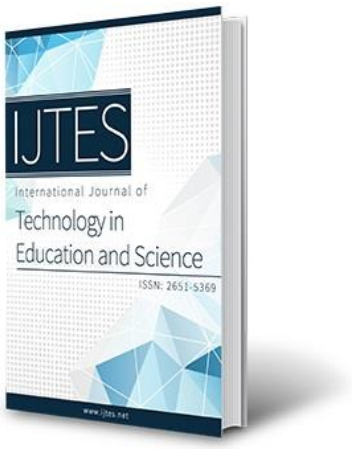

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Information and Communication Technologies in Science Instruction: Systematic Review of Publications in Last Decade

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Information and Communication Technologies in Science Instruction: Systematic Review of Publications in Last Decade

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Abstract

The purpose of this study is to determine the trend in studies related to Science instruction and ICT. The study has been studied with extensive data, and the data mining method has been used. Some articles entered the ERIC database within the research scope and published in January 2020, starting from 1965. In this context, 1,783,418 articles published between 1965 and 2020 have been formed the population of the research. Analyzes have been performed from the publications' titles, the publications' abstracts, and the Descriptor information of the publications determined by ERIC and word clouds have been constituted. As a result, it is seen that there has been a general increase in studies in the last decade. In parallel with the scientific and technological developments, it has been seen that the developments and needs in terms of both science teaching and technology have been reflected and determined the trend in the studies. As a result of the research, it has been determined as an unprecedented situation that few studies for students and families are among the essential joint owners of the process.

Introduction

In today's world, which is enriched and globalized in terms of technology, science and society are becoming more complex, and socio-economic, cultural, and political changes frequently affect our lives (Chowdhury, 2016). Individuals must have scientific processes and skills to comply with this world, which is continually changing and developing, and have to interrogate the facts and events around them. As citizens, individuals regularly participate in or are exposed to different scientific and technological applications (Roth & McGinn, 1998). As these experiences directly affect the individual's life, the individual's behavior is vital in shaping their reactions in the light of the information coming from their environment. It is inevitable for individuals to benefit from scientific knowledge and skills during these experiences. In particular, teaching processes in general and science teaching will help individuals live independently without support (Rizzo & Taylor, 2016). Different technologies will help move learning and teaching processes beyond traditional methods (Dani & Koenig, 2008). With the help of technology, students will have the opportunity to work with experts from different positions. For example, students will observe studies such as space research and underwater research, with data open to scientists (Woolsey & Bellamy, 1997).

Teaching these skills to individuals will shape not only their school life but also their daily and professional life,

as they will make a decision (decisions) using not only scientific processes but also scientific processes and skills related to the facts and events faced by the individual with the help of technology. The way to enable individuals to reach scientific data and decide (decisions) based on these data will be possible using different and up-to-date technologies in educational processes. Mobile technologies also enable educators and researchers to enrich mobile devices' learning and teaching processes by increasing popularity, developing features, and becoming more accessible (Zydney & Warner, 2016). Today's world is changing rapidly, and traditional teaching methods cannot keep up with this speed (Iwuanyanwu, 2019). Recently, the future of educational processes, especially new formations related to science, technology, and engineering teaching, take place in the literature (Potkonjak, Gardner, Callaghan, Mattila, Guetl, Petrović, & Jovanović, 2016). Nevertheless, researchers are trying to explain how technology supports student learning and the effect of technology-supported applications in science classes (Kim, Hannafin, & Bryan, 2007). When studies have been examined in terms of the effects of technology use in teaching processes, it is seen that the effect of technology use in science teaching is moderate (Campbell & Abd-Hamid, 2013).

Woolsey and Bellamy (1997) list that science teaching is among the critical objectives of the modern schooling process, and the contributions of technology applications to science teaching processes are as follows:

1. Observation and reporting
2. Phenomena and media
3. Analysis and mathematical capabilities
4. Collaboration and networks

With the technology applications, the students have improved in the four skills mentioned above, and the problems occurring in these processes have been eliminated, and the interactions of the individuals involved in the teaching processes have increased. Among the difficulties faced by science teachers, managing pedagogical practices, students' rapidly changing world perceptions, students who become more different from each other with the help of technology, and society's pressure to raise individuals with 21st-century skills stand out (Iwuanyanwu, 2019). The way to overcome these difficulties will be possible by understanding society's technological changes and applying them to teaching processes. Besides, most of the 21st-century skills are related to gains from technology or technological channels. Campbell and Abd-Hamid (2013) stated that the combined use of science content, pedagogy, and technology are three crucial factors that can shape science learning experiences. Technological developments have also changed the educational processes, similar to the change in individuals' and societies' lives. Smetana and Bell (2012) stated that using computer simulations with appropriate teaching techniques will provide learners with different opportunities, abstract concepts will become easier to learn, and tacit processes will be more visible.

Technology and its applications have become widely used in both students and adults (Campbell & Abd-Hamid, 2013; Smetana & Bell, 2012). Students have become tech-savvy and are eager to bring more educational technology to the classroom (Smetana & Bell, 2012). These pressures have led both teachers and researchers to research technology in teaching processes and develop software and hardware. Especially in science education, computer simulations have become an integral part of science classes (Van Joolingen & Van Der Veen, 2012).

The way to use specialized hardware and software in science classrooms is through students 'willingness to use these tools and combining teachers' pedagogical knowledge and technological knowledge. Dani & Koenig (2008) stated that science classes could be developed, and learning communities can be created with technological applications. Campbell and Abd-Hamid (2013) stated that technology, pedagogy, and content are the elements that teachers need to complete their instructional objectives. Gutman, Steiner and Mendelovich (2016) stated in their research that technology (ICT) channels are didactic channels that can be used to visualize science concepts and that students' high-order thinking can be developed through teaching processes using ICT. With the use of technology in teaching processes, these deficiencies of disadvantaged or have deficiencies in science teaching can be eliminated. For example, Mayer-Smith, Pedretti and Woodrow (2000) found in their research that they created a technology-enriched classroom environment that female students learn at least as male students.

The development of technology, from the use of simple technologies in classrooms to the use of computer technologies, to the use of computer simulations, and as we approach today, more up-to-date technologies and applications are becoming widespread. A decade ago, computer simulations were widely used in science classrooms. Van Joolingen and Van Der Veen (2012) argue that the use of computer simulations has become widespread. However, Smetana & Bell (2012) stated that computer simulations in educational processes bring technology to educational purposes beyond entertainment-oriented production.

Zydney and Warner (2016) stated that mobile learning applications in science teaching have strong potential, especially mobile devices' affordability increases this potential. In addition to mobile learning, educational institutions and distance education content providers are looking for ways to increase the number of courses offered in Science, Technology, and Engineering disciplines as online courses (Potkonjak, Gardner, Callaghan, Mattila, Guetl, Petrović, & Jovanović, 2016). Woolsey and Bellamy (1997) lists the benefits of technology and ICT tools to teaching environments as follows: Calculation, Data collection, Imaging, Writing, Information Access, Networking, Presentation, and Portability.

Tsai and Lydia Wen (2005) stated that systematic reviews of research published in academic journals would lead educators to understand the current situation and future trends better. Tsai and Lydia Wen (2005) examined the researches published between 1998 and 2002 in 3 journals they determined in their studies, and according to the results of the research, it has been stated that the one-third of the studies has been made from 4 major English speaking countries, the majority of the studies were experimental studies, theoretical studies and review papers. They determined that the prominent research topics were students' conceptions and conceptual change.

As a result of the analysis of the researches published in five major journals that published research articles in the field of science education between 2005 and 2014 (O'Toole, Freestone, McKoy & Duckworth, 2018), it has been observed that there was an increase in the number of researches during the decade, mostly qualitative than quantitative. Then mixed-method research focused on teaching, teaching strategies. Practical work, and then ICT and assessment are the most prominent, while research focusing on learning, which is one of the focal points of science teaching, has the highest number, learning theories follow the topic of learning, as the prominent issues in the studies have been determined as the preparation and development of teachers, professional development

and pedagogical content-knowledge issues are on the decline. At the same time, there are many more qualitative studies than quantitative studies, as they stated.

Purpose

The role of today's information and communication technologies in science teaching processes is of indisputable importance in taking responsibility for the individual's learning, structuring the learned information in a meaningful way, and ensuring that individuals are educated in light of scientific developments. Along with 21st-century skills, teachers, who are the joint owners of the teaching process, are expected to use appropriate technologies and designing lessons (Chai, Tan, Deng, & Koh, 2017). Examining the studies on science teaching and information and communication technologies in the literature, determining the needs, if any, determining the trends, determining the level of information and communication technologies in science teaching will contribute to the teaching processes. This study aims to analyze the studies about Science instruction and ICT and determine the studies' trends in this context. Considering that the number of journals on education scanned in the ERIC database is relatively high, the articles examined within the study's scope will provide information about the world's trends and light the way for other studies.

Method

This study aimed to analyze the Science instruction and ICT studies and determine the studies' trends, it has been studied with big data, and the data mining method has been used. Although it is not possible to make a definition accepted by all scientists for big data, scientists working in different disciplines attribute different meanings (Chen, Mao & Liu; 2014). However, Fan, Han and Liu (2014) stated that the concept of big data includes a large amount of multidimensional data and expresses an approach that is cheaper to produce and store unstructured data in a short time.

The process of collecting, recording, integrating big data for analysis, cleaning, analyzing, visualizing, interpreting, and making a decision (decisions) based on these processes is different from today's research methods and techniques, and extraordinary methods and techniques, also require more time. (Chen & Zhang; 2014; Davi, Haughton, Nasr, Shah, Skaletsky & Spack; 2005). In big data studies, methods and techniques of different branches of science are needed to access, store and analyze data, and methods and techniques of different branches of science are being used in each step. The disciplines and techniques used in the big data analysis proposed by Chen and Zhang (2014) are shown in Figure 1.

One of the frequently used effective data analysis methods for text-based data heaps is the data mining method. Data mining is an analysis method performed to extract meaningful information, new patterns, and transform data into information from unstructured and large amounts of text data sources (He, Zha & Li; 2013; Tsantis & Castellani; 2001). Standard data mining methods include text classification, text clustering, ontology and taxonomy creation, document summarization, and latent corpus analysis (Feinerer, Hornik & Meyer; 2008). There is no single truth in big data analysis or data mining processes, and the researcher (researchers) develops an

analysis method suitable for the data they collect. Among the data mining targets are extracting critical elements from the big data set and summarizing by identifying the relationships between these elements (Davi, Haughton, Nasr, Shah, Skaletsky & Spack, 2005). Fan, Han and Liu (2014) stated that big data and data mining processes would bring many challenges to researchers and bring many opportunities. The data mining literature has been developed with general rules that researchers will follow rather than a template to follow step by step. Due to these processes, researchers' programs/scripts, rather than package programs, have become used in data mining processes.

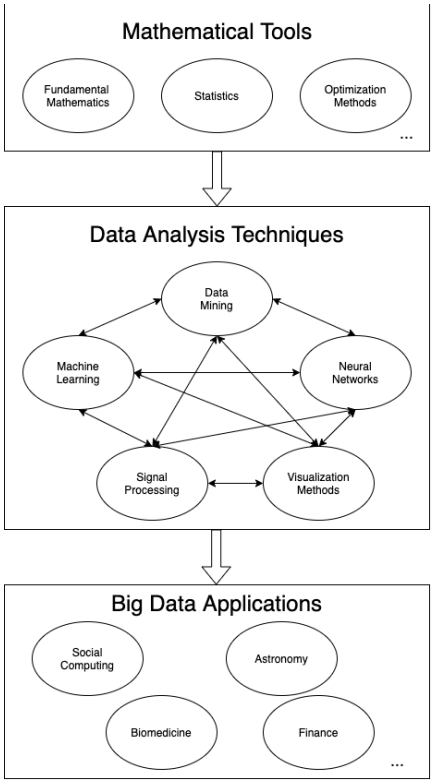

Figure 1. Big Data & Other Disciplines and Techniques (Chen & Zhang; 2014)

The steps specified by Gandomi and Haider (2015) as a course of action that can be followed in data mining processes are shown in Figure 2.

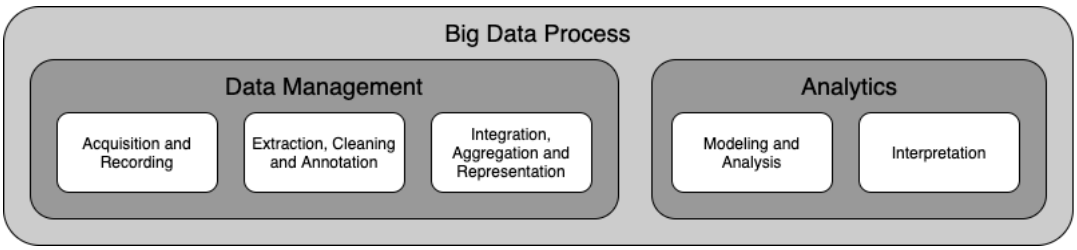

Figure 2. Big Data Process (Gandomi & Haider; 2015)

The articles published in the ERIC database in January 2020 and published as separate XML files starting from 1965 until 2020 have been included in the research's scope. ERIC cover educational science articles and ERIC started coverage from 1965. In this context, 1,783,418 articles published between 1965 and 2020 constitute the

universe of the research. The number of studies and cumulative studies included in each year's research scope is shown in Figure 3.

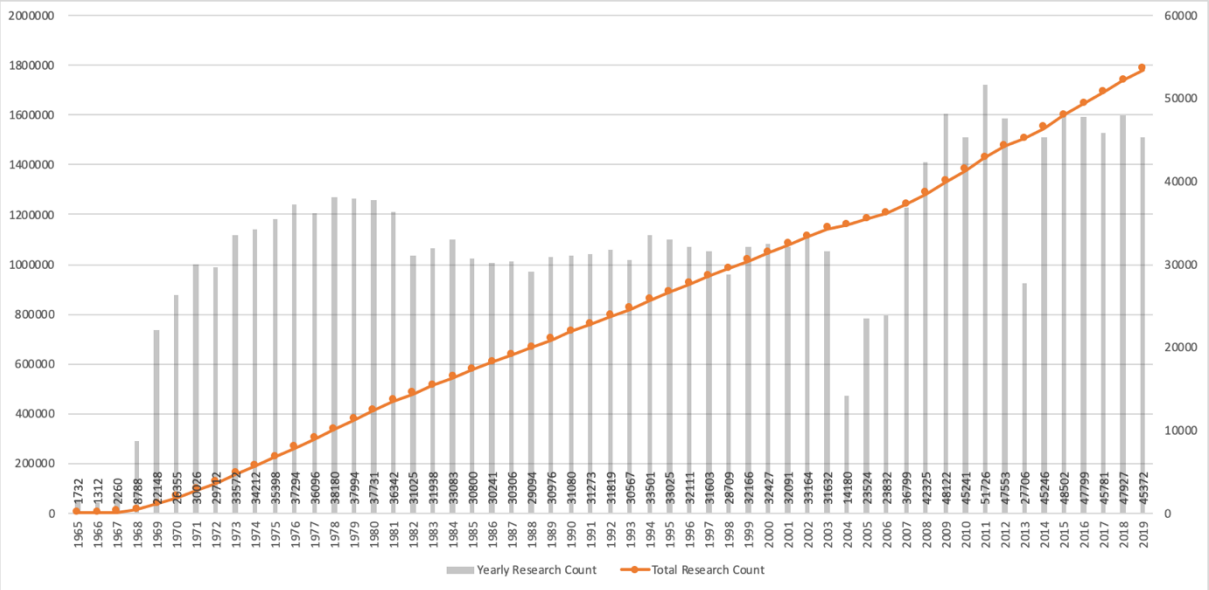

Figure 3. The Annual and Cumulative Numbers of the Studies Indexed in the ERIC Database between 1965 And 2020

It has been examined in the context of different variables within the study's scope. The article records indexed in the ERIC database from the ERIC index website (www.eric.ed.gov) have been downloaded and recorded as separate XML files for each year to achieve this target. Within the scope of the research, while Python programming language is used in data analysis and data visualization processes, The Element Tree XML API (https://docs.python.org/3/library/xml.etree.elementtree.html), Pandas (McKinney & others, 2010), and NLTK (Bird, Loper & Klein; 2009) libraries have widely been used.

In the research, the level 1 keyword ERIC Thesaurus has been determined as "Science Instruction", which is used to describe the articles and is among the topics named as a descriptor by ERIC. 2. Descriptor variables such as 'Educational Technology', 'Computer Uses in Education', 'Technology Uses in Education', 'Laptop Computers', 'Electronic Learning', 'Virtual Classrooms' in order to cover the concept of 2nd level keyword information and communication technologies. ',' Videoconferencing ',' Web-Based Instruction ',' Information Technology ',' Computers', 'Handheld Devices',' Information Systems', 'Online Systems',' Computer Games', 'Distance Education', 'Internet', "Online Courses" has been selected.

Results

In Figure 4, the studies' distribution in the ERIC database and defined with the descriptors "Science Instruction" and "Science Instruction and ICT" by years are shown. While there are 41194 studies with the descriptor of science instruction published since 1965, there are 4835 studies with science instruction and ICT. When the graph is examined, and a linear trend is added to the graph with the help of spreadsheet programs, the number of

publications exceeds the trend as of 2010, and the number of publications is above the trend. When the year 2010 is taken as the breakpoint, there are 18268 studies with the descriptor of science instruction, while there are 2816 studies with the descriptor of science instruction and ICT. The year 2010, determined with the help of the linear trend study on the graph, has been taken as the cut-off point, and in the analysis, the publications were divided into two groups, and the studies published between 1965 and 2010 have been made as a group, and the studies published between 2010 and 2020 have been determined as the second group, and the analyzes have been carried out on these groups.

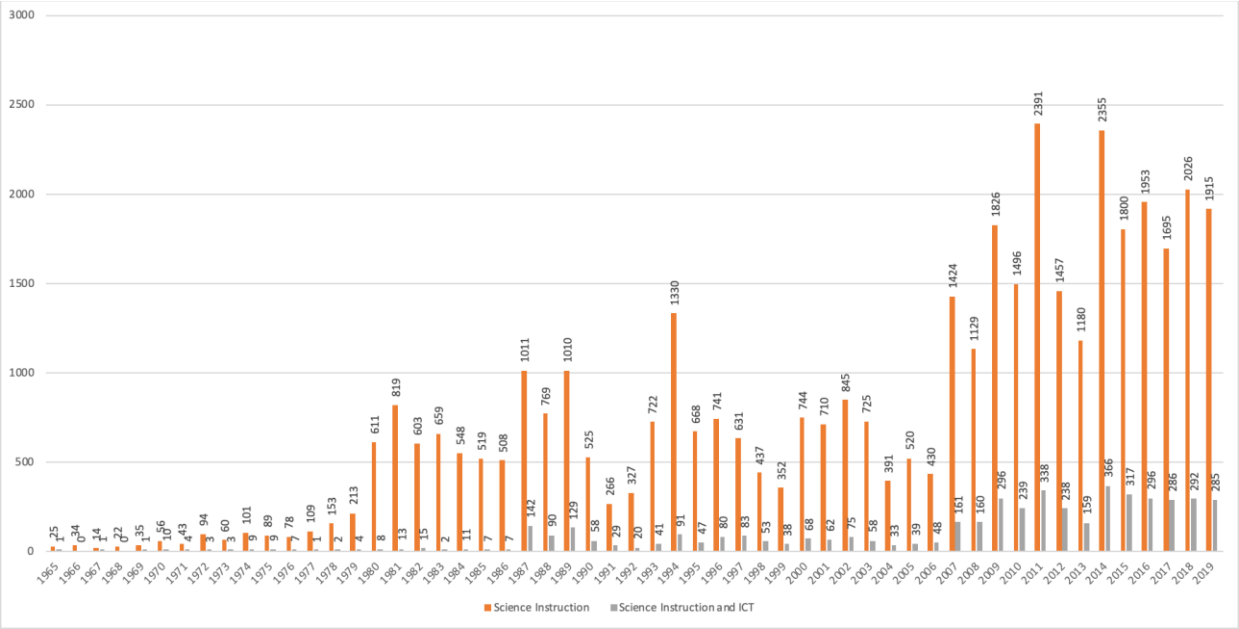

Figure 4. Science Instruction and Science Instruction & ICT publications

Figure 5 shows the word cloud created from the descriptors of Science Instruction articles. When the word cloud is examined, the descriptors that outstanding are “college science”, “secondary school science”, “higher education”, which define studies focusing on different classes and educational levels of science teaching; It is seen that physics, chemistry, biology, and science teaching, which are sub-disciplines covered by science teaching, are the descriptors of teaching methods, science activities, science education, scientific concepts.

Figure 5. Word Cloud Created from Descriptors of Science Instruction Descriptive Articles.

Figure 6. The 20 Most Frequently Used Concepts and Frequencies in the Word Cloud/Titles Created from the Titles of Science Instruction Descriptive Articles

When the Figure 6 is examined, it is seen that among the headings of the study, the studies of science instruction have been made in the fields of physics, chemistry, and biology, which are the three fields that the concept of science includes. Besides, it can be said that these studies focus on individuals and processes in learning environments, based on keywords such as teaching, learning, classroom, and laboratory. It is among the concepts that outstanding in concepts such as understanding, experiment, curriculum, effect, and concept in the titles.

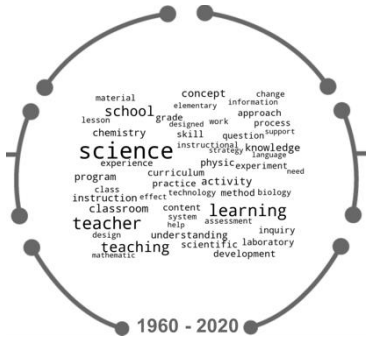

Figure 7. The 20 Most Frequently Used Words and their Frequencies in the Word Cloud/Abstracts Created from the Abstracts of Science Instruction Descriptive Articles

When Figure 7 is examined, the word cloud/abstracts created from the summaries of the science instruction studies and finding is similar to the finding in the titles of the studies appears. Thus, it can be said that with the findings obtained from both titles and abstracts, the studies cover other sub-disciplines covered by the concept of science and focus on the process and joint owners.

Figure 8. Science Instruction Findings Regarding the Audience of Descriptive Articles

When Figure 8 is examined, it is seen that studies with descriptive science instruction mostly target teachers and practitioners and then researchers. However, it is striking that although policymakers and students are among the studies examined, they are not sufficient. In addition to all these findings, it has been determined that there are very few studies involving administrators and their parents in their target audience.

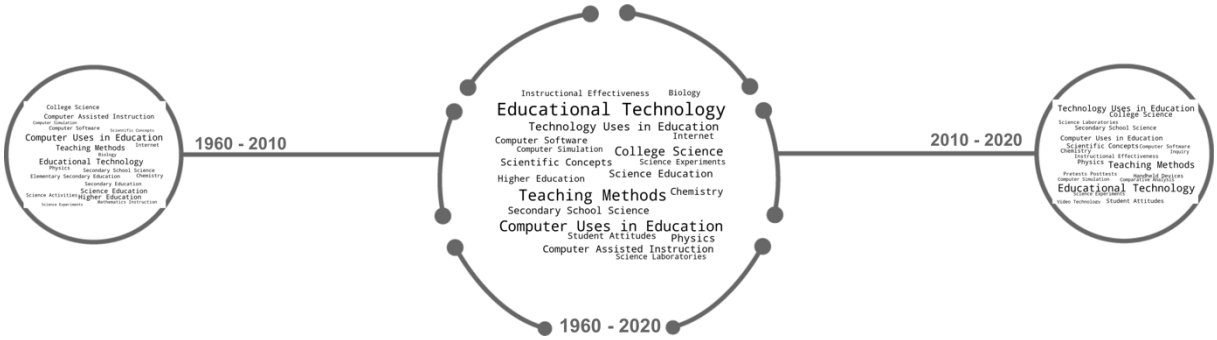

Figure 9. Descriptors of Science Instruction and ICT Studies

When Figure 9 is examined, word clouds are formed from the studies' descriptors, including ICT keywords among the descriptors of Science Instruction studies. When the word cloud, which has been created between 1960 and 2020 and gives the general trend from ICT studies have been examined, it is seen that descriptors that may be related to ICT such as Educational Technology, Computer Uses in Education, Technology Uses in Education, Computer Assisted Instruction are outstanding. In addition to these descriptors, it is seen that descriptors focusing on different points of Science Instruction processes such as Teaching Methods, Science Education and Scientific Concepts, and descriptors focusing on different levels of education and different sub-disciplines of science such as College Science, Secondary School Science and Physics. Although it is at the forefront of word clouds created from studies between 1960 and 2020, the descriptors that do not appear in the foreground in word clouds between 2010 and 2020 have been determined as Science Education and Computer-Assisted Instruction. Although it has been in the foreground between 2010 and 2020, another descriptor in the foreground between 1960 and 2020 has been determined as Student Attitudes.

Figure 10. Most Frequently Used Words in the Titles of Science Instruction and ICT Studies

When Figure 10 is examined, the central concepts used in the Science instruction and ICT studies titles are seen. When the stand-out concepts have been examined, it has been determined that the words did not change much

yearly. It has been observed that the concepts used in the titles of the studies are words for teaching processes such as learning and teaching, as well as concepts such as the classroom and laboratory, where science instruction processes take place. However, two concepts that change over the years come to the forefront; while the word computer came to the forefront between 1960 - 2010 and 1960 - 2020, it did not appear in the foreground between 2010-2020. Besides, the word online, which was not in the foreground between 1960 and 2010, has been determined between 2010 and 2020.

Figure 11. The Most Frequently Used Words in the Abstracts of Science Instruction and ICT Studies

Figure 11 shows the most frequently used concepts in the summaries of science instruction and ICT studies. The most frequently used concepts in the summaries of the studies are parallel to those used in the titles, and it is seen that concepts such as learning, technology, a teacher come to the forefront in the studies conducted for all three time periods. Although it has not been in the foreground between 1960 and 2010, the concepts that came to the forefront between 2010 and 2020 have been determined online and knowledge. Similar to the analysis results of the titles' concepts, it has been determined that the computer concept was at the forefront between 1960 and 2010, but not between 2010 and 2020. Unlike the titles, two other concepts that came to the forefront between 2010 and 2020 are knowledge and design concepts.

Figure 12. Science Instruction and Findings Regarding the Audience of ICT Descriptive Articles

Figure 12 shows the findings regarding Science instruction and the audience of ICT descriptive studies. When the findings on audiences are examined, it is seen that the studies are mostly for practitioners and teachers. The audience group after these two groups is the researchers' group. Among the studies' audience, it has been

determined that there are few studies for students, who are an essential element of the science instruction process. However, it has been determined that there are very few studies on parents.

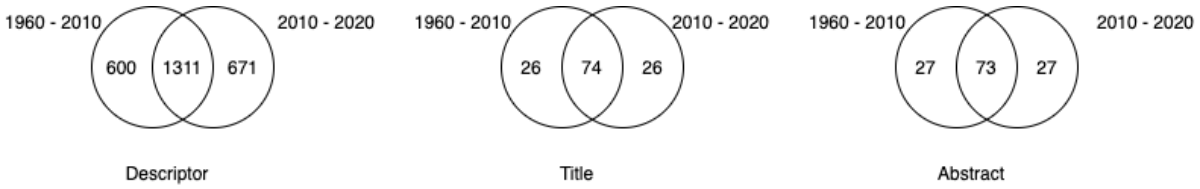

Figure 13. Science Instruction and Comparison of a Descriptor, Title, and Abstract of ICT Descriptive Studies

Figure 13, a comparison of a descriptor, title, and abstracts of the studies published between 1960 - 2010 and 2010 - 2020 with the descriptor of science instruction and ICT. In the context of the descriptors in the figure, it has been determined that 51% of the descriptors were common descriptors for both groups of studies, and 26% of different descriptors have been used between 2010 and 2020, and 23% of different descriptors have been used between 1960 and 2010. The examination of the descriptors, which is common to both groups of studies; Descriptors such as Computer Uses in Education, Educational Technology, Teaching Methods, Computer Assisted Instruction come to the forefront. Examining the descriptors used in the studies between 1960 and 2010, it has been determined that descriptors such as Microcomputers, World Wide Web, Videodisks, Videotape Recording, Computer Managed Instruction, and Computer Programs, which reflected the technology of the period, came to the forefront. In the studies between 2010 and 2020, descriptors such as STEM Education Student-Centered Learning descriptors that are in line with the prominent subjects in science education or educational sciences, descriptors such as Social Media, Usability, Open Source Technology, Audience Response System, Web 2.0 Technologies that reflect changes in technology has been determined that descriptors that reflect changes in research methods such as Mixed Method Research, Semi Structured Interviews, Online Surveys, and data collection methods come to the forefront. When evaluated in the context of the titles of the studies, it has been determined that 74 of the 100 words frequently used in the titles for both groups were common, and 26 different words have been used in both groups. In the context of the works' abstracts, it has been determined that 73 of the 100 words frequently used in the abstracts were common, and 27 different words have been used in both groups. It has been determined that learning, teaching, Computer, instruction, classroom, and laboratory are prominent for both study groups in the studies' titles and abstracts. It has been determined that words such as multimedia, distance, computer-assisted came to the forefront in the studies between 1960 and 2010, and words such as digital, mobile, effectiveness, content interaction, visualization, context, pedagogical, computational, ICT came to the forefront in studies between 2010 and 2020.

Discussion

In the search conducted within the research scope, 41194 studies related to science instruction have been attained. Among these studies, there are 4835 studies on ICT. There are 18268 studies with the descriptor of science instruction, while there are 2816 studies with the descriptor of science instruction and ICT in the period from 2010 until today, which is the breakpoint. As examine the studies, it is observed that there has been a significant increase in both science instruction and ICT studies in the last ten years. When the articles published between the

beginning of 2005 and the end of 2014 in five journals on Science-education were conducted by O'Toole, Freestone, McKoy and Duckworth in 2018, the number of articles has increased significantly. Due to the advantages that technology offers when well-managed, calls are made to integrate technologies in science classrooms (Noemi Waight & Fouad Abd-El-Khalick, 2012). As a result of scientific and technological developments, it can be said that scientific studies that focus on applications in both science and technology may have been enriched science classrooms.

When the studies on the Science Instruction are examined in the context of their descriptors; In studies related to science teaching, focusing on different class and educational levels (college science, secondary school science, higher education), teaching/learning processes, and methods of teaching (teaching methods, science activities, science education, scientific concepts), as well as science teaching and ICT, is seen that sub-disciplines (physics, chemistry, biology) are also included in the studies. Examining the most frequently used concepts in the titles of the studies on Science Instruction, it is seen that similar studies have been conducted in the field of physics, chemistry, and biology. Besides, based on the keywords such as teaching, learning, classroom, laboratory, which are among the central concepts, it can be said that the studies focus on the components of learning environments and learning processes. Furthermore, it can be said that some of the key concepts that come to the forefront (understanding, experiment, curriculum, effect, and concept) have contents for the components of science education/teaching of the studies. The analysis results based on the studies' summaries are similar to the findings revealed in their titles. From this point of view, it can be said that with the findings obtained from both descriptors, titles, and abstracts, the studies include other sub-disciplines covered by the science discipline, focus on the elements in the teaching process and a practical science teaching.

It is seen that studies with the description of the Science Instruction mostly target teachers, practitioners, and researchers. However, although some studies take policymakers and students to their target audience, it draws attention that they are not enough and/or come to the forefront. Moreover, the number of studies that include administrators and parents as their target audience is very few. It is essential to carry out studies that include students, administrators, and parents, who are among the critical joint owner of the teaching process, as the target audience. The same result is seen in the Science instruction and ICT descriptive studies. Joint owners' responsibilities, competencies, and cooperation between joint owners in teaching processes are essential in achieving the programs' target. Conducting studies that focus on these joint owners' effects on science instruction processes will make science teaching more effective and positively affect using ICT in science teaching. Teachers are a crucial joint owner in this process. It is not easy to make teachers, who are an essential joint owner of the process, competent in technology; it requires sufficient effort, time, and opportunity. It is a known fact that most of the teachers know technology but a lack of essential knowledge on how to integrate technology into their applications. (NCES, 2000) Market Data Retrieval, 2001; Dani & Koenig, 2008). According to Dani and Koenig, 2008, teachers must know the possibilities of technological application and understand the relationship between concepts, processes, and skills in order for teachers to plan and select appropriate pedagogical practices. For this reason, it is vital to carry out guiding studies that provide the path to follow, what should be done, the strengths and weaknesses to reach the target. In this context, it has been thought that the studies which address the target audience of teachers may have come to the forefront.

An exciting finding encountered in the study; it is the defining concept of "Student Attitudes", which was in the foreground between the years 2010 and 2020, but was not in the foreground between 1960 and 2020. While there are not many studies that take students, who are also critical joint owners of the teaching process, to their target audience, it has been determined that the tendency towards studies on attitudes has increased in studies conducted in the last decade. In the last ten years of studies; considering the definitions, titles, and concepts that stand out in the abstracts, it can be said that technological developments are reflected in the teaching processes, and the effects of this are tried to be revealed. Of course, developments in science and technology necessitate the effective use of technology in learning environments, especially in recent years. It is thought that this situation may have led to an increase and trend in the number of studies conducted to reveal the effect on attitude as a result of including information and communication technologies in science lessons. As it is known, developing positive attitudes towards science lessons and determining students' attitudes are essential in terms of meaningful learning and internalizing science concepts. Students' attitude affects the interest, curiosity, motivation, and academic success towards the lesson. When the literature is examined, it is possible to see that these are mentioned (Reiss, 2004; Papannastasiou & Zembylas; 2002; Singh, Granville & Dika, 2002).

When the concepts in the word cloud, which was created between 1960 and 2020 and which gave the general trend, have been examined among the studies dealing with science education, information and communication technologies, descriptors that could be related to ICT such as Educational Technology, Computer Uses in Education, and Technology Uses in Education, Computer Assisted Instruction were at the forefront. In addition to these descriptors, it is seen that descriptors such as Teaching Methods, Science Education, and Scientific Concepts focusing on different points of Science Instruction processes and focusing on different levels of education such as College Science and Secondary School Science come to the forefront too. Researchers and practitioners try to explain when technologies support students 'scientific understanding, which activities and support practices facilitate students' inquiry processes, and how to sustain technology-enhanced innovations in science lessons (Kim, Hannafin, & Bryan, 2007). The findings also show that descriptors focusing on sub-disciplines of science such as physics come to the forefront. Science such as physics, chemistry, biology, environment, etc. covers the subjects related to other disciplines. However, the handling of science lessons in education programs can be changeable from countries to countries.

Although "Science Education" and "Computer-Assisted Instruction" are generally at the forefront in the context of all studies, it is not in 2010 and 2020. In parallel with the developing technologies, technology is just not a computer as it comes to mind and offers many application possibilities that can be used for educational purposes and do not require technical knowledge, like web 2.0 tools. Web 2.0 tools are emerging as the new generation internet technologies offer many opportunities such as interaction, communication, information sharing, easy access to information, collaborative work, content creation, sharing, etc. (Andersen, 2007; Dearstyne, 2007; Oliver, 2010). All individuals include these innovative technologies in their lives for educational purposes. It has been thought that the studies have increased in this direction, and the education processes have replaced the content "Computer-Assisted Instruction". Similarly, in the findings obtained from the concepts used in the titles of the Science instruction and ICT studies, it is seen that the word "computer" has lost its popularity in recent years. It can be thought to stem from the use of different technological tools and applications in teaching

environments. While the concept of computers is not in the foreground in this study, it is seen that the popularity of the online concept has increased in recent years. Especially after 2010, the increase in the number of internet tools available to teachers, students, and teaching processes and the possibilities of connecting to the internet can be shown as the reason. Today, it is possible for both institutions and individuals to access the internet in their social lives or educational processes and to benefit from the internet effectively in the environment at will.

The reflections of the innovations and changes in technologies that individuals can use in their teaching processes and the advantageous situations these technologies offer in terms of ease of use on the studies conducted in the last decades are seen in parallel with the summaries and the results of the titles in the Science Instruction and ICT studies. In addition to the results obtained from the titles, it is seen that the concepts of knowledge and design came to the forefront between 2010 and 2020. It can be said that the concept of design comes to the forefront, especially since online tools have an essential place in the design of the classroom and learning environment. Considering that the primary purpose of teaching is meaningful learning away from memorization considered an expected result, it will take place more in parallel with its studies focusing on scientific knowledge using online tools. The use of ICT is one of the preferred ways of dealing with students' misunderstandings of scientific principles and processes. Many teachers use ICT in their classrooms as an instructional solution for visualizing science concepts (Gutman, Steiner & Mendelovich, 2016).

Especially in parallel with the developments in recent years, it is seen that subjects such as STEM Education and Student-Centered Learning have become more prevalent in science teaching in studies between 2010 and 2020. STEM education has been adopted by countries that aim to train individuals who have innovative and creative thinking and innovation skills. In recent years, it is seen that the study subjects have a trend in science education. (Elmalı and Balkan-Kıyıcı, 2017; Jayarajah, Mohd Saat, and Abdul Rauf, 2014; Bybee, 2010). It is stated in the literature that this trend towards STEM has been detected.

It is seen that the descriptors for technology are those that reflect the changes in technology such as Social Media, Usability, Open Source Technology, Web 2.0 Technologies. Besides, it is seen that descriptors that reflect changes in research methods and data collection methods such as Mixed Method Research, Semi Structured Interviews, and Online Surveys come to the forefront. It has been determined that concepts such as learning, teaching, Computer, instruction, classroom, and laboratory stand out in the studies' titles and abstracts. While the concepts such as multimedia, distance, computer-assisted came to the forefront in the studies between 1960 and 2010, it has been determined that the words such as digital, mobile, effectiveness, content interaction, visualization, context, pedagogical, computational, ICT came to the forefront in the studies between 2010 and 2020. In this case, it is apparent how the technologies, which come up with a constant change and renewal, reflect on the lessons and thus on the studies.

Conclusion

Research proclivity can be learnt in this study. When science instruction studies related to ICT are examined, it is seen that there has been a general increase in studies in the last ten years. In parallel with the scientific and

technological developments, it is seen that the developments and needs in terms of both science teaching and technology are reflected in the studies and determine the trend in the studies. Studies that reveal the tendency have the feature of guiding future studies (Chang, Chang, & Tseng, 2010). After all, this study will contribute to research examining science instruction and studies related to ICT. As a result of this research conducted to determine the tendency in scientific studies, it is suggested that there are few studies, especially for students and families, who are critical joint owners of the science teaching process, and studies should be conducted for these joint owners.

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