educate learners in the face of today's technology and the speed of the use of information and communication technology in the global arena and prepare them for life in such societies. The answer to this challenge is the integrated learning model that combines the best features of face-to-face and electronic learning. By adding learner-centered learning to face-to-face learning and using powerful tools such as standardized instructional content, this method can easily achieve higher quality education than both learning methods. In addition to the quality of learning, the integrated education system is implemented at a lower cost than face-to-face methods and at a higher quality than electronic education (Forootan et al., 2023).

Zimmerman (2000) argues that self-guidance is not only an academic performance but also a self-management process through which learners transfer their mental abilities to relevant study skills. The need to pay attention to learners' cognitive theories of learning has led to the emphasis on complex thinking skills and cognitive and self-guidance stimuli. Today, more attention is paid to how learners interpret their thoughts to solve complex problems. Today, the issue of education in schools requires the use of methods that make learning enjoyable and effective for students. Moreover, the application of proposals and attention to research results has led to a change in the attitude of teachers, planners, and educational policymakers towards using technology more and more purposefully in education.

Given that now, the impact of the flipped classroom approach on learning is being studied with various statistical communities worldwide. Emphasis on learners in their learning process and meaningful evaluation has gained significant meaning. This also affects the students' mental construction, and these students will be more successful (Kenna, 2014).

Experimental science is one of the important subjects in elementary school, and today this field of elementary education is undergoing significant changes, to the extent that the practical teaching of this subject has become very important, and those responsible for education are seeking to apply and deeply learn this subject. Creating a transformation in past processes is inevitable to achieve these goals. In this regard, implementing innovative learning models is one of the important components of this transformation. Teaching science and technology is one of the fundamental pillars of education and development, and its direct impact on the cultural, economic, political, social, and material and spiritual

[DOR: 20.1001.1.25884395.2023.5.2.2.1]
[DOI: 10.61186/ieepj.5.2.14]

capital development of a society is well established. With the acceptance of the importance of science in determining the cultural, social, and economic position of a society, the importance of teaching science and the need to make it universal is better understood. One of the most important achievements of science education is the education of individuals with knowledge who can think logically and make informed decisions (Harlen, 2005). Since it can be expected that teaching science in elementary school prepares students for lifelong learning and, in other words, teaching science increases students' ability to acquire scientific and technological literacy, given the advances in today's science, learning experimental science, like other sciences, is an important matter because it is related to daily life and its importance has increased with the advancement of technology.

In the discussion of research proposals, it should be noted that the interdisciplinary and logical combination (integration) of subjects is essential in guiding learners' academic and personal development, as it can strengthen the transfer of learning. Learners have the opportunity to learn similarities in concepts and strategies better than when subjects are taught separately, and they learn to use concepts in different areas. It also teaches them how to think, make decisions, organize their thoughts, acquire learning, research, data collection, and analysis skills and leads to the development of learners' thinking.

Conflict of interest: The authors state no conflict of interest in the study.

Acknowledgment: Authors thank and appreciate all those who have cooperated in this research.

Financial sponsor: The authors acknowledge that they have not received any financial support for all stages of the study, writing and publication of the paper.

References

Abdolmaleki, S., Khosravi, M., Ghaderi, M., & Maleki, H. (2021). The comparison of guided Play, free Play and Direct instruction effects in children's learning of first grade science. *Research in Curriculum Planning*, *17*(67), 167-182. https://doi.org/10.30486/jsre.2021.1898106.1627

Abolghasemi, M., & Mohamadi, H. (2020). The effectiveness of filliped learning method on attitude and academic performance in Mathematics in elementary schools. *Technology of Education Journal (TEJ)*, *15*(1), 1-8. https://doi.org/10.22061/jte.2019.5169.2183

Ahmadabadi, A., zeinabadi, h. r., & Ostadrahimi, M. (2021). The effect of flipped teaching methods in comparison with cooperative, inquiry and speech methods on learning experimental sciences for sixth grade elementary

[DOR: 20.1001.1.25884395.2023.5.2.2.1]

[DOI: 10.61186/ieepj.5.2.14]

students. *Research in Teacher Education(RTE)*, *4*(1), -. https://te-research.cfu.ac.ir/article_1471_953e367e5e405d2f16ce4e9a14dda13b.pdf

Amani Saribaglou, J., Vahedi, S., Fathi azar, E., & Abidi, L. (2019). The effect of reversed jigsaw classroom on university students' academic performance and statistics anxiety. *Educational Psychology*, *15*(52), 133-153. https://doi.org/10.22054/jep.2019.30599.2183

Bergmann, J., & Sams, A. (2012). *Flip your classroom: Reach every student in every class every day*. International society for technology in education.

Brahuei Moghadam, N. M., & Kahrazehi, M. (2020). A Comparative Study of Teaching Methods Used for Teaching Science in the Elementary Schools in Iran and the United Kingdom. *Teacher Professional Development*, *5*(2), 41-58. https://tpdevelopment.cfu.ac.ir/article_1416_b8b6e8ba78f531fd97aea8c5ae7bba74.pdf

Forootan, K., Hashemi, S. A., Qaltash, A., & Mashinchi, A. A. (2023). The effect of using the reverse class approach on learning the experimental sciences of elementary school students [Research]. *Journal of Psychological Science*, *21*(119), 2285-2302. https://doi.org/10.52547/jps.21.119.2285

Harlen, W. (2005). *Teaching, learning and assessing science 5-12*. Sage.

Hug, B., Krajcik, J. S., & Marx, R. W. (2005). Using innovative learning technologies to promote learning and engagement in an urban science classroom. *Urban Education*, *40*(4), 446-472.

Kenna, D. C. (2014). *A study of the effect the flipped classroom model on student self-efficacy* North Dakota State University].

Mirdrikvandi, F. (2016). The effect of active teaching method on academic performance in science: the case of 3rd grade junior high school students in Andimeshk city (2010-2011). *Research in Curriculum Planning*, *12*(47), 133-144. https://jsr-e.isfahan.iau.ir/article_534406_2a18b79383144b02baf17b1ea0263dc7.pdf

Momeni Mehmoi, H., Karsheki, H., Azizi Fard, T., & Ajam, A. A. (2013). *The role of teachers' awareness of new teaching methods and career motivation on students' academic progress* The first national conference on sustainable development in educational sciences and psychology, studies Social and Cultural,, Tehran. https://civilica.com/doc/320404

Perignat, E., & Katz-Buonincontro, J. (2019). STEAM in practice and research: An integrative literature review. *Thinking skills and creativity*, *31*, 31-43.

Stinner, A., Mcmillan, B. A., Metz, D., Jilek, J. M., & Klassen, S. (2003). The renewal of case studies in science education. *Science & Education*, *12*, 617-643.

Strand-Cary, M., & Klahr, D. (2008). Developing elementary science skills: Instructional effectiveness and path independence. *Cognitive Development*, *23*(4), 488-511.

Zimmerman, B. J. (2000). Attaining self-regulation: A social cognitive perspective. In *Handbook of self-regulation* (pp. 13-39). Elsevier.

[DOR: 20.1001.1.25884395.2023.5.2.2.1]

[DOI: 10.61186/ieepj.5.2.14]

Appendix

Table 1. Summary of 15 study selected for analysis

Row	Researcher(s)	Year	Title	Results	Extracted themes
1	Fuat Serkan	2020	FLIPPED CLASSROOM IMPLEMENTATION IN SCIENCE TEACHING	The lack of technical tools as a weakness in the reverse learning model, students are interested in the teaching model.	Increase participation in lessons
2	S.Nursetiawati	2020	SCIENCE EDUCATION IN THE FAMILY ENVIRONMENT WITH THE EXPERIMENTAL METHOD OF FACIAL COSMETICS PLANT FERTILIZATION IN THE COVID-19 PANDEMIC ERA	The results showed that family participation motivates students when doing experiments.	Family participation Using the online method Creating independent learning Teacher and parent relationship
3	Sirinapa Kijkuaku	2019	Professional changes of primary science teachers: experience on collaborative action research in Thailand	The analysis showed that joint science action research enables teachers to change their teaching methods in classroom conditions and they needed the support and attention of their school principal.	Professional development of teachers Support of school principals Changing teaching methods Attention school principal Reflection on teaching methods High quality support The important role of parents
4	Dolores López Carrillo	2019	Using Gamification in a Teaching Innovation Project at the Univers of Alcalá: A New Approach to Experimental Science Practice	The general goals were to eliminate negative prejudices, fear and rejection of attitudes towards science, foster conceptual and procedural learning of knowledge among students, and provide real life examples and experience using gamification to learners.	Use of gamification Eliminate negative biases Eliminate fear Rejection of attitude towards science Fostering conceptual learning Fostering procedural learning among students Provide real examples Increase motivation Improving students' skills Professional development of students
5	Rita Yeboah	2019	Making primary school science education more practical through appropriate interactive instructional resources: A case study of Ghana	This project is to produce low-cost educational resources to develop practical and interactive resources for teaching science at the primary school level in developing countries, and it can be found that waste materials can be safely used to be appropriate and useful. This research is for science teachers. It designs that they can collect waste and low-cost materials freely and turn them into useful resources for effective lessons.	Use of waste materials Turning waste materials into useful resources for lessons Use attractive educational resources to attract attention Using the teacher's improvisational skills
6	MaiderPérez de Villarreal	2018	Design of Knowledge Models for Teaching Experimental Sciences at University	Experimental science education is a compulsory subject in the Bachelor of Elementary Education (BDPE). This field is related to the field of education and in the field of "knowing the social and natural environment."	Knowing the natural social environment Concept maps Student engagement with learning Promotion of motivation Promotion of metacognition
7	Isabelle Girault	2017	LABBOOK: A WEB ENVIRONMENT FOR ACTIVE SCIENCE LEARNING	Teaching based on active learning that requires writing scientific reports. For example, inquiry learning, project-based learning (PBL), are experiential processes that aim to promote active learning	Education based on active learning Writing scientific reports Investigative learning

[DOR: 20.1001.1.25884395.2023.5.2.2.1]

[DOI: 10.61186/ieepj.5.2.14]

					Project-based learning
8	Luis Del Espino Díaz	2017	The Teaching of the Experimental Sciences in Primary Education through a Methodology by Inquiry: Learning Difficulties and Pedagogical Guidelines	The attitude of promoting experimental science from school to form a part of society's culture is still insufficient, it is necessary to take initiatives according to society's interest in science and to create a real scientific culture.	Creating a real scientific culture Developmental growth of students Attention to the abilities of students
9	Book	2017	Inquiry-Based Science Education Promoting changes in science teaching in the Americas	It should be taught in science classes by teachers who know the basic principles of science and who are able to stimulate children's curiosity and help them develop their experimental skills, through simple experiments using, teaching materials, that teach. Facilitates	Use simple tests Creative dealing with everyday and objective problems Motivational training Education based on research and development Holding a class in the laboratory Searching for answers to the mysteries of nature Discover basic science concepts Recognizing the difference between science and prophecy
10	Matthew John Caicco	2016	Teacher Experiences with Flipped Classrooms in Secondary Science	In order to foster a dynamic and interactive learning environment, the teacher should engage students with the subject while using guiding concepts and creatively.	Dynamic learning environment Interactive learning environment Creative engagement with the subject
11	Saber Abdolmaleki	2020	Comparison of the effects of guided play, free play and direct teaching on children's learning in the first grade experimental science course	Teachers guide them toward curriculum goals, which makes children experience fun and discovery-filled play. Guided play can enhance the discovery of unknown functions.	Guided play free play Direct training Focus on learning objectives A pleasant experience An experience full of discovery Increase the discovery of unknown functions
12	Brahoei, N.M.	2020	A comparative study of teaching methods of experimental science education in Iran and England	Based on the findings of this research, new teaching methods and models, especially exploratory and collaborative methods, are actively used along with practical and laboratory activities in the teaching of experimental sciences in England.	exploratory methods Collaborative methods Scientific and laboratory activities Having educational facilities and equipment Using information and communication technology Lifelong learning Creating talent and the ability to acquire scientific-technological literacy observe measurement Interpretation of findings make a hypothesis

[DOR: 20.1001.1.25884395.2023.5.2.2.1]

[DOI: 10.61186/ieepj.5.2.14]

13	Ahmadabadi, Arezo	۲۰۲۰	The effect of teaching with the flipped method compared to collaborative, exploration and lecture methods on the learning of experimental science in the sixth grade.	New teaching methods, such as flipped teaching, make exploration more attractive in experimental science education.	Flipped teaching exploratory method Deep learning of science Learning critical thinking Flexibility factor in science education Learning life skills
14	Negahban, Mohadesh	2020	Identifying some of the misunderstandings of fourth grade students at the beginning of the experimental science course based on the 2015 Tims study	In order to teach the topics of earth sciences and astronomy, it is not limited to theoretical topics, and students are asked to express their mental patterns regarding the rotation of the earth around the sun, and scientific demonstrations and educational clips are used for better understanding. In addition, it is recommended to use functional assignments to clear misunderstandings in the field of earth sciences.	Drawing a mental model by the student Clearing misunderstandings Use of functional assignments Coordinated changes
15	Jahani, Jafar	2020	Development and validation of the interactive model of teaching creativity in the experimental science course of the first year of high school and its effect on the development of students' creativity.	The content of science textbooks should insist on direct, continuous education and the development of logical thinking and the acquisition of creative knowledge of students. So considering that the most important issue in teaching creative students is the use of appropriate educational content and various methods, problem finding, problem solving, creativity and thinking. Textbooks, including experimental sciences, can have a very positive effect on the growth and flourishing of students' creative and divergent thinking.	Cultivating logical thinking Creative knowledge acquisition Use of appropriate educational content Using different methods Using problem solving Problem solving method Use creativity Use thinking Growth and flourishing of creative thinking Different learners A creative look at phenomena Application of new methods of education Promotion and development of new educational methods Interactive approach to teaching creativity Analytical and meticulous in all areas of life searching Abilities with practice and repetition and practice

[DOR: 20.1001.1.25884395.2023.5.2.2.1]

[DOI: 10.61186/ieepj.5.2.14]