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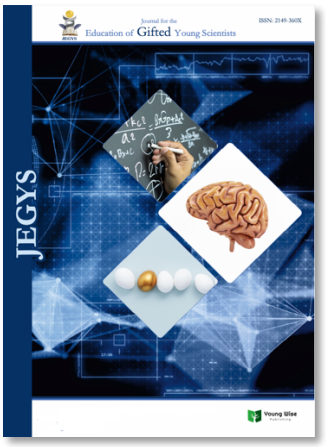

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Review Article

A review of the system for gifted young scientists education in the field of musicology in Turkiye

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Abstract

This study provides a comprehensive evaluation of the system for training gifted young scientists in the field of musicology in Türkiye. Undergraduate and graduate programs in universities offering musicology education in Türkiye, their academic structures, career opportunities for students, and the impact of existing educational processes on the development of scientists have been examined in detail. The curriculum structures of musicology departments, the adequacy of course contents, and the theoretical and practical aspects of these educational programs have been discussed, focusing on how this field contributes to scientific advancements in Türkiye. By closely analyzing the educational processes within musicology departments, the study evaluates their position and scientific contributions within national and international academic circles. Additionally, the historical development of musicology education in Türkiye and the current challenges in its structure have been identified, and solutions to address these issues have been proposed. Based on the findings of the research, it is concluded that interdisciplinary collaboration, curriculum development in musicology departments, the expansion of graduate programs, and the improvement of the processes for training scientists are necessary. This study offers significant recommendations for enhancing musicology education in Türkiye, making it more effective and grounded in scientific principles.

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Introduction

Musicology is a discipline that aims to study music in a scientific and systematic manner, encompassing a wide range of research areas through various methodological approaches and interdisciplinary interactions from historical times to the present. This field not only seeks to understand the structure of music itself but also investigates its place within the context of societal structures, cultural dynamics, technological developments, and the needs of the era. The primary goal of musicology is to comprehensively examine the structural characteristics of music, its historical evolution, its impact on different societies, and its relationship with other academic disciplines. These examinations aim to facilitate both the perception of music as an art form and the understanding of its roles within social and cultural contexts.

In line with this broad perspective, musicology demonstrates a multidisciplinary nature, encompassing historical, theoretical, sociological, psychological, and philosophical dimensions (Hodges, 2023). The study of the structure and performance of music facilitates an understanding of how music has evolved across various cultural, social, and historical contexts. Moreover, musicology is not limited to the technical analysis of music but also seeks to comprehend its

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influence on societies, its contributions to social transformations, and its changing nature in response to the demands of the time (Shanmugaboopathi & Catoto, 2022; Shepherd, 1991). Thus, the investigation of how music interacts with elements such as society, technology, environment, and cultural trends is one of the fundamental aspects that expands the scope of this discipline.

The field of musicology is divided into various subfields, each approaching this wide research area with different methodological approaches. Historical musicology examines the historical development processes of music, exploring the periodic changes in music, its key figures, and the historical influences on musical structures (Hansen et al., 2016). Ethnomusicology, on the other hand, studies the music of different cultures and their socio-cultural contexts, investigating the functions of music as a cultural expression (Barton, 2018). Systematic musicology focuses primarily on the structural analysis and theoretical examinations of music, providing an in-depth exploration of its technical aspects (Rohrmeier & Pearce, 2018). In addition to these subfields, disciplines such as the philosophy of music, music archaeology, music sociology, and music psychology also contribute to scientific endeavors aimed at understanding music from different perspectives. The philosophy of music investigates the ontological and epistemological structure of music, music sociology explores its relationship with social processes, while music psychology attempts to comprehend the effects of music on the human mind, and its emotional, cognitive, and behavioral influences.

The interdisciplinary nature of musicology holds the potential to make significant contributions to various fields of academia. Throughout its historical development, musicology has enabled a systematic accumulation of musical knowledge and demonstrated that it is not limited to an analysis of music as an art form, but rather intersects with disciplines such as social sciences, philosophy, and psychology, a development that dates back to the 19th century. Within this framework, musicological research is not confined to analyzing musical structures; it also provides in-depth analyses of the meanings music holds in social and cultural contexts.

This study will thoroughly examine the current state of the system for training scientists in the field of musicology in Türkiye. The structure of institutions offering musicology education in Türkiye, the undergraduate and graduate programs implemented in musicology departments, and academic career processes will be evaluated in this context. Specifically, the educational processes in musicology departments in Türkiye, the career opportunities available to musicology students, and the contributions of this field to scientific advancements in Türkiye will be analyzed based on academic outputs. The quality of academic work in musicology, its position and influence in both national and international academic circles, and the impact of musicology education on the training of scientists in Türkiye will also be discussed. Additionally, the general structure of the system for training scientists in musicology in Türkiye, the current challenges, and recommendations for addressing these issues will be presented.

In this regard, the process of training scientists in the field of musicology in Türkiye, the organization of musicology departments, their academic outputs, and the contributions of these outputs to the scientific field will be examined in depth. Thus, an evaluation will be provided on the necessary steps for transforming the system of musicology education in Türkiye into a more effective and scientifically grounded structure.

Definition and Research Areas of Musicology

Musicology is an interdisciplinary academic field that studies music from historical, theoretical, cultural, and sociological perspectives, encompassing a broad spectrum of research. The primary goal of musicology is to understand the structure of music, its historical development, theoretical foundations, and its social and cultural contexts. In this process, both the intrinsic dynamics of music as an artistic form and its interactions with societal structures are analyzed. Musicology seeks to understand not only the aesthetic aspects of music but also how cultures have expressed themselves through music throughout history, how music has evolved, and the relationship between societies and music. In line with these broad objectives, musicology is divided into various sub-disciplines that cover a range of research topics.

Historical musicology, one of the oldest and most established subfields, focuses on the historical development of music. This area examines the musical characteristics of different periods, the forms and structural analyses of works, and the lives and compositions of important composers within their historical context (Weiss et al., 2019). Music historians strive to understand how music has developed throughout history by considering the social and cultural

influences and the contextual conditions in which works were created. Historical musicology also details the evolution of musical culture by investigating how musical works were performed, the stylistic trends of different eras, and the transitions between musical periods. In this regard, musical analysis is not limited to composers and their works but also encompasses a thorough examination of the changes that musical forms have undergone throughout history.

Ethnomusicology, on the other hand, is a sub-discipline that adopts an intercultural perspective. Ethnomusicologists study the production and consumption processes of music in various cultures, the cultural functions of music, and the impact of social structures on musical practices (Clayton, 2016). This field highlights what music means as a form of cultural expression, how it functions within different societies, and how musical practices fit into the broader social and cultural framework. Ethnomusicology treats music as a social phenomenon and, through comparative studies, provides in-depth analyses of cultural interactions and musical commonalities, revealing the significance of music within cultural diversity. It demonstrates that music is not merely a technical or aesthetic product but also a cultural vehicle that reflects a society's identity, values, and history.

Systematic musicology, another prominent sub-discipline, focuses on the structural and theoretical analyses of music. This field examines the theoretical foundations, acoustic properties, psychological effects, and aesthetic dimensions of music (Honing et al., 2004; Honing, 2006). Systematic musicology emphasizes the technical and structural analyses of music, concentrating on harmony, melody, rhythm, and form. These analyses involve comprehensive studies aimed at understanding the mathematical and theoretical aspects of music. Music theory, a significant part of this field, focuses on how musical structures are formed, the theoretical principles that underpin different musical forms, and how these structures have transformed over time. Additionally, systematic musicology explores the acoustic dimensions of music, examining topics such as the physical properties of sound waves, the perceptual processes involved in listening to music, and the human brain's responses to music.

In addition to these three primary subfields, musicology intersects with other disciplines, such as the philosophy of music, music psychology, music sociology, and music archaeology (Currie et al., 2016). The philosophy of music explores the aesthetic and ontological dimensions of music, developing in-depth reflections on the meaning and function of music. Music psychology investigates the psychological effects of music on individuals, focusing on the mental processes involved in listening to and creating music. Music sociology examines the interaction between music and social structures, seeking to understand how music influences social transformations. Music archaeology studies the material remnants of musical works from ancient times to the present, offering insights into the role of music in prehistoric and historical periods.

Musicology, while remaining an academic discipline, also significantly contributes to the development of music performance and education. The theoretical foundations of music education, musical analyses, and the understanding of cultural contexts have laid the groundwork for important advancements in music pedagogy. In this regard, musicology plays a key role in establishing a scientific basis for music performance, contributing to the development of musical talents and helping music reach broader audiences. Furthermore, musicological research aids in the development of curricula in music education, aiming to enhance the effectiveness of music teaching.

In conclusion, it can be stated that research conducted in the field of musicology contributes to a deeper understanding of the historical, theoretical, cultural, and sociological dimensions of music. Musicological studies emphasize the social and cultural significance of music, providing a scientific foundation for understanding how music has evolved throughout human history and explaining the relationship between societies and music.

Departments and Major Fields of Study Related to Musicology in Türkiye

Musicology education in Türkiye is carried out through comprehensive academic programs at various universities. There are numerous institutions offering undergraduate, master's, and doctoral programs in this field. According to Öztutgan's (2019) extensive research, 19 different universities across Türkiye offer undergraduate-level musicology education, and within these universities, there are a total of 22 major departments or fields of study. These programs vary in terms of student capacity, typically accepting between 10 and 40 students. Musicology education is organized within four main academic units: Conservatories, Faculties of Fine Arts, Faculties of Music Sciences and Technologies,

and Faculties of Fine Arts and Design. Within these units, three distinct departments—Musicology, Music, and Music Sciences—exist, and educational and research activities are conducted across various subfields of musicology.

Öztutgan's research indicates that musicology programs in Türkiye are grouped into four major fields of study: Musicology, Music Sciences, General Musicology, and Ethnomusicology and Folklore. These subfields focus on different aspects of musicological research and education, enabling the systematic study of both local and universal music cultures. Additionally, these programs offer opportunities for specialization in interdisciplinary fields such as music theory, historical musicology, ethnomusicology, the philosophy of music, and music psychology, allowing music scholars to acquire a broad base of academic knowledge.

Yıldırım (2004) examined the musicology departments within the State Conservatories and Faculties of Fine Arts at five leading universities offering musicology education in Türkiye. These universities include the Music Sciences Department at Ege University Faculty of Fine Arts, the Music Sciences Department at Dokuz Eylül University Faculty of Fine Arts, the Musicology Department at Mimar Sinan Fine Arts University State Conservatory, the Musicology Department at Hacettepe University State Conservatory, and the Musicology Department at Istanbul Technical University Turkish Music State Conservatory. These departments offer undergraduate, master's, and doctoral programs, aiming to cultivate qualified scholars in the field of musicology.

In evaluations of the curriculum structure of musicology education, Terzioğlu (2018) emphasizes that musicology and music sciences departments in Türkiye do not provide sufficient courses in music theory, composition techniques, counterpoint, and harmony compared to European universities. This shortcoming indicates that musicology programs in Türkiye need further development, particularly in terms of theoretical music education. Nevertheless, musicology education in Türkiye generally focuses on music theory, performance practice, and musical culture, aiming to enhance musical knowledge and promote scientific research in the field of music.

Leading universities offering musicology education in Türkiye include prestigious institutions such as Istanbul University, Hacettepe University, Istanbul Technical University, Mimar Sinan Fine Arts University, and Ege University. These universities possess strong academic foundations in the field of musicology and aim to cultivate scholars who will contribute to the development of the discipline. The programs in musicology not only focus on academic research but also aim to preserve Türkiye's rich musical heritage through a scientific perspective, contributing to its promotion on the international academic stage.

Table 1. Undergraduate and graduate programmes in musicology

University	Unit	Department	Main Science Branch (MSB) /Main Art Branch (MAB) Programme			
			Undergraduated	Master Degree	PhD	Institute
Adıyaman Uni.	State Conservatory (S.C.)	Musicology	Musicology	Musicology	-	Postgraduate Education
Anadolu Uni.	State Conservatory	Musicology	General Musicology	Music Therapy (Non-thesis)*	-	Postgraduate Education
Ankara H.B.V. Uni.	Turkish Music State Conservatory	Musicology	Musicology	Turkish Music	Turkish Music	Postgraduate Education
Ankara Music and Fine Arts Uni.	Fac. of Music Sciences and Technologies	Musicology	Musicology	Musicology	Music Sciences	Music and Fine Arts
Ankara Y. B. Uni.	Turkish Music S.C.	Musicology	-	-	-	-
Artvin Çoruh Uni.	Faculty of Art and Design	Musicology	Music Sciences	-	-	-
Atatürk Uni.	Faculty of Fine Arts	Musicology	Musicology	Music Sciences	-	Fine Arts
Atatürk Uni	Turkish Music S.C.	Musicology	-	-	-	-
Aydın A.M. Uni.	State Conservatory	Musicology	General Musicology	-	-	-
Çukurova Uni.	State Conservatory	Musicology	-	-	-	-
Çukurova Uni.	Faculty of Fine Arts	Musicology	-	-	-	-
Dokuz Eylül Uni.	Faculty of Fine Arts	Musicology	Musicology	Music Sciences	Music Sciences	Fine Arts
Dokuz Eylül Uni.	İzmir State Conservatory	Musicology	General Musicology	Music Sciences	Music Sciences	Fine Arts
Erzincan B.Y. Uni.	Faculty of Fine Arts	Musicology	Musicology	-	-	-
Hacettepe Uni.	Ankara State Conservatory	Music Sciences	Musicology	-	-	-

University	Unit	Department	Main Science Branch (MSB) /Main Art Branch (MAB) Programme			
			Undergraduated	Master Degree	PhD	Institute
Harran uni.	State Conservatory	Musicology	-	-	-	-
Hatay M.K. Uni.	Antakya State Conservatory	Musicology	Musicology	-	-	-
Iğdır Uni.	Faculty of Fine Arts	Musicology	Musicology	-	-	-
İnönü Uni.	Faculty of Fine Arts and Design	Music Sciences	Musicology	Music, Music Sciences and Technology	Music, Music Sciences and Technology	Social Sciences
İstanbul Technical Uni.	İstanbul Turkish Music State Conservatory	Musicology	MusicologyMSB	Musicology	Musicology and Music Theory	Postgraduate Education
İstanbul Uni.	State Conservatory	Musicology	Musicology ,Etnomusicology	Musicology	Musicology	Social Sciences
Kafkas Uni.	State Conservatory	Musicology	Etnomusicology and Folklore	-	-	-
Kastamonu Uni.	Faculty of Fine Arts and Design	Musicology	Musicology	-	-	-
Kocaeli Uni.	State Conservatory	Musicology	General Musicology	Traditional and Cultural Musics	-	Social Sciences
Mardin Artuklu Uni.	State Conservatory	Musicology	Musicology	-	-	-
Mersin Uni.	State Conservatory	Musicology	Etnomusicology and Folklore, Traditional and Modal Musics, General Musicology	-	-	-
Mersin Uni.	Faculty of Fine Arts	Musicology	-	-	-	-
Mimar Sinan Fine Arts Uni.	İstanbul State Conservatory	Musicology	Etnomusicology, General Musicology	General Musicology, Etnomusicology and Folklore	General Musicology, Etnomusicology and Folklore	Social Sciences
Niğde Ö.H. Uni.	Turkish Music State Conservatory	Musicology	Musicology	Musicology	-	Social Sciences
Ondokuz Mayıs Uni.	State Conservatory	Musicology	General Musicology, Etnomusicology	-	-	-
Ordu Uni.	Faculty of Music and Performing Arts	Musicology	Musicology	-	-	-
Sakarya Uni.	State Conservatory	Musicology	Music Sciences	Music Sciences	Music Sciences	Social Sciences
Trabzon Uni.	State Conservatory	Musicology	Musicology	Musicology	-	Postgraduate Education
Trakya Uni.	State Conservatory	Musicology	-	-	-	-
Zonguldak B.E. Uni.	State Conservatory	Musicology	-	-	-	-

When examining the general status of musicology departments in Türkiye, according to data from the Council of Higher Education (CHE) Information Management System, there are a total of 33 musicology departments. Additionally, there are two Music Sciences departments. A total of 35 musicology and music sciences departments are actively functioning across 31 universities in Türkiye (CHE, 2024). These departments offer educational opportunities at both undergraduate and graduate levels. Notably, Anadolu University's Institute of Graduate Studies offers a Non-Thesis Music Therapy Master's Program, independent of the conservatory. Ankara Hacı Bayram Veli University provides undergraduate musicology education and offers master's and doctoral programs in the field of Turkish Music.

Although Ankara Yıldırım Beyazıt University is listed in the YÖK Information Management System as having a musicology department, an examination of the university's website reveals that there is no active program related to musicology within the Turkish Music State Conservatory or the Institute of Social Sciences. Similarly, the Music Sciences Department in the Faculty of Art and Design at Artvin Çoruh University is listed as a musicology department in the YÖK Information Management System. However, upon checking the university's website, while the musicology department is visible on the faculty page, the department is referred to as the Music Sciences Department when clicked. A similar situation is observed at Atatürk University's Faculty of Fine Arts, where the Music Sciences Department also

includes the Musicology Main Art Branch. However, no musicology department is listed on Atatürk University's Turkish Music State Conservatory website, even though it is recorded in the CHE Information System.

A similar situation exists at Çukurova University's State Conservatory. The Music Sciences Department exists within the Faculty of Fine Arts at Çukurova University, but educational activities have yet to commence. While the Music Sciences Department is listed on the Mersin University Faculty of Fine Arts website, it is recorded as a musicology department in the CHE Information Management System, and it appears that the department has not yet started admitting students.

Moreover, similar issues are observed at Harran University State Conservatory, Hatay Mustafa Kemal University Antakya State Conservatory, and Kafkas University State Conservatory. In these universities, musicology departments are listed in the CHE Information Management System, but there is no clear information regarding the educational activities of these departments. At Dokuz Eylül University's State Conservatory, the institution is registered under the name İzmir State Conservatory in the CHE Information System. Additionally, no information can be found regarding the active or inactive status of the Musicology Department within the Faculty of Fine Arts at Erzincan Binali Yıldırım University, based on its website. While the musicology department is listed in the CHE Information System at Trakya University's State Conservatory, the department does not appear on the university's website. Furthermore, it has been determined that there is no musicology department at Zonguldak Bülent Ecevit University.

In this context, the musicology departments in Türkiye offer various academic programs and course content designed to provide a comprehensive musicology education. Courses covering a wide range of subjects such as music history, music theory, ethnomusicology, and systematic musicology aim to equip students with the ability to understand and analyze different aspects of music. Undergraduate programs are designed to provide students with fundamental knowledge in musicology and to focus on research methodologies, while master's and doctoral programs encourage in-depth research on more specialized topics. In particular, graduate programs adopt interdisciplinary approaches, fostering high-quality research in the field of musicology.

Academic Career Paths in Musicology and Research Conducted in This Field

In Türkiye, individuals aspiring to pursue an academic career in the field of musicology must undergo certain educational and qualification processes. These processes begin with high school graduation and continue through undergraduate, master's, and doctoral studies. The first step, undergraduate education, provides students with comprehensive training in musicology, covering fundamental concepts, history, and theory of music. Students who wish to study musicology are admitted to the departments after successfully passing special aptitude exams conducted by universities. Undergraduate education equips students with a broad knowledge base in subfields such as music history, music theory, ethnomusicology, and systematic musicology. This education is provided within different academic units such as State Conservatories, Faculties of Fine Arts, Faculties of Art and Design, and Faculties of Music and Performing Arts. These departments offer interdisciplinary curricula, ensuring that students receive a well-rounded education in musicology.

After completing undergraduate studies, students may apply to master's programs to continue their academic careers and specialize in specific areas. Graduate education offers students the opportunity to conduct in-depth research on a specific topic and develop their academic skills. Graduate programs are offered within universities' graduate institutes, social sciences institutes, or fine arts institutes. Master's students can pursue either thesis or non-thesis programs in musicology, adopting an interdisciplinary approach to their studies. During this process, departments of musicology host a wide range of research projects exploring the relationship between music and other disciplines. Graduate students often specialize in specific areas such as music theory, music therapy, ethnomusicology, or music history, conducting original thesis research.

Doctoral education represents the highest level of academic career in musicology. Students who successfully complete their master's studies are admitted to doctoral programs, where they gain the ability to conduct independent research. Doctoral programs aim to encourage students to make original and significant contributions to the field of musicology. During this stage, students select an original research topic and conduct comprehensive dissertation work.

Doctoral education is typically managed by university institutes, offering opportunities for specialization in various subfields of musicology, such as music theory, music sociology, and music psychology.

There are various career opportunities available for individuals pursuing an academic career in musicology. Starting with the position of research assistant, individuals can progress to academic titles such as assistant professor, associate professor, and full professor. Those holding academic positions can teach at undergraduate and graduate levels, conduct scientific research, and contribute to scientific knowledge by publishing articles in national and international academic journals. Additionally, they can work as independent researchers, publishers, or editors, and take on roles in fields such as music archiving and librarianship. They may also work as art directors or music managers in museums, cultural centers, and arts organizations, or participate in fieldwork as ethnomusicologists, advancing their careers in ethnomusicology. By providing consultancy services for cultural projects, governmental organizations, or non-governmental organizations, they can explore the social and cultural impacts of music and prepare reports in this area. Furthermore, they can offer consultancy services in music production, media, and entertainment sectors, bringing an academic perspective to various projects.

In Türkiye, academic work in the field of musicology is presented in different forms, such as theses, books, and articles. Graduate theses include original research in various subfields of musicology. These theses contribute significantly to fields such as music history, music theory, ethnomusicology, organology, music sociology, and music psychology. Each year, numerous master's and doctoral theses are completed in Türkiye, expanding the body of scientific knowledge in the field of musicology.

Books are another important form of publication in musicology. Books written in this field in Türkiye often include comprehensive studies examining the historical development, theoretical foundations, and cultural contexts of music. These books not only appeal to academic circles but also help the general public understand music, bringing musicological knowledge to a broader audience. Moreover, articles written in the field of musicology are published in national and international academic journals, contributing to scholarly discussions and paving the way for new research topics.

Finally, conference papers and presentations serve as another key form of academic dissemination in musicology, allowing researchers to share their work at scientific events. Presentations at national and international congresses and symposiums provide an opportunity to share up-to-date knowledge and findings on various aspects of music. All of these academic works contribute significantly to advancing scientific research in musicology in Türkiye, further establishing the discipline within national and international academic communities.

In this context, scholars in the field of musicology in Türkiye make significant contributions to both national and international levels, leading the development and enrichment of the discipline.

Conclusion and Discussion

This review focuses on the current state of musicology education in Türkiye, the processes involved in training scholars, and the challenges encountered in this field. The research findings reveal that although significant progress has been made in musicology, there are numerous aspects of the current system that require improvement. In the discussion section, the results will be interpreted in comparison with other studies in the literature, emphasizing the importance of these findings for general musicology education and scientific research.

Firstly, it has been observed that the institutional structure of musicology education in Türkiye has expanded. According to data from the Council of Higher Education Information Management System, there are 33 musicology departments and two Music Sciences departments across the country. This expansion strengthens the relationship between musicology and other disciplines, offering students more educational opportunities. However, as noted in Öztutgan's (2019) study, discrepancies in curricula and the lack of strong theoretical foundations among these departments create difficulties in the process of training scholars. This is in line with Terzioğlu's (2018) study, which highlights the theoretical course deficiencies in Turkish musicology programs compared to European counterparts. Terzioğlu points out that core music theory courses, such as composition techniques, harmony, and counterpoint, are

not sufficiently provided, arguing for the necessity of more in-depth music theory education in Turkish musicology departments.

Furthermore, Yıldırım's (2004) research suggests that musicology education in Türkiye tends to be more performance-oriented, with limited focus on theoretical studies. These findings indicate that institutions offering musicology education need to place greater emphasis on theoretical and interdisciplinary approaches. Increasing research focused on cultural studies, particularly in areas such as ethnomusicology, could contribute to a better academic understanding of Türkiye rich musical heritage. Clayton's (2016) research on the cultural functions of music supports this view, arguing that ethnomusicology education in Türkiye should be further promoted to foster a deeper understanding of music within its cultural context.

This research also evaluates the academic career opportunities available to students in musicology departments. An examination of the structure of undergraduate, master's, and doctoral programs reveals that specialization in musicology requires a clearly defined academic process. However, the fact that some universities' graduate programs have not yet become fully operational hinders the training of scholars. For instance, the musicology departments at Çukurova and Mersin universities have not yet begun accepting students, limiting the career opportunities available for students interested in pursuing a career in musicology.

Academic research in the field of musicology in Türkiye has made significant contributions through products such as theses, books, and articles. Graduate theses, in particular, contain original research in various subfields of musicology, expanding the body of scientific knowledge in the field. However, as highlighted by Hansen et al. (2016) in their work on historical musicology, research in this area remains limited in Türkiye, and academic work in historical musicology needs to be further encouraged. Historical musicology plays a critical role in understanding the evolution of musical cultures, and musicology departments in Türkiye should increase their focus on research in this field.

In conclusion, while musicology education in Türkiye holds significant potential in the training of scholars, there are several aspects of the current system that need to be developed. Strengthening the curriculum, deepening theoretical education, and expanding graduate programs will enable the training of more qualified scholars in the field of musicology. Additionally, by collaborating with international academic communities, the global impact of musicology research can be broadened. These developments in musicology will also contribute to a better understanding and preservation of Türkiye's rich musical culture. In this context, transforming musicology education into a more effective and scientifically grounded system will be a critical step for future academic work.

Recommendations

Based on the review, several recommendations can be made to improve musicology education and the process of training scholars in Türkiye. First, the curricula of musicology departments should be restructured with a more comprehensive and interdisciplinary approach. Core courses such as music theory, composition techniques, harmony, and counterpoint should be adequately provided, addressing current deficiencies in these areas. As Terzioğlu also emphasized, placing greater emphasis on theoretical music courses will enhance students' academic skills. Furthermore, increasing research and educational opportunities in interdisciplinary areas such as ethnomusicology, music sociology, and music psychology will provide students with a broader perspective. In this way, musicology departments can train scholars who are not only focused on the technical aspects of music but also engaged with its cultural and social impacts.

A major priority should be the expansion and activation of graduate programs in universities offering musicology education. During the research, it was observed that some universities had not yet launched graduate programs or were not accepting students, which negatively affects the process of training scholars in musicology. Therefore, it is crucial that these programs become active and begin admitting students as soon as possible to ensure the sustainability of academic work in the field of musicology. Similarly, the curricula of graduate programs should be updated and diversified in line with international academic standards. Master's and doctoral programs, in particular, should be designed to provide students with opportunities for independent research and contributions to the scientific community.

Enhancing academic career opportunities is another key area for development. The research and publication processes of academics working in musicology departments should be supported, and their participation in international projects should be encouraged. Participation in national and international conferences by academics will increase the exchange of scientific knowledge in this field and help establish global recognition for musicology research in Türkiye. Additionally, supporting independent researchers and postdoctoral research projects will pave the way for innovative research in musicology.

It is important for musicology departments to place greater emphasis on local and cultural research projects to better understand and preserve Türkiye's rich musical heritage. More resources and research opportunities should be allocated to cultural music studies, particularly in areas such as ethnomusicology. Investigating the musical traditions of different regions of Türkiye will enable a deeper exploration of the social and cultural significance of music. These studies will not only benefit the academic community but also contribute to the preservation of music as a cultural heritage.

Finally, musicology departments in Türkiye should strengthen international collaborations. Developing joint projects with musicology departments abroad and increasing student and faculty exchange programs will enhance the quality and diversity of musicology education. Additionally, increasing the number of academic articles published in international journals and encouraging publications in different languages will help promote national musicology research on international platforms. This will result in greater recognition and contributions of musicology research from Türkiye on a global scale.

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Research Article

The defense of socrates: argument analysis

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Abstract

Socrates lived in Athens between 469 BC and 399 BC. He was a philosopher who led people to question and attracted attention with his courage. Socrates was accused of corrupting the youth by three people: the poet Meletus, the politician Anitus, and the orator Lycheon. The court used democratic means and decided to execute him with 280 votes against 221 in a jury of 501 people. Socrates was 70 years old when he was forced to drink hemlock poison. The book "The Defense of Socrates" by Plato focuses on how Socrates conducted his defense. It aims to analyze how he defends himself against the majority's argument with content and argument analysis techniques and to obtain a visual schema. Content analysis is planned to be interpreted in terms of (a) the sub-issues on the table, (b) discourse style, and (c) intra-textual coherence. As an argument analysis, the maneuvers he uses against the discourse of the majority in the face of authority will be examined. Witnessing how honest Socrates was when he used these maneuvers in his trial is admirable. Considered as a method, the premise of an argument analysis is that there must be disagreement in the argument. Based on this assumption, Toulmin Model, Pragma-Dialectics, Political Discourse Analysis, and Argument Sources Model have been established as the contemporary ones. This study plans to use Frans Van Emerman's pragma-dialectical approach. In this model, argument is defined as defending or rejecting an opinion. It divides the review into four parts: encounter, opening, discussion, and conclusion. Based on this, this study will first (1) reveal the disagreement. In the following, (2) irrelevant topics in the text will be eliminated, (3) implied content will be emphasized, (4) ambiguity will be clarified, and (5) the mess of the text will be rearranged according to logical relationship. The text processed in this way is simplified verbally. The most important feature of this model is that it pays attention to the natural structure of the language. This model was preferred because the discussions can be transferred to the model more easily. It is thought that this study will help our teachers teach thinking education as an elective in primary education and philosophy in high school.

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Introduction

Examining the text of a dying man, philosopher or not, in terms of his defensive techniques may at first appear to be a soulless exercise. However, because of high intelligence and courage, it is, at the same time, a sign of great respect and admiration. As a critical thinking tool, it is one of the best ways to witness authentic persuasion, especially for someone in big trouble or under a severe threat. Socrates lived in Athens between 469 BC and 399 BC. He was a philosopher who led people to question and attracted attention with his courage. Unfortunately, he was accused of corrupting the youth by three people: the poet Meletus, the politician Anitus, and the orator Lycheon. The court used democratic means and

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decided to execute him with 280 votes against 221 in a jury of 501 people. Socrates was 70 years old when he was forced to drink hemlock poison.

His defense was not just for the jury but also for Athenians (Leibowitz, 2010). Thanks to Plato's book The Defense of Socrates, his words extended to the people of Athens, now and probably the future of the world. Except for the last part of the book, the speech is included in two parts: one before and after the verdict of the court.

The Apology has been known to be composed within a decade after the trial by Platon (Hansen, 1995). Unfortunately, Sokrates cannot be known from his writing but from Plato's texts. He preferred to discuss and make mutual conservations alive (Waterfield, 2009). When we leave behind the question of whether we can trust Plato's writings, according to Plato's dialogues, who is the figure of Socrates is an inquirer like his mother's midwifery gives birth to ideas (Burnyeat, 1977). Generally, he works untiringly for definitions with neat clarity. He usually does not try to produce but evaluates the deficiencies and inaccuracies of others' definitions (De Vogel, 1963). Concepts like virtue, courage, justice, goodness, knowledge, friendship, and fineness are the main concepts (Wolfsdorf, 2003).

Trying to find clarity in definitions, from the Socratic approach, "what is F?" is generally the first question. Here, Socrates's job was to unearth statements, not satisfying F-conditions, interlocutor Wolfsdorf, D. (2003). He states that he does not know anything, but never put thoughts just attacks to the missing points of propositions made by others. Başkalarıyla olan tartışmalarında izlediği yolu, konu kendisine gelince izleyebilmekte midir? Could he follow the same path in discussions with others regarding himself? or did he deviate from it?

Problem of Study

The study's main research question is "How did Socrates conduct his defense?"

Method

Research Model

The current study adopts a qualitative research model to answer the question, "How did Socrates conduct his defense?" Based on this inquiry, contemporary models for analyzing arguments will be considered.

Data Analysis

How this fundamental critical stance should be analyzed plays a crucial importance. While reducing the speech to an argumentation form, the natural tongue of an authentic and unique speech should not be missed in the name of reliability. The speech might include self-defense and sometimes a reaction to the possible verdict. In his speech, Socratic style can be captured for and against himself. This subjectivity might be missed under rigid argument-analyzation techniques. Frans Van Emerman's pragma-dialectical approach balances the most formal and least formal methods. While pragmatists focus on bringing order, dialectics pursue the observational effect of sayings on others (Van Eemeren, Houtlosser & Henkemans, 2008). Pragma-Dialectics perfectly fits well among contemporary models.

Procedure

Socrates' apology is the main tool for collecting data. The text has been read four times, and each time, a note was taken for the procedure below:

- the main disagreement of the text will be clarified.
- irrelevant issues will be removed,
- the implied content will be emphasized,
- any ambiguity shall be clarified; and
- the clutter of the text will be reordered according to the logical relationship (van Eemeren & Grootendorst, 2004)

All argument-basis sayings were divided into four categories: (1) confrontation, (2) opening, (3) discussion, and (4) finalization. In the phase of confrontation, argument analysis begins by identifying the disagreement.

Results

		Related script
Confrontation	1.1	I don't know* how you, fellow Athenians,* have been affected by my accusers, but for my part I felt myself almost transported by them, so persuasively did they speak. (p. 27)
	1.2	But the most absurd thing of all is that one cannot even get to know their names or say who they were except perhaps one who happens to be a comic playwright.* The ones who have persuaded you by malicious slander, and also some who persuade others because they have been persuaded themselves, are all very hard to deal with: one cannot put any of them on the stand here in court, or cross-examine anybody, but one must literally engage in a sort of shadow-boxing to defend oneself, and cross-examine without any one to answer. (p.28)
Opening	2.1	Let me read out their deposition, if they were my legal accusers: 'Socrates is guilty of being a busybody, in that he inquires into what is beneath the earth and in the sky, turns the weaker argument into the stronger, and teaches others to do the same.' (p.29)
	2.2	Now perhaps one of you will interject: 'Well then, Socrates, what is the difficulty in your case? What is the source of these slanders against you? If you are not engaged in something out of the ordinary, why ever has so much rumour and talk arisen about you? It would surely never have arisen, unless you were up to something different from most people. (p.31)
Discussion	Premise 1	'Here is someone wiser than I am, and yet you said that I was the wisest.' So I interviewed this person-I need not mention his name, but he was someone in public life; and when I examined him, my experience went something like this, fellow Athenians: in conversing with him, formed the opinion that, although the man was thought to be wise by many other people, and especially by himself, yet in reality he was not. So I then tried to show him that he thought himself wise without being so. I thereby earned his dislike, and that of many people present; but still, as I went away, I thought to myself: 'I am wiser than that fellow, anyhow. Because neither of us, 1 dare say, knows anything of great value; but he thinks he knows a thing when he doesn't; whereas I neither know it in fact, nor think that do. At any rate, it appears that I am wiser than he in just this one small respect: if I do not know something, I do not think that I do.' Next, I went to someone else, among people thought to be even wiser than the previous man, and I came to the same conclusion again; and so I was disliked by that man too, as well as by many others. (p.32)
	Premise 2	In addition, the young people who follow me around of their own accord, t the ones who have plenty of leisure because their parerits are wealthiest, enjoy listening to people being cross-examined. Often, too, they copy my example themselves, and so attempt to cross-examine others. (p.34)
	Premise 3	Then when asked just what he is doing or teaching, they have nothing to say, because they have no idea what he does... (p.35)
	Premise 4	... rather than seem at a loss, they resort to the stock charges against all who pursue intellectual inquiry, trotting out 'things in the sky and beneath the earth', 'failing to acknowledge the gods', and 'turning the weaker argument into the stronger'. They would, I imagine, be loath to admit the truth, which is that their pretensions to knowledge have been exposed, and they are totally ignorant. So **because these people have reputations to protect,** I suppose, and are also both passionate and numerous, and have been speaking about me in a vigorous and persuasive style, they have long been filling your ears with vicious slander. (p.35)
	Premise 5	I believe, God has attached to our city just such a creature-the kind which is constantly alighting everywhere on you, all day long, arousing, cajoling, or reproaching each and everyone of you. You will not easily acquire another such gadfly, gentlemen; rather, if you take my advice, you will spare my life. (p.45)
	Premise 6	because if I do corrupt any of our young people, or have corrupted others in the past, then presumably, when they grew older, should any of them have realized that I had at any time given them bad advice in· their youth, they ought now to have appeared here themselves to accuse me

		and obtain redress.· Or else, if they were unwilling to come in person, members of their families fathers, brothers, or other relations--had their relatives suffered any harm at my hands, ought now to put it on record and obtain redress.
	Premise 7	... perhaps, among your number, there may be someone who will harbour resentrrient when he recalls a case of his own: he may have faced a less serious trial than this one, yet begged and implored the jury, weeping copiously, and producing his children here, along with many other relatives and loved ones, to gain as much sympathy as possible. By contrast, I shall do none of those things, even though I am running what might be considered the ultimate risk. Perhaps someone with those thoughts will harden his heart against me; and enraged by those same thoughts, he may cast his vote against me in anger. Well, if any of you are so inclined-not that I expect it of you, but if anyone *should* be-I think it fair to answer him as follows: 'I naturally do have relatives, my excellent friend, because-in Homer's own words*-I too was "not born of oak nor of rock", but of human parents; and so I do have relatives-including my sons,* fellow Athenians. There are three of them: one is now a youth, while two are still children. Nevertheless, I shall not produce any of them here, and then entreat you to vote for my acquittal.' And why, you may ask, will I do no such thing? Not out of contempt or disrespect for you, fellow Athenians whether or not I am facing death boldly is a different issue. The point is that with our reputations in mind yours and our whole city's, as well as my own-I believe that any such behaviour would be ignominious, at my age and with the reputation I possess; that reputation mayor may not, in fact, be deserved, but at least it is believed that Socrates stands out in some way from the run of human beings. Well, if those of you who are believed to be pre-eminent in wisdom, courage, or any other form of goodness, are going to behave like that, it would be demeaning. (p.49-50)
Finalization	4.1	For many reasons, fellow Athenians, I am not dismayed by this outcome-your convicting me, I mean-and especially because the outcome has come as no surprise to me. I wonder far more at the number of votes cast on each side, because I did not think the margin would be so narrow. (p.51)
	4.2	For the sake of a slight gain in· time, follow Athenians, you will incur infamy and blame from those who would denigrate our city, for putting Socrates to death-a 'wise man'-because those who wish to malign you will say I am wise, even if I am not; in any case~ had you waited only a short time, you would have obtained that outcome automatically. You can see, of course, that I now well advanced in life, and death is not far off. I address that not to all of you, but to those who condemned me to death;* and to those same people I would add something further.
	4.3	let us also reflect upon how good a reason there is to hope that death is a good thing. It is, you see, one or other of two things: either to be dead is to be nonexistent, as it were, and a dead person has no awareness whatever of anything at all; or else, as we are told, the soul undergoes some sort of transformation, or exchanging of this present world for another. Now if there is, in fact, no awareness in death, but it is like sleep-the kind in which the sleeper does not even dream at all*-then death would be a marvellous gain. On the other hand, if death is like taking a trip from here to another place, and if it is true, as we are told, that all of the dead do indeed exist in that other place, why then, gentlemen of the jury, what could be a greater blessing than that? If upon arriving in Hades, and being rid of these people who profess to be 'jurors', one is going to find those who are truly judges, and who are also said to sit in judgment there*-Minos, Rhadamanthys, Aeacus, Triptolemus, and all other demigods who were righteous in their own lives-would that be a disappointing journey? Or again, what would any of you not give to share the company of Orpheus and Musaeus, of Hesiod and Homer? I say 'you,' since I personally would be willing to die many times over, if those tales are true. (p. 57)

Discussion and Conclusion

Self-examination behavior is the main style of Socrates used for others who want to discuss concepts with him. In this regard, Socrates' confrontation might surprise readers by showing how he uses his method intelligently against himself, although he is on the brink of death. The first sentence clearly dictates that he doubted himself in the face of the accusations, so he almost believed it. By emphasizing that the rumors were quite convincing, later, he will separate what seems on the surface and the reality behind it.

Socrates does not hurry to reveal the truth. At the confrontation stage, he makes a second move. He declares his weak position based on the fact that his accusers are not here. He employs a rich use of language by metaphorically resembling this situation as fighting with shadows (See 1.2). The fact that he prefers that the accusers were there is attributable to truth-seeking behavior, as he cannot cross-examine, but it also indicates that he is giving the first signals that the accusation is unfounded. Therefore, Sokrates has already given that they are persuasive but invalid before the opening stage of his defense.

In the opening stage, he firstly describes the accusation (See 2.1.). He continues questioning like an impartial person by asking "if I am are not engaged in something out of ordinary, why ever has so much rumour and talk arisen about me?" (See 2.2.). with this question he starts the discussion part and tell how he is the enemy of society. He explains that he visited people who pretended to be knowledgeable; that he tried to explain to them what they thought they knew but in reality did not know, and that as a result he earned enmity.

Socrates calls this sitation as double ignorance. People don't panic when they are asked a question and they know the answer nor they know they don't know the answer. However, they are alarmed when they think they know and then realize they don't. (Farnsworth, 2021). The realization that you know less than you thought is at first a rude awakening, but extremely valuable. It is perceived by the ego as a loss. However, Socratic work helps to make this discovery more welcome. This discovery is the coming of wisdom. Based on this idea, Socrates find himself more knowledgeable than the people he visits who thinks are they are knowledgeable, because at least he was aware that he does not know, but they do not.

As a second premise of the discussion, he constitutes that he is not an enemy of all people but a sage for the youth. In this way, he breaks the general validity by saying that he was not also haunted by the youth but also they questioned others just like himself (See 3.2.). However, the first time that he reveals the accusation's invalidity is in premise 3. He states that if his accusers were asked what Socrates teaches, they would not know (See 3.3.). So what is their motivation for doing this? He explains in his 4th premise that they do not want their pretense of knowing to be exposed, so they gain a favor by slandering (See 3.4).

From now on, Sokrates will leave the main statements and attack by using supplementary argumentations. Firstly, in the fifth premise, he supports that the reason for executing should be the reason for keeping him alive, since there will be nobody like him in the world. He advises the court not to deprive them of himself. This is where he compares himself to a horsefly, which clearly shows that he does not reject the fact that he makes people uncomfortable (See 3.5.). Secondly, in the sixth premise, he uses a hypothetical approach: If what the accusers said was true, those young who have grown up today would take revenge by exposing what he has done wrong so far (See 3.6.). Thirdly, in the seventh premise Socrates addresses the audience who wonder why he does not beg the judges enough and become angry. He explains that it is against his honor not to resort to such manipulative means (See 3.7.).

The court sentences him to death. At that point, Socrates makes his final speech. (See 4.1.). Contrary to what is supposed, this section is not sentimental but, again, reasonable. First of all, with 221 votes in favor to 280 against, he says he did not expect the votes to be so evenly matched. Secondly, he warns the court that the execution of a wise man will not be forgotten and remembered as infamy (See 4.2.). Thirdly and lastly, he does something that he does not do in his other texts. In his debates, Socrates usually does not reach conclusions, but he finds the shortcomings of the proposition the other has established. Here, Sokrates completes his defense by conceptualizing death. He explains in detail what death means in two ways to him: either derin uyku or tanrılara ulaşmak. In either means there is nothing to be feared, he lastly says.

Claiming that his lectures are paid for is an attack of "you are a sophist, not a philosopher". Sophists make money by teaching how to strengthen arguments (Sharrock & Ashley, 2013). For Sockrates, receiving payment in the face of teaching virtue is embarrassing based on the reasons that (1) teachers should reach everyone, not just people who have Money, and (2) taking pay might decrease the real love of learning but may increase the love of Money. (3) taking pay makes one a whore (Corey, 2002).

Recommendations

Recommendation for further research

In this article, only Socrates' techniques are revealed. In the future, comparisons can be made between Socrates' defense and other texts in the same genre in terms of style and form. Subtle differences between defenses of ideas can be revealed. Draw attention to the nuances between spontaneous and deliberate arguments.

Recommendation for application

The Defense of Socrates should be taught as a subject in schools. It is the main text for understanding how to be oneself under stressful conditions.

Limitation of the Study

This study has a limitation of one personal view which might differ accordingly.

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Assoc.Prof. **Burcu Seher Çalıkoğlu** graduated from Boğaziçi University Science Education Department with an additional diploma in "Elementary Mathematics Education Department" in 2006. She studied with gifted children for her both master and doctoral dissertation, In July 2015, she founded the Thinking Education Center in order to provide high-level thinking skills to gifted and talented students or those who want to develop their potential, and to contribute to the dissemination of high-level thinking culture. While working in Thinking Education Center, she deeply focuses on "challenge-oriented behaviors," "false-beliefs," "argumentation," "Socratic dialogue," "dialogue of full conflict," and "paradoxes" in her education. After leaving the center and passing to Izmir Democracy University, directed her concentration to research on these subjects. Currently, she is working as an associate professor at the Department of Special Education, Faculty of Education, Ağrı İbrahim Çeçen University. **Affiliation:** Ağrı İbrahim Çeçen University Education Faculty, Department of Special Education, Kahramanmaraş, Turkiye. **E-mail** : bscalikoglu@agri.edu.tr
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Research Article

Preparing future-ready students: the role of transformational leadership in equipping students for the 21st-century workforce

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Abstract

This study examines the role of transformational leadership in developing essential 21st-century skills like innovation, adaptability, problem-solving, and digital literacy within educational institutions. Using a cross-sectional survey design, data was collected from educators in public and private schools. The survey assessed leadership practices, including innovation inspiration, professional development opportunities, and guidance on adapting teaching strategies. T-tests and correlation analyses were used to explore the relationships between leadership and educational outcomes. Results indicate that transformational leadership significantly enhances STEM education, with 62.67% of respondents inspired to innovate and 56.67% reporting improved confidence in STEM teaching. No statistically significant differences were found between public and private schools, suggesting these practices are universally applicable. The correlation analysis revealed a moderate positive correlation ($r = 0.495$, $p < 0.001$) between fostering adaptability and preparedness for the workforce, underscoring the critical role of leadership in equipping students with the skills needed for success in the 21st-century job market. The findings underscore the critical role of leadership in equipping students with the skills needed for the 21st-century workforce and highlight the importance of fostering lifelong learning and adaptability. Future research should explore long-term impacts and applicability across diverse educational contexts.

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Introduction

The 21st-century workplace is marked by unprecedented transformations driven by rapid technological advancements, globalization, and evolving industry demands. As organizations navigate these changes, there is a growing emphasis on equipping students with the skills, knowledge, and adaptability required to thrive in an increasingly complex and dynamic job market (Turi et al., 2022; Jada & Mayayise, 2024). Despite the clear need for these competencies, research consistently highlights a significant gap between the skills employers expect and those that recent graduates possess, revealing a critical misalignment between educational outcomes and market demands (Tushar & Sooraksa, 2023). This gap underscores the necessity for educational institutions to adopt a more proactive approach in preparing students for the workforce (Li, 2022). Central to this effort is the role of transformational leadership in education, which has the potential to bridge the divide by fostering a culture of innovation, critical thinking, and technological readiness. Transformational leaders can drive meaningful changes in educational practices, ensuring that curricula are aligned with the skills required in the modern workplace (Sliwka et al., 2023; Heenan et al., 2023; Kareem et al., 2023). By integrating

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technology into learning and emphasizing the development of employability skills, educational leaders can better prepare students to meet the challenges of the 21st-century workforce (Oliveira & Marques, 2024; Cassidy, 2006). This study explores the pivotal role of transformational leadership in equipping students with the competencies needed for success in today's rapidly evolving job market.

Specifically, this research aims to:

- Evaluate the influence of transformational leadership on the development of 21st-century skills such as innovation, adaptability, problem-solving, and digital literacy in STEM education
- Assess the role of school leaders in providing professional development opportunities and involving teachers in decision-making processes related to STEM education
- Analyze the consistency of perceptions regarding transformational leadership practices in STEM education across public and private schools
- Examine the correlation between leadership practices and key educational outcomes such as adaptability, problem-solving, and digital literacy
- Investigate how transformational leadership prepares students for the challenges of the 21st-century workforce by fostering a culture of lifelong learning and adaptability.

The study investigates how transformational leadership influences the development of 21st-century skills—innovation, adaptability, problem-solving, and digital literacy—in STEM education. It explores the role of school leaders in providing professional development opportunities and involving teachers in STEM-related decision-making. Additionally, the study examines whether perceptions of transformational leadership in STEM education are consistent across public and private schools. It also assesses the relationship between leadership practices and key educational outcomes, such as adaptability, problem-solving, and digital literacy. Finally, the study evaluates how transformational leadership prepares students for 21st-century workforce challenges by fostering a culture of lifelong learning and adaptability.

The study proposes several hypotheses: H1 suggests that transformational leadership significantly influences the development of 21st-century skills such as innovation, adaptability, problem-solving, and digital literacy in STEM education. H2 posits that school leaders who actively provide professional development opportunities and involve teachers in decision-making processes significantly enhance the effectiveness of STEM education. H3 asserts that perceptions of transformational leadership practices in STEM education are consistent across public and private schools, with no statistically significant differences. H4 indicates a positive correlation between transformational leadership practices and key educational outcomes, particularly adaptability and workforce preparedness, with adaptability showing a stronger correlation.

Literature review

The Critical Role of Employability Skills in the 21st-Century Workplace

The 21st century has transformed the workplace environment, driven by advancements in technology, socioeconomics, and industry. These changes, accelerated by the COVID-19 pandemic, have made it imperative for organizations to adapt by fostering employees who excel in technical and professional skills, embrace emerging technologies, and demonstrate self-motivation. These qualities, broadly termed employability skills, are essential for achieving competence, confidence, and effectiveness in modern work settings. Despite their importance, research consistently shows that many graduates lack the market-driven employability skills necessary for success in today's rapidly evolving workplace, highlighting a critical gap that needs to be addressed for future workforce readiness (Lim, 2023; Llinares-Insa et al., 2018; Tushar & Sooraksa, 2023).

Aligning Educational Outcomes with Employability Skills

Tushar & Sooraksa (2023) identified a gap between employers' expectations and the skills that graduates possess. As a result, the employability skills highlighted in their study can serve as an essential resource for bridging this gap. These skills include problem-solving, communication, teamwork, adaptability, willingness to learn, creativity and initiative,

ICT skills, analytical and critical thinking, integrity, interpersonal skills, leadership, planning and organizing, self-management, responsibility, and maintaining a positive attitude and behavior. These skills are seen as critical for graduates to meet employers' expectations and succeed in a rapidly evolving job market. The study emphasizes the importance of aligning educational outcomes with these skills to better prepare students for the modern workplace (Tushar & Sooraksa, 2023).

Employers are focused on closing skill gaps through strategies like hiring skilled employees, retraining current staff, and leveraging automation. They also believe that higher educational institutions play a vital role in developing these necessary skills (Cassidy, 2006). According to Qenani et al. (2014), universities should act as hubs of culture and creativity, fostering the development of knowledge, traits, and skills vital for students' personal and professional growth. This highlights the shared responsibility between employers and educational institutions in preparing a workforce equipped for the demands of the modern workplace.

Preparing Future-Ready Graduates: The Need for Transformational Leadership

The 21st-century workplace is characterized by workforce diversity, technological advancements, and evolving management strategies (Turi et al., 2022). Technology has revolutionized work, enabling remote collaboration and global connectivity, but also presenting challenges like cybersecurity threats and the ongoing need for skill development. These changes require new management approaches that address the dynamic workplace environment (Jada & Mayayise, 2024).

Preparing students for the 21st-century workforce involves equipping them with the skills, knowledge, and character needed to thrive in a constantly changing job market. As globalization and population growth intensify, higher education must not only produce graduates but also transform educational practices to better prepare them for workplace challenges. This includes providing meaningful and authentic educational experiences that enhance human capital (Casillas et al., 2019). Leadership within higher education institutions plays a pivotal role in student success, demanding focused attention to its impact. Institutions must shift from merely developing human capital to fostering "future-ready" graduates. Current teaching philosophies may fall short in equipping students with the necessary skills for the modern workforce, highlighting the need for improved teacher training and classroom approaches. Higher education leaders must adapt to ensure that graduates are prepared to meet the demands of the 21st-century workplace (Oliveira & Marques, 2024).

Transforming Education Through Technology-Ready Leadership

Employees' technology readiness is increasingly essential in the 21st-century workplace, with many key competencies reflected in the Technology Readiness Level (TRL) model. School leadership's transformational role is vital in fostering a culture that equips students with these competencies. As technology becomes more integral to daily life, the educational sector—comprising leadership, educators, and students—faces mounting pressure to produce individuals proficient in using and adapting to advanced technology. This requires not only familiarity with current technology but also the ability to navigate continuous technological advancements.

For meaningful change in the classroom, educational organizations must undergo transformation from the top down. Leadership at all levels must be retrained in the effective integration of technology into their roles. Educational leaders must address the same pedagogical challenges as teachers and support them in this transition. Professional development should begin at the administrative level, guiding leaders to develop and implement a vision for integrating web-based instruction and technology into curricula. By doing so, educational leadership can ensure that technology is effectively utilized in teaching, training, and support services, ultimately enhancing learning outcomes and preparing students for a tech-driven future.

The Role of Human Capital Resources in Organizational Success

Human capital resources are not just the sum of individual employee characteristics but emerge from the interactions among employees' knowledge, skills, abilities, and organizational factors. These resources, including both explicit and

tacit knowledge, are critical for gaining a competitive edge. Explicit knowledge is well-documented and easily shared, while tacit knowledge, derived from experience, is more nuanced and essential for effective decision-making.

The development and utilization of human capital resources are heavily influenced by organizational context—such as structure, culture, and work design—and by human resource policies and talent management practices. Training and development initiatives play a vital role in shaping these resources, ensuring that employees can apply their knowledge effectively within the organization. By fostering an environment that promotes the interaction of these factors, organizations can enhance their human capital resources, thereby driving innovation, adaptability, and sustained competitive advantage (Noe et al., 2014; Ployhart & Moliterno, 2011).

Navigating Career Challenges in Higher Education and the Transition to the Workforce

The rapid social, economic, and political changes of recent years have introduced new challenges in career construction, particularly for college students. These challenges impact students' ability to adapt to and persist in higher education and their transition to or specialization within the job market. Key vocational tasks during this period include preparing for professional roles and aligning jobs with their training.

Students must navigate increasingly complex and dynamic academic environments, manage their time effectively, and balance studies with personal life. Upon graduation, they face the challenge of finding or creating jobs that match their training and career goals while making significant career decisions in often precarious and unstable labor markets. This transition requires students to adapt and assume new professional roles in society amid these uncertainties (Savickas, 2005; Soares et al., 2021). Preparing future-ready students for the 21st-century workforce necessitates transformational leadership that aligns educational outcomes with essential employability skills and technological readiness. As the workplace evolves due to technological advancements and global connectivity, educational institutions must foster a culture that equips students with critical skills, adaptability, and innovation. By transforming educational practices and integrating technology, leaders can ensure students are well-prepared to navigate the challenges of modern careers. This holistic approach, emphasizing leadership, human capital development, and technology, is essential for bridging the gap between academic preparation and workforce demands.

Conceptual Framework

The conceptual framework of this study is centered on the relationship between transformational leadership and the development of 21st-century skills within STEM education. It is designed to explore how leadership practices influence educational outcomes and prepare students to meet the demands of the modern workforce. At the core of this framework is transformational leadership, characterized by four key components: inspirational motivation, intellectual stimulation, individualized consideration, and idealized influence. Inspirational motivation involves leaders inspiring and motivating educators to pursue innovation and creativity in their teaching practices, particularly within STEM education. Intellectual stimulation refers to leaders encouraging critical thinking and problem-solving, challenging educators to continuously improve their teaching methods and adapt to new educational demands. Individualized consideration highlights how leaders provide tailored support and professional development opportunities, addressing the unique needs of each educator to enhance their effectiveness in STEM education. Idealized influence encompasses leaders serving as role models, fostering a culture of trust, respect, and commitment to educational excellence.

The framework posits that transformational leadership directly impacts the development of essential 21st-century skills in students, including innovation, creativity, adaptability, lifelong learning, problem-solving, critical thinking, and digital literacy. Leadership-driven initiatives inspire educators to integrate new ideas and technologies into the curriculum, while an emphasis on continuous learning and adaptability helps students thrive in changing circumstances. Intellectual stimulation further develops problem-solving and critical thinking skills, and leadership support enhances digital literacy by integrating digital tools into the educational environment. This framework also explores the relationship between transformational leadership and key educational outcomes, specifically within STEM education. These outcomes include increased teacher confidence and competence, as leaders' support and guidance improve educators' ability to deliver STEM education effectively. Additionally, transformational leadership prepares students for

the demands of the modern job market by fostering essential 21st-century skills. The framework examines whether perceptions of transformational leadership are consistent across public and private schools, emphasizing the universal applicability of these practices.

Finally, the framework includes a feedback loop where the outcomes of transformational leadership inform and refine leadership practices. This continuous improvement cycle ensures that leadership strategies remain relevant and effective in addressing emerging challenges in STEM education and workforce preparation. Overall, this conceptual framework provides a comprehensive structure for understanding the critical role of transformational leadership in shaping educational practices and outcomes in the 21st century, with a particular focus on STEM education.

Significance of Study

The significance of the study lies in its exploration of the impact of transformational leadership on the development of essential 21st-century skills in STEM education, such as innovation, adaptability, problem-solving, and digital literacy. By examining how school leaders influence these outcomes through professional development and teacher involvement, the study provides valuable insights into effective leadership practices that can enhance STEM education across different types of institutions. Additionally, the study's findings on the consistency of leadership perceptions between public and private schools contribute to understanding the universal applicability of transformational leadership. Ultimately, the research helps to inform educational leaders and policymakers on strategies to better prepare students for the challenges of the 21st-century workforce, fostering a culture of lifelong learning and adaptability essential for future success.

Problem of Study

The 21st-century workforce demands a new set of skills, including innovation, adaptability, problem-solving, and digital literacy, which are essential for success in a rapidly evolving and complex job market. Despite this need, there is a significant gap between the skills employers expect and those that recent graduates, particularly in STEM (Science, Technology, Engineering, and Mathematics) education, possess. This misalignment underscores the urgent need to explore how educational leadership, specifically transformational leadership, can address this gap. Key areas of investigation include understanding how transformational leadership influences the development of 21st-century skills in STEM education, the extent to which school leaders involve teachers in decision-making processes related to STEM education, the consistency of perceptions of transformational leadership across different types of educational institutions, such as public and private schools, and the relationship

Method

Research model

This study employed a mixed-methods research design to examine the influence of transformational leadership on the development of 21st-century skills—specifically innovation, adaptability, problem-solving, and digital literacy—in STEM education. The research integrated both quantitative and qualitative components to provide a comprehensive understanding of the connections between leadership practices, teaching methods, and the enhancement of critical skills in educational settings. The quantitative component involved the use of surveys to assess the impact of transformational leadership, while the qualitative component included in-depth interviews to gain deeper insights into participants' experiences and perceptions.

Participants and Sampling

The study included 150 participants, comprising 115 university students enrolled in STEM courses and 35 professors teaching STEM subjects. These participants were selected using a stratified random sampling technique to ensure diversity in experience levels and educational backgrounds. Additionally, purposive sampling was employed for qualitative interviews with school district officers, capturing a diverse range of perspectives on the influence of leadership on STEM education. This approach allowed the study to gather a representative sample across different educational contexts and ensured a broad range of opinions.

Data Collection Tools

Data collection involved two primary tools: a 37-item questionnaire rated on a 5-point Likert scale, based on Peck & Shu (2009), and a set of demographic questions regarding participants' employment. The questionnaire was designed to assess perceptions of transformational leadership's role in fostering innovation, adaptability, problem-solving, and digital literacy in STEM education, with a particular focus on its impact on teaching practices and student preparedness for the workforce. Additionally, qualitative data were collected through in-depth interviews with selected school district officers, providing richer context and deeper understanding of the quantitative findings.

Data Analysis

The data were analyzed using a combination of descriptive statistics, t-tests, and correlation analysis. Descriptive statistics provided an overview of perceptions related to leadership's role in innovation, professional development, decision-making, confidence in STEM implementation, and fostering lifelong learning. The t-tests were conducted to compare perceptions between public and private schools, revealing no significant differences and indicating consistent views of leadership practices across institutions. Correlation analysis was employed to examine the relationships between leadership practices and key educational outcomes, showing a strong correlation between adaptability and workforce preparedness, with weaker correlations for problem-solving and digital literacy.

Procedure

The survey was distributed online using Amazon Mechanical Turk (MTurk). Of the 190 questionnaires distributed, 150 were completed and returned, yielding a response rate of 78.95%. The qualitative interviews were conducted following the survey to complement and deepen the understanding of the quantitative data. This combined approach allowed for a holistic examination of the impact of transformational leadership on the development of 21st-century skills in STEM education, aligning with Creswell's (2014) mixed-methods methodology. The data organization and analysis were performed using the Statistical Package for the Social Sciences (SPSS). After data cleaning and weighting, the mean and standard deviation were calculated to provide a descriptive overview of the collected data.

Results

The Role of Transformational Leadership in Enhancing 21st-Century Skills

The Table 1 indicates several key insights regarding the role of leadership in advancing STEM education. Leadership inspiration for innovation in STEM was evident, with 62.67% of respondents agreeing that their school leaders inspire them to be more innovative and creative in implementing STEM education in their classrooms. Opportunities for professional development were also significant, as 37.33% of respondents reported that their school leaders frequently provide opportunities and resources related to STEM education. When it comes to involvement in decision-making, 53.33% of respondents agreed that their school leaders actively involve teachers in decision-making processes concerning STEM education implementation. Leadership's impact on building confidence in implementing STEM education was notable, with 56.67% of respondents expressing confidence due to the support and guidance provided by their leaders. Additionally, 60.00% of respondents found leadership guidance to be effective in helping them adapt their teaching strategies for STEM education.

Moreover, 51.33% of respondents agreed that transformational leadership effectively prepares students for the challenges of the 21st-century workforce through STEM education. Similarly, 51.33% of respondents agreed that leadership fosters a culture of lifelong learning and adaptability among students, which is essential for their success in the modern workforce.

Table 1. Percentage distribution of variables related to STEM education and leadership

Variables	%
Leadership Inspiration for Innovation in STEM	62.67
Opportunities for Professional Development	37.33
Involvement in Decision-Making	53.33
Confidence in Implementing STEM Education	56.67
Leadership Guidance on Adapting Teaching Strategies	60.00
Preparation for the 21st Century Workforce	51.33
Fostering Lifelong Learning and Adaptability	51.33

Consistent Perceptions of Transformational Leadership in STEM Education Across Public and Private Schools

As stated in the table 2, the t-test results comparing responses between public and private schools indicate that none of the differences in the average responses for the key questions are statistically significant at the 5% level. This means that the observed differences in perceptions of transformational leadership in STEM education between public and private schools are not statistically significant, suggesting that these differences could be due to chance. These results suggest that the overall perceptions of transformational leadership in advancing STEM education are relatively consistent between public and private educational institutions.

Table 2. Consistent leadership perceptions in STEM education across school Types

Statements	t	*p*
Innovation and creativity inspired by leadership	-0.0214	0.9830
Teacher involvement in STEM decision-making by leadership	0.0878	0.9302
Confidence in STEM implementation with leadership support	-1.0114	0.3139
Impact of leadership on adapting STEM teaching strategies	-0.5097	0.6112
Motivation from transformational leadership to integrate STEM	-0.0428	0.9660
Effectiveness of leadership in fostering a supportive STEM environment	-1.1013	0.2737
Transformational leadership prepares students for 21st-century workforce challenges through STEM	0.2326	0.8164
Leadership fosters lifelong learning and adaptability through STEM education	0.2039	0.8388

The Influence of Leadership on Adaptability, Problem-Solving, and Digital Literacy

The correlation analysis reveals that leadership practices have a significant impact on key variables like adaptability and preparedness for the 21st-century workforce (Table 3). A moderate positive correlation (0.495) exists between fostering adaptability and workforce preparedness, with a strong significance. A weaker yet positive correlation (0.291) is found between fostering adaptability and adapting teaching strategies. The correlation between workforce preparedness and adapting teaching strategies is the weakest (0.159), with a p-value slightly above the 5% significance level. These findings suggest that leadership significantly influences adaptability and preparedness, with a somewhat weaker effect on problem-solving and digital literacy (Table 3).

Table 3. Influence of leadership on adaptability, problem-solving, and digital literacy

Variables	r	*p*
Culture of lifelong learning and adaptability to change vs Student preparation for 21st-century workforce	0.4951	4.33
Culture of lifelong learning and adaptability to change vs ability to adapt teaching strategies	0.2907	0.00
Student preparation for 21st-century workforce vs ability to adapt teaching strategies	0.1595	0.05

Discussion

The relationships between transformational leadership practices and key educational outcomes, specifically problem-solving, adaptability, and digital literacy, in various types of educational institutions was investigated in the present study. The descriptive statistics provide a clear indication of the significant role that leadership plays in advancing STEM education. The data highlights several key areas where effective leadership positively influences educational outcomes,

particularly in fostering innovation, professional development, decision-making involvement, confidence in teaching, and overall preparedness for future challenges.

Leadership Inspiration for Innovation in STEM

With 62.67% of respondents agreeing that their school leaders inspire them to be more innovative and creative in implementing STEM education, it is evident that leadership plays a crucial role in encouraging educators to embrace and promote innovative practices within their classrooms. This high level of agreement underscores the importance of visionary leadership that motivates teachers to explore new teaching methods and integrate creative approaches into their curriculum. Leaders who prioritize innovation are likely to create a dynamic and engaging learning environment that benefits both teachers and students (Candrasari et al., 2023).

Opportunities for Professional Development

The fact that 37.33% of respondents reported frequent opportunities for professional development indicates that while a significant portion of educators recognize the efforts of their leaders in this area, there is still room for improvement. Professional development is essential for equipping teachers with the latest tools, resources, and knowledge necessary to effectively teach STEM subjects (Huang et al., 2022; Hasim et al., 2022). Leadership that actively supports continuous learning and provides access to development resources can help teachers stay current with educational trends and best practices, ultimately enhancing their teaching effectiveness (Germuth, 2018; Hurley et al., 2023).

Involvement in Decision-Making

With 53.33% of respondents agreeing that their leaders involve them in decision-making processes related to STEM education, the data suggests that participatory leadership is fairly common. Involvement in decision-making can empower teachers, giving them a sense of ownership and responsibility for the educational strategies implemented in their schools. Leaders who involve teachers in such decisions are likely to foster a collaborative environment where teachers feel valued and motivated to contribute to the success of STEM initiatives (Park et al., 2020; Nezhad & Stolz, 2024).

Confidence in Implementing STEM Education

The finding that 56.67% of respondents feel confident in implementing STEM education due to leadership support indicates that effective leadership directly contributes to teacher confidence. Confidence is fundamental for the successful delivery of STEM education, as it affects how teachers approach their subjects, manage their classrooms, and engage with students. Leaders who provide clear guidance, resources, and encouragement can significantly boost teachers' confidence, leading to more effective teaching and better student outcomes (McTigue et al., 2024).

Leadership Guidance on Adapting Teaching Strategies

The fact that 60.00% of respondents found leadership guidance effective in helping them adapt their teaching strategies highlights the importance of adaptive leadership in a rapidly changing educational landscape. As educational needs evolve, particularly in STEM fields, teachers must continually adjust their methods to meet new challenges. Leaders who offer strong guidance in this area enable teachers to remain flexible and responsive, ensuring that their teaching remains relevant and effective (Friesen & Brown, 2020).

Preparation for the 21st Century Workforce

The agreement from 51.33% of respondents that transformational leadership prepares students for the challenges of the 21st-century workforce underscores the critical role of leadership in aligning education with future workforce demands. In a world where STEM skills are increasingly vital, leaders who focus on preparing students for these demands help ensure that their education is not only academically rigorous but also practically applicable in real-world scenarios (Whorton et al., 2017; Tushar & Sooraksa, 2023).

Fostering Lifelong Learning and Adaptability

Similarly, the agreement from 51.33% of respondents that leadership fosters a culture of lifelong learning and adaptability is significant. In today's fast-paced and ever-changing world, the ability to adapt and continue learning throughout one's life is essential. Leaders who instill these values in their students and staff contribute to a culture that

values growth, resilience, and continuous improvement, which are key to long-term success in any field, particularly in STEM (Feraco et al., 2023).

Universal Perceptions of Transformational Leadership in STEM Education across School Types

The t-test analysis shows no statistically significant differences in perceptions of transformational leadership in STEM education between public and private schools, suggesting that observed differences are likely due to random variation. This finding indicates that transformational leadership practices are perceived consistently across both institution types, underscoring the universal applicability and value of effective leadership strategies in STEM education. Educational leaders can confidently implement these strategies across different institutions without significant modifications (An et al., 2018). The results challenge assumptions about inherent differences between public and private schools, emphasizing the importance of considering individual school cultures. Further research could explore other factors influencing leadership perceptions and examine the impact of school-specific characteristics on these perceptions (Veletić et al., 2023).

Influence of Leadership on Adaptability, Problem-Solving, and Digital Literacy

The correlation analysis, as presented in Table 3, underscores the significant role of leadership practices in shaping key educational outcomes such as adaptability, problem-solving, and digital literacy. The analysis reveals a moderate positive correlation between fostering adaptability and preparedness for the 21st-century workforce, with a correlation coefficient of 0.495. This finding highlights the strong influence of leadership on these critical skills, suggesting that when leaders emphasize adaptability, it significantly enhances students' readiness for the challenges of the modern workforce (Chughtai et al., 2023; Tagscherer & Carbon, 2023; Matsunaga, 2024). Leadership positively influences problem-solving, though the correlation is weaker, indicating that promoting adaptability supports teachers in improving instructional methods (Schott et al., 2020). The weakest correlation, between workforce preparedness and adapting teaching strategies, suggests a modest link between leadership and digital literacy. These findings imply that while leadership significantly impacts adaptability, additional strategies may be needed to enhance problem-solving and digital literacy skills (Huang et al., 2022).

Conclusion

This study underscores the pivotal role of transformational leadership in enhancing STEM education and equipping students with essential 21st-century skills such as innovation, adaptability, problem-solving, and digital literacy. The findings reveal that leadership practices, including fostering a culture of lifelong learning and providing professional development opportunities, significantly impact educational outcomes. Moreover, the consistency of these effects across public and private schools highlights the universal applicability of transformational leadership in education. By aligning leadership strategies with the demands of the modern workforce, educational institutions can better prepare students for future challenges.

The study's limitations include a specific sample size, which may restrict the generalizability of the findings to other educational institutions, especially those in different regions or with varying resources. Reliance on self-reported data introduces potential biases, affecting the reliability of the results. The cross-sectional design captures data at one point in time, limiting the ability to assess changes over time or establish causal relationships. Additionally, the focus on STEM education may not fully apply to other disciplines, and the lack of longitudinal data restricts the examination of long-term effects of transformational leadership on student outcomes and teacher development.

Recommendations

For Researchers

Future research should explore the long-term impacts of transformational leadership on educational outcomes by conducting longitudinal studies. Such studies would provide insights into how leadership practices influence the development of 21st-century skills and teacher effectiveness over time. Expanding the research to include non-STEM disciplines could help determine whether the positive effects of transformational leadership observed in STEM

education are also applicable in other fields. Additionally, comparative studies across different educational contexts, such as rural versus urban schools or institutions in diverse cultural settings, would offer a broader understanding of the universality of transformational leadership practices. Researchers should also consider employing mixed-methods approaches, combining quantitative data with qualitative insights to capture the nuances of how leadership influences educational practices. Finally, investigating the role of digital tools in enhancing transformational leadership could provide valuable information on integrating technology into leadership strategies to foster innovation and adaptability in education.

For Practitioners

Educational leaders are encouraged to adopt transformational leadership practices to enhance the development of 21st-century skills in students. This includes inspiring innovation in teaching practices, involving educators in decision-making processes, and providing continuous professional development opportunities. Leaders should focus on fostering a culture of lifelong learning and adaptability, ensuring that both teachers and students are equipped to meet the challenges of the modern workforce. Policymakers should consider developing frameworks that support the implementation of transformational leadership across educational institutions, recognizing its potential to standardize effective leadership practices across public and private schools. Additionally, it is recommended that educational institutions invest in professional development programs that train leaders in transformational leadership techniques, emphasizing the importance of creating dynamic and responsive learning environments that prepare students for future success.

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Research Article

Action research in science education: a systematic review

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Abstract

This study aims to systematically examine the importance and use of action research in science education. 30 articles in the Web of Science (WoS) database were analyzed according to the research, problem status, distribution by years, study groups and findings. It was determined that the most studied problem status was students' skills and emotions; there was a noticeable change between 2013 and 2023; most of the study groups of the articles were high school students, student candidates and teachers, and the findings were in the areas of "scientific thinking and skill development", "design of educational environments and use of technology", "understanding of concepts", "intercultural and inclusive education", "new student-centered educational approaches", "teacher education and professional development". According to this article, it was observed that action research has positive effects on science education, and it is expected that providing support to teachers and researchers will increase the conduct of action research and increase the quality of science education.

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Introduction

The main objective of science education, which has great importance in the development of countries, in the educational context is to ensure that students comprehend scientific concepts, promote their structuring of scientific knowledge, gain the skill of scientific thinking and adopt the scientific process skills. In order for individuals to have the desired qualities with a view to ensuring the sustainable scientific, technological and economic development of countries, the quality of science education needs to be improved (Ayas, 1995). Teachers, as education practitioners in raising individuals who will ensure sustainability, are a vital part of the educational process (Eilks et al., 2006; Loughran, 2007). In addition to their role of teaching in the classroom setting, teachers also have duties, like, to be investigative in assessing the practices and introducing new seekings to improve the quality of teaching and perform conscious educational practices. To achieve this, teachers need to use their reflective thinking skills in relation to educational process. The research method that can be employed by teachers for this purpose in the process of practicing and by which they can assume the responsibility of research is the “action research”. Action research was suggested as an approach that encourage teachers to control their own studies contributing their academic progress and will contribute to development to fill the gap between theoretical (Bolton, 2010; Burnaford, 2011; Burns, 2010; Farel, 2004; Jay & Johson, 2002) and

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practical teaching practices (Eilks & Ralle 2002; Scott & Driver 2003). The aim of action research is not to generate new knowledge but improve and change the process in the educational situation (Feldman, 1996). The aim of action research is to identify real-world problems and develop practical and applicable solutions (Coghlan & Shani, 2014). It is achieved through a systematic research by comparing different approaches, exchanging ideas, analyzing the problem, finding solutions for the problems it analyzes (Capone et al., 2016). The basic cycle of action research consists of identifying the problematic area, gathering and organization of data, interpretation of data, and databased action and reflection stages. Research cycle is as given in Figure 1.

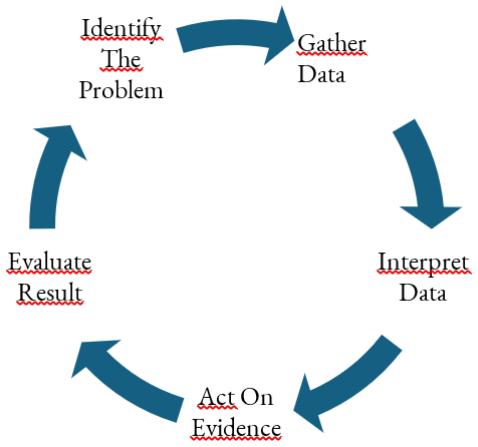

Figure 1. The cycle of action research (Ferrance, 2000)

In the step of identifying the problem, which is the first stage of action research, researcher asks meaningful and applicable questions. A careful planning of the first stage will ensure action research to proceed smoothly (Ferrance, 2000). After gathering the data, the data interpreted guides researcher in drawing out the needs of action. Whether or not improvement has occurred is demonstrated by examining the action research results planned based on the results from the data. This cycle should continue until the desired result is achieved (Carr & Kemmis, 1996).

Action research can be performed by the practitioner's himself/herself or an external researcher while it can be done by several practitioners together. There are various classifications in the literature by different qualities of action research depending on the point of view of the researcher.

Table 1. Classification of action research

Grundy (1988, as cited in Berg, 2001)	Technical Action Research Practical Action Research Emancipatory Action Research
Holter & Schwartz- Barcott (1993, as cited in Berg, 2001)	Technical-Collaborative Action Research Mutual-Collaborative Action Research Enhancing Action Research
McKernan (1991, as cited in Berg, 2001)	Scientific-Technical Action Research Based on Problem Solving Practical-deliberative action research Critical-emancipatory action research

Berg (2001) combined these approaches and classified action research under three types:

Technical/Scientific/Collaborative Action Research: According to this approach, the first aim is to evaluate a specific situation within a predetermined theoretical framework

Practical/Mutual Collaborative/Deliberative Action Research: In this approach the researcher and the practitioner come together to identify potential problems and look for ways to avoid their underlying causes and possible interventions

Emancipatory / Enhancing / Critical Action Research: Emancipatory / enhancing / critical action research is an approach that provides new knowledge and skills to researcher ensuring them to perform reflective thinking towards their own

practices. Thus, the researcher will be able to look critically their own practice, generate explanations for the problems in practice and question their role in the process.

Action research is one of the research methods employed in sciences education, as in many disciplines of education, to eliminate the emerging problems. A literature review revealed that there is no review study that addresses the studies on action research carried out in sciences education from different perspectives. This study is assumed to fill this gap in the literature, being guiding for researchers and educators who will use action research method.

Problem of Study

By this study, it is aimed to set forth the problem situation, working groups and subject area of action researches in science as a result of review of articles in the Web of Science (WoS) database. In this respect, the general purpose of the study was determined to "review the articles involving action research in sciences education published in WoS database". In line with this general purpose, answers were sought for the research questions given below:

- Which problem situations did the articles in the Web of Science (WoS) database involving action research in sciences address?
- What is the distribution of the articles in the Web of Science (WoS) database involving action research in sciences by years?
- What working groups do the articles in the Web of Science (WoS) database involving action research in sciences involve?
- What findings were obtained in the articles in the Web of Science (WoS) database involving action research in sciences?

Method

Research Model

This research is a type of qualitative research and was designed as a review study Maule and Goodman (2009) state that review studies are carried out in three different types (as cited in Karaçam, 2013). These are narrative review, systematic review and meta-analysis. This article is based on a systematic review of action research studies on science education. Systematic review aims to bring evidence together to answer a pre-defined research question. This involves the identification of all primary research relevant to the defined review question, the critical appraisal of this research, and the synthesis of the findings (Gough, Oliver & Thomas, 2012). Systematic reviews use objective and transparent methods to identify, evaluate and summarize all relevant research findings. When carried out well, systematic reviews provide the most reliable evidence about the effects of tests, treatments and other interventions (Centre for Reviews and Dissemination, 2024). Within this scope, the studies that were carried out using action research in science education were reviewed in this study taking certain criteria into consideration and presented to the attention of researchers with certain characteristics.

Inclusion and Exclusion Criteria

This study was carried out on the research articles in the Web of Science (WoS) database as it includes the reference indexes regarded as most prestigious by academic circles (Şeref and Karagöz, 2019). WoS provides a wide range of data repository as it contains numerous databases and journals. It, thus, provides great opportunities for researchers for literature review. In the study, many different criteria were applied in selecting the relevant researches. The assessment steps related to these criteria are presented in Table 2.

Table 2. Criteria for Selecting Articles

Inclusion Criteria	Exclusion Criteria
Studies including the key term "Action research"	Studies carried out before 2014 and after 2023
WoS database	
Last 10 years from 2013 to 2023	

Firstly, articles were restricted to the years 2014 to 2023. In this context, the studies the publication year of which is a year between 2023 and 2024 with "action research" as the research method were included in the study. This period was selected because it represents recent research in science education. In addition, the studies which are "Open access" and "article" were included in the review while "Education & educational research" was selected as WoS category. Narrowed-down citation topics was selected as "Science education" with inclusion of the research articles in English in the review study.

Search Procedures

To begin with, the phrase "action research" was typed in the search bar in WoS Core Collection database on 1 January 2013 and a search was performed selecting the following criteria: Language: English, Document Type: Article, Timespan: 2013-2023, Open Access: All Open Access. Besides, with the inclusion of the fields "Education & educational research" in the scope of the review study, 47 studies were included in the study and reviewed in line with the study objectives set. While the action research articles in science education were reviewed within the scope of the study, the studies that include the practices for the problematic cases experienced were made subject of review. The action research articles which were carried out in theoretical scope in science education were excluded. The reason why researchers have such an attitude is to provide a general point of view towards the problems that are experienced in science education and share, in general, the results achieved.

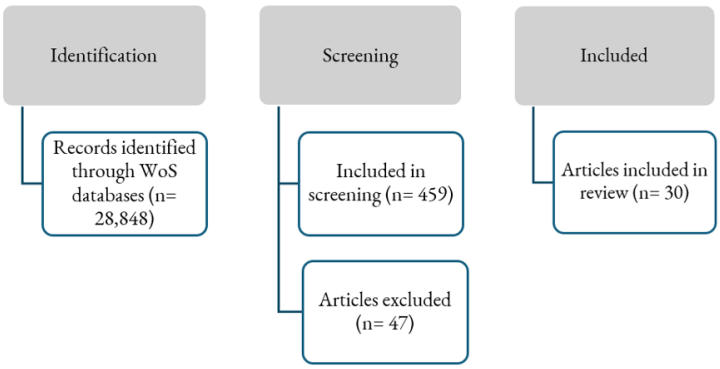

Figure 2. Numerical data used to evaluate stages based on specific criteria

Researcher Positionality

Researchers selected the articles at the time of screening in parallel to the criteria set. Apart from the researchers, expert opinion was obtained on whether the articles meet the criteria set, after screening. With this, it was aimed to strengthen the aspects of validity and confidence targeting "internal consistency" and "persuasiveness". Another point for which an expert support was needed is the phase where the data collected in line with the subgoals of the study was set forth. And after the content analysis performed, it was aimed to receive feedback on the unbiasedness of the data by sharing the findings with the same expert apart from researchers.

Data Analysis

First, the selection of articles is performed based on the inclusion criteria set. All articles selected were reviewed by the researchers and a consensus was sought on whether any given article meets the criteria set and achieve the subgoals of the study. All articles selected were sent to the expert, who gave feedback on whether they are in line with the subgoals.

As the second phase, articles were reviewed in line with the subgoals of the study set. At this phase, content analysis was employed. A coding scheme was created for this purpose. The articles were shared out by researches for content analysis and were reviewed on a shared database by importing the coding scheme into Excel. Among the articles, which were analyzed for content, three were selected for different researchers, each, to review for consistency across researchers. The consistency across encoders was found to be high as a consensus of 90 percent was observed as a result of the consistency study performed (Miles & Huberman, 1994). This result can be interpreted that the findings obtained from the content analysis by researchers are valid and reliable.

The data obtained in the third phase of the study were submitted for expert opinion. Content analysis was performed by the expert by randomly selecting three articles which were analyzed by different researchers. It was concluded that as a result of the analysis, the findings that were analyzed by the expert and the findings by the researchers were significantly compatible. In this context, the review study revealed the following findings.

Findings

The following sections present the results of the review. Findings for Research Question (RQ) 1 are presented in what problem situations are addressed in the articles containing action research in the field of science education found in the Web of Science database. Findings for RQ 2 illustrated what is the distribution of articles containing action research in the field of science education in the Web of Science database by year. Findings for RQ 3 are presented which study groups are included in the articles containing action research in the field of science education in the Web of Science database. Findings for RQ 4 are presented as findings obtained in the articles containing action research in the field of science education in the Web of Science database.

Research Question 1. The problem situations that articles containing action research in the field of science education address

This study reviewed 30 articles that employ action research in the field of science education. In reviewing the articles, the unique structures of the problem situations addressed were employed with no limitation on subject. The frequency of the problem situations addressed in the articles are summarized in Table 3.

Table 3. Problems addressed in action research

Theme	**f**	**%**
Teaching methods	5	16.67
Students' skills and emotions	13	43.33
Teacher Education and Development	7	23.33
Learning Environments and Technologies	3	10
Scientific Concepts and Content	2	6.67
Total	30	100

As shown in Table 3, the problem situations addressed in the action researches in science education were divided into 5 different categories. The most studied problem situation is the situations related to "students' skills and emotions" (43.33%) which is followed by the situations related to "teacher education and development" (23.33%) and to "teacher methods" (16.67%), respectively.

Year

This study also addressed the distribution of the studies on action research by years. The chart on the results is given below.

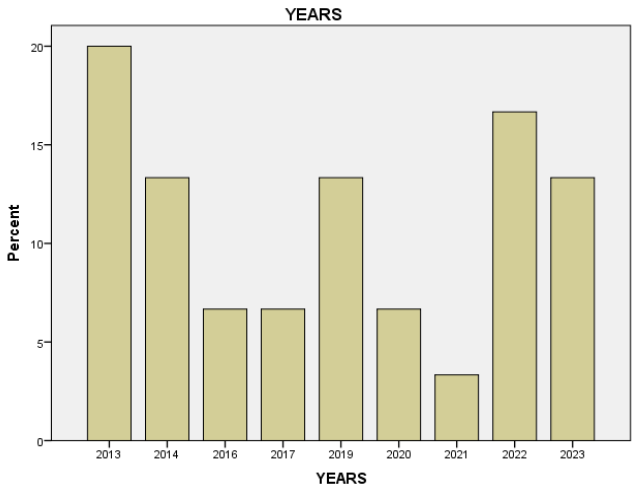

Figure 2. Number of action researches in science education between 2013- 2023

A remarkable fluctuation is observed between 2013 and 2022. Number of studies increased in some years while they decreased in some others. The reasons for this fluctuation may be research budgets, academic interests or external factors (e.g. pandemic) etc. And in recent years, particularly in 2023, 4 studies (13,3 per cent) were performed. This may indicate that recently, the interest in the subject has still been strong.

Study Group

It gives ideas for practical use to researchers in addition to the group in which action research was studied. Therefore, this study reviewed with which group or groups the action researches were performed. The results were presented in Table 4.

Table 4. The study groups in the articles

Participations	**f**	**%**
Pre-school students	1	3.33
Elementary school students	1	3.33
Middle school students	2	6.67
High school students	9	30.00
University students	3	10.00
Pre-service teachers	5	16.67
Teachers	4	13.33
Teacher + Middle school students	2	6.67
Teacher + High school students	3	10.00

It is seen that most of the researches included high school students, candidate teachers and teachers. It is remarkable that pre-school pupils and elementary school students were less included in the studies. This distribution may offer the opportunity to focus on the missing or less represented groups in future studies.

Findings

The findings of the majority of action research have been positive. The findings were established to be in the fields of "scientific thinking and skills development", "design of educational settings and use of technology", "understanding of terms", "intercultural and inclusive education", "new student-centered educational approaches", and "teacher education and Professional development". Table 5 presents the distribution of findings.

Table 5. Distribution of findings

Field	**f**	**%**
Innovative Educational Approaches	8	26.67
Teacher Education and Professional Development	8	26.67
Scientific Thinking and Skills Development	7	23.33
Intercultural and Inclusive Education	4	13.33
Understanding of Terms	2	6.67
Design of Educational Settings and Use of Technology	1	3.33
Total	30	100

As shown in Table 5, the fields in which most findings were obtained the "Innovative Educational Approaches" with 26,67% and "Teacher Education and Professional Development", respectively. These are followed by "Scientific Thinking and Skills Development" with 13.33%, "Understanding of Terms" with 6.67% and "Design of Educational Settings and Use of Technology" with 3.33%.

Discussion

Sciences education plays an important role in providing scientific knowledge and skills to learners. Efforts are made to improve the quality of science education. In this context, the articles on action researches in science education in WoS database were reviewed.

As per the findings of the study, the problem situation of "learners' skills and emotions" was addressed most in the studies on action research in science education that was carried out between 2013 and 2023. Emotions are factors that

affect one's way of life, working capacity and increase or decrease of their activities. Dzerviniks (2011) concluded that the active learning of learners may be remarkable depending on the learner-teacher relationship, emotional state of teacher and learner, and learner's cognitive skills. Poonputta (2021) concluded that the emotional attitude after the application of STEM education instructional plans is higher than the emotional attitude prior to the application. In other words, action research applications in STEM education has a favorable effect on the emotional attitude of students. Another subject which was studied most in the studies on action research in science education is "teacher education and development". Teachers can closely review the needs and change of the teaching environment by getting familiar to themselves in research and practice within their reflecting skills through their own research. Action research enables educators to review and improve the teaching and learning process. In this context, the challenges of teaching practice, professional skills and development caused the demand for the practice-based research. Varsat (2013) concluded that teachers develop both professionally and personally as they participate in action research and what they learn from teaching process has effects on what will happen in the education and training processes in future. It can be claimed that action research applications positively affect the aspects of learners' skills and emotions and teacher education and development.

When examined by years, action research in science education was performed most in 2013 and least in 2021 between 2013-2023. A fall might have occurred in the number of the studies due to the COVID-19 (Coronavirus disease 2019) pandemic experienced in 2020 and 2021 as active participation in action research is important. The reason why the number of studies carried out after COVID-19 can be construed with the sudden changes in the field of education caused by the pandemic. The impact to education, remote education, online environment and individualized teaching gained importance with the pandemic. It can be interpreted as the adaptation to the changing conditions in the field of education after COVID-19 pandemic and the preparedness for similar situations that may be faced in future. Most of the action research studies carried out in the field of sciences education after COVID-19 pandemic addressed the "Socio-scientific" subject while stress was laid on the creation of social product creation and development of reasoning skills in students.

It was found that most of the studies on action research in sciences education that was carried out from 2013 to 2023 included high school students, candidate teachers and teachers. The reason why most of the studies were carried out in high school students is that the students were in a critical phase, would pass to young adulthood and to contribute to the academic, social and emotional development of students. One of the study groups most studied were candidate teachers and teachers. It can be claimed that teachers and candidate teacher, who will raise the future generations, are one of the study groups most studied as they contribute to professional development, classroom management skills, ensuring the active participation of learners, use of learner-centered educational approaches that increase the permanence in learning, ensuring the cooperation between teachers, and improvement of educational activities. The group least studied was pre-school and elementary school students. It can be claimed that less number of studies were carried out in pre-school and elementary school students as the attention level of such students are low, scientific education involves abstract concepts, and STEM education, which is one of the innovative approaches, requires the provision of high level thinking skills such as critical thinking, problem solving skills. In order to be able to maintain the high quality of education, teachers should have learning characteristics involving continuity such as adaptation to changes, self-improvement etc., and be provided the opportunity to continuously improve. In Table 5, one of the findings obtained most is "Teacher Education and Professional Development". In her study where she investigated the influence of an in-service training program on English language teachers' professional development, Qındah (2019) demonstrated that it has a positive influence on their professional development in terms of learner's participation, teaching strategies and evaluation and that the skills of giving constructive feedback and classroom management were developed. Table 5 shows that one of the findings most commonly found is "Innovative Teaching Approaches". While inclusion of the ways of learning such as online environments, which is one of the innovative teaching approaches replacing conventional educational practices, individualized learning etc. in education, saves time and place, they offer learners the opportunity to watch the recorded courses over and over again in the cases such as COVID-19 pandemic in

2019 and to regulate their own learning experiences. The outbreak of COVID-19 pandemic in 2019 caused a decrease in the number of action researches in sciences education in 2020 and 2021 as shown in Table 2. Innovative teaching approaches are an approach that gives place to STEM applications and allow for individual learning, providing reasoning skills, and project-based learning, shifting learners from conventional learning environment and offers a social point of view. It provided the opportunity to employ online media, which is one of the innovative teaching approaches, in such extraordinary situations. It can be claimed that the number of action researches carried out in this field increased with the online media, individual learning etc. that has become important. Another innovative approach is STEM education. Landicho (2020) found in his study of 46 STEM teachers/researchers that teachers/researchers developed positive attitudes towards their own learning skills and students' learning experiences. In Escopete's study (2023), motivation of teachers to carry out action research is the provision of a quality environment and support and fosterage by school administrators. Teachers should be encouraged and supported to do action research.

Conclusion

Action researches are an important research method for the enhancement of the quality of sciences education and for improvement. It is clear that the studies on action research in sciences education contributes the learners' development cognitively, emotionally and socially. Action research is a frequently employed method in science education to address and improve issues, as in many other disciplines of education. A review of the literature revealed no systematic review studies examining different aspects of action research in science education. This study aims to analyze articles indexed in the Web of Science (WoS) database to identify the problem statements, study groups, and subject areas addressed. The research is based on a qualitative research method, specifically a systematic review. As a result of the keywords determined, 30 articles published between 2013 and 2023 were included in the study.

According to the findings, the most frequently studied problem statements were related to "students' skills and emotions," while the least addressed problem statements were associated with "scientific concept and content." In terms of distribution over the years, the highest number of studies were conducted in 2013 and 2022, while the lowest number was observed in 2021. Regarding the study groups in action research conducted in science education, it was found that most studies focused on high school students, preservice teachers, and in-service teachers. The majority of the findings pertained to "innovative educational approaches," while the least focus was on "designing educational environments and the use of technology."

This research highlights the need to encourage and support teachers in conducting action research. In line with this study, it is seen that action research in sciences education helps the professional development of teachers in the changing and improving matters and the enhancement of the quality of education in classroom management. This study hopes to emphasize the importance of action researches in science education and promote the action research studies in science education. Providing support to teachers and researchers is expected to increase the conduct of action researches and improve the quality of science education.

Recommendations

In future studies, the scope can be expanded by incorporating different keywords not only in science education but also in interdisciplinary topics. By comparing the results of action research from various fields, issues in science education can be identified more clearly. Challenges in science education can be supported with data obtained through interviews with individuals working in this field. Additionally, this research can be revisited in the future to regularly track changes in trends related to the subject.

Limitations of Study

This study included articles indexed in the Web of Science (WoS) database that contained the keyword "action research" and were published between 2013 and 2023. For WoS categories, "Open access," "article," and "Education & educational research" were selected. The narrowed citation topic was determined as "Science education," and only research articles in English were included in the review.

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