Searching For Traces of Pragmatism

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Abstract

Researchers must present a philosophical rationale to conceptualize and operationalize the mixed research method. This study aims to examine to what extent 27 studies published in the last five years reflect the characteristics of pragmatism. We identified these studies using the PRISMA model and analyzed the abstracts, keywords, and introductions of the studies with content analysis. We concluded that researchers need to make more efforts to reflect the philosophical perspective in the abstract and introduction. We propose a framework for researchers using the mixed research method to use the features of pragmatism. We believe that the relevant framework will contribute to mixed methods research.

Introduction

In the last few decades, there has been a dramatic increase in labeling social scientific research as "*mixed methods* " and thus professional research (Biddle & Schafft, 2014). There is ample evidence that mixed methods research is increasing in volume and acceptability within the scientific community, as well as increasing levels of proven methodological and theoretical sophistication (Denzin, 2010; Small, 2011). All of these developments raise critical questions within the broader community of scientists engaged in mixed methods research.

A growing number of authors are discussing how the quality of mixed methods research should be conceptualized and operationalized, with the ultimate goal of promoting mixed methods research that is well designed and properly implemented (Fa'bregues & Molina-Azorı´n, 2017). In this context, Creswell and Plano-Clark (2018) argue that in their bedside book for mixed methods researchers, researchers should provide a clear philosophical justification for their methodological choices in light of the still-evolving norms and practices of mixed methods study.

There are many philosophical perspectives or worldviews discussed and used in the literature on the mixed research method (Ghiara, 2020);*pragmatism* (Morgan, 2007; Teddlie & Tashakkori, 2009; Yvonne Feilzer, 2010), *transformative* (Mertens, 2003; Mertens & Hesse-Biber, 2013), *critical realism* (Maxwell & Mittapalli, 2010; Zachariadis et al., 2013), *postpositivism* (Phillips et al., 2000), *constructivism* (Creswell & Plano Clark, 2018),*realism* (Maxwell, 2016; Maxwell & Mittapalli, 2010; Pawson, 2013), *feminism* (Crasnow, 2015; Hesse-Biber, 2012; Leckenby & Hesse-Biber, 2007). Shannon-Baker (2016) emphasizes four perspectives in the mixed research method: pragmatism (Morgan, 2007), transformative-emancipation (Mertens, 2003), dialectics (Greene & Hall, 2010), and critical realism (Maxwell & Mittapalli, 2010). Of these paradigms, pragmatism is one of the most widely used philosophical frameworks, mostly in mixed research. It is often described as such in theory or method books and major articles in the field (Bryman, 2007; Creswell & Plano-Clark, 2018; Yvonne Feilzer, 2010; Johnson & Onwuegbuzie, 2004; Johnson et al, 2007; Morgan, 2007; Scott & Briggs, 2009; Tashakkori & Teddlie, 2003, 2010). The popularity of pragmatism in mixed-method studies is

partly explained by its use as a philosophical tool to address the many unhelpful dualisms at the center of "*paradigm wars* " (Biesta, 2010). Perhaps the most profitable scientific research method from paradigm wars has been the mixed research method. Rossman and Wilson (1985) suggested that the views of purists who adopt a pure research paradigm, situationists who adopt a case-by-case research paradigm, and pragmatists who adopt a utilitarian research paradigm are combined in a mixed method.

Using these philosophical perspectives, researchers try to explain knowledge in terms of *ontological* (what is knowledge),*epistemological* (how do we know the information),*axiological* (what values are included in the information),*rhetorical* (how do we write about information), and*methodological* (processes of examining knowledge) dimensions (Creswell, 2003). Pragmatist philosophy considers the nature of reality ontologically in multiple forms of reality. Information is explained by adopting a usefulness-oriented understanding of reality. From an epistemological point of view, the relationship between the knowing subject and the known object can be used together to increase the reliability of the research. Axiologically, values are brought to the fore and it is accepted that values affect the research process. Both formal and informal writing styles can be used rhetorically. In other words, the researcher can use accepted definitions of variables as well as make definitions in different ways according to his or her point of view. He uses various forms of qualitative and quantitative data to develop an understanding from a methodological point of view, integrating them to serve the purpose of his research. Tashakkori and Teddlie (2003) state that pragmatism supports the use of both qualitative and quantitative methods, places the research question at the center of the research, and all knowledge claims depend on the research question. In this respect, it can be said that the pragmatist approach, which uses the advantages of qualitative and quantitative data, has a pluralistic perspective. (Creswell, 2009). The phenomenon investigated with multiple data is explained in a comprehensive, detailed, and more convincing way (Mills & Gay, 2016). It is important to determine the reason for using quantitative and qualitative data together, the reason and contribution of using more than one method, and the relationship between them. From the title of the study and research questions to the recommendations, a report should be created that is not only representative of qualitative or quantitative but also pluralism by pragmatism. Pragmatism allows researchers the freedom to choose their methods, techniques, and procedures to best meet the needs and goals of research (Murphy, 1990). All kinds of quantitative and qualitative data that are useful in the research process and that will help to solve the problem can be consulted. Therefore, it can be said that the word most associated with pragmatism is "*utilitarianism* " (Doğan, 2003). While pragmatism includes utilitarianism, it is a much more comprehensive and newer trend than utilitarianism. (Türer &Aydin, 2019). In pragmatism, we can measure the accuracy or value of information according to the usefulness it provides. Pragmatism, which evaluates truth or reality according to the result of the action, evaluates it in terms of utilitarianism. Contribution to the solution of the problem is the main one (James, 2004). Ease of action can be defined more simply as usefulness. The emphasis on the interpretation of pragmatist philosophy as "*what does it do* " in pursuit of research is actually " *what good is it for whom?* " and "*for what purpose?* " makes sense with questions. The pragmatic approach also preserves the "*valuable contributions* " of the metaphysical paradigm, namely the importance of epistemology and the centrality of one's worldviews for research (Morgan, 2007). In addressing these issues, pragmatism focuses on what makes the difference, as well as linking abstract issues at the epistemological level to the methodological level (Shannon-Baker, 2016).

Pragmatism is result-oriented and is concerned with determining the meaning of facts (Johnson & Onwuegbuzie, 2004) or focusing on the product of research (Biesta, 2010). It emphasizes communication and creating shared meaning to create practical solutions to social problems. Pragmatism deals with what function, in theory, is in practice and how it is applied (Cevizci, 1999). Theoretical knowledge is valuable with its function in practice.

Pragmatism uses transferability to consider the results of research (Leininger, 1994; Lincoln & Guba, 1986). This philosophy is based on the belief that theories can be both contextual and generalizable by analyzing them for "*transferability* " to another situation (Shannon-Baker, 2016). Pragmatists agree that research always takes place in social, historical, political, and other contexts. In this way, mixed-method studies can include a theoretical lens that reflects a postmodern turn, social justice, and political goals. Transferability is a concept related to how and to what extent the acquired knowledge affects different fields, environments,

or results. It is necessary to look at how the obtained information manifests itself in different areas or can it be transferred to different areas. It is the explanation of how the obtained knowledge or result corresponds to another field and to what extent it can be adapted (Arastaman et al., 2018). To better understand the usefulness, functionality, and transferability of the research results, it should be emphasized which uncertainty the information obtained in the study will eliminate or in which area it will fill the gap. If the solution to the problem depends on the findings of the research, it can be said that the research has a problem-solving feature (Doğan, 2003).

Taşçıoğlu et al. (2022) examined which paradigm/research method dominates the 500 most cited articles in the field of education in the last 10 years and whether dominant paradigms affect citations. As a result of the examination of the Web of Science Core Collection, Social Science Citation Index-SSCI indexed articles, they determined that the most preferred methodological paradigms were quantitative, mixed methods, and qualitative, respectively. Ghiara (2020) argued that mixed research is a new paradigm to use concepts such as paradigms and worldviews more clearly in the literature and that more than one paradigm can be used in research. In these studies, we see that the concept of paradigm and research method are often used interchangeably. Coates (2020) explored the presentation of philosophical assumptions in 1,026 mixed-methods research papers in education. Eighty-one articles (7.9%) were reported to have made philosophical commitments and 31 of them had different stances/claims. Coates (2020) found that pragmatism was the most used philosophical approach. Alise and Teddlie (2010) present a new line of research on the prevalence of mixed methods. They analyzed 600 studies in fields such as psychology, sociology, and education. They reported that only one of these studies mentioned the philosophical paradigm that formed the basis of the research.

Fa'bregues and Molina-Azori n (2016) argued that mixed-method research has several unique features compared to single-method research and therefore should be evaluated according to its quality criteria. They reported that publications on the quality of mixed methods research are becoming more common and detailed and that a common set of basic quality criteria can be determined among publications to evaluate mixed methods research. Shannon-Baker (2016) stated that we should be concerned with the way researchers legitimize and functionalize the paradigm they choose to make paradigms meaningful in mixed studies. "Are the chosen paradigm values compatible with the research focus?", "*Are the implications of the paradigm discussed clearly?* ", "*How do the implications relate to the paradigm(s) being discussed?* " It is necessary to focus on the questions. The same study noted that researchers should focus more on the details of how they use the paradigm(s) and how they will do it. Heyvaert et al. (2013) provided an overview of current critical review frameworks developed to evaluate primary mixed-methods research papers. They compared frameworks used in studies examining studies using the mixed method and the quality criteria they included. Researchers have found that quality criteria have evolved and changed; reported the need for more detailed criteria. Therefore, we anticipate that the criteria we propose are for learning purposes for novice researchers. We also hope that our criteria will be of great help to novice researchers to avoid deficiencies that more experienced researchers are aware of. In addition, we plan to provide a framework for reflecting philosophical perspectives in mixed studies. Thus, we will give an idea to ensure a clear and conscious interaction with philosophical foundations in the design, implementation, and reporting stages of the research. The questions we will focus on solving in the research are as follows: "*Can we understand that pragmatist philosophy is used in a study using a mixed research method?* ", "*What are the clues about pragmatist perspective in an academic study?* ", "*Can we show that the research is based on pragmatist philosophy?* " Therefore, this research aims to examine the reflection of pragmatist philosophy on mixed studies.

Method

Research Design

The present study employs the case study, one of the qualitative research designs. A case study is defined as an in-depth description and examination of a limited system (Merriam, 2013). The current study prefers the case study because it aims to examine the reflection of the pragmatist perspective on the academic articles published in the field of science education using a mixed research method.

Data Collection Procedure

The authors prefer the PRISMA model to obtain the data in this study. The PRISMA model is recommended in the academic literature in meta-analysis research, reporting, and critical evaluation of research (Moher et al., 2009). First of all, we have searched on the ERIC, Web of Science, and Google Scholar databases. We have employed the "*Mixed Method* " as a key concept in databases. A search on Google Scholar yields 16,800 studies. When searching the word "*Mixed Methods* " with the same criteria, we have come across 86,900 studies. When we look at the studies in the ERIC database, 10,305 results have appeared when searching with the keyword "*Mixed Methods* ". We have eliminated conflicting studies because some studies in the databases were common in searches. We have limited the remaining studies to the last five years, then 1,009 studies have remained. We have identified the research articles among these studies, then 878 studies have remained. We have selected 185 studies in the field of science education from these studies. After the expert control, we have decided to include 27 studies in the qualitative analysis (Figure 1). As a result, the characteristics of 27 studies are explained in Table 1.

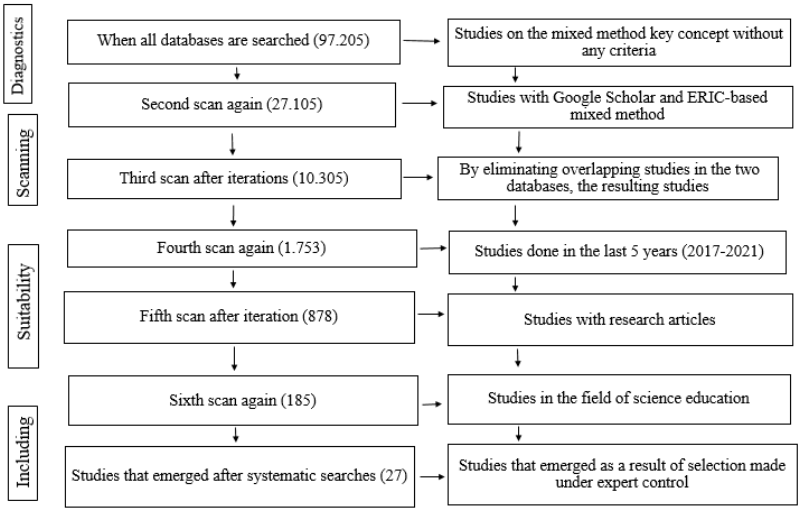

Figure 1: PRISMA flow model

Table 1: Articles we reviewed and their features

Tag	Code	Title	Published in the journal	Index	Sample/ Study group	Data collection tool	Data analysis
Barak, 2017	A1	Science Teacher Education in the Twenty-First Century: A Pedagogical Framework for Technology-Integrated Social Constructivism	Research in Science Education	SSCI	63 teacher educator- 52 science teachers	The questionnaire, interview, Written reflections	ANOVA Content analysis (Descriptive-interpretive perspective)
Canipe & Coronado Verdugo, 2020	A2	The Influence of a Science Methods Course on Prospective Elementary Teachers' Visions of Science Teaching	Journal of Educational Research & Practice	ERIC	171 undergraduate science teaching students	Survey, interview	Wilcoxon signed-rank test Thematic coding
Çevik, 2018	A3	Investigating STEM Semantics and Perceptions of Engineer Candidates and Pre-Service Teachers: A Mixed-Method Study	Internatıonal Journal of Educatıonal Technology	ERIC	228 students enrolled in the undergraduate program	The questionnaire, Case study	ANOVA Content analysis

Tag	Code	Title	Published in the journal	Index	Sample/ Study group	Data collection tool	Data analysis
Demiral, 2018	A4	Examination of Critical Thinking Skills of Preservice Science Teachers: A Perspective of Social Constructivist Theory	Journal of Education and Learning	ERIC	200 science teachers	Survey, interview	ANOVA Content analysis
DeWitt & Archer, 2017	A5	Participation in informal science learning experiences: the rich get richer?	International Journal of Science Education	SSCI	6000 children aged 11-16	Survey, interview	Regression analysis
Fettahlıoğlu & Kaleci, 2018	A6	Online Argumentation Implementation in the Development of Critical Thinking Disposition	Journal of Education and Training Studies	ERIC	43 science 3rd-grade teacher candidates	Open-ended questions, questionnaire, open-ended interview	Descriptive analysis
Fredricks et al., 2018	A7	Supporting Girls' and Boys' Engagement in Math and Science Learning: A Mixed Methods Study	Journal of Research in Scıence Teachıng	SSCI	38 middle and high school students	Semi-structured interview, questionnaire	Combination of induction, interruption, and verification techniques

Tag	Code	Title	Published in the journal	Index	Sample/ Study group	Data collection tool	Data analysis
Gårdebjer et al., 2017	A8	The Babushka Concept– An Instructional Sequence to Enhance Laboratory Learning in Science Education	Journal of Education in Science, Environment, and Health	ERIC	30 graduate students	Pretest-posttest, quasi-experimental design, semi-structured interview	Descriptive statistics-analysis
Gholam, 2017	A9	Visual Thinking Routines: A Mixed Methods Approach Applied to Student Teachers at the American University in Dubai	Journal of Inquiry & Action in Education	ERIC	8 female teachers	The questionnaire, open-ended interview	Descriptive statistics-analysis
Kavai et al., 2015	A10	Animal Organ Dissections in High Schools: Is There More than just Cutting?	African Journal of Research in Mathematics, Science and Technology Education	ESCI	224 Grade 11 students	Test/survey, interview	Descriptive and inferential statistics ANOVA

Tag	Code	Title	Published in the journal	Index	Sample/ Study group	Data collection tool	Data analysis
Kim & Alghamdi, 2019	A11	Female Secondary Students' and Their Teachers' Perceptions of Science Learning Environments Within the Context of Science Education Reform in Saudi Arabia	International Journal of Science and Mathematics Education	SSCI	202 female students, 3 science teachers	Survey, interview	Descriptive statistics Examining the transcript according to the OBLEQ subscale questions
Korkmaz et al., 2017	A12	Students' Out-Of-School Experiences, Job Priorities, and Perceptions toward Themselves as a Scientist: A Cross-cultural Study	International Journal of Curriculum and Instruction	ERIC	479 students aged 11-13	The survey, opinion taking	Content analysis, descriptive statistics
Lamar et al., 2018	A13	A mixed-methods comparison of teachers' lunar modeling lesson implementation and student learning outcomes	The Journal of Educational Research	SSCI	6 secondary school teachers	Pre-test, post-test, interview	MANOVA, ANOVA, Tukey Post hoc testing

Tag	Code	Title	Published in the journal	Index	Sample/ Study group	Data collection tool	Data analysis
Lane et al., 2021	A14	Engagement and Satisfaction: Mixed-Method Analysis of Blended Learning in the Sciences	Can. J. Sci. Math. Techn. Educ.	ERIC	For quantitative 692 university students for qualitative 48 participants	Survey, interview	Multiple regression analysis, thematic evidence, content analysis
Mercer-Mapstone& Kuchel, 2017	A15	Core Skills for Effective Science Communication: A Teaching Resource for Undergraduate Science Education	International Journal of Science Education	SSCI	20 experts	Survey, interview	A simplified version of thematic analysis
Özbuğutu, 2021	A16	An Investigation into Anxiety about the Science Lesson Through a Mixed Model	Journal of Education and Learning	ERIC	158 middle school students	The questionnaire and qualitative data were collected through the form	Content analysis, analysis with SPSS package program
Özkale & Kanadlı, 2021	A17	An Investigation of Feedback Strategies Used by Science Teachers in the Classroom Setting: A Mixed-Methods Research	International Journal of Progressive Education	ERIC	1696 middle school students, 51 middle school science teachers	Survey, open-ended questions	Descriptive content analysis, with the help of the relevant package program (such as exploratory factor analysis, and item analysis) ANOVA

Tag	Code	Title	Published in the journal	Index	Sample/ Study group	Data collection tool	Data analysis
Özkul & Özden, 2020	A18	Investigation of the Effects of Engineering-Oriented STEM Integration Activities on Scientific Process Skills and STEM Career Interests: A Mixed Methods Study	Education and Science	SSCI	19 middle school students	Pre-test/post-test scale, semi-structured interview	Thematic analysis, statistical analysis (related package program analyses), and qualitative data were conducted and compared by two independent people
Reilly et al., 2021	A19	Assessing Science Identity Exploration in Immersive Virtual Environments: A Mixed Methods Approach	The Journal of Experimental Education	SSCI	126 students aged 12-13	Survey, interview	ANOVA
Rüschenpöhler & Markic, 2019	A20	A Mixed Methods Approach to Culture-Sensitive Academic Self-Concept Research	Education Sciences	ESCI	Interview (43) Survey (116)	The questionnaire, semi-structured interview	ANOVA, content analysis

Tag	Code	Title	Published in the journal	Index	Sample/ Study group	Data collection tool	Data analysis
Scogin et al., 2018	A21	Inspiring science achievement: a mixed-methods examination of the practices and characteristics of successful science programs in diverse high schools	Cult Stud of Sci Educ	SSCI	10 schools	The questionnaire, semi-structured interview	Sociocultural perspective (constant communication analytical methods with science relations)
Solomon et al., 2018	A22	A Mixed-Methods Investigation of Clicker Implementation Styles in STEM	CBE—Life Sciences Education	ERIC	2180 students	Observation, interview, survey	Core analysis methods, visual analysis
Thiry et al., 2017	A23	Linkages between youth diversity and Organizational and program characteristics of out-of-school-time science programs: a mixed-methods study	International Journal of Science Education	SSCI	408 students	Survey, interview	NVivo 10 domain analysis, statistical analysis (SPSS-Cross tabs analysis)

Tag	Code	Title	Published in the journal	Index	Sample/ Study group	Data collection tool	Data analysis
Uğraş & Asiltürk, 2018	A24	Perceptions of Science Teachers on Implementation of Seven Principles for Good Practice in Education by Chickering and Gamson in Courses	Journal of Education and Training Studies	ERIC	Scale for 216 science teachers Interview with 45 teachers	Scale and interview	Descriptive analysis
Ültay & Alev, 2017	A25	Investigating the Effect of the Activities Based on Explanation Assisted REACT Strategy on Learning Impulse, Momentum, and Collisions Topics	Journal of Education and Practice	SCI	50 university students	Pre-test-post test-delayed test, interview	IMCCT analysis, deductive analysis
Webb Williams, 2018	A26	Science Self-Efficacy in the Primary Class-room: Using Mixed Methods to Investi-gate Sources of Self-Efficacy	Res Sci Educ	SSCI	182 children between the ages of 10 and 12	Survey, interview	SPSS, analysis with the help of an atlas for qualitative data

Tag	Code	Title	Published in the journal	Index	Sample/ Study group	Data collection tool	Data analysis
Wilson et al., 2018	A27	Student perceptions of teamwork within assessment tasks in undergraduate science degrees	Assessment & Evaluation in Higher Education	SSCI	198 students	The questionnaire, semi-structured interview	Microsoft Excel (Version 15.0, 2013) and R-Studio (Version 3.1.2, 2014), NVivo for qualitative data

Data analysis

The present study employs content analysis. It is compiled to disseminate information and guide future research, by systematically examining written materials and grouping them with certain criteria (Berelson, 1952). The concepts of content analysis, meta-analysis, and meta-synthesis are used interchangeably, and approaches with the same structure are defined with different concepts. However, the distinction can be easily made. The use of quantitative data according to certain principles in content analysis indicates meta-analysis, and the use of qualitative data indicates meta-synthesis (Dinçer, 2018). The present study prefers content analysis because it examines the reflection of the pragmatism features of the articles using mixed research methods published in the field of science education.

In the beginning, we identified 37 criteria covering all phases of an academic study. It includes abstract, keywords, introduction, method, findings, conclusion and discussion, and recommendations (Table 2). While creating criteria, we have examined studies on the definition and characteristics of pragmatism, its contributions to mixed research, the reflection of philosophy on research, and its importance (Christ, 2013; Creswell & Creswell, 2017; Johnson & Onwuegbuzie, 2004; Leavy, 2017; Morgan, 2007; Palinkas et al., 2011; Shannon-Baker, 2016; Tashakkori & Teddlie, 1989).

Table 2. *Criteria for pragmatism*

Footprints of Pragmatism

Abstract	**Abstract**	**Abstract**
Keywords	**Keywords**	**Keywords**
Introduction	**Philosophical Paradigm**	2. Deduction and induction or deduction and deduction are us
	Theoretical/ Conceptual Framework	3. The subject of the study is justified by the mixed research
		4. Key concepts (central, core concepts) cannot be explained l
		5. A conceptual framework has been drawn by establishing a
		6. Literature review was conducted with a pluralistic and/or u
		7. The suitability of the theoretical model for the research is e
	Rationale/Problem Statement	8. Activities covering the process and result of solving a probl
		9. Justification has been established that an ambiguous situat
		10. A justification is given to explain that a problem will be s
	The Importance of the Study	11. The reason for using the mixed research method is explain
		12. There are utilitarian and pluralistic justifications.
		13. The contribution of activities for the solution of a problem
	The aim of the study	14. The predicted results of the study can be environmental, s

Research Questions	15. The theoretical/theoretical model chosen is functional in t 16. The suitability of the mixed research is stated. 17. The research question includes a utilitarian perspective. 18. While creating the research questions, the reason for the r

As part of the research, examining 37 items for each article and reporting them as a single article would make it difficult to understand, so we decided to report the study in two parts. For this reason, in the first part of the research, we examined the summary, keywords, and introduction of the articles. The authors decided that it would be more appropriate to classify them according to criteria. For this reason, we classified the studies as Not applicable (0), Low (1), Medium (2), and High (3) based on the utilitarian feature and converted them into rubric format under the control of an assessment and evaluation specialist (Table 3).

Table 3. *Rubric based on pragmatism*

No	Criteria
1	The abstract reflects the characteristics of pragmatism
2	Pragmatism-specific keyword used.
3	The conceptual framework was created by considering the characteristics of pragmatism based on theory or philosoph
4	The conceptual framework was created by considering the characteristics of pragmatism based on theoretical knowled
5	The rationale (answering the research question, identifying the gap in the literature, etc.) based on past research is st
6	The study explained that the subject of the study cannot be studied with a single research method, based on the cha
7	The contributions of the analysis of the research question with the mixed research method to the researchers are expl
8	The research question suitable for the mixed research method was included.

The authors used the article review template to review articles in a common format. Each author individually scored all 27 articles first. After each author finished reviewing all the articles, we compared the ratings. We conducted repeated interviews until we reached a consensus on the scoring of each article. In cases where we could not reach a consensus, we sought the opinion of an expert in the field of measurement and evaluation and science education.

RESULTS

Abstract

Table 4. *The abstract reflects the characteristics of pragmatism*

Criteria	Article Tag
High (3)	A1, A10, A14, A22, A26
Moderate (2)	A5, A9, A11, A12, A19, A20, A21
Low (1)	A2, A3, A4, A6, A8, A7, A15, A16, A17, A18, A23, A24, A25, A27
Not applicable (0)	A13

We have evaluated five of the articles as High in terms of reflecting the characteristics of pragmatism in the abstract (Table 4). For example, A1 reveals the utilitarian feature of pragmatism with the statement *"Findings also indicated four attributes for teaching and learning in the twenty-first-century: (a)..."* . In study A1, the author explained that multiple data collection tools were used with the phrase *"... Quantitative and qualitative data were collected via an online survey, personal interviews, and written reflections with science teacher educators and student teachers..."*. Thus, the author has used the property of pluralism. In addition, in this study, the author emphasized the functionality by stating that the results can be used to determine the characteristics of teachers in the 21stcentury. The sentence that reveals this feature is as

follows:

"Findings also indicated four attributes for teaching and learning in the twenty-first century: adapting to frequent changes and uncertain situations, collaborating and communicating in decentralized environments, generating data and managing information, and releasing control by encouraging exploration."

We found that seven studies (A5, A9, A11, A12, A19, A20, and A21) were Moderate. For example, A5 mentioned utilitarianism: *"Informal science learning experiences have been found to provide valuable opportunities to engage with and learn about science and, as such, form a key part of the STEM learning ecosystem"* . A5 presented multiple perspectives: *"Survey findings are illustrated by interview data from the same project"* .

We have determined that 14 articles were Low. For example, A2 reflects a pluralistic perspective with the statement: *"We used an explanatory sequential mixed methods approach with a collection of survey data followed by interviews with selected participants"* .

Specific Keywords

Table 5. *Specific keyword use*

Criteria	Article Tag
High (3)	-
Moderate (2)	-
Low (1)	A7; A8, A20, A21
Not applicable (0)	A1, A2, A3, A4, A5, A6, A9, A10, A11, A12, A13, A14, A15, A16, A17, A18, A19, A22, A23, A24, A25

As seen in Table 5, except for four studies (A7, A8, A20, and A21), no keywords reflecting the characteristics of pragmatism were found in other studies. In the four studies, the phrase "Mixed methods" was used as a keyword.

Creating A Conceptual Framework Based on Theory/Philosophy

Table 6. *Creating a conceptual framework based on theory/philosophy*

Criteria	Article Tag
High (3)	A1, A7, A18, A19, A20, A25
Moderate (2)	A23
Low (1)	A4, A8, A12, A14, A21
Not applicable (0)	A2, A3, A4, A6, A9, A10, A11, A13, A15, A16, A17, A22, A24, A26, A27

Six of the articles (A1, A7, A18, A19, A20, and A25) were evaluated as High in terms of reflecting the characteristics of pragmatism in the introduction (Table 6). For example, the pragmatism features of A19's work are as follows:

Utilitarianism:

"These more authentic and situated learning opportunities therefore also hold promise for improving students' self-perceptions and identification with science by allowing students to investigate authentic science problems, trying on new identities as scientists."

Transferable:

"... After participating in the curriculum, students' self-efficacy increased about scientific inquiry and stronger

initial science identity led to higher efficacy gains."

Functional:

"By emphasizing the tools and inquiry practices of real scientists, the curriculum is designed to promote deeper learning that can potentially prepare students for the modern job market by giving them a case-based, open-ended task that can link to personal passions and their everyday lives. . . "

As a result of the analysis, we identified that only A23 was moderate:

Transferable:

". . . Organizational and programmatic design elements are important in the study of OST learning because these features, such as the physical space or location of the program, or the available expertise, resources, and materials, will influence learning processes and outcomes. . . "

Utilitarianism:

". . . instead, learning involves the interaction of people, places, and cultures and the transfer or movement of knowledge, beliefs, attitudes, and skills across contexts . . . ."

Five studies (Table 7) were determined to be Low. For example, A8 explained:

"The overall design of the Babushka concept is strongly rooted in a constructivist view on learning. . . For meaningful learning to occur, students must link new ideas to their prior knowledge and experiences, and determine the activity's relevance for themselves. . . ."

The remaining 15 studies were N/A. These studies did not explain the reasons for choosing the philosophy on which the research was based (e.g., A3) or did not explain this reason in terms of the characteristics of pragmatism (e.g., A4).

Creating A Conceptual Framework Based on Theoretical Knowledge

Table 7. *Creating a conceptual framework based on theoretical knowledge*

Criteria	Article Tag
High (3)	A7, A10, A11, A14, A15, A18, A20, A23, A25
Moderate (2)	A2, A3, A4, A8, A13, A16, A17, A19, A21, A22, A26, A27
Low (1)	A1
Not applicable (0)	A5, A6, A9, A12, A24

The reviewed articles were evaluated in terms of revealing the conceptual framework of the study in a way that reflects the characteristics of pragmatism. Accordingly, nine studies were determined to be High (Table 7). For example, A11 used the following features of pragmatism:

Utilitarianism:

"*. . . Thus, this study aims to explore the current status of science teaching and learning within the context of contemporary KSA science education reform efforts."*

Functional:

"*The Course System, in which some of the teachers participating in this study teach, is a new Saudi system of teaching whose most prominent feature is the opportunity for students to finish secondary school in 2.5 years instead of 3 years, achieved by adding two summer classes .*"

Transferable:

"*Students' perceptions of their outcome-based learning environment provide insights into how Saudi Arabia's educational reform efforts are functioning for science educators and teachers* ."

We determined that 12 of the articles were Moderate. For example, the pragmatism features in A4's study are:

Pluralist:

"*Critical thinking skills are measured to determine the students' level of critical thinking ability, to give feedback to students on critical thinking, to motivate students to be critical thinkers, to inform teachers about their successes in teaching critical thinking, to make research on critical thinking and to inform schools about developing critical thinking skills of students, etc* ."

Problem solver:

" *Tests developed for different purposes have been used to measure critical thinking skills. However, as one of the most effective ways, the necessity of using these techniques together to examine critical thinking skills has been emphasized."*

On the other hand, we evaluated A1 in the low category: *"Social contexts for learning make learners' thinking apparent to teachers and peers so that it can be examined, questioned, and built on. This study was therefore undertaken to examine science teacher educators' predominant instructional technologies, in the context of teacher education in Israel."*

The five studies did not explain the theoretical information using pragmatism-specific features, so they were considered Not Applicable (Table 7).

Reasoning Based on The Characteristics of Pragmatism

Table 8. *Reasoning based on the characteristics of pragmatism*

Criteria	Article Tag
High (3)	A7 A10 A13 A18 A19 A20 A23 A25
Moderate (2)	A4 A17 A21 A22 A26
Low (1)	A2 A3 A5 A6 A8 A11 A12 A14 A15 A16 A27
Not applicable (0)	A1 A9 A24

We found that eight studies were High (Table 8). For example, A25:

"Apart from the REACT strategy, new strategies or teaching models should be developed for the implementation of context-based learning approach which is found as effective in learning environments in terms of increasing students' interest and motivation, relating content knowledge to daily life experiences, providing more meaningful learning."

Therefore, A25 pointed out different functions (functionality) of strategy in the same area. In addition, A25 emphasized utilitarianism with the following sentences: *"Teachers can therefore help students make learning more meaningful by guiding, bringing together students' experiences, explaining results, and creating new concepts."*Finally, A25 followed a problem-solving strategy with the following sentences: "*In the REACT strategy, discussion and explanation parts were missing. Because teachers got used to making explanations after each teaching activity and students got used to listening to their teachers' explanations were made for summarizing the activity; lacking explanation part was obvious. . . . Also, a discussion part was needed in the implementation of the REACT strategy. . . .* "

Five of the reviewed studies were classified as Moderate. For example, A26 expressed a problem and suggested a solution with the following sentences:

"Previous research has shown self-efficacy to be strongly related to academic achievement, course selection,

and career choice. . . . It stands to reason, therefore, that if we can understand what influences the development of self-efficacy, then we can utilize this knowledge to promote and encourage engagement and participation in science."

A26 revealed the contribution of the study with the following sentences:

"Whilst external environmental and societal influences on self-efficacy (such as parents and family) have been extensively studied, and school experiences have been suggested to be a key factor in the development of beliefs, limited research has yet to be conducted within the school environment that looks at the sources of self-efficacy."

A27 was one of the studies that we placed in the low category in this section. It reflects a pluralistic perspective as it justifies its explanations in terms of different variables.

"This research shows that a dominant concern of students is the presence of 'free-loaders' or 'social-loafing', whereby one or more team members contribute less than others. . . ."

The Study Cannot Be Studied with A Single Research Method

Table 9. *The study subject cannot be studied with a single research method*

Criteria	Article Tag
High (3)	A19, A20
Moderate (2)	-
Low (1)	A4, A13, A21, A22, A26
Not applicable (0)	A1, A2, A3, A5, A6, A7, A8, A9, A10, A11, A12, A14, A15, A16, A17, A18, A23, A24, A25, A27

Two of the examined articles were found to be high (Table 9). A19 stated that the subject is too complex to be explained with a single research method with the following sentences: *"Employment in science, technology, engineering, and mathematics (STEM) careers grew by 10.5% from 2009 to 2015 compared to 5.2% growth in non-STEM jobs, and the average national wage for STEM jobs is nearly double that of other occupations. Despite this, employers report difficulty filling these positions due to a lack of sufficiently qualified candidates."* Based on the problem-solving feature of pragmatism, A19 stated that the subject is too complex to be explained with a single research method, with the following sentences: *"His style of authentic instruction may help ameliorate the "leaky pipeline" often discussed in STEM education in which qualified candidates (often women and underrepresented minorities) stop pursuing STEM careers for a wide variety of reasons. . . ."* A19 expressed the functionality with the following sentences: " *Teaching through authentic scientific practice also aligns with situated learning theory, which contends that learning cannot take place outside of the context where that skill is used, and typically takes place in a community of practice where members can learn from each other and develop their identity."*

Five studies were in a low category. For example, A22:

"Quantitative classroom observation data were paired with qualitative interview data to gain insight into how and why faculty implemented clickers in their courses. The mixed-methods approach taken in this study highlights the complexity of implementing active learning into lecture-based undergraduate STEM courses. . . ."

The Contributions of the Analysis of the Research Question

Table 10. *The contribution of the analysis of the research question*

Criteria	Article Tag
High (3)	A10, A19, A20
Moderate (2)	A17, A26
Low (1)	A1, A2, A7, A21

Criteria	Article Tag
Not applicable (0)	A3, A4, A5, A6, A8, A9, A11, A12, A13, A14, A15, A16, A18, A22, A23, A24, A25, A27

Three of the articles were found to be High (Table 10). For example, A20:

Problem solver: *"Important measurement difficulties remain unresolved in self-concept research... This was shown by Barbara Byrne who identified "a grave need for researchers to move beyond the paper-and-pencil approach to self-report measurement" (p. 904) because responses to self-concept questionnaires will be "influenced by a cultural bias that ultimately leads to differential perceptions of self" (p. 903)."*

Utilitarianism /Functional: *"Since investigations based on the prevailing theoretical models of self-concept are almost exclusively quantitative in nature, critical scrutiny of the theoretical foundations of science self-concept research is needed."*

Two of the articles are Moderate. For example, A26:

Utilitarianism: *"It stands to reason, therefore, that if we can understand what influences the development of self-efficacy, then we can utilize this knowledge to promote and encourage engagement and participation in science. This would be of particular value to those working with girls who fail to continue with science beyond compulsory education despite high academic achievement in science."*

Functional: *"It is hoped that furthering our understanding of self-efficacy formation may provide crucial information that will enable teachers to tailor their support and instruction to enhance student's future take-up of science."*

Four articles were classified as Low.

Including The Research Question Appropriate to The Mixed Research Method

Table 11. *Including the research question appropriate to the mixed research method*

Criteria	Article Tag
High (3)	A10, A13, A18, A19, A20, A22, A23
Moderate (2)	A1
Low (1)	A2, A3, A4, A5, A6, A7, A9, A11, A12, A15, A16, A17, A21, A24, A26, A27
Not applicable (0)	A8, A14, A25

Seven of the reviewed articles were found to be High (Table 11). For example, A18 mentioned the contribution of quantitative and qualitative findings to each other with the following sentences: *"Do quantitative results from the process of engineering-oriented STEM integration activities and qualitative results from the views on the implementation process support each other?"*

We evaluated A1 as Moderate, as it contains quantitative and qualitative questions that provide versatile solutions for the main purpose of the questions: "*1. What are the predominant instructional technologies and methods that lecturers in teacher education institutions apply, 2? What are the significant attributes of teaching and learning that should be practiced in contemporary teacher education programs according to the teacher educators? 3. What characterizes a pedagogical framework that is based on the integration of social constructivism and cloud technologies?"*

16 articles were identified as Low. For example, A16:

"Is there a relationship between science anxiety scores and the gender of the students? Is there a relationship between science anxiety scores and grade levels of the students? Is there a relationship between science anxiety scores and the family income level of the students? Is there a relationship between their science anxiety scores

and the type of school? What are the anxieties about the science lesson the students?"

The first three questions are quantitative while the last question is qualitative. No mixed-specific questions have been identified.

Discussion

Although the number of mixed studies is increasing day by day, these studies remain weak in terms of quality (Fa'bregues & Molina-Azorı´n, 2017). To enrich mixed research qualitatively, it is important to determine the philosophy that fully reflects the nature of the mixed research method and to create the study based on this philosophy (Creswell & Plano-Clark, 2011).

There are many meta-synthesis studies examining mixed studies in the related literature (Alise & Teddlie, 2010; Coates, 2021; Fàbregues & Molina-Azorín, 2017; Taşçıoğlu et al., 2022). Among the studies, only Coates (2021) examined mixed studies from a philosophical point of view. Coates (2021) emphasizes that since philosophical arguments form the basis of the research, the philosophy that is the basis of the research should be mentioned in detail in the study. Based on this idea, Coates (2021) concluded that philosophical assumptions were mentioned in only 81 of the 1,026 mixed studies.

We concluded that many of the mixed studies do not accurately reflect the characteristics of pragmatism. The current research has concluded that researchers have difficulties in determining the research question and keywords specific to the mixed method reflecting the pragmatic philosophy, revealing the reasons for choosing the mixed method, and creating the conceptual framework based on pragmatism. When we look at the parts where researchers are less successful in reflecting the characteristics of pragmatism, it is noteworthy that these parts are the only parts that contain the pragmatic philosophy-based nature of mixed methods research. In these parts, we concluded that the researchers accepted the mixed research method as the sum of the qualitative and quantitative tradition, and therefore did not seek a different third way to reflect the nature of the mixed method. Therefore, the present study will raise the awareness of researchers to reflect on the nature of pragmatism.

We have determined that the studies reflect the characteristics of pragmatism at a good level in terms of the abstract, conceptual framework, and reasoning. The possible reason for this situation is that these parts are not only about the nature of pragmatism but also the nature of scientific research in general. We thought that researchers who are familiar with qualitative and quantitative research methods and generally have scientific research experience do not have any difficulty in reflecting the pragmatic philosophy in these parts. In addition, pragmatism is a broad-based philosophical approach that can be used not only in mixed research but also in qualitative and quantitative research.

Contribution to Mixed Methods Research

The fact that researchers using mixed research methods do not tend to think about the philosophy of the study and focus only on results prevents the integration of qualitative and quantitative methods (Bryman, 2006). Therefore, to be able to integrate mixed methods research, researchers should initially construct their studies according to the relevant philosophical approach, rather than adding the philosophical approach to their studies later. In this study, we supported this idea in parallel with the literature. In addition, we suggested to researchers who will use the mixed research method that it is the right way to start planning the study with philosophy, and we presented a roadmap on how to plan according to the philosophy on which the study is based.

Considering that philosophical approaches underlie every stage of the studies in the field of social sciences (Bryman, 2007), it emerges that these philosophical approaches must be accurately reflected in the studies (Ivankova & Plano Clark, 2018). Therefore, this study will shed light on researchers in this sense.

Limitations

According to the criteria determined at the beginning of the study, 27 mixed research articles were examined. In addition, the 37-item rubric, which was originally prepared to examine all parts of an article, was divided

into two due to difficulties in reporting, publishing, and intelligibility.

The study was limited to only the abstract and introduction parts. Although it is thought that the basic philosophy is mentioned in the introduction part in scientific studies, the philosophy on which the study is based can be mentioned in other parts of the research. For example, in the introduction to A22, the conceptual framework is not reported as taking into account the characteristics of pragmatism. The same study, in the method part, mentioned the characteristics of pragmatism. Therefore, it would be a wrong or incomplete practice to decide whether to reflect the characteristics of pragmatism by looking only at the abstract and introduction part of the study.

Suggestions for Future Researchers

- We suggest that researchers who set out to reveal the quality of mixed studies should examine the reflection of philosophy in studies in more detail.
- Although pragmatist philosophy is commonly preferred in mixed studies, we underline those studies that can be conducted based on different philosophical approaches in this research. We suggest that whichever philosophical perspective is suitable for the research and can answer the research questions most clearly, that approach should be preferred. We argue that this situation will be more pragmatist.
- New researchers can use our rubric and criteria as a checklist or as a planning framework at the beginning of their studies.

References

Alise, M. A., & Teddlie, C. (2010). A continuation of the paradigm wars? Prevalence rates of methodological approaches across the social/behavioral sciences. *Journal of mixed methods research, 4* (2), 103-126.*https://doi.org/10.1177%2F1558689809360805*

Arastaman, G., Fidan, I. O., & Fidan, T. (2018). Validity and reliability in qualitative research: A theoretical analysis. *YYU Journal of Education Faculty, 15* (1), 37-75.*http://dx.doi.org/10.23891/efdyyu.2018.61*

Barak, M. (2017). Science teacher education in the twenty-first century: a pedagogical framework for technology-ıntegrated social constructivism.*Res Sci Educ , 47,* 283–303.*https://doi.org/10.1007/s11165-015-9501-y*

Berelson, B. (1952). *Content analysis in communication research* . New York: Free Press.

Biddle, C., & Schafft, K. A. (2015). Axiology and anomaly in the practice of mixed methods work Pragmatism, valuation, and the transformative paradigm. *Journal of Mixed Methods Research, 9* (4), 320-334.*https://doi.org/10.1177%2F1558689814533157*

Bietsa, G. (2010). *Pragmatism and the philosophical foundations of mixed methods research* . Pages 95–117 in A. Tashakkori and C. Teddlie, (eds). Handbook of mixed methods in social & behavioral research. Sage, Thousand Oaks, California.

Bryman, A. (2007). Barriers to integrating quantitative and qualitative research. *Journal of mixed methods research, 1* (1), 8-22.*https://doi.org/10.1177%2F2345678906290531*

Canipe, M. M., & Coronado Verdugo, J. Y. (2020). The influence of a science methods course on prospective elementary teachers' visions of science teaching. *Journal of Educational Research & Practice* ,10(1), 299-316.*https://doi.org/10.5590/JERAP.2020.10.1.19*

Cevizci, A. (1999). *Felsefe sözlüğü* (3. baskı). İstanbul: Paradigma Yayınları.

Christ, T. W. (2013). The worldview matrix as a strategy when designing mixed methods research. *International Journal of Multiple Research Approaches, 7* (1), 110-118.*https://doi.org/10.5172/mra.2013.7.1.110*

Coates, A. (2021). The prevalence of philosophical assumptions described in mixed methods research in education. *Journal of Mixed Methods Research, 15* (2), 171-189.*https://doi.org/10.1177%2F1558689820958210*

Crasnow, S. (2009). *Feminist perspectives on science.*

Creswell, J. W. & Plano Clark, V. L. (2018). *Designing and conducting mixed methods research* (3rd ed.). Sage

Creswell, J. W. (2003). A framework for design. *Research design: Qualitative, quantitative, and mixed methods approach* . 9-11.

Creswell, J. W. (2009). *Research design, qualitative, quantitative, and mixed methods approach* (Third Edition). California: SAGE Publications.

Creswell, J. W., & Creswell, J. D. (2017). *Research design: Qualitative, quantitative, and mixed methods approach* . Sage publications.

Çevik, M. (2018). Investigating STEM semantics and perceptions of engineer candidates and pre-service teachers: A mixed-method study.*International Journal of Educational Technology,* 5(2), 1-18.

Demiral, Ü. (2018). Examination of critical thinking skills of preservice science teachers: a perspective of social constructivist theory. *Journal of Education and Learning* , *7* (4), 179-190.

Denzin, N. K. (2010). Moments, mixed methods, and paradigm dialogs.*Qualitative inquiry, 16* (6), 419-427.*https://doi.org/10.1177%2F1077800410364608*

DeWitt, J., & Archer, L. (2017). Participation in informal science learning experiences: the rich get richer? *International Journal of Science Education* , *Part B, 7* (4), 356-373.*https://doi.org/10.1080/21548455.2017.1360531*

Dinçer, S. (2018). Content analysis in scientific research: Meta-analysis, meta-synthesis, and descriptive content analysis.*Bartin University Journal of Faculty of Education, 7* (1), 176-190.*https://doi.org/10.14686/buefad.363159*

Doğan, N. (2003). Pragmatizmin felsefi temelleri. *Erciyes Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi, 20* (1), 83-93.

Fàbregues, S., & Molina-Azorín, J. F. (2017). Addressing quality in mixed methods research: A review and recommendations for a future agenda. *Quality & Quantity, 51* (6), 2847-2863.*https://doi.org/10.1007/s11135-016-0449-4*

Fettahlıoğlu, P., & Kaleci, D. (2018). Online argumentation implementation in the development of critical thinking disposition.*Journal of Education and Training Studies* . *6* (3), 127-136.

Fredricks, J. A., Hofkens, T., Wang, M. T., Mortenson, E., & Scott, P. (2018). Supporting girls' and boys' engagement in maths and science learning: A mixed-methods study. *Journal of Research in Science Teaching, 55* (2), 271-298.*https://doi.org/10.1002/tea.21419*

Gårdebjer, S., Larsson, A., & Adawi, T. (2017). The babushka concept–an instructional sequence to enhance laboratory learning in science education. *Journal of Education in Science Environment and Health, 3* (2), 213-222.*https://doi.org/10.21891/jeseh.326757*

Ghiara, V. (2020). Disambiguating the role of paradigms in mixed methods research. *Journal of mixed methods research, 14* (1), 11-25.*https://doi.org/10.1177%2F1558689818819928*

Gholam, A. P. (2017). Visual Thinking Routines: A mixed-methods approach applied to student teachers at the American University in Dubai.*Journal of Inquiry and Action in Education, 9* (1), 12-27. Retrieved from*https://digitalcommons.buffalostate.edu/jiae/vol9/iss1/2*

Greene, J., & Hall, J. N. (2010). *Dialectics and pragmatism* . Sage handbook of mixed methods in social & behavioral research, 119-167.

Hesse-Biber, S. (2012). Feminist approaches to triangulation: Uncovering subjugated knowledge and fostering social change in mixed methods research. *Journal of Mixed Methods Research, 6* (2), 137-146.*https://doi.org/10.1177%2F1558689812437184*

Heyvaert, M., Hannes, K., Maes, B., & Onghena, P. (2013). Critical appraisal of mixed methods studies. *Journal of mixed methods research, 7* (4), 302-327.*https://doi.org/10.1177%2F1558689813479449*

Ivankova, N. V., & Plano Clark, V. L. (2018). Teaching mixed methods research: using a socio-ecological framework as a pedagogical approach for addressing the complexity of the field. *International Journal of Social Research Methodology, 21* (4), 409-424.*https://doi.org/10.1080/13645579.2018.1427604*

James, W. (2004). *Pragmatism and four essays from The Meaning of Truth,* Meridian Books.

Johnson, R. B., & Onwuegbuzie, A. J. (2004). Mixed methods research: A research paradigm whose time has come. *Educational Researcher, 33* (7), 14-26.*https://doi.org/10.3102%2F0013189X033007014*

Johnson, R. B., Onwuegbuzie, A. J., & Turner, L. A. (2007). Toward a definition of mixed methods research. *Journal of mixed methods research, 1* (2), 112-133.*https://doi.org/10.1177%2F1558689806298224*

Kavai, P., De Villiers, R., Fraser, W., Sommerville, J., & Strydom, N. (2015). Animal organ dissections in high schools: is there more than just cutting? *African Journal of Research in Mathematics, Science and Technology Education, 19* (2), 143-155.*https://hdl.handle.net/10520/EJC171553*

Kim, S. Y., & Hamdan Alghamdi, A. K. (2019). Female secondary students' and their teachers' perceptions of science learning environments within the context of science education reform in Saudi Arabia.*International Journal of Science and Mathematics Education, 17* (8), 1475-1496.*https://doi.org/10.1007/s10763-018-09946-z*

Korkmaz, H., Thomas, J. A., Tatar, N., & Altunay, S. (2017). Students' out-of-school experiences, job priorities, and perceptions toward themselves as a scientist: A cross-cultural study. *International Journal of Curriculum and Instruction, 9* (1), 63-80.

Lamar, M. F., Wilhelm, J. A., & Cole, M. (2018). A mixed-methods comparison of teachers' lunar modeling lesson implementation and student learning outcomes. *The Journal of Educational Research, 111* (1), 108-123.*https://doi.org/10.1080/00220671.2016.1220356*

Lane, S., Hoang, J. G., Leighton, J. P., & Rissanen, A. (2021). Engagement and satisfaction: Mixed-method analysis of blended learning in the sciences. *Canadian Journal of Science, Mathematics and Technology Education, 21* (1), 100-122.*https://doi.org/10.1007/s42330-021-00139-5*

Leavy, P. (2017). *Research design: Quantitative, qualitative, mixed methods, arts-based, and community-based participatory research approaches.* Guilford Publications.

Leckenby, D., & Hesse-Biber, S. N. (2007). *Feminist approaches to mixed-methods research.* Feminist research practice: A primer, 249-291.

Leininger, M. (1994). *Evaluation criteria and critique of qualitative research studies* . In J. M. Morse (Ed.). Critical Issues in Qualitative Research Methods. (p. 95-115). Thousand Oaks, CA: SAGE Publications, Inc.

Lincoln, Y. S., & Guba, E. G. (1986). But is it rigorous? Trustworthiness and authenticity in naturalistic evaluation. *New directions for program evaluation, 1986* (30), 73-84.*https://doi.org/10.1002/ev.1427*

Maxwell, J. A. (2016). Expanding the history and range of mixed methods research. *Journal of mixed methods research, 10* (1), 12-27.*https://doi.org/10.1177%2F1558689815571132*

Maxwell, J. A., & Mittapalli, K. (2010). Realism as a stance for mixed methods research. A. Tashakkori & C. Teddlie (Eds.) içinde, *Sage handbook of mixed methods in social and behavioral research* (2nd ed., s. 145-167). Thousand Oaks, CA: Sage.

Mercer-Mapstone, L., & Kuchel, L. (2017). Core skills for effective science communication: A teaching resource for undergraduate science education. *International Journal of Science Education, Part B, 7* (2), 181-201.*https://doi.org/10.1080/21548455.2015.1113573*

Merriam, S. B. (2013). *Qualitative research: a guide to pattern and application* . S. Turan (Translation Ed.). Nobel Publication Distribution.

Mertens, D. M. (2003). Mixed methods and the politics of human research: The transformative emancipatory perspective. A. Tashakkori ve C. Teddlie (Eds.) içinde, *Handbook of mixed-method social & behavioral research* (s. 135-164). Thousand Oaks,

Mertens, D. M., & Hesse-Biber, S. (2013). Mixed methods and credibility of evidence in evaluation. *New directions for evaluation, 2013* (138), 5-13.*https://doi.org/10.1002/ev.20053*

Mills, G. E. & Gay, L. R. (2016). *Educational research: competencies for analysis and applications* . (11. Baskı) USA: Pearson Education.

Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., & the PRISMA Group. (2009). Reprint—preferred reporting items for systematic reviews and meta-analyses: The PRISMA Statement. *Physical Therapy, 89* (9), 873-880.

Morgan, D. L. (2007). Paradigms lost and pragmatism regained: Methodological implications of combining qualitative and quantitative methods. *Journal of Mixed Methods Research, 1* (1), 48-76.*https://doi.org/10.1177%2F2345678906292462*

Murphy, J. P. (1990). *Pragmatism: From Peirce to Davidson* . Boulder, CO: Westview Press.

Özbugutu, E. (2021). An Investigation into Anxiety about the Science Lesson through a Mixed Model. *Journal of Education and Learning, 10* (1), 104-117.

Özkale, U., & Kanadli, S. (2021). An investigation of feedback strategies used by science teachers in the classroom setting: A mixed-methods research. *International Journal of Progressive Education, 17* (1), 439-457.

Özkul, H., & Özden, M. (2020). Investigation of the effects of engineering-oriented STEM integration activities on scientific process skills and STEM career interests: A mixed-methods study. *Education and Science, 45* (204), 41-63.*https://doi.org/10.15390/EB.2020.8870*

Palinkas, L. A., Aarons, G. A., Horwitz, S., Chamberlain, P., Hurlburt, M., & Landsverk, J. (2011). Mixed method designs in implementation research. *Administration and Policy in Mental Health and Mental Health Services Research, 38* (1), 44-53.*https://doi.org/10.1007/s10488-010-0314-z*

Pawson, R. (2013). *The science of evaluation: a realist manifesto* . Sage.

Phillips, D. C., Phillips, D. C. & Burbules, N. C. (2000).*Postpositivism and educational research* . Rowman & Littlefield.

Reilly, J. M., McGivney, E., Dede, C., & Grotzer, T. (2021). Assessing science identity exploration in immersive virtual environments: a mixed-methods approach. *The Journal of Experimental Education, 89* (3), 468-489.*https://doi.org/10.1080/00220973.2020.1712313*

Rossman, G. B., & Wilson, B. L. (1985). Numbers and words: Combining quantitative and qualitative methods in a single large-scale evaluation study. *Evaluation Review, 9* (5), 627-643.*https://doi.org/10.1177%2F0193841X8500900505*

Rüschenpöhler, L., & Markic, S. (2019). A mixed-methods approach to culture-sensitive academic self-concept research. *Education Sciences, 9* (3), 240.*https://doi.org/10.3390/educsci9030240*

Scogin, S. C., Cavlazoglu, B., LeBlanc, J., & Stuessy, C. L. (2018). Inspiring science achievement: a mixed-methods examination of the practices and characteristics of successful science programs in diverse high schools. *Cultural Studies of Science Education, 13* (3), 649-670.*https://doi.org/10.1007/s11422-016-9796-7*

Scott, P. J., & Briggs, J. S. (2009). A pragmatist argument for mixed methodology in medical informatics. *Journal of Mixed Methods Research, 3* (3), 223-241.*https://doi.org/10.1177%2F1558689809334209*

Shannon-Baker, P. (2016). Making paradigms meaningful in mixed methods research. *Journal of mixed methods research, 10* (4), 319-334.*https://doi.org/10.1177%2F1558689815575861*

Small, M. L. (2011). How to conduct a mixed-methods study: Recent trends in a rapidly growing literature. *Annual review of sociology, 37* , 57-86.*https://doi.org/10.1146/annurev.soc.012809.102657*

Solomon, E. D., Repice, M. D., Mutambuki, J. M., Leonard, D. A., Cohen, C. A., Luo, J., & Frey, R. F. (2018). A mixed-methods investigation of clicker implementation styles in STEM. *CBE—Life Sciences Education, 17* (2), ar30.*https://doi.org/10.1187/cbe.17-08-0180*

Tashakkori, A. & Teddlie, C. (1989). *Mixed methodology: Combining qualitative and quantitative approaches.* Thousand Oaks, CA: SAGE.

Tashakkori, A. & Teddlie, C. (2010). *Handbook of mixed methods in social & behavioral research* . Sage, Thousand Oaks, California.

Tashakkori, A., & Teddlie, C. (2003). Issues and dilemmas in teaching research methods courses in social and behavioral sciences: US perspective. *International journal of social research methodology, 6* (1), 61-77.*https://doi.org/10.1080/13645570305055*

Tashakkori, A., & Teddlie, C. (2009). Integrating qualitative and quantitative approaches to research. *The SAGE handbook of applied social research methods, 2* , 283-317.*https://dx.doi.org/10.4135/9781483348858.n9*

Taşçıoğlu, R., Gürsoy, İ. N., Kaçar, E., Erbaş, E., ve Fırat, M. (2022). Methodological trends of 500 most-cited educational research articles in the last decade. *Journal of Mixed Methods Studies* , 5, 1-16.*https://doi.org/10.14689/jomes.2022.5.1*

Thiry, H., Archie, T., Arreola-Pena, M., & Laursen, S. (2017). Linkages between youth diversity and organizational and program characteristics of out-of-school-time science programs: a mixed-methods study.*International Journal of Science Education, Part B, 7* (2), 121-145.*https://doi.org/10.1080/21548455.2015.1105397*

Türer, C., & Aydın, M. (2019). Utilitarianism and Pragmatism: Differences, similarities. *Journal of Philosophy and Social Sciences* , (28), 121-149.

Ugras, M., & Asiltürk, E. (2018). Perceptions of science teachers on the implementation of seven principles for good practice in education by Chickering and Gamson in courses. *Journal of Education and Training Studies, 6* (3), 170-183.

Ültay, E., & Alev, N. (2017). Investigating the effect of the activities based on explanation assisted REACT strategy on learning ımpulse, momentum, and collisions topics. *Journal of Education and Practice, 8* (7), 174-186.

Webb-Williams, J. (2018). Science self-efficacy in the primary classroom: Using mixed methods to investigate sources of self-efficacy.*Research in Science Education, 48* (5), 939-961.*https://doi.org/10.1007/s11165-016-9592-0*

Wilson, L., Ho, S., & Brookes, R. H. (2018). Student perceptions of teamwork within assessment tasks in undergraduate science degrees.*Assessment & Evaluation in Higher Education, 43* (5), 786-799.*https://doi.org/10.1080/02602938.2017.1409334*

Yvonne Feilzer, M. (2010). Doing mixed methods research pragmatically: Implications for the rediscovery of pragmatism as a research paradigm. *Journal of mixed methods research, 4* (1), 6-16.*https://doi.org/10.1177%2F1558689809349691*

Zachariadis, M., Scott, S., & Barrett, M. (2013). Methodological implications of critical realism for mixed-methods research. *MIS Quarterly* , 855-879.*https://www.jstor.org/stable/43826004*