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Prospective Science Teachers' Self-Efficacy Beliefs and Perspectives on Instructional Technologies in Science Education: Online Instructional Technology Training

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Research Article

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ABSTRACT

This study aims to investigate the effects of activities focused on preparing digital teaching materials using web 2.0 tools, conducted within the framework of online instructional technology training, on prospective science teachers' self-efficacy beliefs and perspectives regarding instructional technologies. In this research, an explanatory mixed-method model was used. A quasi-experimental pre-test and post-test design without a control group was employed in the study. The study group consisted of 41 (n_{male}=3, n_{female}=38) science prospective teachers enrolled in the first year at a university in Ankara. Science prospective teachers participated in activities related to preparing digital teaching materials using Web 2.0 tools for ten weeks as part of their online instructional technology training. The study's quantitative data were obtained by administering the "Self-Efficacy Scale for Instructional Technologies in Science Education" as pre-and post-tests. Qualitative data were collected by using a "Semi-Structured Interview Form on Instructional Technologies in Science Education." The results indicated that the activities focused on preparing digital teaching materials using web 2.0 tools conducted online positively and significantly impacted the development of prospective science teachers' self-efficacy beliefs in instructional technologies. Interviews conducted after the implementation revealed that using web 2.0 digital teaching tools in science education enabled prospective teachers to gain teaching professional experience and technological competence.

Keywords: Instructional technologies; web 2.0; self-efficacy belief; online education; prospective science teachers.

Fen Bilgisi Öğretmen Adaylarının Fen Eğitiminde Öğretim Teknolojilerine Yönelik Özyeterlik İnançları ve Görüşleri: Çevrimiçi Öğretim Teknolojisi Eğitimi

**Sorumlu yazar*

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ÖZ

Bu araştırmanın amacı, çevrim içi olarak düzenlenen öğretim teknolojileri eğitimi kapsamında uygulanan web 2.0 araçları ile dijital öğretim materyali hazırlama etkinliklerinin fen bilgisi öğretmen adaylarının öğretim teknolojileri özyeterlik inançları ve görüşleri üzerine etkisinin araştırılmasıdır. Araştırmada açıklayıcı karma yöntem araştırma modeli kullanılmıştır. Araştırmanın çalışma grubu, 2022-2023 eğitim ve öğretim yılı bahar döneminde Ankara'da bir üniversitede birinci sınıfta öğrenim görmekte olan 41 (n_{erkek}=3, $n_{kız}$=38) fen bilgisi öğretmen adayından oluşmaktadır. Fen bilgisi öğretmen adayları çevrim içi olarak on hafta boyunca öğretim teknolojileri eğitimi kapsamında web 2.0 araçları ile dijital öğretim materyali hazırlama ile ilgili etkinliklere katılmışlardır. Araştırmanın nicel verileri, "Fen Eğitiminde Öğretim Teknolojileri Özyeterlik Ölçeği" ile ön ve son test olarak uygulanması sonucu elde edilmiştir. Nitel veriler ise, "Fen Eğitiminde Öğretim Teknolojilerine Yönelik Yarı Yapılandırılmış Görüşme Formu" ile toplanmıştır. Nicel verilerin analizinde SPSS programı, nitel verilerin analizinde ise içerik analizi kullanılmıştır. Elde edilen sonuçlara göre, çevrim içi olarak düzenlenen web 2.0 araçları ile dijital öğretim materyali hazırlama etkinliklerinin öğretmen adaylarının öğretim teknolojileri özyeterlik inançlarının gelişiminde olumlu ve yüksek düzeyde etkiye sahip olduğu görülmüştür. Uygulama sonrasında yapılan görüşmelerde, öğretmen adaylarının web 2.0 dijital öğretim araçlarının fen eğitiminde kullanımının deneyim kazanmalarını ve teknolojik yetkinliğe sahip olmalarını sağladığı ortaya çıkmıştır.

Anahtar Kelimeler: Öğretim teknolojileri, web 2.0, özyeterlik inancı, çevrim içi eğitim, fen bilimleri öğretmen adayı.

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Introduction

From birth, humans continually need learning, which is essential for survival. This need for learning varies according to the life stages and the era's demands. In the early stages of life, individuals primarily require physiological needs such as breathing, feeding, and sleeping. In contrast, in later years, they also require sociological and psychological needs alongside basic physiological needs (Maslow, 1943). As individuals meet their lower-tier physiological and safety needs, they begin to seek fulfillment of higher-order psychological and social needs. Motivation is typically activated once foundational needs are satisfied, allowing individuals to engage in the pursuit of more advanced aspirations. In the context of lifelong learning, it is therefore imperative that the design and implementation of educational processes—particularly in science education—are grounded in the recognition of learners' developmental and hierarchical needs. The needs and desires of individuals serve as vital motivating factors for their learning. As a result, individuals desiring to learn are expected to have high motivation and drives for success. Hence, it is imperative to consider individuals' and the era's needs in arranging educational programs across disciplines and utilizing methods, techniques, and materials within lessons. One of the necessities of our rapidly changing and developing era is to nurture qualified individuals as demanded by the times. One of the most crucial determinants of a country's level of development today lies in advancements in science and technology. The sustainability of these advancements and developments is dependent on education. Education transfers knowledge to society and plays a significant role in disseminating and teaching evolving technologies to communities. The integration of contemporary technologies has become an essential component at all levels of the educational process. This development has led to the emergence of the concept of "educational technology integration" within the academic discourse. There is a growing scholarly consensus on the importance of examining the perspectives of both pre-service and in-service teachers to effectively incorporate and adapt emerging digital and social technologies into classroom practices, particularly within the context of science education (Coutinho, 2009; Scott & Ryan, 2009). A rising tendency has emerged to integrate Web 2.0 technologies into educational settings, driven by their potential pedagogical advantages, including student publication, active learning, and social learning (Albion, 2008; Ferdig, 2007). Among the subjects where the inclusion of instructional technologies in the education and teaching process is most essential is the field of science education. This is because science education deals with abstract topics and concepts, making it challenging for students to achieve desired outcomes. In this context, numerous studies within the academic literature have demonstrated that the integration of instructional technologies into science education contributes to increased student achievement, fosters more positive attitudes, and enhances learners' awareness regarding the use of such Technologies (Akbaba & Ertaş Kılıç, 2022; Aslan & Güner, 2022; Gürleroğlu & Yıldırım, 2022; Kahyaoğlu & Elçiçek, 2016). Web-based technologies are among the primary instructional technologies in science education classes today. Given the realities of the information and technology age, it is imperative to carry out research aimed at preparing teachers who are capable of effectively integrating these essential technologies into their instructional practices. In this regard, teachers are anticipated to engage in co-learning, modeling, and facilitating the acquisition of various digital and social competencies to effectively engage with these digital natives. Put differently, teachers' proficiency in digital literacy concerning Web 2.0 technologies should not lag behind that of students in order to adequately address these emerging competencies. Accordingly, there is a growing need for further research to explore the strategies and pedagogical approaches that teachers might adopt to educate digital-native learners through the use of emerging social web technologies (Schwartz & Digiovanni, 2009; Scott & Ryan, 2009). As emphasized by Albion (2008), it is crucial for teacher education programs to develop effective models and strategies for the integration of Web 2.0 tools into instructional settings. A review of the existing literature reveals that many studies have investigated pre-service teachers' competencies regarding instructional technologies from diverse perspectives. However, there remains a notable need for more research focusing on the development and enhancement of these competencies. In this context, the current study seeks to fill this gap in the existing literature. Specifically, it examines the influence of activities involving the creation of digital instructional materials using Web 2.0 tools—conducted within the framework of an online instructional technologies course—on the instructional technology self-efficacy beliefs and perceptions of prospective science teachers. In alignment with the study's purpose, responses to the following main research question and its sub-questions were sought.

Research questions:

Does participation in activities aimed at developing digital teaching materials using Web 2.0 tools in an online environment influence the self-efficacy beliefs and perspectives of prospective science teachers concerning instructional technologies?

Sub questions:

1. Is there a statistically significant difference between the means of pre and post-test scores of prospective science teachers' self-efficacy beliefs regarding instructional technologies?

1.1. Is there a statistically significant difference between the means of pre and post-test scores of prospective science teachers' one of the sub-dimensions of instructional technology self-efficacy beliefs?

1.2. Is there a statistically significant difference between the means of pre and post-test scores of prospective science teachers' one of the sub-dimensions of instructional technology self-efficacy beliefs?

1.3. Is there a statistically significant difference between the means of pre and post-test scores of prospective science teachers' one of the sub-dimensions of instructional technology self-efficacy beliefs?

1.4. Is there a statistically significant difference between the means of pre and post-test scores of prospective science teachers' one of the sub-dimensions of instructional technology self-efficacy beliefs?

2. What are the perspectives of prospective science teachers on engaging in activities focused on preparing digital teaching materials using web 2.0 tools conducted online?

Method

This study employed an explanatory mixed-method model, which is one of the mixed-methods research approaches. In explanatory mixed-methods research, the process begins with the gathering of quantitative data, which is then complemented by qualitative data to provide a deeper and more detailed interpretation of the initial results (Creswell & Plano Clark, 2011). This explanatory sequential design consists of two separate phases. The first stage focuses on the analysis of the collected quantitative data, while the second stage involves the gathering of qualitative data aimed at further exploring and clarifying the insights obtained from the quantitative phase. As a result, the researcher supplements their quantitative study with qualitative research, enriching the interpretation. Since the explanatory sequential design typically initiates with quantitative research and qualitative research is conducted based on quantitative research results, quantitative research is generally predominant in this design. However, the researcher decides on this matter throughout the research process. In this study, priority was given to quantitative data, which This represents the first stage of the explanatory design. The goal was to enhance the analysis and interpretation of the significant quantitative findings by incorporating qualitative data analysis (Creswell & Plano Clark, 2020).

In this research, by the explanatory sequential design, quantitative data were initially collected using the "teaching technology self-efficacy belief" scale. Subsequently, qualitative data were collected using the "Semi-Structured Interview Form on Teaching Technologies in Science Education" to support the in-depth examination of quantitative data. Therefore, the research employed an explanatory sequential design.

In this study, an experimental design, which is one of the quantitative research methods, was employed to determine the effects of activities focused on preparing digital teaching materials using web 2.0 tools, conducted within the framework of online instructional technology training, on the self-efficacy beliefs and perspectives of prospective science teachers regarding instructional technologies. Experimental designs are research designs used to determine cause-and-effect relationships between variables (Büyüköztürk, 2011). According to Arıkan (2000: 69), the experimental method involves measuring, weighing, counting, observing, smelling, etc., the material that is divided into groups or exists as a single group without subjecting it to any process, or conducting experiments by subjecting the same material to a process (Arıkan, 2000: 69). The study employed a quasi-experimental pre-test post-test design without a control group (Karasar, 2006). In this design, interventions were applied exclusively to the experimental group, without including a control group for comparison. Measurements of the dependent variables, whose effects were observed before and after the intervention, were compared. Due to the participants not having received any prior education related to instructional technologies, the change in the dependent variable in the study is thought to have stemmed from the digital teaching material preparation activities conducted during the intervention. This study is constrained by its sample size (n=44 for quantitative data and n=7 for qualitative data), which may restrict the generalizability of the findings. Moreover, the focus on prospective science teachers within a specific context may limit the transferability of the results to other disciplines or educational settings. The reliance on self-report measures also introduces the potential for social desirability bias. Additionally, the study did not investigate the long-term effects of the training on teachers' classroom practices. Future research should address these limitations by utilizing larger, more diverse samples, incorporating observational data, and conducting longitudinal studies.

In the qualitative dimension of the research, the interview technique was employed. Interviewing is a data collection technique utilized in qualitative research (Punch, 2005). An interview aims to delve into the participants' inner world to understand their perspective on the relevant topic or situation (Patton, 1987). In semi-structured interviews, an interview form contains a predetermined set of questions. Additional follow-up questions may be introduced during the interview to explore the details of the data or to address any incomplete points (Karataş, 2017). In this study, the "Semi-Structured Interview Form on Teaching Technologies in Science Education" was utilized to comprehensively gather teacher candidates' perspectives on teaching technologies in science education.

In this context, the study sought to examine the impact of activities centered on the development of digital teaching materials using Web 2.0 tools, conducted within the scope of an online instructional technology course, on the self-efficacy beliefs and perspectives of prospective science teachers concerning instructional technologies

Table 1. Descriptive statistics results for participants in the study group

	Gender					
	Female		Male		Total	
Class Groups	n	%	n	%	n	%
First Group	20	52,63	1	33,33	21	51,21
Second Group	18	47,37	2	66,67	20	48,79
Total	38	92,68	3	7,32	41	100

According to Table 1, participants consist of 92.68% female students and 7.32% male students.

Study Group

This research was carried out with prospective science teachers enrolled in the first year of the science education program during the spring semester of the 2022-2023 academic year, as part of the "Instructional Technologies" course. A non-probability sampling method was used for this study, and the participants were selected through the convenience sampling technique. In this approach, participants are chosen based on their availability, willingness to participate, and relevance to the research objectives (Gravetter & Forzano, 2012). The study group consisted of 41 prospective science teachers (3 male, 38 female) from a central university in Ankara. The study initially began with 43 science prospective teachers enrolled at a central university in Ankara. However, it was found that 2 participants did not provide objective responses in the pre-test, so their data were excluded from the study. The activities were conducted in two separate groups, and participants were required to continue in the group they were registered for. Descriptive statistics results for the participants in the study group are presented in Table 1.

Data collection instruments

The quantitative data of the research were obtained through the application of the "Self-Efficacy Scale for Instructional Technologies in Science Education" as pre and post-tests. Qualitative data were collected using the "Semi-Structured Interview Form on Instructional Technologies in Science Education."

Self-efficacy scale for instructional technologies in science education

To assess the pre- and post-application self-efficacy of prospective science teachers regarding instructional technologies in science education, the scale developed by Taşdemir (2021) was utilized. The scale consists of 40 items formatted in a 5-point Likert scale. Scoring for the measurement tool ranges from 1 to 5, with the following ratings: strongly agree (5), agree (4), undecided (3), disagree (2), and strongly disagree (1). The total possible scores on the scale range from a minimum of 40 to a maximum of 200. A higher score reflects a greater level of self-efficacy in the use of instructional technologies in science education.

Validity and reliability analyses of the 40-item scale developed by Taşdemir (2019) were conducted with a sample of 368 prospective science teachers. Through exploratory and confirmatory factor analyses, it was found that the 40 items were organized into four distinct factors. These sub-factors are: "Self-Efficacy Beliefs in Using Technology in Science Lessons (13 items)", "Professional Technological Self-Efficacy (13 items)", "Expectations for Teacher Development (8 items)", and "Expectations for Student Development (6 items)". The scale, with its 4-factor structure, was observed to explain 65.010% of the variance. The results of the confirmatory factor analysis indicated that the fit indices showed acceptable values of fit. Additionally, it was determined that the value of $x^2/sd= 3.652$ was below 4. The Cronbach's Alpha reliability coefficient of the scale was reported as 0.974. It was determined as .96 for the self-efficacy in using technology in science teaching sub-dimension, .94 for the self-efficacy in using technology professionally, .89 for the expectation sub-dimension for educating students, and .92 for the expectation sub-dimension produced by the teacher.

Within the scope of this study, the Cronbach's Alpha reliability coefficient of the measurement tool was recalculated. The scale was administered to a different group of 358 prospective teachers. Following the analysis, the coefficients of internal consistency and the sub-factors were computed. The reliability coefficient was found to be $\alpha = .92$. The reliability coefficient was found to be .92 for the self-efficacy in using technology for science teaching sub-dimension, .94 for the self-efficacy in using technology professionally, .88 for the expectation sub-dimension related to educating students, and .92 for the expectation sub-dimension generated by the teacher. Given that the reliability coefficient exceeds .70, the measurement instrument demonstrates adequate reliability (Büyüköztürk, 2011).

Semi-structured interview form on instructional technologies in science education

In this study, the "Semi-Structured Interview Form on Instructional Technologies in Science Education," developed by the researcher, was utilized to gather the views of prospective science teachers on instructional technologies in science education following the intervention. Interviews are one of the qualitative data collection methods that allow us to gain in-depth knowledge about cognitive and affective learning outcomes related to the instructional technologies involved in the application process. In terms of their structure, interviews are classified into three categories. Semi-structured interviews are preferred in the field of education among interview techniques due to their pre-planned structure before the interview, a certain degree of flexibility, and standardization (Dörnyei, 2007). The "Semi-Structured Interview Form on Instructional Technologies in Science Education" used in this research was prepared by the researcher after conducting a detailed literature review on the subject, containing an adequate number of questions for data collection. To ensure the internal and external validity of the questions in the semi-structured interview forms, the prepared interview form was given to 2 field experts and one language expert for their evaluations. The experts checked the appropriateness of the interview questions for the purpose, whether they were clear and understandable, and whether they could provide the necessary information. Two of the six questions prepared have been revised as necessary. After the expert evaluations, the semi-structured interview form was finalized a total of six questions have been prepared. Thus, the validity of the items in the interview form was ensured. After the application, semi-structured interviews were conducted online with 7 participants who volunteered to participate from among the prospective teachers in the study group. Both audio recordings and written statements by the prospective teachers were used to record the semi-structured interview data. The environment of the prospective teachers recorded with the recording device was transcribed into writing and included in the qualitative data analysis. Each prospective teacher who participated in the semi-structured interview has been coded as person and number (P1, P2, P3...).

Implementation process

After the earthquake disaster in Kahramanmaraş on February 6, 2023, the Council of Higher Education decided to carry out the spring semester of the 2022-2023 academic year through distance education (Council of Higher Education, 2023). In this regard, the study was carried out online during the spring semester of the 2022-2023 academic year. A 14-week implementation process conducted by the same researcher was carried out for prospective science teachers enrolled in two separate sections. These practices conducted online were observed by another field expert. Communication with the prospective teachers was facilitated through mobile-based groups and the remote learning platform provided by the university. Before the implementation, plans regarding the process were shared with the prospective teachers, and solutions were offered to those participants who faced computer or internet-related issues.

The scale used to assess the self-efficacy beliefs of prospective science teachers regarding instructional technologies was prepared online and administered to the participants prior to the implementation process. Following the administration of the pre-test, the first activity was initiated. A total of 8 activities were conducted over a period of 8 weeks, with 2 class hours per week. These activities were focused on instructional technologies within the scope of the 2018 Science curriculum objectives. During the first class hour, the researcher provided theoretical knowledge, skills, and practical information related to the activity. In the second-class hour, the prospective teachers were asked to create products related to the topic covered in the activity. The planning for the implementation process is outlined in Table 2.

Table 2 reveals that eight activities were conducted over the course of 8 weeks, with 2 class hours per week. In the first hour of each session, the researcher provided theoretical information regarding the instructional technologies for that week in virtual classrooms online. The researcher incorporated illustrative examples and provided detailed answers to participants' questions. In the second hour, participants were assigned the task of developing a web-based instructional technology focused on a specific topic from the 2018 science curriculum. They then uploaded their web-based instructional technologies to distance learning platforms. and shared the link in mobile applications. completion of the eight activities, the scale used to assess participants' self-efficacy beliefs regarding instructional technologies in science education was administered online once again. After completing the post-tests, online semi-structured interviews were conducted with 7 participants who volunteered to participate. The data from these interviews were recorded using audio recordings and transcriptions of the participants' responses. Examples of the instructional technologies created by participants during the implementation process are provided in Figure 1. (Appendix-1)

In Activity 1, online surveys created using Google Forms; In Activity 2, online remedial classes conducted via Zoom; In Activity 3, explaining adolescence period with animations using the Powtoon application;

In Activity 4, a journey into the world of living organisms utilizing the Quiver application;

In Activity 5, introduction of the parts of a flowering plant with a Prezi presentation;

In Activity 6, announcement of telescope sky observation using the Canva application;

In Activity 7, storytelling of rain formation with a digital book using the Storybird application; and finally,

In Activity 8, preparation of assessment related to simple electric circuits using the Kahoot application for mobile implementation were facilitated.

In order to determine the instructional technology self-efficacy beliefs of science prospective teachers before and after the application, the "Instructional Technology Self-Efficacy Scale in Science Education" was used. Since the scale consisted of 4 subscales, the pre-test and post-test comparisons were analyzed in terms of the subscales of the variables. A paired samples t-test was deemed appropriate for each subscale. Therefore, before conducting the paired samples t-test, the assumptions of the test were tested, and it was determined that the assumptions were met.

Table 2. Implementation process

Week	Activity	Topic	2018 Science Curriculum Achievement
1	Pre-test administration (1 hour) Informative session on instructional technologies and the implementation process (1 hour)		
2	Theoretical knowledge on creating online surveys (1 hour) Activity 1. "Learning My Students' Opinions with Online Surveys" (1 hour)	Student Views on Distance Science Education	
3	Theoretical knowledge on creating online meeting technologies (1 hour) Activity 2. "Conducting Remedial Classes with Online Meetings" (1 hour)	Simple Machines	S.8.5.1.1. Explains the advantages provided by simple machines through examples.
4	Theoretical knowledge on interactive animation technologies (1 hour) Activity 3. "Teaching with Fun through Animations" (1 hour)	Adolescence Period	S.6.6.1.3. Explains the physical and psychological changes occurring during the transition from childhood to adolescence.
5	Theoretical knowledge on augmented reality technologies (1 hour) Activity 4. "Virtual Reality Observation with AR Application" (1 hour)	World of Living Organisms	S.5.2.1.1. Classifies living organisms based on examples, according to their similarities and differences.
6	Theoretical knowledge on online presentation technologies (1 hour) Activity 5. "Preparing a Web Presentation" (1 hour)	Parts of a Flowering Plant	S.7.6.2.2. Describes the processes of growth and development in plants and animals, providing examples. Focuses on a flowering plant example.
7	Theoretical knowledge on preparing visual content (posters, bulletins, etc.) using technology (1 hour) Activity 6. "Designing My Poster" (1 hour)	Observing the Sky with a Telescope	S.7.1.1.4. Explains the structure and function of a telescope.
8	Theoretical knowledge on e-book technologies (1 hour) Activity 7. "Creating My Digital Book" (1 hour)	Formation of Rain	S.8.1.2.1. Describes the difference between climate and weather events.
9	Theoretical knowledge on creating online exam/test technologies (1 hour) Activity 8. "Assessing My Learning with Online Games" (1 hour)	Simple Electric Circuit	S.5.7.1.1. Represents elements of an electric circuit with symbols.
10	Post-test administration (1 hour) Online semi-structured interviews with voluntary participants (1 hour)		

"When examining Table 3, it can be observed that the pre-test and post-test data regarding the four sub-factors of the 'Self-efficacy beliefs in using technology in science education' scale are typically distributed at the .05 significance level ($p > .05$) (Büyüköztürk, 2011). As the specified tests exhibit normal distribution, parametric tests were utilized in the quantitative data analysis.

On the other hand, an inductive approach using content analysis methods was employed to analyze qualitative data obtained from the research. Open coding was initially conducted to identify standard codes and categories at the outset of the inductive analysis process. After removing irrelevant codes and categories, the data analysis reached its final iteration. The researcher and subject matter expert annotated the data, with quotations selected from among the identified categories. The process of inductive content analysis involves sequential steps, including planning the analysis process, coding and categorizing the data, and generating and interpreting findings (Strauss & Corbin, 1990).

Table 3. Normality test results

Shapiro-Wilk							
Dependent Variable	**Statistics**	**df**	**p**	**Dependent Variable**	**Statistics**	**df**	**p**
"The sub-dimension of 'Self-efficacy beliefs in using technology in science education' pre-test	.97	43	.50	"The sub-dimension of 'Self-efficacy beliefs in using technology in science education' post-test	.95	43	.16
The sub-dimension of 'Professional self-efficacy in using technology' pre-test	.96	43	.25	The sub-dimension of 'Professional self-efficacy in using technology' post-test	.97	43	.36
The sub-dimension of 'Expectations for teacher development' pre-test	.96	43	.14	The sub-dimension of 'Expectations for teacher development' post-test	.96	43	.25
The sub-dimension of 'Expectations for student development' pre-test"	.96	43	.16	The sub-dimension of 'Expectations for student development' post-test"	.96	43	.14

Results

Findings Related to Data

In this study, which investigated the effects of activities on preparing digital teaching materials with web 2.0 tools within the scope of the online instructional technologies course on the self-efficacy beliefs and opinions of science prospective teachers regarding instructional technologies, findings were obtained through quantitative and qualitative data analyses.

Findings Related to Quantitative Data

Findings related to the first sub-problem:

Is there a statistically significant difference between the mean pre-test and post-test scores of the sub-dimension "Self-efficacy beliefs in using technology in science education," which is part of the instructional technology self-efficacy beliefs? The results of the dependent samples t-test analysis for the specified sub-problem are presented in Table 4.

Upon examining Table 4, it is evident that there is a significant difference in the pre-test-post-test mean scores of prospective teachers regarding the sub-dimension of "Self-efficacy beliefs in using technology in science education" ($t_{43} = -6.20$, $p = 0.00 < 0.05$). The post-test mean scores of prospective teachers ($\overline{X}$ = 47.53, Item-based mean = 3,65) are higher compared to the pre-test mean scores ($\overline{X}$ = 55.79, Item-based mean = 4,29). The item-based mean scores (3,65 for the pre-test and 4,29 for the post-test) provide a more interpretable measure, indicating an increase in prospective teachers' self-efficacy beliefs on a 5-point Likert scale. The eta squared value obtained for the dependent groups (η^2 = .48) indicates a large effect size (Büyüköztürk, 2011).

Findings related to the second sub-problem:

Is there a significant difference between the pre-test and post-test means of 'Professional self-efficacy in using technology,' one of the sub-dimensions related to instructional technology self-efficacy beliefs? The results of the dependent samples t-test analysis for the specified sub-problem are presented in Table 5.

Upon examining Table 5, it is observed that there is a significant difference in the pre-test-post-test mean scores of prospective teachers regarding the sub-dimension of "Professional self-efficacy in using technology" ($t_{43} = -4.24$, $p = 0.00 < 0.05$). The post-test mean scores of prospective teachers ($\overline{X}$ = 58.70, Item-based mean = 4,51) are higher compared to the pre-test mean scores ($\overline{X}$ = 53.21, Item-based mean = 4,09). The item-based mean scores (4,09 for the pre-test and 4,51 for the post-test) provide a more interpretable measure, indicating an increase in prospective teachers' professional self-efficacy on a 5-point Likert scale. The eta squared value obtained for the dependent groups (η^2 = .30) indicates a large effect size (Büyüköztürk, 2011).

Findings related to the third sub-problem:

Is there a significant difference between the pre-test and post-test means of 'Expectations for teacher development,' one of the sub-dimensions related to instructional technology self-efficacy beliefs? The results of the dependent samples t-test analysis for the specified sub-problem are presented in Table 6.

Table 4. Dependent samples t-test results for the pre-test-post-test mean scores of the sub-dimension 'Self-efficacy beliefs in using technology in science education' of prospective teachers

	n	$\overline{X}$	SD	df	t	p	η²
Pretest	43	47.53	7.45	42	- 6.20	.00	.48
Posttest	43	55.79	5.73				

Table 5. Dependent samples t-test results for the pre-test-post-test mean scores of teacher candidates' sub-dimension 'Professional self-efficacy in using technology'

	n	$\overline{X}$	SD	df	t	p	η²
Pretest	43	53.21	7.67	42	-4.24	.00	.30
Posttest	43	58.70	4.96				

Table 6. Dependent samples t-test results for the pre-test-post-test mean scores of the sub-dimension 'Expectations for teacher development' of prospective teachers

	n	$\overline{X}$	SD	df	t	p	η²
Pretest	43	21.58	4.28	42	-5.47	.00	.42
Posttest	43	25.37	2.91				

Table 7. Dependent samples t-test results for the pre-test-post-test mean scores of prospective teachers sub-dimension 'Expectations for student development'

	n	$\overline{X}$	SD	df	t	p	η²
Pretest	43	31.79	4.85	42	-4.33	.00	.31
Posttest	43	35.14	4.03				

Upon examining Table 6, it is observed that there is a significant difference in the pre-test-post-test mean scores of prospective teachers regarding the sub-dimension of "Expectations for teacher development" ($t_{43} = -5.47$, $p = 0.00 < 0.05$). The post-test mean scores of prospective teachers ($\overline{X}$ = 25.37, Item-based mean = 3,17) are higher compared to the pre-test mean scores ($\overline{X}$ = 21.58, Item-based mean = 2,69). The item-based mean scores (2,69 for the pre-test and 3,17 for the post-test) provide a more interpretable measure, indicating an increase in prospective teachers' expectations for teacher development' on a 5-point Likert scale. The eta squared value obtained for the dependent groups ($\eta^2 = .42$) indicates a large effect size (Büyüköztürk, 2011).

Findings related to the fourth sub-problem:

Is there a significant difference between the pre-test and post-test means of 'Expectations for student development,' one of the sub-dimensions related to instructional technology self-efficacy beliefs? The results of the dependent samples t-test analysis for the specified sub-problem are presented in Table 7.

Upon examining Table 7, it is observed that there is a significant difference in the pre-test-post-test mean scores of prospective teachers regarding the sub-dimension of "Expectations for student development" ($t_{43} = -4.33$, $p = 0.00 < 0.05$). The post-test mean scores of prospective teachers ($\overline{X}$ = 35.14, Item-based mean = 5,85) are higher compared to the pre-test mean scores ($\overline{X}$ = 31.79, Item-based mean = 5,29). The item-based mean scores (5,29 for the pre-test and 5,85 for the post-test) provide a more interpretable measure, indicating an increase in prospective teachers' expectations for student development' on a 5-point Likert scale. The eta squared value obtained for the dependent groups ($\eta^2 = .31$) indicates a large effect size (Büyüköztürk, 2011).

Findings Related to Qualitative Data:

Semi-structured interviews were conducted with 7 participants (P1, P12, P18, P27, P29, P33, P40) who volunteered to participate to determine the views of science prospective teacher son preparing digital teaching materials with web 2.0 tools organized online. The presentation of qualitative findings includes responses obtained within the framework of questions directed to prospective teachers and direct quotations.

Findings regarding the evaluation of the concept of "instructional technologies" by teacher candidates:

Categories, codes, frequencies, and sample expressions regarding how science prospective teachers evaluate the concept of "instructional technologies" in online instructional technology education are presented in Table 8.

Upon examining Table 8, it is observed that prospective teachers primarily associate the concept of instructional technologies with the objectives of the learning process. Their characterization of these as tools/materials that facilitate effective learning is particularly noteworthy.

Findings regarding the evaluation of teacher candidates' "self-efficacy in using instructional technologies":

Categories, codes, frequencies, and sample expressions regarding the evaluation of prospective science teachers' "self-efficacy in using instructional technologies" in online instructional technology education are presented in Table 9.

Upon reviewing Table 9, it is clear that a significant number of prospective teachers do not view themselves as fully competent in terms of their "self-efficacy in using instructional technologies". Two participants have expressed that the online education they received was sufficient in terms of instructional technologies.

Findings regarding the evaluation of "benefits and drawbacks of instructional technologies" by teacher candidates:

Categories, codes, frequencies, and sample expressions regarding how science prospective teachers evaluate the "benefits and drawbacks of instructional technologies" in online instructional technology education are presented in Table 10.

Table 8. Evaluation of the concept of "instructional technologies" by prospective teachers

Category	Code	f	Direct quotations
Teaching material (n=16)	Tool/Equipment	6	"Tools and materials that appeal to students' attention and stimulate multiple sensory organs in lessons." P18
	Material Internet	5	"They are various teaching materials whose usage has been increasingly growing in recent years..." P27
	Web	5	"These are applications that we can use through the internet. We can customize them according to the subject." P40
Teaching purpose (n=18)	Effective learning	7	"These are tools used to help students achieve greater success and learn more effectively..." P12
	Permanent learning	4	“These are materials that enable students to learn permanently, rather than by rote, with the support of technology.” P1
	Facilitating/Fun	4	"These materials enable my students to learn information permanently with technology support rather than memorization." P29
	Age necessity	3	"Internet-based technologies that meet the learning needs of Generation Z students in this era." P33

Table 9. Evaluation of prospective teachers’ "self-efficacy in using instructional technologies"

Category	Code	f	Direct quotations
Yes (n=2)	Lesson/Education	2	“With the training we received this semester, I learned the applications easily and I continue to learn on my own.” P1
Partially (n=13)	Too many applications	5	"I cannot fully trust myself in this matter because there are too many applications..." P40
	Foreign language	4	"The applications are in English. I cannot fully master them due to my foreign language problem." P33
	Technical knowledge	2	"It seems like each application requires different knowledge; I feel confident in what I've learned in education, but I'm not sure about the others." P29
	Lack of interest	2	"I don't approve of technology being too prevalent in the education process. Therefore, I can say that my proficiency is low because I am not very interested in it." P12
No (n=0)	-	0	-

Table 10. Evaluation of "benefits and drawbacks of instructional technologies" by prospective teachers

Category	Cod	f	Direct quotations
Advantages (n=17)	Effective learning	6	"These applications are highly effective in engaging students in the classroom, thus making learning effective as well." P1
	Enjoyable/easy/fast learning	5	"Applications like Prezi, Powtoon, and Kahoot make lessons more enjoyable..." P29
	Cost-effectiveness	3	"...For instance, we can conduct a costly or difficult experiment very conveniently using virtual applications." P33
	Attention-grabbing	3	"The study where we explained adolescence using an animation application even caught my attention." P40
Disadvantages (n=14)	Technology/Internet dependency	7	"Frequent use of technology in lessons can turn children into sedentary individuals who are constantly immersed in technology. Providing internet-supported applications to students who are always connected to the internet is akin to adding fuel to the fire." P18
	Social isolation/Loneliness	4	"It can personalize learning. This means individuals who are alone." P12
	Distraction	3	"Too much animation, song, entertainment, and presentation, in my opinion, makes it difficult to focus on the lesson..." P27

Table 11. Evaluation of "instructional technologies that should be present in a classroom" by prospective teachers

Category	Code	f	Direct quotations
Equipment/Materials (n=21)	Smartboard	7	"Smartboards are the most essential instructional technology that should be accessible from cities to rural areas today." P33
	Computer/Tablet	5	"Computers, ideally, should be available in every classroom so that technology can take its place in teaching..." P12
	Mobile phone	5	“Mobile phones are now small computers. Everything from models to experiments can be found within them." P18
	Projector	4	"A computer and a projector in the classroom are essential bedside technologies..." P40
e-connection (n=17)	Internet	7	"Without internet connection, it's difficult to talk about technology in materials." P29
	Mobile applications	5	"...For example, there are mobile applications for these technologies we learn in class. Observing the sky within the classroom with just one application..." P27
	Web-supported applications	5	"Accessing every program isn't always possible. But with web support, you can present your Prezi prepared anywhere in the world." P29

Upon examining Table 10, prospective teachers perceive the benefits of instructional technologies as effective/efficient learning, while they believe that it may lead to technology/internet addiction as a drawback. As mentioned by K18, technology/internet-supported instructional technologies are characterized as adding fuel to the fire for students.

Findings regarding the evaluation of "instructional technologies that should be present in a classroom" by teacher candidates:

Categories, codes, frequencies, and sample expressions regarding how science prospective teachers evaluate the "instructional technologies that should be present in a classroom" in online instructional technology education are presented in Table 11.

Upon examining Table 11, all participants prioritize smartboards and the internet as instructional technologies that should be present in a classroom. It is noteworthy that participants who also mention cell phones and mobile applications as instructional technologies liken cell phones to computers.

Findings on the evaluation of "purposes for using instructional technologies in the classroom" by prospective teachers:

Table 12 presents the categories, codes, frequencies, and sample expressions related to how prospective teachers evaluate the "purposes of using instructional technologies in the classroom" within the context of online instructional technology education.

Upon reviewing Table 12, it was noted that participants primarily utilize instructional technologies at the beginning of the lesson to facilitate effective and lasting learning.

Findings regarding the evaluation of "challenges encountered in the process of using instructional technologies" by teacher candidates:

Categories, codes, frequencies, and sample expressions regarding how science prospective teachers evaluate the "challenges encountered in the process of using instructional technologies" in online instructional technology education are presented in Table 13.

Upon examining Table 12, participants have expressed that the most significant challenge they encounter in the process of using instructional technologies is the problem with an internet connection, followed by the issue of web 2.0 applications being written in a foreign language.

Table 12. Evaluation of "purposes of using instructional technologies in the classroom" by prospective teachers

Category	Code	f	Direct quotations
Purpose of usage (n=13)	Effective/permanent learning	6	"I use them to ensure better learning for students." P40
	Engaging/stimulating	4	"In fact, science lessons are more enjoyable with these technologies..." P27
	Enriching	3	"I would use them to enrich my teaching materials." P29
Order of use (n=11)	At the beginning of the lesson	5	"I use them to capture students' attention at the beginning of my science lessons..." P33
	During the lesson	4	"I can use instructional technologies at any moment throughout my lesson, depending on the topic." P18
	At the end of the lesson	2	"I use them at the end to summarize the topic." P12

Table 13. Evaluation of "challenges encountered in the process of using instructional technologies" by prospective teachers

Category	Code	f	Direct quotations
General (n=11)	Internet connection	5	"I occasionally experienced internet connection issues due to being in an earthquake-prone area..." P40
	Technical knowledge	4	"It turns out that it's necessary to familiarize oneself with these technologies first. If this information wasn't provided in the initial lessons, I would have struggled the most with this." P33
	Lack of materials	2	"Not having a computer made it difficult to perform some applications with just a cell phone, of course..." P27
Personal (n=6)	Foreign language	4	"The fact that the applications are in English sometimes forces me to memorize where to click." P12
	Distance from technology	2	"I'm not very interested in technology, which also makes it challenging for me." P18

Discussion

This research explored how online training in instructional technology, with an emphasis on utilizing Web 2.0 tools and creating digital teaching materials, influenced the self-efficacy beliefs and perspectives of prospective science teachers regarding instructional technologies. In this context, based on the stated aim, the following results were obtained:

There was a statistically significant increase in the sub-dimensions of instructional technology self-efficacy beliefs of prospective science teachers, namely, "self-efficacy beliefs in using technology in science classes," "professional self-efficacy in using technology," "expectations for teacher development," and "expectations for student development," after online instructional technology training (Table 4, 5, 6, and 7). This finding is consistent with a growing body of research highlighting the positive impact of targeted technology integration training on teachers' self-efficacy (e.g., Ertmer & Ottenbreit-Leftwich, 2010;). This finding can be further explained through the lens of Social Cognitive Theory (SCT) (Bandura, 1986). SCT posits that self-efficacy is influenced by four main sources: mastery experiences, vicarious experiences, social persuasion, and emotional states. The online training likely offered participants mastery experiences through practical activities and the development of digital instructional materials, vicarious experiences by watching other teachers effectively use technology, social persuasion through constructive feedback and support, and positive emotional states from the enjoyment and fulfillment of successfully using technology. Specifically, the observed increase in "self-efficacy beliefs in using technology in science classes" can be attributed to the hands-on, practical nature of the training, which allowed prospective teachers to directly experience the potential of Web 2.0 tools to enhance science education. This aligns with Bandura's (1977) social cognitive theory, which emphasizes the role of mastery experiences in building self-efficacy. Furthermore, the significant gains in "professional self-efficacy in using technology" suggest that the training not only boosted confidence in classroom technology use but also fostered a broader sense of professional competence among participants. The improvements in "expectations for teacher development" and "expectations for student development" reflect the participants' growing awareness of the potential of technology to support their own professional growth and to enhance student learning outcomes. Çakır, Yükseltürk, and Top (2015) discovered in their study that prospective teachers held more positive attitudes and perceptions towards Web 2.0 technologies than practicing teachers, highlighting the crucial role of pre-service training in fostering favorable attitudes towards technology integration. This finding also resonates with the Technological Pedagogical Content Knowledge (TPACK) framework (Mishra & Koehler, 2006), which emphasizes the need for teachers to develop expertise in technology, pedagogy, and content knowledge to effectively integrate technology into their teaching. The training likely helped participants develop their TPACK by providing them with opportunities to explore the intersections between technology, pedagogy, and science content.

After the implementation of the online training, semi-structured interviews were conducted online with 7 participants who volunteered from the study group to participate in activities related to the preparation of digital instructional materials using Web 2.0 tools. The analysis of these interviews revealed that prospective teachers primarily associated the concept of instructional technology with the objectives of the learning process (Table 8). They viewed technology as tools, resources, and materials that facilitate effective learning. This focus on the pedagogical goals of technology integration is encouraging, as it suggests that prospective teachers are not simply viewing technology as a novelty but rather as a means to enhance teaching and learning. This perspective aligns with the growing emphasis on using technology to promote active learning, collaboration, and critical thinking skills (Jonassen et al., 2003; Partnership for 21st Century Skills, 2019). From a constructivist perspective (Vygotsky, 1978), technology can serve as a powerful tool for scaffolding student learning and facilitating the construction of knowledge. Technology enables students to access a vast array of resources and tools, empowering them to explore concepts, experiment with ideas, and develop their own understanding of the world. Despite the gains in self-efficacy observed in the quantitative data, a significant portion of prospective teachers reported that they did not consider themselves fully competent in terms of "using instructional technologies" after the training (Table 9). This apparent contradiction highlights the importance of qualitative data in providing a nuanced understanding of participants' experiences. It suggests that while the training may have increased their overall self-efficacy, they still perceived gaps in their knowledge and skills, perhaps due to the rapidly evolving nature of technology and the ongoing need for professional development. According to Kartal, Kartal, and Uluay (2016), educators should provide prospective teachers with the opportunity to learn teaching with technology effectively, flexibly, and productively, and should interpret teaching and learning based on existing knowledge, beliefs, and tendencies as a "constructive and iterative" process, reinforcing the importance of ongoing, iterative professional development in this area. This finding also suggests the importance of providing ongoing support and mentoring to help teachers translate their knowledge and skills into effective classroom practice (Guskey, 2002). This could involve providing teachers with opportunities to collaborate with experienced technology users, participate in professional learning communities, or receive individualized coaching.

Further analysis of the interview data revealed that the abundance of Web 2.0 applications and their prevalence in foreign languages (primarily English) reduced the participants' perceived competence in using instructional technologies (Table 10). The sheer number of available options can be overwhelming for teachers, making it difficult to identify the most effective and appropriate tools for their needs (Schrum et al., 2005). The fact that many of these applications are in foreign languages creates an additional barrier for teachers who may not be proficient in those languages. This highlights the need for developers to create more user-friendly, accessible, and multilingual applications. From a Connectivist perspective (Siemens, 2005), learning is a process of forming connections and networks. The abundance of Web 2.0 applications can be seen as both an opportunity and a challenge from this perspective. While it provides learners with access to a vast network of resources and connections, it can also be overwhelming and difficult to navigate. The lack of multilingual support further exacerbates this challenge by limiting access to information and resources for non-English speakers. Interestingly, two participants stated that the online training they received was sufficient for their instructional technology needs, suggesting that some individuals may be more adaptable and confident in their ability to learn and use new technologies. Adıgüzel (2010) found in a study that primary school teachers were more inclined to use traditional instructional materials and were insufficient in using instructional technologies, reinforcing the importance of providing early, targeted training to pre-service teachers. Qureshi, Khan, Raza, Imran & İsmail (2021) conducted a bibliometric analysis based on 47 studies on digital technologies and education, revealing that teachers show less interest in adapting to new digital teaching methods and learning. In contrast, prospective teachers are more favorable toward learning new technologies. These findings in the literature support the research results. Additionally, the interviews revealed that while prospective teachers primarily viewed the benefits of instructional technologies as effective and efficient learning, they also expressed concerns about the potential for technology/internet addiction (Table 10). This concern about the potential for technology overuse and addiction is a common one, particularly among educators working with digital natives (Prensky, 2001). It is important for teachers to be aware of these potential risks and to implement strategies to promote responsible technology use in the classroom, such as setting clear expectations for technology use, promoting digital citizenship, and providing opportunities for students to engage in non-digital activities (Ribble & Bailey, 2007). From a critical pedagogy perspective (Freire, 1970), it is important to critically examine the potential social, cultural, and economic implications of technology use in the classroom. This includes considering issues such as digital equity, access to technology, and the potential for technology to perpetuate existing social inequalities. All participants ranked interactive whiteboards and the internet as the instructional technologies that should be present in every classroom (Table 11). This preference likely reflects the participants' familiarity with these technologies and their perceived usefulness in delivering engaging and interactive lessons. According to a study by Soylu and Bozdoğan (2019), approximately half of 146 teachers were observed to use intelligent boards by taking advantage of their internet connectivity to teach courses. It is noteworthy that participants who express mobile phones and mobile applications as instructional technologies liken them to computers. This suggests that they recognize the potential of mobile devices to provide access to a wide range of learning resources and tools. Korkmaz (2015) found in a literature review on emerging trends in mobile learning that mobile applications stand out in formal education. According to Bircan (2022), using the internet enables teachers to access information faster and more efficiently, and using instructional technologies in their classrooms increases their belief in themselves as better or more competent teachers. The incorporation of mobile devices into the classroom, commonly known as mobile learning or m-learning, has been found to improve student engagement, allow for personalized learning experiences, and provide better access to educational resources (Crompton, 2013). Mobile learning can also support student-centered learning by allowing students to access learning materials, collaborate with peers, and complete assignments at their own pace and in their own way.

Finally, the participants reported that they primarily used instructional technologies at the beginning of lessons to achieve effective and permanent learning (Table 12). This suggests that they were primarily using technology as a means of introducing topics and capturing students' attention, rather than as an integral part of the entire learning process. This finding could be further explored to understand why they are not using technology more extensively and to identify strategies to promote its integration throughout the lesson. Weller (2013) found in a study conducted with pre-service teachers using web 2.0 applications in a natural classroom environment that pre-service teachers could understand how web technologies could be used in the classroom in real-time processes. Şeker and Kartal (2017) concluded in their study that technology-enhanced learning environments address different learning styles of students and thus lead to positive results in many aspects, such as students' achievements, motivations, and attitudes towards learning and teaching. The study by Okoro, Hausman, and Washington (2012), which supports this research, demonstrated that teaching with Web 2.0 technologies made the learning experience more engaging and enjoyable. The participants also identified internet connectivity issues and the prevalence of Web 2.0 applications in foreign languages as the most significant challenges they encountered in using instructional technologies (Table 12). These practical challenges highlight the importance of providing adequate infrastructure and support to facilitate technology integration. The lack of reliable internet access can be a significant barrier, particularly in schools with limited resources. Similarly, the language barrier can hinder the use of many valuable applications. It is entirely meaningful that some participants who think they are lacking in instructional technology use also mention the lack of foreign language capability. This underscores the importance of providing language support and resources to help teachers overcome this barrier. In a study conducted by Bircan (2022), it was observed that the low level of belief in using out-of-school learning environments (virtual museums, science centers, virtual laboratories, etc.) as internet-supported learning environments by teachers may have negative reflections on the teaching process. A variety of research has highlighted that the advancement and widespread adoption of new Web 2.0 technologies provide distinct advantages for education at every level (Anderson, 2007; Bennett et al., 2012; Bull et al., 2008; Ulrich et al., 2008; Voithofer, 2007). However, despite their extensive usage and positive impact, these technologies also present a number of challenges. Activity Theory (Vygotsky, 1978) provides a framework through which these challenges can be examined. Activity Theory suggests that learning is situated within a specific activity system comprised of the subject (teacher), the object (learning goal), the tools (instructional technologies), the rules (classroom norms), the community (students and colleagues), and the division of labor (roles and responsibilities). Internet connectivity issues and language barriers represent disruptions to the tools element, impacting the entire activity system and hindering effective technology integration.

Recommendations

Based on the results of the study, the following suggestions are provided for practitioners, program developers, and researchers:

Recommendations for practitioners:

• It was observed in this study that science prospective teachers had low self-efficacy beliefs in technologies before the application of online instructional technology training and activities related to the preparation of digital instructional materials. In this respect, more emphasis could be placed on training programs that will increase the competence of prospective teachers in using instructional technologies.

• In the study, activities aimed at enhancing the self-efficacy beliefs of first-year science prospective teachers in instructional technologies in science education were included. In future studies, activities/practices/research aiming to improve the competence of prospective teachers in using instructional technologies could be included for different classes and branches.

Recommendations for program developers:

• Considering the current era of information and technology, when designing educational programs to train teachers capable of using instructional technologies effectively and possessing self-efficacy in their use, greater emphasis could be placed on practices that target cognitive, affective, and behavioral outcomes.

Recommendations for researchers:

- The impact of various socio-demographic factors on prospective teachers' self-efficacy beliefs related to instructional technologies, along with the specific dimensions of these effects, can be further investigated.
- A comprehensive analysis of self-efficacy and belief levels concerning instructional technologies among higher education students, across different disciplines and academic levels, can be conducted and compared in the literature.

Ethical Approval

The research was conducted in line with ethical standards, and ethical approval for the study was obtained. Permission for the study was granted by the ethics committee of Gazi University, with the approval decision dated 09.03.2023 and numbered 04.

Genişletilmiş Özet

Giriş

Eğitim ve öğretim süreçlerinde öğretim teknolojilerinin kullanımının en fazla önem taşıdığı derslerin başında Fen Bilimleri dersi yer almaktadır. Bunun nedeni, fen bilimlerinin soyut konular ve kavramlar içermesidir. Bu da öğrencilerin istenilen öğrenme kazanımlarına ulaşmalarını zorlaştırmaktadır. Bu bakımdan alan yazındaki çeşitli öğrenim kademesinde fen bilimleri dersine yönelik yapılan birçok çalışmada fen bilimleri derslerinde öğretim teknolojilerinin kullanımının öğrencilerdeki akademik başarıyı arttırdığı, tutumlarının olumlu yönde değiştirdiği, öğretim teknolojilerine yönelik farkındalıklarının geliştirdiği görülmektedir (Akbaba & Ertaş Kılıç, 2022; Aslan & Güner, 2022; Gürleroğlu & Yıldırım, 2022; Kahyaoğlu & Elçiçek, 2016). Günümüzde fen bilimleri dersinde kullanılan öğretim teknolojilerinin başında web tabanlı teknolojiler gelmektedir. Teknoloji ve bilgi çağında yaşadığımız bu dönemde, hayatımızın ayrılmaz bir parçası hâline gelen teknolojileri derslerinde kullanabilen ve bu konuda özyeterliliğe sahip öğretmenlerin yetiştirilmesi amacıyla bu çalışmanın yapılması gereklilik arz etmiştir. Alanyazın incelendiğinde, öğretmen adaylarının öğretim teknolojilerine yönelik yeterliklerinin çeşitli değişkenler açısından araştırıldığı çalışmaların fazlaca olduğu ancak geliştirilmesi ve iyileştirilmesine yönelik çalışmaların oldukça sınırlı olduğu dikkat çekmektedir. Bu bağlamda, bu araştırmanın alanyazındaki boşluğu dolduracağı düşünülmektedir. Bu çalışmada, çevrim içi olarak gerçekleştirilen öğretim teknolojileri dersi kapsamında Web 2.0 araçlarıyla dijital öğretim materyali hazırlama etkinliklerinin, fen bilgisi öğretmen adaylarının öğretim teknolojileri özyeterlik inançları ve görüşleri üzerindeki etkisi incelenmiştir.

Yöntem

Bu çalışmada açıklayıcı karma yöntem araştırma modeli kullanılmıştır. Açıklayıcı karma yöntemlerde, önce nicel veriler toplanır ve bu verilerin daha iyi anlaşılabilmesi için sonrasında nitel veriler toplanır (Creswell ve Plano Clark, 2011). Bu çerçevede, çevrim içi olarak gerçekleştirilen öğretim teknolojileri dersi kapsamında, Web 2.0 araçlarıyla dijital öğretim materyali oluşturma etkinliklerinin fen bilgisi öğretmen adaylarının öğretim teknolojilerine dair özyeterlik inançları ve görüşleri üzerindeki etkisini incelemek amacıyla deneysel bir desen uygulanmıştır. Deneysel araştırma desenleri, değişkenler arasındaki neden-sonuç ilişkilerini belirlemek amacıyla kullanılan araştırma yöntemleridir (Büyüköztürk, 2011). Araştırmanın nicel verileri, "Fen Eğitiminde Öğretim Teknolojileri Özyeterlik Ölçeği" ile uygulanan ön ve son testler aracılığıyla elde edilmiştir. Nitel veriler ise, "Fen Eğitiminde Öğretim Teknolojilerine Yönelik Yarı Yapılandırılmış Görüşme Formu" kullanılarak toplanmıştır.

Sonuç

Fen Bilgisi öğretmen adaylarının öğretim teknolojilerine dair özyeterlik inançlarının alt boyutları arasında yer alan "fen bilimleri dersinde teknoloji kullanma özyeterlik inançları", "mesleki olarak teknoloji kullanma özyeterliği", "öğretmen gelişimine yönelik beklenti" ve "öğrenci gelişimine yönelik beklenti" üzerinde, çevrim içi öğretim teknolojileri eğitiminin ardından olumlu bir ilerleme gözlemlenmiştir. Haftada 2 ders saati olmak üzere, Fen Bilimleri dersi öğretim programı kazanımları dahilinde toplam 8 hafta boyunca öğretim teknolojileri temelinde web 2.0 destekli 8 etkinlik gerçekleştirildiği bu çalışmada, öğretmen adaylarının öğretim teknolojileri özyeterlik inançlarına yönelik dört alt boyutta da gelişim göstermeleri dikkat çekmiştir. Uygulama sonrasında, çalışma grubunda yer alan öğretmen adayları arasından gönüllü olarak katılmak isteyen 7 katılımcı ile çevrim içi olarak düzenlenen Web 2.0 araçlarıyla dijital öğretim materyali hazırlama uygulamalarına yönelik gerçekleştirilen yarı-yapılandırılmış görüşmeler sonucunda, öğretmen adaylarının öğretim teknolojileri kavramını daha çok öğrenme sürecinin amaçlarıyla ilişkilendirdikleri gözlemlenmiştir. Çalışmaya katılan öğretmen adaylarının öğretim teknolojilerini kullanma süreçlerinde karşılaştıkları sorunlar açısından en çok internet bağlantısı sorunu olması ve web 2.0 uygulamalarının yabancı dilde yazılmış olmasını belirtmişlerdir. Öğretim teknolojilerini kullanma özyeterliği bakımından eksik olduğunu düşünen bazı katılımcıların yine yabancı dil eksikliğini dile getirmiş olmaları oldukça manidardır.

Tartışma

Bu çalışmanın bulguları, öğrencilerin öğretim teknolojilerine yönelik özyeterlikleri, alanyazındaki çalışmalarla uyumludur. Adıgüzel (2010) tarafından yapılan bir çalışmada, sınıf öğretmenlerinin geleneksel öğretim araçlarını tercih ettikleri ve öğretim teknolojilerini kullanmada yetersiz kaldıkları tespit edilmiştir. Soylu ve Bozdoğan (2019) tarafından yapılan bir araştırmada 146 öğretmenin yaklaşık yarısının akıllı tahtanın internete bağlanma özelliğinden yararlanarak derslerini işledikleri görülmüştür. Cep telefonu ve mobil uygulamaları da öğretim teknolojileri içerisinde ifade eden katılımcıların cep telefonlarını bilgisayarlara benzetmeleri dikkat çekmektedir. Korkmaz (2015), tarafından yapılan mobil öğrenmede yeni eğilimlerin araştırıldığı alanyazın araştırmasında, mobil uygulamaların örgün eğitimde öne çıktığı görülmektedir. Bircan (2022) tarafından yapılan bir araştırmada, sınıf öğretmenlerinin fen bilimleri derslerinde öğretim teknolojilerine yönelik özyeterlik düzeylerinin farklı faktörler ışığında incelendiği ve internetin sağladığı kolay erişimle öğretmenlerin bilgilere hızla ulaştıkları, bunun yanı sıra sınıf ortamlarında teknoloji kullanarak öz güvenlerini artırdıkları ifade edilmiştir. Diğer taraftan, öğretmen adaylarının öğretim teknolojilerini en çok dersin başında ve etkili/kalıcı öğrenmeyi sağlamak amacıyla kullandıkları belirtilmiştir. Weller (2013), öğretmen adaylarıyla gerçek sınıf ortamında gerçekleştirdiği bir araştırmada, Web 2.0 araçlarının öğretim sürecine etkilerini incelemiş ve öğretmen adaylarının bu teknolojileri gerçek zamanlı sınıf ortamlarında nasıl kullanabileceklerini kavrayabildiklerini göstermiştir. Şeker ve Kartal (2017) tarafından yapılan bir çalışmada, teknoloji destekli öğrenme ortamlarının, farklı öğrenme tarzlarına sahip öğrencilere hitap ederek, öğretim sürecindeki başarı, motivasyon ve öğrenmeye yönelik tutumlarını pozitif yönde etkilediği sonucuna ulaşılmıştır. Bu bulguları destekleyen bir diğer çalışma, Okoro, Hausman ve Washington (2012) tarafından yapılmış olup, Web 2.0 teknolojileriyle gerçekleştirilen öğretim sürecinin öğrenmeyi eğlenceli hâle getirdiği görülmüştür.

Öneri

Araştırma sonuçlarına dayanarak, uygulayıcılara, program geliştiricilere ve araştırmacılara yönelik öneriler aşağıda sıralanmıştır:

Uygulayıcılara yönelik öneriler:

Fen bilgisi öğretmen adaylarının çevrim içi öğretim teknolojisi eğitimi ile dijital öğretim materyali hazırlama etkinliklerinin öğretim teknolojileri özyeterlik inançlarına ve görüşlerine etkisinin araştırıldığı bu çalışmada, uygulama öncesi öğretmen adaylarının teknolojileri özyeterlik inançlarının düşük olduğu görülmüştür. Bu açıdan öğretmen adaylarının öğretim teknolojileri kullanma yeterliliklerini arttıracakları eğitimlere daha çok yer verilmelidir.

Çalışmada, birinci sınıf öğretmen adaylarıyla fen eğitiminde öğretim teknolojilerine yönelik özyeterlik inançları düzeylerini artırmaya yönelik etkinlikler gerçekleştirilmiştir. Gelecekteki araştırmalarda, farklı sınıf seviyelerinde ve branşlarda öğretmen adaylarının öğretim teknolojilerini kullanma yeterliliklerini artırmaya yönelik eğitimler, uygulamalar veya çalışmalar yapılabilir.

Program geliştiricilere yönelik öneriler:

Teknoloji ve bilgi çağında bulunduğumuz düşünüldüğünde, öğretim teknolojilerini derslerinde kullanabilen ve kullanma özyeterliliğine sahip öğretmenler yetiştirmek için öğretim programları hazırlanırken daha çok bilişsel, duyuşsal ve davranışsal kazanımlar kazandırmaya yönelik uygulamalara yer verilebilir.

Araştırmacılara yönelik öneriler:

Araştırmada, çeşitli demografik özelliklere göre bağımsız değişkenlerin bağımlı değişken üzerindeki etkisi değerlendirilmemiş olup, bu durum çalışma kapsamında bir sınırlılık olarak kabul edilmiştir. Öğretmen adaylarının öğretim teknolojilerine yönelik özyeterlik inanç düzeyleri farklı sosyo-demografik değişkenler açısından incelenerek, bu değişkenlerin öğretim teknolojilerine yönelik özyeterlik inançları üzerindeki etkileri ve bu etkinin boyutları araştırılabilir.

Araştırmada Eğitim Fakültesi Fen Bilgisi Öğretmenliği birinci sınıf öğrencilerinin öğretim teknolojilerine yönelik özyeterlik inanç düzeylerini artırıcı etkinliklere yer verilmesi çalışmanın sınırlılıkları arasında yer almaktadır. Farklı branşlarda ve sınıf düzeylerindeki öğrencilerin öğretim teknolojilerine yönelik özyeterlik düzeylerinin gelişimini sağlamak ve gözlemlemek için deneysel çalışmalar yapılabilir.

Farklı disiplinlerde ve sınıf düzeylerinde yükseköğretimde öğrenim görmekte olan öğrencilerin öğretim teknolojilerine yönelik özyeterlikleri ve inanç düzeyleri incelenebilir ve bu düzeyler kendi aralarında karşılaştırılabilir.

Araştırmanın Etik Taahhüt Metni

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Kaynaklar

Adıgüzel, A. (2010). The status of instructional technology in the primary schools and classroom teachers' level of using these technologies. *Dicle University Ziya Gökalp Faculty of Education Journal, (15),* 1-17.

Akbaba, K., & Ertaş Kılıç, H. (2022). The effect of web 2.0 applications in science teaching on students' attitudes towards science and technology use. *Journal of Erzincan University Faculty of Education, 24*(1), 130-139. https://doi.org/10.17556/erziefd.880542

Albion, P. R. (2008). Web 2.0 in teacher education: Two imperatives for action. *Computers in the Schools, 25*(3/4), 181-198.

Anderson, P. (2007). What is Web 2.0? *Ideas, technologies and implications for education.* Technical report, JISC.Available at:
http://www.jisc.ac.uk/media/documents/techwatch/tsw0701b.pdf. Accessed April 14 2015.

Arıkan, R. (2000). Araştırma teknikleri ve rapor yazma [Research techniques and report writing]. Ankara: Gazi Kitapevi.

Aslan, S., & Güner, T. (2022). An investigation of science teachers' experiences with online learning (sync) environments. *International Journal of Turkish Literature Culture Education, 11*(1), 398-421.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review, 84*(2), 191-215.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory.* Prentice-Hall.

Bennett, S., Bishop, A., Dalgarno, B., Waycott, J., & Kennedy, G., (2012). Implementing Web 2.0 technologies in higher education: A collective case study. *Computers & Education, 59*(2), 524-534.

Bircan (2022). Investigation of primary school teachers' instructional technologies self-efficacy levels in science courses in terms of different variables. (Master's thesis) Kırşehir Ahi Evran University, Institute of Social Sciences, Kırşehir.

Bull, G., Thompson, A., Searson, M., Garofalo, J., Park, J., Young, C., & Lee, J. (2008). Connecting informal and formal learning: Experiences in the age of participatory media. *Contemporary Issues in Technology and Teacher Education, 8*(2), 100-107.

Büyüköztürk, Ş. (2011). *Deneysel desenler.* [Experimental patterns]. Ankara: Pegem Akademi.

Council of Higher Education. (2023). https://www.yok.gov.tr/Sayfalar/Haberler/2023/universitelerde-bahar-egitim-ve-ogretim-donemi-acilisi-ikinci-bir-duyuruya-kadar-gecici-olarak-ertelendi.aspx

Coutinho, C. P. (2009). Challenges for teacher education in the learning society: Case studies of promising practice. In H. H. Yang & S. H. Yuen (eds.) *Handbook of research on practices and outcomes in e-learning: Issues and trends.* (pp. 385-401). Hershey, New York: IGI Global.

Crompton, H. (2013). *A historical overview of mobile learning: Toward learner-centered education.* In Z. L. Berge & L. Y. Muilenburg (Eds.), Handbook of mobile learning (pp. 3-14). Routledge.

Creswell, J. W., & Plano Clark, V. L. (2011). *Designing and conducting mixed methods research.* Thousand Oaks, CA: Sage.

Çakır, R., Yükseltürk, E., & Top, E. (2015). Pre-service and ın-service teachers' perceptions about using web 2.0 in education. *Participatory Educational Research (PER),* 2(2), 70-83. https://doi.org/10.17275/per.15.10.2.2

Dörnyei, Z. (2007). *Research methods in applied linguistics: Quantitative, qualitative, and mixed methodologies.* Oxford: Oxford University Press.

Ertmer, P. A., & Ottenbreit-Leftwich, A. T. (2010). Teacher technology change: How knowledge, beliefs, and attitudes intersect. *Journal of Research on Technology in Education, 42*(3), 255-284.

Freire, P. (1970). *Pedagogy of the oppressed.* Continuum.

Ferdig, R. E. (2007). Editorial: Examining social software in teacher education. *Journal of Technology and Teacher Education, 15*(1), 5-10.

Gravetter, F. J., & Forzano, L. B. (2012). *Research methods for the behavioral sciences.* Belmont, CA: Wadsworth.

Guskey, T. R. (2002). Does it make a difference? Evaluating professional development. *Educational Leadership, 59*(6), 45-51.

Gürleroğlu, L., & Yıldırım, M. (2022). Investigation of secondary school students' views on web 2.0 supported educational web site. *The Journal of National Education, 51*(233), 191-217. https://doi.org/10.37669/milliegitim.776977

Jonassen, D. H., Howland, J., Moore, J., & Marra, R. M. (2003). *Learning to solve problems: An instructional design guide.* Pfeiffer.

Karasar, N. (2006). *Bilimsel araştırma yöntemi [Scientific research methodology].* Ankara: Nobel Yay.

Karataş, Z. (2017). Paradigm transformation in social sciences research: Rise of qualitative approach. *Turkish Journal of Social Work Research, 1*(1), 68-86.

Kartal, T., Kartal, B., & Uluay, G. (2016). Technological pedagogical content knowledge self-assessment scale (TPACK-SAS) for pre-service teachers: Development, validity and reliability. *International Journal of Eurasia Social Sciences, 7*(23), 1-36.

Korkmaz, Ö. (2015). New trends on mobile learning in the light of recent studies. *Participatory Educational Research (PER), 2*(1), 1-10. http://dx.doi.org/10.17275/per.14.16.2.1

Maslow, A. H. (1943). A theory of human motivation. *Psychological Review, 50*(4), 370–396. https://doi.org/10.1037/h0054346

Mishra, P., & Koehler, M. J. (2006). Technological Pedagogical Content Knowledge: A Framework for Teacher Knowledge. *Teachers College Record, 108*(6), 1017–1054. https://doi.org/10.1111/j.1467-9620.2006.00684.x

Okoro, E. A., Hausman, A., & Washington, M. C. (2012). Social media and networking technologies: An analysis of collaborative work and team communication. *Contemporary Issues in Education Research, 5*(4), 295–9.

Patton, M. Q. (1987). *How to use qualitative methods in evaluation.* Newbury Park, CA: Sag.

Partnership for 21st Century Skills. (2019). Framework for 21st centurylearning. http://www.battelleforkids.org/networks/ p21/frameworks-resources.

Prensky, M. (2001). Digital natives, digital immigrants*. On the Horizon, 9*(5), 1-6.

Punch, K. F. (2005). *Sosyal araştırmalara giriş. [Introduction to social research]. (*Translation) Bayrak D., Arslan H. B. & Z. Akyüz, Ankara: Siyasal Bookstore.

Qureshi, M. I., Khan, N., Raza, H., Imran, A. & Ismail, F. (2021). Digital technologies in education 4.0. Does it enhance the effectiveness of learning? A systematic literature review. *International Journal of Interactive Mobile Technologies, 15*(04), 31–47. https://doi.org/10.3991/ijim.v15i04.20291

Ribble, M. S., & Bailey, G. D. (2007). *Digital citizenship in schools.* International Society for Technology in Education.

Schrum, L., Thompson, A., & Sprague, D. (2005). *Foundations of educational technology: Integrating teaching strategies and exemplary resources (2nd ed.).* Pearson Education.

Schwartz, S., & Digiovanni, L. (2009). *About, for, and with students: Connecting teaching and teacher education through digital literacy.* In G. Siemens & C. Fulford (Eds.), Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications (pp. 2047-2050). Chesapeake, VA: AACE.

Siemens, G. (2005). Connectivism: A learning theory for the digital age. International Journal of Instructional Technology and Distance Learning, 2(1), 3-10.

Scott, A., & Ryan, J. (2009). *Digital literacy and using online discussions: Reflections from teaching large cohorts in teacher education.* In J. Zajda & D. Gibbs (eds.), Comparative information technology: Languages, societies and the internet. (pp. 103- 120). Dordrecht, Netherlands: Springer.

Soylu, Ü. İ., & Bozdoğan, A. E. (2019). Determination of smart board usage status of science teachers: Example of Tokat province. *International Journal of Turkish Education Sciences, 2019* (13), 15-29. https://doi.org/10.46778/goputeb.590327

Strauss, A., & Corbin, J. (1990). *Basics of qualitative research: grounded theory procedurs and tecniques.* Newbury Park, C. A.: Sage.

Şeker, R., & Kartal, T. (2017). The effect of computer-assisted instruction on students' achievement in science education. *Turkish Journal of Education, 6(*1), 17-29.

Taşdemir, A. (2021). Development of the self-efficacy scale for instructional technologies in science education*. 12th International Scientific Research Congress (Oral Full Paper Presentation),* Ankara. https://ubaksymposium.org/duzenle.php?alias=program_ozet adresinden alınmıştır.

Ullrich, C., Borau, K., Luo, H., Tan, X., Shen, L., &Shen, R. (2008). *Why Web 2.0 is good for learning and for research: Principles and prototypes.* In WWW 2008 (pp. 705-714). Beijing, China.

Voithofer, R. (2007). Web 2.0: What is it and how can it apply to teaching and teacher preparation? Paper presented at the American Educational Research Association Conference, Chicago, IL. Conference. Available at: http://citeseerx.ist.psu.edu/viewdoc/download;jsessionid=C7EC6A6242E3A3B4BA64 A6FFECFC8083?doi=10.1.1.94.5875&rep=rep1&type=pdf.Accessed April 14 2014

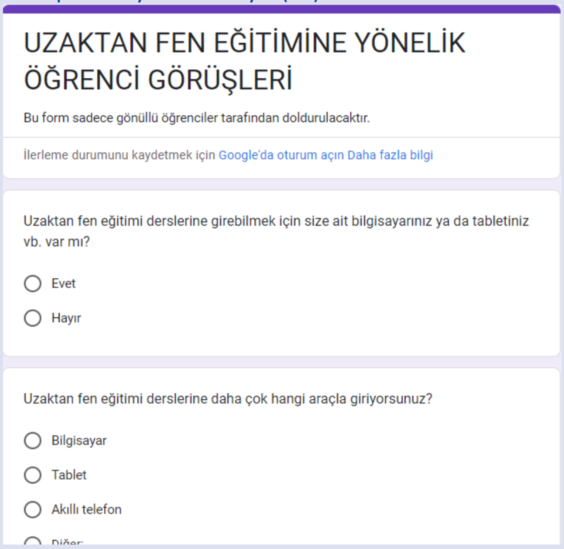
Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes.* Harvard University Press.

Weller, A. (2013). The use of Web 2.0 technology for pre-service teacher learning in science education. *Research in Teacher Education. 3*(2),40 46.

Appendix – 1

Figure 1. Examples of applications created by participants in the implementation process

Example Study for Activity 1 (P4)



UZAKTAN FEN EĞİTİMİNE YÖNELİK ÖĞRENCİ GÖRÜŞLERİ

Bu form sadece gönüllü öğrenciler tarafından doldurulacaktır.

İlerleme durumunu kaydetmek için Google'da oturum açın Daha fazla bilgi

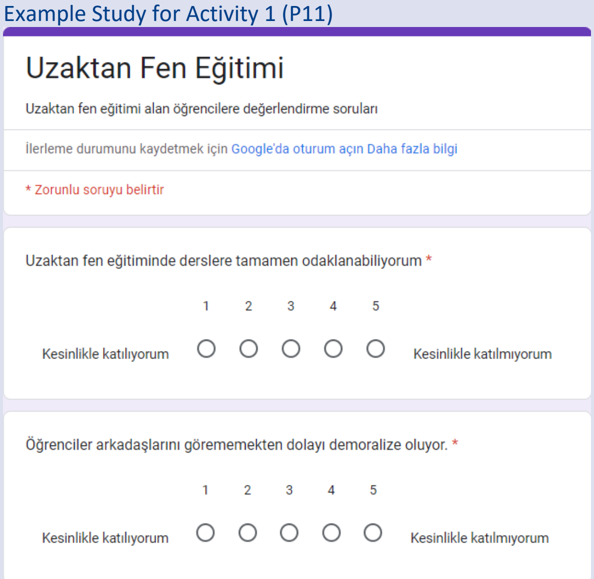
Uzaktan fen eğitimi derslerine girebilmek için size ait bilgisayarınız ya da tabletiniz vb. var mı?

- Evet
- Hayır

Uzaktan fen eğitimi derslerine daha çok hangi araçla giriyorsunuz?

- Bilgisayar
- Tablet
- Akıllı telefon

Example Study for Activity 1 (P11)



Uzaktan Fen Eğitimi

Uzaktan fen eğitimi alan öğrencilere değerlendirme soruları

İlerleme durumunu kaydetmek için Google'da oturum açın Daha fazla bilgi

* Zorunlu soruyu belirtir

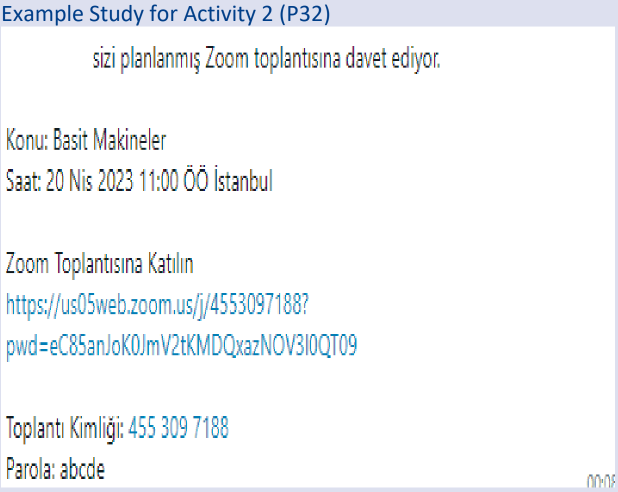
Uzaktan fen eğitiminde derslere tamamen odaklanabiliyorum *

Kesinlikle katılıyorum 1 2 3 4 5 Kesinlikle katılmıyorum

Öğrenciler arkadaşlarını görememekten dolayı demoralize oluyor. *

Kesinlikle katılıyorum 1 2 3 4 5 Kesinlikle katılmıyorum

Example Study for Activity 2 (P32)



sizi planlanmış Zoom toplantısına davet ediyor.

Konu: Basit Makineler
Saat: 20 Nis 2023 11:00 ÖÖ İstanbul

Zoom Toplantısına Katılın
https://us05web.zoom.us/j/4553097188?pwd=eC85anJoK0JmV2tKMDQxazNOV3I0QT09

Toplantı Kimliği: 455 309 7188
Parola: abcde

Example Study for Activity 2 (P40)

Join our Cloud HD Video Meeting
Zoom is the leader in modern enterprise video communications, with an easy, reliable cloud platform for video and audio conferencing, chat, and webinars across mobile, desktop, and...
us05web.zoom.us

sizi planlanmış Zoom toplantısına davet ediyor.

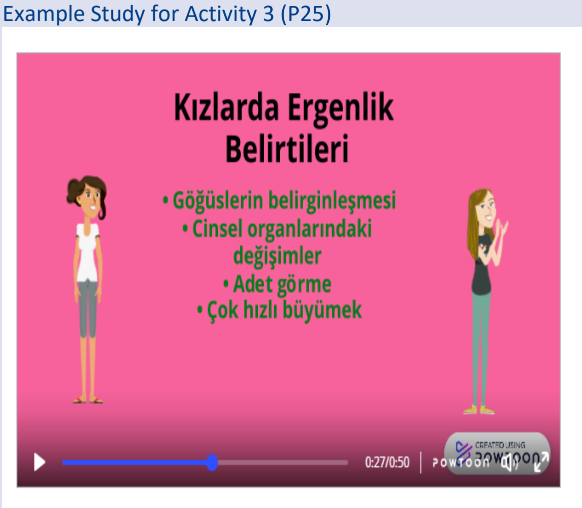
Konu: Basit Makineler
Saat: 17 Nis 2023 11:00 ÖS İstanbul

Zoom Toplantısına Katılın
https://us05web.zoom.us/j/84233201365?pwd=QVd0NFJUYTBRU0I5YnliOGhCYnUyZz09

Toplantı Kimliği: 842 3320 1365
Parola: 6ASINIFI

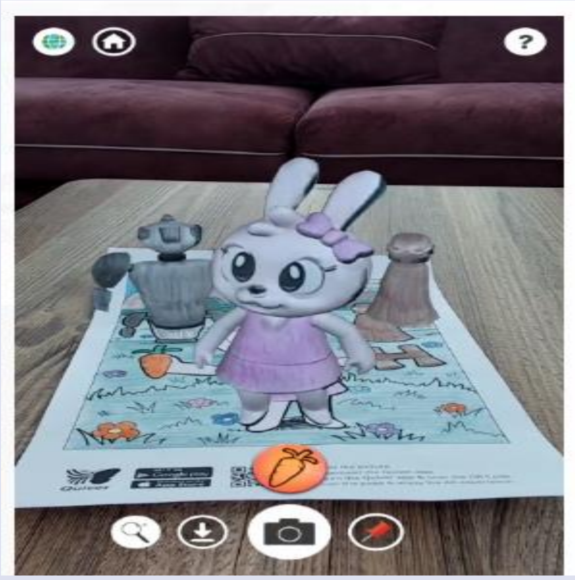
Example Study for Activity 3 (P20)

Example Study for Activity 3 (P25)

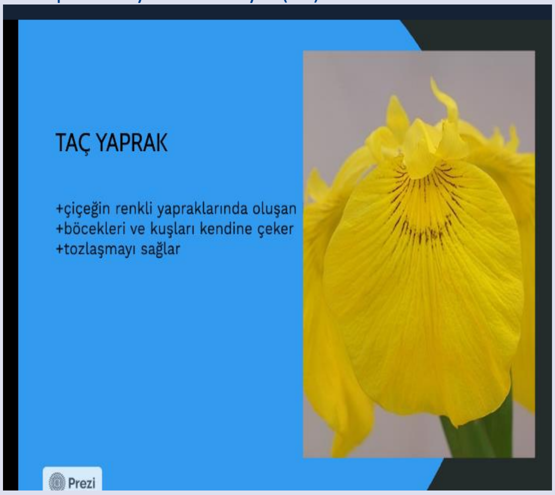


Example Study for Activity 4 (P13)

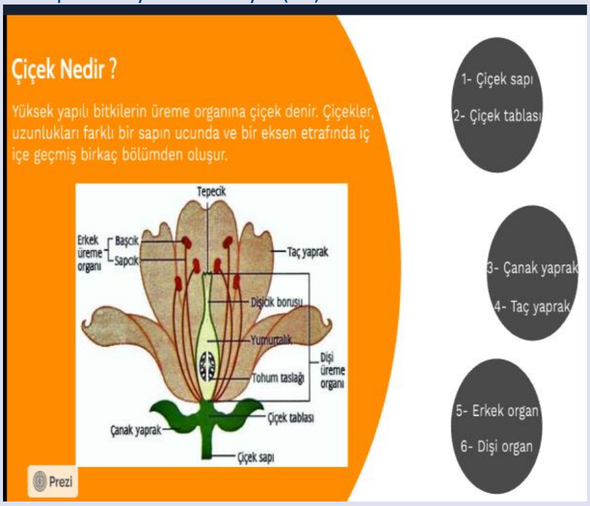
Example Study for Activity 4 (P28)



Example Study for Activity 5 (P1)

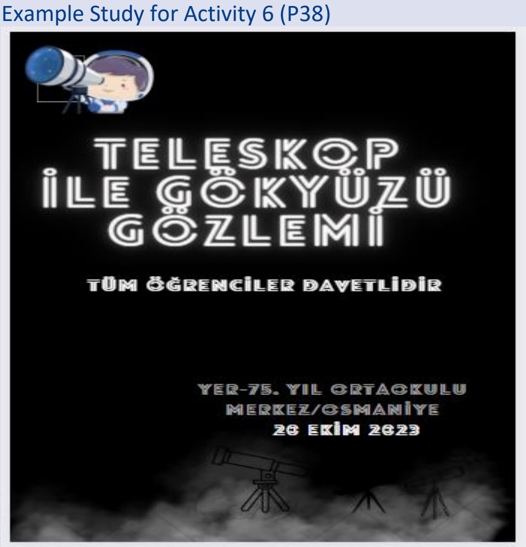


Example Study for Activity 5 (P9)

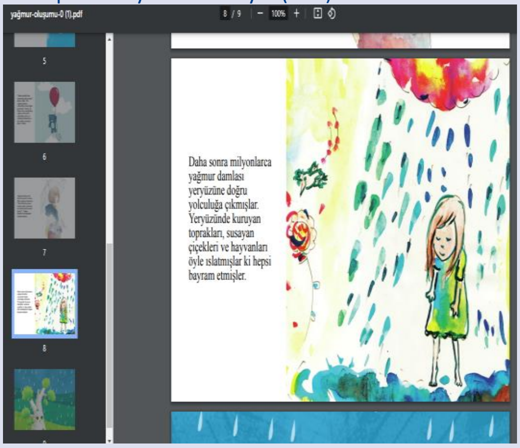


Example Study for Activity 6 (P27)

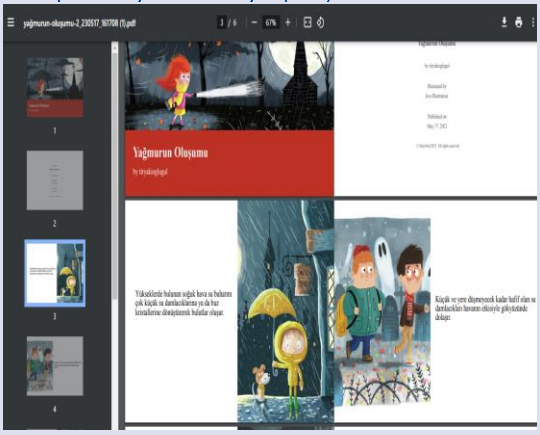
Example Study for Activity 6 (P38)



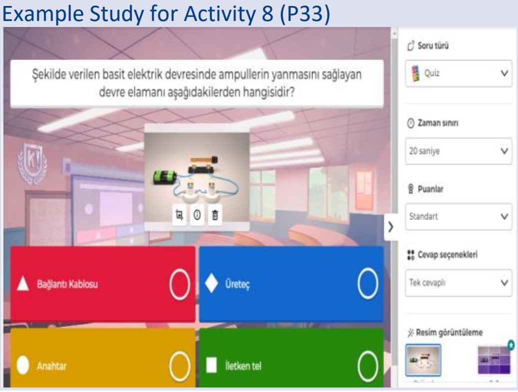
Example Study for Activity 7 (P19)



Example Study for Activity 7 (P34)



Example Study for Activity 8 (P33)



Example Study for Activity 8 (P36)