

Scientific and methodological foundations in the process of training future biology teachers

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Abstract

The purpose of this research; The aim is to get the opinions of prospective teachers on scientific and methodological foundations in the process of educating future biology teachers. In order to illuminate the main purpose of the study with a holistic approach, qualitative research method was used and phenomenology was chosen as the research design. The study group of the research consists of 40 pre-service teachers studying in biology teaching departments at various universities in Kazakhstan in the 2021-2022 academic year. Research data were collected with a semi-structured interview form developed by the researchers. As a result of the research; The vast majority of future biology teachers rated their competence in scientific and methodological foundations as partially adequate. Pre-service teachers also stated that they found the establishment of scientific and methodological foundations in the education given at universities partially sufficient. Future biology teachers

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participating in the research offered suggestions for what needs to be done in establishing scientific and methodological foundations, such as improving field knowledge, increasing the quality of field education, providing biology literacy and providing technology literacy.

Keywords: Scientific, methodological, biology, teachers of the future

1. Introduction

The progress of societies from the technology age to the information age and the scientific and technological developments that have occurred in recent years have caused the expectations from students to differ (Erdogan et al., 2018; Garbin et al., 2021). These developments and advancements provide students with basic knowledge and skills as well as cognitive; social; makes it compulsory to acquire personal competence and skills (Elci and Uzunboylyu, 2020). The changes experienced have revealed the importance of qualified manpower. Training of qualified manpower; education systems can be provided by updating the programs and by the educators who will put the current system into practice. The important problems that have been going on for years in undergraduate and graduate programs that train teachers and the basic needs of contemporary developments and trends in teacher training show that these programs need to be redeveloped (Baskan & Atalar, 2014).

1.1. Theoretical and conceptual framework

Teachers are one of the most important elements of educational activities. What the country needs is trained manpower. The trained manpower will be trained by well-educated teachers (Khajayeva et al., 2021). A well-educated teacher means that he is well-trained both in his field and in terms of general culture and teaching knowledge (Jahangard et al., 2020). In addition, teachers should be trained in accordance with the requirements of the age, versatile and by analyzing the technology of the age well (Keten, 2020). Within the framework of these expectations, there is a need to prepare the curriculum of teacher training institutions very well, to reorganize them in line with the needs of the society and in accordance with the conditions of the age, and to evaluate the programs for this (Blandul, 2022).

Biology; It is the science that studies the structure, formation, functions and behavior of living things. It focuses on the biological units that make up nature and the balance between them. Even if the meaning of the word is "science of living things", it tries to explain all living and non-living beings that make up the biological balance and the relationships between them. Biology; distribution of living things on earth, anatomy, physiology, genetics, systematics, etc. It is a science that does education and research on it (Tanner and Allen, 2006). The curriculum is formed by arranging the course subjects that are intended to be taught at the education levels, in line with the objectives of the education program, taking into account the time and process components (Sumantri et al., 2018).

Biology teaching is; It is one of the most effective ways that can be used to transfer the information obtained about the formation and order of biological events in nature to people's lives and gain certain behaviors and characters (Suhirman et al., 2022). In recent years, studies on curriculum have emphasized that changing a curriculum is not a guarantee to achieve the goals desired to be achieved

with that curriculum. Therefore, the success of curricula is closely related to their adoption by teachers and their effective implementation in learning environments. In this respect, it is important for teachers to acquire the necessary knowledge and skills to implement innovations in the curriculum in a healthy way, which requires paying attention to their views on this issue (Reid & Horvathova , 2016).

In addition to the competencies that teachers should have, they are expected to have a positive attitude towards the teaching profession and a high level of self-efficacy (Gurban et al., 2022). Because it is emphasized that a teacher who is qualified in his field should have positive attitudes and beliefs about his field and teaching profession in order to have a positive effect on the learning of his students . In addition to the knowledge, skills and positive attitudes aimed to be gained by teacher candidates in teacher training programs, it is expected that their self-efficacy will be high in order to enable them to be more willing and successful in their professional lives (Ulla , 2016).

1.2. Related research

Ekici et al. (2014) examined the effects of biology self-efficacy and self-efficacy beliefs towards the teaching profession on attitudes towards the teaching profession of students studying in the biology department and biology education department. In the study conducted with a total of 469 participants, the self-efficacy beliefs of the students studying in the biology department towards the teaching profession were 12%; It was determined that the students studying in biology education predicted the attitude at the level of 13%.

Zientek (2007) makes some recommendations regarding higher education programs in his research. He states that the prepared training programs often contain high standards of expectations, making this process more stressful and more challenging. For this purpose, he stated that the standards that teachers should have should be compatible with and parallel to student standards. With the help of a scale developed within the scope of the study, a study was conducted in which 2000 teachers participated. The results of the study indicate that more qualified teachers should be trained for qualified students and more importance should be given to teacher training systems.

Darling-Hammond (2017), in his study titled “Teacher education around the world: what we can learn from international practice”; Teacher education in countries with well-developed systems in teacher education is described. Teacher education policies and practices in Australia, Canada, Finland and Singapore are presented comparatively in terms of teacher appointment, teacher preparation, promotion and continuing professional context.

Hökka and Etalepelto (2013), in their study of seeking a new perspective on the development of teacher education, aimed to develop new perspectives in order to overcome the obstacles that arise due to the slow development of teacher education in the world and difficult to implement. To this end, resources and barriers were explored in the context of academic and university-based teacher education in Finland. The challenges that emerged as a result of the research are: barriers to renegotiating professional identity, internal competition between subject groups within the department, and inconsistencies between individual agency and organizational development.

Hu and Verdugo (2015), in their study of an analysis of teacher education policies in China, stated that past reforms and educational indicators played an important role in teacher education in China. For this reason, the policies implemented in teacher education in China have been scrutinized. As a result of the research; Reforms in teacher education arose out of the country's political and economic needs rather than the needs of the Chinese people.

Simola (2005) focused on Finland's educational success in PISA exams in his study titled "Historical and sociological explanations about Finland's PISA miracle, teaching and teacher education". In this study, Simola stated that qualified teachers and quality teacher education were effective in this magnificent success. He stated that sociological and historical factors play an important role in the background of success.

1.3. Purpose of the research

The purpose of this research; The aim is to get the opinions of prospective teachers on scientific and methodological foundations in the process of educating future biology teachers. In this direction, answers are sought for the following sub-objectives.

1. How do future biology teachers evaluate their competence in scientific and methodological foundations?
2. Do future biology teachers find it sufficient to establish scientific and methodological foundations in the education given at universities?
3. How do future biology teachers evaluate what needs to be done in establishing scientific and methodological foundations?

2. Methods and Materials

In this part of the research, detailed information about the method of the research, the participant group of the research, the data collection tool, the data collection process and the evaluation of the data are given.

2.1. research method

In order to illuminate the main purpose of the study with a holistic approach, qualitative research method was used and phenomenology was chosen as the research design. Phenomenological studies are an inquiry strategy applied to reveal the researcher's human experiences about a phenomenon defined by the participants. Phenomena can appear in various forms such as events, experiences, perceptions, orientations, concepts and situations in the world we live in. Phenomenology is an appropriate research method for studies that aim to investigate phenomena that are not completely foreign to us and that we cannot fully comprehend (Creswell & Poth , 2016). In the process of educating future biology teachers, the views of pre-service teachers on scientific and methodological foundations were evaluated in a phenomenological pattern.

2.2. Participants

The study group of the research consists of 40 pre-service teachers studying in biology teaching departments at various universities in Kazakhstan in the 2021-2022 academic year. Future biology teachers voluntarily participated in the research. Of the teacher candidates, 17 are girls and 23 are boys. Of the future biology teachers participating in the research, 13 are studying in the 1st grade, 11 in the 2nd grade, 9 in the 3rd grade and 7 in the 4th grade.

2.3. Data collection tools

Research data were collected with a semi-structured interview form developed by the researchers. The interview form is prepared in order to obtain the same type of information from different people, especially in order to address similar issues. The interview form is a method developed to ensure that all dimensions and questions related to the research problem are covered. In the research, semi-structured interview method was used to get in-depth thoughts of teacher candidates on the subject. While preparing the interview form, it is important that it is prepared in accordance with the principles of question preparation (Punch, 2013). In this context, the questions are; Care was taken to include easy-to-understand, purpose-oriented, open-ended questions. In order to increase the content validity of the prepared questions, expert opinion was sought and the reliability of the measurement tool was determined by ensuring consistency in line with the feedback of the experts. In the semi-structured interview form developed to collect data within the scope of the research, there are two demographic questions in order to get the gender and class information of future biology teachers. In the process of training future biology teachers, 3 questions were asked in order to get the opinions of pre-service teachers on scientific and methodological foundations. Semi-structured interview questions are given below.

1. How do you evaluate your competences on scientific and methodological foundations? Choose one of the categories "Very adequate", "Adequate", "Partially sufficient", "Insufficient" and "Very insufficient" and explain why.
2. Do you find it sufficient to establish scientific and methodological foundations in the education given at universities? Choose one of the categories "Very adequate", "Adequate", "Partially sufficient", "Insufficient" and "Very insufficient" and explain why.
3. How do you evaluate what needs to be done in establishing scientific and methodological foundations? What are your suggestions?

2.4. Data collection process

During the data collection process, face-to-face interviews were conducted with future biology teachers. During the interviews, the questions in the semi-structured interview form were asked to the teacher candidates in the same order and without any direction. Permission was requested from the pre-service teachers to record audio during the interview. All of the biology teacher candidates who

constituted the study group of the research allowed voice recording. The interviews were conducted in a quiet interview room within the university, where audio recordings could be easily taken. It took approximately 1 month to complete the interviews with all biology teacher candidates.

2.5. Data collection analysis

In the analysis of the data, content analysis based on coding was used depending on the inductive analysis method. Based on the codes that emerged, it was tried to reach the relations between the codes, in other words, the categories, and the themes from the categories. In determining the themes, it was checked whether the expressions under each theme were consistent with themselves and with the theme title. Thus, the suitability of codes, categories and themes was tried to be ensured.

In order to increase the validity and reliability of the research and to prevent data loss, the audio recordings taken during the interviews with the pre-service teachers were transferred to semi-structured interview forms and converted into text. Then, the coding of the data set was carried out. The coded qualitative data set was recoded by two faculty members from the field in order to eliminate reliability problems. In order to check the consistency between the two codings, the people who performed the coding came together and reviewed the meaningful data units that were coded. The data units coded in different ways were discussed and the agreed points were taken as the basis for reaching the themes, while the other points were not examined.

3. Results

In this part of the research, future biology teachers His views on scientific and methodological foundations during the training process are given together with frequency and percentage tables. Under each table, the views of some pre-service teachers are given by making direct quotations, keeping their personal information confidential (coding).

Table 1 presents the evaluation of future biology teachers participating in the research on scientific and methodological foundations.

Table 1

Evaluation of the competence of future biology teachers on scientific and methodological foundations

Category	F	%
Very enough	3	7.5
Sufficient	8	20
Partly enough	22	55
Insufficient	5	12.5
Very inadequate	2	5
Total	40	100

In Table 1, the competencies of future biology teachers participating in the research on scientific and methodological foundations are categorized. 7.5% of the future biology teachers who participated in the research evaluated their proficiency on scientific and methodological foundations as very sufficient, 20% as sufficient, 55% as partially sufficient, 12.5% as insufficient and 5% as very insufficient.

The opinions of some future biology teachers who participated in the research about their competencies in scientific and methodological foundations are given below with direct quotations.

19. Pre-service teacher: I am a teacher candidate who is open to self-improvement. I am improving myself scientifically and methodologically, with the awareness that I am in the last year of my studentship and that I will be a teacher next year. I can say that I find myself very competent. 7. Pre-service teacher: I chose the department I am studying because it is the field that I am interested in. Apart from the university education I received in this field, I always tried to improve. I find myself sufficient. Of course, there is a lot of information that I need to learn and I think that I should constantly update this information. 34. Pre-service teacher: I find myself partially competent in terms of scientific and methodological aspects. I believe that theoretical knowledge cannot be put into practice without being fully supported by practice. I think it is difficult for me to fully see my shortcomings without putting the scientific and methodological foundations that I think I partially possess into practice in the classroom environment. 21. Pre-service teacher: I do not find myself sufficient. Of course, I receive a scientific and methodological education. However, I do not believe that self-sufficiency in a field can be achieved while still a student. In order to give an adequate answer to this question, I need to be an experienced teacher who is an expert in my field. 13. Pre-service teacher: I find myself very inadequate. Because I still think that the scientific and methodological information I have is raw. That is, solid foundations have not been established. Over the years, I think that I will be able to be scientifically and methodologically sufficient both as I develop myself and as I learn by doing and living during my job as a biology teacher.

In Table 2, the situation of the future biology teachers participating in the research finding the establishment of scientific and methodological foundations in the education given at universities sufficient.

Table 2

The situation of future biology teachers considering the establishment of scientific and methodological foundations in the education given at universities sufficient

Category	F	%
Very enough	3	7.5
Sufficient	7	17.5
Partly enough	26	65
Insufficient	4	10
Very inadequate	2	5
Total	40	one hundred

In Table 2, the status of future biology teachers participating in the research who find it sufficient to establish scientific and methodological foundations in the education given at universities is categorized. 7.5% of future biology teachers stated that they found the establishment of scientific and methodological foundations in the education given at universities very sufficient, 17.5% sufficient, 65% partially sufficient, 10% insufficient and 5% very insufficient.

The opinions of some future biology teachers who participated in the research regarding their finding that the establishment of scientific and methodological foundations in the education given at universities are given below, using direct quotations.

3. Teacher candidate: I am very satisfied with the education I received. Therefore, I can say that I find it very sufficient. I am given a training that meets my expectations. 22. Pre-service teacher: I think the training given in universities on the establishment of scientific and methodological foundations is sufficient. I think it would be better if it was supported a little more from a technological point of view. 15. Pre-service teacher: I find it partially sufficient. I think the reason for this is that education is not given with the understanding of education required by the age. Many innovations are being made in education every day. Unfortunately, universities cannot integrate these innovations into their education programs immediately. 40. Pre-service teacher: Unfortunately, I do not find it sufficient. Generally, a uniform education is given. As technology-age students, I don't think it meets our expectations. 38. Pre-service teacher: The concept of technological pedagogical content knowledge is now used instead of pedagogical content knowledge. Education is not a field where mere knowledge is transferred as it was in the past. However, we still take lessons from educators who act with the understanding of classical education in order to establish scientific and methodological foundations in the classroom environment. Therefore, I definitely do not find it sufficient.

In Table 3, the opinions of future biology teachers participating in the research on what needs to be done in establishing scientific and methodological foundations are given.

Table 3

Opinions of future biology teachers on what needs to be done in establishing scientific and methodological foundations

Theme	Category	F	%
Developing domain knowledge	Basic concepts, theories and hypotheses should be taught repeatedly until learning occurs.	31	77.5
	Relationships should be made between biology and other branches of science.		
The quality of field education should be increased	Ability to analyze	23	57.5
	New methods and approaches should be applied		
	Course materials should be selected according to learning outcomes.		
	New measurement and evaluation techniques should be used		

	The course environment should be selected and organized according to the subject to be learned.		
Biology should ensure literacy	Scientific research skills should be gained		
	Laboratory skills should be acquired.		
	Science, technology, society and environment interaction should be established	19	47.5
	To have biology attitudes and values		
Technology must ensure literacy	Acquiring the ability to relate biology and technology		
	Gaining technology-supported education skills	8	20
	Acquiring the habit of self-improvement by utilizing technology in the field of biology		

In Table 3, the opinions of future biology teachers participating in the research on what needs to be done in establishing scientific and methodological foundations are categorized. Under the theme of developing field knowledge; basic concepts, theories and hypotheses should be taught by repetition until learning takes place, making connections between biology and other branches of science, and gaining the ability to analyze are included. Under the theme that the quality of field education should be increased; New methods and approaches should be applied, course materials should be selected according to learning outcomes, new assessment and evaluation techniques should be used, and the course environment should be selected and arranged according to the subject to be learned. Under the theme of providing biology literacy; scientific research skills should be gained, laboratory use skills should be gained, science, technology, society and environment interaction should be created, and there are categories of having biology attitudes and values. Under the theme that technology should provide literacy; There are categories of acquiring the ability to associate biology with technology, acquiring the ability to provide technology-supported education, and acquiring the habit of self-improvement by making use of technology in the field of biology. Of the future biology teachers participating in the research, 77.5% should develop their field knowledge on what needs to be done in establishing scientific and methodological foundations , 57.5% should increase the quality of field education, 47.5% should provide biology literacy, and 20% technology They developed suggestions in the form of providing literacy.

4. Discussions

The vast majority of future biology teachers who participated in the study evaluated their proficiency in scientific and methodological foundations as partially sufficient. In the study conducted by Demirtaş, Cömert, and Özer (2011), pre-service teachers studying in Turkish, Social Studies, Music and Art teaching programs, Science, Biology, Chemistry, Classroom Teaching, Elementary Mathematics, Preschool, English, Computer and Teaching. They perceive themselves as more competent than pre-service teachers studying in technology programs. Evans and Tribble (1986), in their study; They found that primary school teacher candidates consider themselves more competent than secondary school and high school teacher candidates.

The majority of future biology teachers who participated in the research stated that they found the establishment of scientific and methodological foundations in the education given at universities partially sufficient. Future biology teachers who participated in the research answered that they should improve their field knowledge, increase the quality of field education, provide biology literacy and technology literacy to what needs to be done in establishing scientific and methodological foundations. Under the theme of developing field knowledge; basic concepts, theories and hypotheses should be taught by repetition until learning takes place, making connections between biology and other branches of science, and gaining the ability to analyze are included. Under the theme that the quality of field education should be increased; New methods and approaches should be applied, course materials should be selected according to learning outcomes, new assessment and evaluation techniques should be used, and the course environment should be selected and arranged according to the subject to be learned. Under the theme of providing biology literacy; scientific research skills should be gained, laboratory use skills should be gained, science, technology, society and environment interaction should be created, and there are categories of having biology attitudes and values. Under the theme that technology should provide literacy; There are categories of acquiring the ability to associate biology with technology, acquiring the ability to provide technology-supported education, and acquiring the habit of self-improvement by making use of technology in the field of biology. In the integration of technology into the teaching process, the effect of teachers' knowledge and self-efficacy beliefs on this subject has also been revealed as a result of many researches (Abbitt, 2011; Al -Awidi & Alghazo, 2012). In order to train innovative and qualified teachers, teacher candidates are expected to be equipped with sufficient knowledge and skills on the appropriate use of technology in teaching activities. However, in this process, pre-service teachers need to deal with the subject area and the teaching and learning of this subject area, as well as reconsidering the effect of technology on the development of the subject area (Niess, 2005).

5. Conclusion

Today, one of the most important goals of societies is to have expert manpower in their field. Individuals who are experts in their fields can only be trained with a good education that meets the requirements of the age. At this point, teachers play a key role. Teachers, who organize the teaching environment and organize teaching activities with the skills they have, have an important role as people who ensure the effective execution of teaching activities. While performing this task, teachers are expected to use their theoretical and practical knowledge in a functional way. For this reason, the qualifications of teacher candidates are extremely important. In this direction, in this research; In the process of educating future biology teachers, it is aimed to get the opinions of prospective teachers on scientific and methodological foundations. As a result of the research; The vast majority of future biology teachers rated their competence in scientific and methodological foundations as partially adequate. Pre-service teachers also stated that they found the establishment of scientific and methodological foundations in the education given at universities partially sufficient. Future biology teachers participating in the research offered suggestions for what needs to be done in establishing scientific and methodological foundations, such as improving field knowledge, increasing the quality of field education, providing biology literacy and providing technology literacy.

6. Recommendations

In the process of training future biology teachers participating in the research, some changes should be made in teacher training programs in universities in order to establish their competences on scientific and methodological foundations. Course contents, in which measurement and evaluation techniques are applied, should be created with new methods and approaches in accordance with the contemporary education approach. Biology teacher candidates need to gain analytical thinking skills, develop scientific research skills, and acquire field-specific attitudes and values. In addition, future biology teachers should acquire the skills of teaching integrated with technology in the university environment. It is extremely important for pre-service teachers to use technology both as a tool for self-development and to integrate it into their teaching understanding. In addition, conducting this and similar studies with other teacher candidates studying at education faculties will contribute to the field.

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