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SCIENCE TEACHERS' EXPERIENCES IN PREPARING A SCIENTIFIC RESEARCH PROJECT: AN ACTION RESEARCH

Abstract: The aim of this study was to investigate the perspectives of science teachers who are pursuing postgraduate studies on their experiences in preparing a research project and to explore the effects of this experience on the participants. In this context, a qualitative research method was employed using an action research design. Seven science teachers who met the research criteria participated, and the research was conducted for 14 weeks during the fall semester. Semi-structured interviews, peer assessment forms, and project evaluation rubrics were used to collect data. The data collected from the interviews were analyzed using content analysis technique. The results indicated that the participants had insufficient knowledge about preparing a research project before the training, but they achieved a certain level of competency by the end of the training. The participants gained knowledge about the stages of the project, how to write the project, what originality means and its importance, and the criteria of a good project as a result of the training. The teachers gained an important understanding about the importance of originality and planning while preparing the project, and they had the most difficulty in determining the originality of the project. In addition, the participants agreed that teacher competency in preparing and conducting a qualitative research project is very important.

Keywords: Science Teachers, Graduate Education, Research Project, Action Research.

Introductıon

In today's understanding of science education, it is crucial to have a research-based process in place where students take responsibility for acquiring knowledge while teachers guide them in this matter. The ultimate goal of this process is for students to learn scientific thinking and develop higher-order thinking skills. Therefore, students should be motivated to ask questions, conduct research, and design projects (Ministry of National Education [MoNE], 2018). One of the most effective ways to accomplish this is through student project production.

Projects are a type of student-centered and practice-based work. They are defined as a process of producing a product that enhances individuals' learning skills (Kokotsaki, Menzies, & Wiggins, 2016). Research projects, which are the focus of the current study, are described by Creswell (2007) as steps used to collect information to solve a problem or to understand a topic, and to analyze the collected information. Thus, the fundamental logic of project work is to solve to an existing problem by utilizing skills such as critical thinking and problem-solving (Viro, Lehtonen, Joutsenlahti, & Tahvanainen, 2020). In this context, the importance of students preparing projects and participating in activities such as exhibitions and science fairs in Science lesson programs has been highlighted. This aims to enable students to learn the process of conducting scientific research, the methodological steps used to access scientific knowledge, as well as to acquire the skills mentioned above (TUBITAK, 2018). Teachers also have a critical role in the preparation and implementation of the project in order to achieve the desired outcomes (Zorlu & Zorlu, 2020). This is because it is essential to determine the problem situation, i.e. the topic, and manage the project process effectively. For the project process to be efficient, project

managers must have information and experience in this regard. Otherwise, teachers who lack the necessary qualifications avoid preparing projects (Artvinli, Cetintas, & Terzi, 2020) or the efficiency of the projects they carry out is low (Cepni, 2005). It is known that teaching experience is important for the development of reflective practices in education (Osmanović Zajić & Maksimović, 2020). Furthermore, for students to acquire the knowledge and skills targeted by project works, teachers must first have these skills. Therefore, one of the goals of teacher training programs should be to equip teacher candidates with the ability to conduct scientific research. This can be considered one of the indicators of quality teacher education (Frank & Barzilia, 2004). Unfortunately, however, teacher training programs in Turkey, which are expected to provide teachers with knowledge and experience related to projects, are inadequate in this regard, and teacher candidates do not gain experience in preparing and conducting a scientific research project in their undergraduate education (Metin Peten, Yaman, Sezen Vekli, & Cavus, 2019). Therefore, teachers need to pursue postgraduate education to enhance their competence in preparing and conducting scientific research projects.

Graduate education aims to equip students with the competence to conduct scientific research using appropriate methodologies (Lindley & Machin, 2013). It serves important functions such as creating resources for research, generating scientific knowledge, and training qualified scientists (Hurst, Cleveland-Innes, Hawranik, & Gauvreau, 2013). In Turkey, the purpose of graduate education is to provide students with scientific methods to gain knowledge, interpret and evaluate acquired knowledge, and develop higher-level thinking skills during the process (YOK, 2016). In summary, the main objectives of graduate education include providing scientific literacy, developing problem-solving and research skills, professional specialization (Gunay, 2018), and the ability to apply scientific methods to solve problems and report the results (Rust, 2009). Additionally, graduate education contributes to professional and personal development (Kovalchuck & Vorotnykova, 2017). Therefore, it is emphasized that teachers should receive graduate education for a more qualitative education (MoNE, 2018; Sahlberg, 2015). Moreover, according to Kovalchuck and Vorotnykova (2017), graduate education is crucial for both professional and personal growth. Considering all of these factors, it has been emphasized that teachers should pursue graduate education to enhance the quality of education (MoNE, 2018; Sahlberg, 2015).

In Turkey, there have been various studies conducted on postgraduate education in the field of educational sciences, focusing on different branch teachers and administrators (e.g. Akay, Boz, & Ulusoy, 2022; Ilter, 2020; Inel Ekici, Ekici, & Can, 2020; Kabasakal & Yel, 2020; Kilinc, Karahaliloz, & Bektas, 2020). These studies generally revolve around three themes, including problems encountered in the postgraduate education process (Avci & Akdeniz, 2021), views on postgraduate education (Bayar & Celenk, 2019; Kosar, Er, & Kilinc, 2020), and the impact of postgraduate education on professional and personal development (Aktan, 2020). However, content analysis research conducted by Aktan and Egdemir (2022) revealed that there is a need for new scientific research to be conducted in different dimensions of postgraduate education, as studies have mostly focused on repetitive topics. In contrast, the present research specifically explores the experiences of postgraduate Science teachers in preparing a scientific research project, which sets it apart from the existing studies on postgraduate education.

Studies focused on science teachers and scientific research projects have explored various topics, such as science teachers' consultation processes in preparing projects for the TUBITAK Middle School Students Research Projects Competition (Artvinli, Cetintas, & Terzi, 2020), the impact of TUBITAK Support Program project writing training on science teacher candidates' project preparation skills (Metin Peten et al., 2019), and science teacher candidates' participation in scientific research projects from primary to third year of undergraduate studies (Bulunuz, 2011). Moreover, Tatik and Aycicek (2020) conducted a study on Scientific Research Project Directing, which was also the focus of the present research. However, the mentioned study explored the directing experiences of faculty members working in different undergraduate programs. Therefore, the current research has a contemporary and original value as it examines science teachers who are pursuing postgraduate studies and receiving scientific research project training, as well as their experiences in preparing a scientific research project. Science is a discipline that is closely linked to scientific knowledge and technological advancements, making it an essential tool in classrooms. It enables students to understand the scientific methodology,

acquire scientific knowledge, actively participate in the research inquiry process, and develop higher-level thinking skills. However, the knowledge and experience of teachers play a significant role in achieving desired outcomes and progress in the scientific research project process. Therefore, it is essential for Science teachers to receive training to develop their competencies in preparing and executing scientific research projects. This training should include a project preparation experience that covers all stages of the project, allows teachers to identify the points they find most challenging, and examines their views on these project process steps. This research was conducted with this perspective in mind, and the results are expected to provide crucial data for both undergraduate and postgraduate education policies in Turkey regarding teachers' competencies in preparing and executing scientific research projects. Ultimately, it is hoped that the results of this research will lead to an increase in both the quantity and quality of scientific research projects conducted by teachers, allowing students and teachers to deepen their understanding of science by participating in scientific production activities and thinking more methodologically.

Methodology

Research Design

The present study utilized a qualitative research method and an action research design. Action research is a systematic research process used by researchers, such as teachers or academics, to examine their practices, observations, and possible directions for a problem or action (Johnson, 2014). The research design-based research process is illustrated in Figure 1.

Figure 1. *Research Process*

Participants

The study involved seven science teachers who were enrolled in a postgraduate course at a state university in the Central Anatolia Region during the 2022-2023 Fall semester. The participants were selected through criterion sampling from purposeful sampling types, based on the following criteria: i) volunteering for the research, ii) not having previous experience as an executor or researcher in a research project, and iii) being enrolled in the relevant postgraduate course. The researcher determined that the participants had no prior experience in preparing and executing research projects and lacked the necessary competencies in this regard. Therefore, an action research was designed by the researchers to facilitate the acquisition of the required competencies. The participants were given code names to ensure anonymity, and Table 1 displays some personal characteristics of the participants.

Table 1. *Some Personal Characteristics of the Participants*

Participant	İdil	Duru	Bade	Utku	Berk	Oya	Öykü
Age	25	24	25	24	25	33	25

Action Plan

The purpose of this action research was to assist science teachers who are pursuing their master's degree in gaining practical experience in preparing a scientific research project, examining their perspectives on the process, and assessing its effects on the participants. The research was conducted in two stages. In the first stage, one of the researchers provided the participants with theoretical knowledge, and sample projects were presented. Figure 2 illustrates the flow of theoretical knowledge provided in this stage.

Week 01 Definition, Purpose And Significance Of Scientific Research Projects

Week 02 Identification Of Research Problem And Formulation Of Hypothesis

Week 03 Design Of Research Project And Methods

Week 04 Data Collection Techniques And Tools

Week 05 Data Analysis Techniques And Statistical Analyses

Week 06 Ethics And Respect For Human Rights In Research Projects

Week 07 Fundamental Principles For Writing Research Projects-I

Week 08 Fundamental Principles For Writing Research Reports

Week 09 Utilization Of Scientific Sources And Preparation Of Bibliography

Week 10 Preparation And Presentation Techniques Of Project Presentations

Week 11 Analysis and Discussion of Sample Research Projects-I

Week 12 Analysis and Discussion of Sample Research Projects-II

Week 13 Defense and Evaluation of Research Projects

Week 14 General Evaluation of the Course and Student Feedback

Figure 2. *Flow of the Action Plan*

In the second part of the study, each participant was required to prepare a project proposal. The Scientific Research Project Form of the Scientific Research Projects Coordination Unit affiliated with a state university in Turkey served as the basis for the proposal preparation. The form consisted of various sections, including the Title of the Project, Project Executives, Researchers, Project Type, Project Group, Purpose/Reason, Keywords, Literature Summary, Original Value, Widespread Impact, Method, Institution Research Opportunities, Success Criteria, Other Organizations Supporting the Project, Work Schedule, Budget, and Reasons. The project titles prepared by the participants were as follows:

Participants and Project Titles

İdil
- Investigating the Impact of Using Web 2.0 Tools in Teaching Science Curriculum on the Academic Achievement and Motivation of Middle School Students in Rural Schools

Duru
- Examining the Effect of Problem-Based Hypothesis Testing Experiments on Students' Self-Learning and Scientific Reasoning Skills

Bade
- Informing Parents about Science Centers as an Out-of-School Learning Environment

Utku
- Inventing and Integrating Traditional Street Games into Science Education

Berk
- Science Teachers in the 21st Century

Oya
- Examining the Impact of Year-End Science Fairs that Feature Engineering Design Projects by Fifth Graders on Their Attitudes Toward Science and Entrepreneurial Skills

Öykü
- Awareness of Pre-Service Science Teachers on Values Education and Their Perspectives on Values Education

Data Collection Methods

The data for the research were collected using three data collection tools: semi-structured interviews with the participants, project evaluation rubric, and peer evaluation forms. Although action research is generally considered a pattern within the qualitative research method, Somekh (2008) and other researchers argue that this pattern should not be restricted to qualitative methods only, and that action research can benefit from both qualitative and quantitative paradigms. Given the nature of action research, it is possible to use both quantitative and qualitative data collection tools simultaneously (Mills, 2014). Therefore, in this study, it was deemed appropriate to use the project evaluation rubric and peer evaluation forms, in addition to the semi-structured interviews.

Semi-Structured Interview:
Before conducting the semi-structured interviews with the participants, the researchers developed an interview form. The form was prepared to take into account the purpose of the research, research questions, and relevant faculty observations. Two field experts with experience in science education were consulted for their opinions and recommendations, and the form was approved by them. The form consisted of 10 items, and some examples of the items included are as follows:
- How would you evaluate your project preparation process? Could you explain your reasoning?
- What were the challenges you faced during the project preparation process? Could you provide some examples?

Project Evaluation Rubric:
A Project Evaluation Rubric was created based on the titles included in the scientific research project form used in the study. The rubric consisted of 10 criteria, such as the appropriateness of the project title, a clear explanation of the project purpose, and the originality of the project topic. Before using the rubric, two field experts with experience in scientific research projects were consulted for their opinions

and recommendations regarding the assessment of the rubric. Additionally, an open-ended survey item was included to allow for additional comments about the project evaluation. The rubric was scored on a five-point Likert scale, and the minimum score that could be obtained was 10, while the maximum score was 50.

Peer Assessments:

The rubric for project evaluation was also utilized for peer assessments. Ultimately, a score was obtained for a scientific research project that was prepared by a participant after being evaluated by their peers and the researchers.

In action research, it is typically recommended to collect data before and following the implementation of an action plan in order to evaluate the process. However, in this study, data collection was not conducted before implementation due to one of the selection criteria being that participants had not previously been involved in a research project as either a coordinator or researcher. During the initial interview conducted as part of the course, participants indicated that they did not know how to conduct scientific research in the field of education and believed that the information and skills they would gain from the course would contribute to the writing of their master's thesis. As the action plan was implemented, participants in the first stage, where theoretical information was provided, found the information to be very helpful and noted that they had heard some concepts, such as original value and widespread effect, for the first time. In the second stage of the action plan, researchers guided participants in preparing their research project. Finally, at the end of all stages, the projects were collected, and participants were asked to present their projects, which were then evaluated using rubrics. Semi-structured interviews were conducted with each participant, face-to-face at their convenience, and with their approval, the recorded interviews lasted an average of 20 minutes.

Data Analysis Techniques

The interviews were transcribed. To protect the privacy rights of the participants by scientific ethics, code names were assigned to each participant. The data collected from the semi-structured interviews were analyzed using content analysis, which involves the systematic decomposition of participant comments into codes, categories, and themes to examine the collected data in more detail (Merriam & Grenier, 2019). All data were first read and then coded. Themes and sub-themes were created as needed. After two independent researchers performed the analysis simultaneously, agreements and disagreements were determined (Creswell, 2007). The data collected from the rubric and peer assessment form were analyzed using quantification. The number of options-1/number of options formula was used to obtain a clear opinion regarding the evaluation of the project. The score ranges of the five-point Likert type evaluation rubric were determined as shown in Table 2.

Table 2. Scoring Ranges for Rubric

Project Evaluation Rubric	Scoring Ranges
Completely Insufficient	1.00-1.80
Insufficient	1.81-2.60
Partially Sufficient	2.61-3.40
Sufficient	3.41-4.20
Completely Sufficient	4.21-5.00

Results

Opinions on the Process of Preparing a Scientific Research Project

During the interviews, participants were asked to evaluate their training experience and their overall experience in the project preparation process. All participants expressed that the training they received as part of the action research process enabled them to develop their knowledge and skills, enhanced

their confidence in project preparation, and provided them with a fresh perspective. The findings related to the project preparation experiences of the participants are presented in Table 3.

Table 3. Views on the Process of Preparing a Scientific Research Project

Codes	Frequency	Participants						
		İdil	Duru	Bade	Utku	Berk	Oya	Oyku
Project Stages	5	X		X	X	X	X	
Project Writing	3	X		X				X
Importance of Original Value	3		X		X	X		
Characteristics of Well Prepared Project	3		X	X				X
Paperwork	2		X					X
Institutions Providing Projects	2	X			X			

Table 3 indicates that a substantial number of participants believe that the process of preparing a research project has equipped them with experience in the various stages involved in conducting research. Following this project preparation process, the participants have gained knowledge on how to write a research project, the essential characteristics of an excellent project, and the institutions or organizations that the project can be submitted to. Furthermore, the participants have recognized the significance of originality in research projects. Alongside these findings, the participants have also gained knowledge and experience on project types (Duru), encountered difficulties (Utku), technical specifications, and proforma invoices (Duru), preparation of a work schedule (Berk), and paperwork (Oyku). Bade has also shared their thoughts on this theme:

"During the project preparation process; I learned this process, the features that should be included in the project, and the steps of writing the project."

In this context, participants were asked what they had learned about the features of the project in order to elaborate on their previous answers. The majority of the participants gave answers focused on the uniqueness of the project, the importance of planned work, the need to prepare a budget, and widespread impact. These findings are presented in Table 4.

Table 4. Views of Participants on the Characteristics of the Project

Codes	Frequency	Participants						
		İdil	Duru	Bade	Utku	Berk	Oya	Oyku
Originality	5		X		X	X	X	X
Planning	3				X	X	X	
Relevance	4			X	X		X	X
Budget	3		X			X	X	
Specifications	2	X			X			
Invoices	2	X			X			
Targeted	2						X	X

Table 4 highlights the significance of project originality, as emphasized by the participants. Moreover, some participants identified the steps involved in writing a project (Idil), the importance of project innovation (Bade), and the necessity of having an implementable project (Oya). The opinions of İdil and Oya regarding these sub-themes are presented below:

"I had no idea of the steps involved in writing a project beforehand."
"The project should be implementable, directed towards achieving the goals that we have set and original."

In this theme, the participants' opinions on the critical sections that should be included in a project during preparation were also examined. The majority of participants believed that the purpose and rationale of the project should be clearly stated (Idil, Duru, Bade, Berk, Oyku). Additionally, originality (Idil, Duru, Utku, Berk), widespread effect (Duru, Utku, Berk), and methodology (Bade, Utku, Berk) were other crucial sections frequently mentioned. Furthermore, some participants highlighted the importance of an attractive and appropriate project title (Idil), conducting a comprehensive literature review (Berk), clearly stating the subject and scope, ensuring the subject is suitable for the research group, and planning the budget adequately (Oya). One example of the participants' opinions are presented below: Utku: *"I learned that originality is the skeleton of the project and its shape is formed on it. I understood that the part of widespread effect is the functioning of the project. I also learned that methodology is the outermost layer, the operating part of the system."*

Lastly, the participants were asked to share their opinions on the difficulties they encountered during the project preparation process. All the participants expressed that their biggest challenge was identifying an original research topic. Bade's opinion on this matter is provided below as an example:

"The most difficult thing for me is to find an original project idea. After the idea comes up, the rest progresses quickly with planning and programming."

In addition, Berk highlighted the overall difficulty of the project preparation process, stating that "Preparing a project is a challenging process because you have to write everything with the purpose of convincing someone." Furthermore, two participants (Berk, Oya) also mentioned the difficulty in selecting an appropriate project title. Oya articulated her viewpoint on this matter as follows:

"I had difficulty in finding an original subject and in selecting the project title. It was also challenging to prepare a scientific research project for the first time and to determine enough activities for the implementation phase of the project."

As Oya's statement suggests, some participants faced difficulties due to their lack of experience in creating content (Oya), selecting the research group (Idil), and managing procedures (Duru). Duru expressed their opinion on this topic as follows:

"There could be a lot of procedures."

Views on the Process of Managing a Scientific Research Project

The current topic pertains to the opinions of the participants regarding the process of conducting a scientific research project. Initially, the participants were asked about their insights into project management, including the education they had received and the process of preparing and presenting the project. Almost all of the participants highlighted the significance of being organized and strategically planned. They emphasized the importance of developing a well-planned project timeline and adhering to it (Duru, Bade, Utku, Berk, Oya, Oyku). Oyku further expounded on the importance of project management with the following thoughts:

"I learned the importance of doing detailed research on project budget, preparation process, work schedule, etc. I learned that a project cannot be managed without these."

Additionally, two participants (Duru, Berk) stressed the significance of outlining each phase of the project and developing a robust B plan for risk management. Duru provided the following opinion on this matter:

"I learned that each stage of the project needs to be detailed and that one needs to adhere to the project timeline and that there should be B plans for each stage of the project."

Moreover, some participants highlighted the importance of obtaining necessary permissions (Idil), conducting continuous research (Utku), the crucial role of the project manager (Oya), a well-prepared process, possessing knowledge and experience, and budget planning (Oyku). İdil provided the following opinion on this topic:

"I learned that this is a process and that the necessary permissions need to be obtained."

Regarding project management, participants were prompted to share what they considered to be the most crucial aspects. In line with earlier findings, the majority of the participants emphasized the importance of well-planned project timelines during preparation and execution (Idil, Duru, Berk, Oya, Oyku). As previously mentioned by Duru, some participants also stressed the significance of developing B plans for risk management (Duru, Oya) and ensuring that project preparation is done thoroughly (Bade, Oyku). For instance, Oyku expressed their opinion on this topic as follows:

"I learned that planning the project is harder than carrying it out."

Furthermore, some participants highlighted the importance of team coordination (Idil), an experienced project manager (Idil), obtaining necessary permissions (Utku), procuring materials, collaborating with stakeholders, and problem-solving abilities (Berk). Berk's respective viewpoints on this topic are presented below:

"When planning the project, it is necessary to obtain ethical permissions if one is to work with humans or animals. When planning the project, I learned the importance of obtaining the necessary permissions, setting the necessary time for the desired materials, timing the surveys or tests depending on the method, of allocating a certain order and sequence to the results obtained from the project."

When asked about their primary focus when presenting their projects, the participants reiterated the importance of highlighting the original value of their research (Idil, Utku, Berk, Oya, Oyku), which aligns with the earlier findings. As an illustration, one of the participants provided the following statement regarding this matter:

Oya: *"When preparing my presentation, I paid attention to all of the titles mentioned in the project application. I paid particular attention to the original value and widespread effect of the project. Because I learned that it is very important for the project I plan to realize to be original and to contribute to the literature. Also, I paid attention to the widespread effect of the project in order to show the contribution of the project to people and science when it is realized."*

In addition to Oya's remarks, participants also emphasized the significance of each stage of the project (Duru, Oya), the need for clarity and comprehensibility in the project (Idil, Berk), and the importance of effectively presenting the theme of widespread impact (Berk, Oya).

Lastly, the participants' perspectives on the impact of teacher competencies on the process of preparing and conducting a research project were examined within this theme. All the participants unanimously agreed on the significance of teacher competencies in this process. The reasons behind the participants' opinions varied considerably. Some participants asserted that a teacher's increased knowledge level would allow for better project topics (Idil, Duru), as well as improved project planning and execution (Duru). Notably, Oya's viewpoint on this topic was particularly noteworthy. According to Oya, when teachers feel inadequate, they are likely to either avoid project work altogether or produce projects of subpar quality.

"If the teacher is insufficient in project management and project preparation, they will not be able to provide enough guidance to the students and unfortunately, quality projects will not emerge. At the same time, teachers who are insufficient in project preparation will be reluctant and have low self-esteem to participate in project competitions."

Oyku, on the other hand, believes that teacher competencies will accelerate the project and make it original. The participant's thoughts on this matter are as follows:

"For example, among the competencies expected from the teacher, reflective thinking enables the teacher to correct the wrong written part in the project, and knowing how to follow the path for the students accelerates the process. Taking the necessary steps according to the need and creating projects in these matters will also increase the originality of the project."

Evaluation of Projects

During the project evaluation stage, the participants transformed their projects into MS PowerPoint presentations and delivered them within a designated 30-minute timeframe. Following the presentations, a 15-minute question and answer session was held for each project, and the projects were evaluated by both researchers and peer assessment. After the scoring period, the researchers provided participants with detailed feedback, focusing on various aspects, including the project's strengths and weaknesses, areas for improvement, and its potential for widespread impact and applicability. Therefore, the evaluation process was not only a scoring exercise but also an opportunity for the participants to enhance their competencies in developing and executing a scientific research project. The average score of each participant was calculated based on the project evaluation rubric devised by the researchers. The obtained scores were evaluated according to the assigned score ranges, and the results are presented in Table 5.

Table 5. Mean Scores and Evaluation of Researchers' Evaluations

Researchers' Assessment	Participants						
	İdil	Duru	Bade	Utku	Berk	Oya	Oyku
Average Score	3.3	3.9	4.0	3.5	2.9	3.7	3.7
Evaluation Based on Score Range	Partially Adequate	Adequate	Adequate	Adequate	Partially Adequate	Adequate	Adequate

Table 6 presents the findings related to peer evaluations, which were carried out similarly. At the outset of this action research process, all participants reported that they lacked the necessary knowledge and competencies to prepare a scientific research project. Furthermore, they had no idea about the titles to be included in the project form and were unfamiliar with terms such as proforma, work schedule, intrinsic value, and general effect. However, an analysis of Tables 5 and 6 reveals that the participants have acquired sufficient knowledge and skills in project preparation and implementation as a result of the training provided within the scope of the action research. Based on peer evaluations, each participant has developed projects that are adequately comprehensive. The professional evaluations conducted by the researchers indicate that two participants (Idil, Berk) have partially completed their projects, while the remaining five participants (Duru, Bade, Utku, Oya, Oyku) have completed their projects satisfactorily, according to the criteria specified in the rubric.

Table 6. Mean Scores and Evaluation of Peer Evaluations

Peer Assessment	Participants						
	İdil	Duru	Bade	Utku	Berk	Oya	Oyku
Average Score	4.39	4.71	4.73	4.57	4.63	4.59	4.74
Rating According to Score Range	Fully Adequate	Fully Adequate	Fully Adequate	Fully Adequate	Fully Adequate	Fully Adequate	Fully Adequate

Discussion

An action research design was employed in this study to provide Science teachers who were pursuing their Master's degrees with an opportunity to gain knowledge in preparing a research project, express their perspectives on this process, and examine the outcomes of their engagement. Action research allows teachers to take control of their own work and obtain data that will benefit their methods (Osmanović Zajić, Mamutović, & Maksimović, 2021). It is valuable in this respect. The research findings were analyzed under two main themes, namely the preparation and implementation process of the project.

Upon evaluating the project preparation process, it can be concluded that the participants perceived the training to be of high quality and effective. The participants concurred that the training was instrumental in their personal and professional growth, enhancing their self-confidence and providing them with a fresh perspective. This outcome can be attributed to the extended duration of the training, the instructor's extensive project experience, and the mentor's guidance throughout the process. Consistent with previous studies in the literature, it was found that project writing training significantly improved the project preparation skills of Science Teacher Candidates in TUBITAK Support Programs (Metin Peten et al., 2019). Therefore, it is recommended that specialized training programs be organized for teachers and students to enhance their ability to prepare research projects (Sozer, 2017).

The participants articulated that the training enabled them to acquire knowledge on various aspects of the project, including the project stages, writing techniques, the significance of originality, and the characteristics of a good project. Additionally, the participants' ability to prepare each topic in the research project form in a comprehensive manner was substantially enhanced after receiving the training. Similar results were reported in a study where project writing training was provided, and it was observed that the participants' project writing skills improved significantly (Metin Peten et al., 2019). In another investigation conducted by Gocen Kabaran and Altintas (2022), which assessed the effectiveness of a scientific research project writing training for classroom teacher candidates, it was discovered that the teacher candidates lacked an understanding of key terms such as research, research development, and research projects before the commencement of the training.

The study participants also expressed their opinions on the essential characteristics of a project. According to their responses, Science teachers involved in the research believed that originality, adherence to a work schedule, effective budget planning, and widespread impact were the most significant project features. The participants' views on the importance of originality suggest that they have recognized its crucial role in developing successful projects. Moreover, the participants highlighted the purpose and justification, originality, widespread impact, and method as the most critical sections of a project. Geuna & Martin (2003) conducted research across various countries and identified four main criteria for evaluating research projects: scope/size, impact, usefulness, and quality. Although there are some variations in the evaluation criteria of different institutions, the project evaluation criteria of TUBITAK, one of the leading institutions in supporting scientific research projects and scientists in Turkey, are based on the qualities of originality, method, project management (team, research facilities), and widespread impact (Aribas & Ozcan, 2016). Aribas and Ozcan (2016) reported that the weighted averages of these criteria were ranked in the following order: originality, widespread impact, project management/team and research facilities, and method. Therefore, originality appears to be the most critical criterion in evaluating a research project. In summary, this action research has provided Science teachers with a valuable understanding of scientific research projects and offered them hands-on experience in their preparation.

The study participants faced challenges in finding an original research topic during the project preparation phase. This difficulty is not surprising, considering that the participants emphasized the importance of originality in their earlier responses. Findik Coskuncay & Bingol (2021) also reported that originality is one of the main obstacles encountered when writing an R&D project. The participants generally concurred that preparing and getting a project accepted is challenging and involves difficulties

at every stage. This perspective is realistic because while each research project is essential, supporting institutions have limited financial resources, labor force, and time resources. Therefore, it is necessary to select the best projects that can make the most significant impact with the limited resources available. Upon analyzing the findings related to the project execution/management process, it was observed that the participants acknowledged the significance of creating a well-structured plan and adhering to it for the successful management of a project. This finding aligns with previous studies in the literature that emphasize the importance of project planning for the successful implementation of a project (Serrador, 2012). Furthermore, the importance of having a contingency plan was also highlighted to ensure effective risk management. To ensure the continuity and successful completion of a project, it is crucial to anticipate potential challenges that may arise during the project process and implement a contingency plan if necessary. This outcome is corroborated by previous studies in the literature. Tatik and Aycicek's (2020) investigation highlights the need for a meticulous process for the efficient execution of each scientific research. In the same study, where the experiences of the academics conducting the research project were examined, the participants emphasized that they attempted to resolve issues by implementing a contingency plan and adhering to a well-planned working process when confronted with a problem during the project process.

The other sub-theme, which investigated the impact of teacher competencies on the project preparation and execution process, revealed that the participants perceived teacher competencies as a critical factor in this process. The ISTE Teacher Standards similarly underscore the importance of teacher competencies, emphasizing that teachers should act as guides, consultants, and mentors to students during projects and possess seven essential attributes to facilitate this process (URL-1). These require a high level of competency. In support of this finding, it is observed that teachers are unable to effectively utilize this process when their scientific project preparation competencies are inadequate (Frank & Barzilia, 2004). In fact, a study conducted with Serbian primary school teachers during the pandemic period concluded that teachers' reflective practices affected the quality of online teaching (Osmanović Zajić, Maksimović, & Sretić, 2023) . This indicates that teachers are a distinctive element for the quality of teaching.

Upon evaluating the projects created by the participants, the professional assessments conducted by the researchers revealed that the participants had mostly achieved a level of competence capable of producing projects of acceptable quality. Peer evaluations were also conducted, which similarly indicated that the projects were of sufficient quality. In a study conducted by Metin Peten et al. (2019), it was also observed that there was a significant improvement in the quality of projects created before and after project writing training. It is worth noting that peer evaluation based on rubrics in this study is particularly noteworthy, as this type of evaluation enhances student performance and increases the consistency of scores (Andrade, Du, & Wang, 2008).

At the commencement of this action research process, all participants acknowledged that they lacked the required knowledge and competencies to prepare a scientific research project. Additionally, the participants disclosed that they were unfamiliar with the titles that should be included in the project form and that they had never heard of some terms such as proforma, work schedule, original value, and widespread effect. Nevertheless, the interview findings and rubric scores indicated that the participants acquired adequate knowledge and skills to prepare and implement projects following the training provided within the ambit of the action research. This outcome aligns with the results of various studies that aimed to evaluate the effectiveness of project writing training (Gocen Kabaran & Altintas, 2022; Metin Peten et al., 2019).

Recommendations

The research findings suggest the following recommendations for implementation:
- Educational policies should be revised to enhance the competencies of teachers by offering them knowledge and experience related to scientific research starting from undergraduate studies.
- Teachers and teacher candidates allowed opportunity to participate in various project activities.

• Courses on research project practices could be introduced before thesis writing in higher education.
• Project offices could be established in universities to provide consultancy services to teachers and teacher candidates in project preparation and implementation activities.
For future research, the following recommendations could be considered:
• Investigating the effectiveness of project writing training for Science teacher candidates and teachers.
• Assessing the impact of the knowledge and skills acquired by teachers through project activities on their success.
• Examining the effect of the knowledge and skills acquired by teachers from different fields through project activities on the teaching profession.

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