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The Effect of Online Entrepreneurial Project Training on the Individual Innovativeness of Pre-service Science Teachers

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Abstract
The purpose of this research was to examine the effect of online entrepreneurial project training on the individual innovativeness of pre-service science teachers. The pilot study and basic study of this research consisted of 11 stages. The pilot study was conducted with 24 third-grade pre-service science teachers, and the basic study was conducted with 33 fourth-grade pre-service science teachers. The research was conducted according to a one-group pre-test and post-test experimental design. The individual innovativeness scale was used in the pre-test and post-test of the pilot and basic study. As an intervention, the online entrepreneurial project training was performed for pre-service science teachers by the researcher-author. While online entrepreneurship project training positively affected the individual innovativeness of pre-service science teachers (large effect), this effect was not observed in the pilot study. In addition, after the implementation of the basic study, the transition of pre-service science teachers from their lower innovativeness categories to upper categories that adapt to innovation is higher (innovators and early adopters). According to these results, one of the ways to improve the individual innovativeness of pre-service science teachers is through entrepreneurial project training.

Keywords: Entrepreneurial project, Individual innovativeness, Online entrepreneurship education, Science teacher education

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Introduction

Entrepreneurship is an important research subject within the literature of science education, especially in recent years (Deveci & Çepni, 2017a). According to the European Commission (2015), the connections between science, creativity, entrepreneurship, and innovation should be strengthened in science education. In Türkiye, entrepreneurship is included in the education curricula from primary school to higher education as a competence that students must acquire. The most comprehensive explanations about entrepreneurship in the middle school curriculum (5th–8th grades) are included in the lower secondary science curricula (Ministry of Education, 2018). Therefore, entrepreneurship education is important in science teacher education curricula in which teachers are trained for lower secondary school science courses in Türkiye.

This study argues that online entrepreneurial project training can be an effective method of developing the innovativeness of pre-service science teachers. It presents the results of online entrepreneurial project training within the scope of the "Entrepreneurship in Science Education" course offered by the research author in the science teacher education program at the faculty of education of a university in Türkiye.

Entrepreneurial Projects

Since the term entrepreneurship is more pronounced in fields such as economics and business, it is necessary to clarify its meaning in the educational context (Dal et al., 2016). The economic perspective is more dominant in the term entrepreneurship used in the traditional context (Haara & Jenssen, 2016). In education, the term entrepreneurship refers to an individual competence that enables turning ideas into practice (European Commission, 2011). Entrepreneurship education has three focal points: business basics, entrepreneurship basics, and entrepreneurial mindset and competencies (Morris & Liguori, 2016). Through entrepreneurship education, educators aim to provide students with an entrepreneurial mindset rather than preparing them to be entrepreneurs. In this sense, educators aim to teach students how to apply their ideas to solving daily life problems through entrepreneurship education (European Commission, 2014). Developing individuals' creativity and innovation, which are the basic components of the entrepreneurial mindset, requires a systematic and comprehensive approach (Zupan et al., 2018). Though the COVID-19 pandemic scenario presents a challenge, it also presents a potential opportunity for entrepreneurship education (Liguori & Winkler, 2020). While some aspects of entrepreneurship education are well-suited to online education, other aspects require much more planning to implement effectively (Liguori & Winkler, 2020). Many entrepreneurship educators need additional curricula, extracurricular pedagogical development, and experiments to teach entrepreneurial mindsets and competencies in online environments (Liguori & Winkler, 2020). In this sense, one of the ways to develop an entrepreneurial mindset is through entrepreneurial projects (Bayram & Çelik, 2023; Deveci, 2019; Deveci & Kurt, 2023; Zupan et al., 2018).

Amid the outbreak of the COVID-19 pandemic, many educational institutions moved the teaching process to online or hybrid modes (Beneroso & Robinson, 2022). Thus, training based on a project-based learning approach was inevitably delivered online. The sudden shift to online learning has created challenges for project training in educational institutions. The profound effects of the COVID-19 pandemic have brought to the agenda the use of online project training and research on what effects it has on participants.

In this sense, the number of studies investigating the effect of online project training on participants is increasing. For example, Samsudin et al. (2014) showed that online project-based learning has a positive effect on students' attitudes towards renewable energy. Moreover, Cholifah et al. (2019) proved that online project-based learning has a positive impact on the innovativeness of pre-service elementary teachers. Recently, both Turkish (Deveci, 2019; Deveci & Çepni, 2014; Deveci & Çepni, 2017b; Deveci & Kurt, 2023) and international literature (Ademola et al., 2023; Hattab, 2010; López-Lemus, 2023; Siam & Rifai, 2012) have discussed the entrepreneurial project. The theoretical foundations of entrepreneurial projects are based on Kilpatrick's (1918) Type 3 projects, which aim to correct intellectual difficulties and solve some problems within the scope of the project method. In addition, the foundations of entrepreneurial projects date back to Dewey's (1910; p. 72) reflective thinking steps. In this sense, Kilpatrick's project method and Dewey's project-based learning approach form the theoretical foundations of entrepreneurial projects. Entrepreneurial projects are product- or service-oriented projects aimed at meeting people's needs in daily life or developing innovative solutions to problems (Deveci, 2019; Deveci & Kurt, 2023). The complex nature of entrepreneurial projects can allow students to develop a variety of skills (Ademola et al., 2023). The current research focuses on the impact of online entrepreneurial project training on the individual innovativeness of pre-service science teachers. Participants need to have some experience during the entrepreneurial project development process. These experiences include identifying the problem, finding an

innovative idea, being selective in finding an idea, developing innovative solutions, finding the difference between the innovative idea and previous ideas, determining the target audience, determining the contribution of the idea to the country's economy, developing a prototype, calculating the cost of the prototype, and sales targets for the idea, determination, developing advertising strategies, developing marketing strategies, finding slogans, and making effective presentations (Deveci, 2019; Deveci & Kurt, 2023; Eltanahy et al., 2020).

Individual Innovativeness

Innovative behaviors of teachers are crucial for the successful implementation of innovations in the education and training process (Thurlings et al., 2015). Teachers must constantly use and adapt to new learning theories, teaching curricula, methods, techniques, and tools in their professional lives. In this sense, there is a need for research on enhancing the individual innovativeness of pre-service teachers in pre-service education. Individual innovation centers around the idea of adopting and adapting to change through risk-taking and is a characteristic not shared by everyone (Bautista et al., 2018). Innovativeness is the degree to which an individual adopts new ideas relatively earlier than other members of a system (Rogers, 2003). The individual innovativeness considered in this research is based on Rogers' theory of the diffusion of innovation. Rogers (1983; 2003) presented the dominant characteristics of each adopter category in five categories. Innovators are individuals who are always actively seeking information about new ideas (Rogers, 2003). Innovators are very eager to try new ideas (Rogers, 1983). The innovator must be able to cope with the high degree of uncertainty involved in adopting an innovation (Rogers, 2003). Early adopters are a more integrated part of the local social system than innovators (Rogers, 1983; 2003). Potential adopters consult early adopters for advice and information about the new idea or innovation (Rogers, 1983). The early majority adopts new ideas in a social system just before the average member (Rogers, 1983). The early majority want to interact frequently with their peers but rarely hold leadership positions (Rogers, 1983; 2003). Late majority are cautious about innovations and wait to make sure if the innovation is in their interests (Rogers, 1983; 2003). The late majority adopts new ideas slightly later than the average among members of the social system (Rogers, 1983; 2003). They expect most others to adopt the innovation (Rogers, 1983; 2003). Laggards are the last to adopt an innovation in a social system. Laggards are, from their perspective, the most local of all adopter categories and have no thought leadership (Rogers, 2003).

There are a small number of studies in the literature that aim to enhance the individual innovativeness of science teachers. For instance, Carungay (2003) examined the innovation attitudes of innovative Japanese secondary science teachers, taking into account factors such as age, gender, attitudes, and self-perception. Ortile and Garcia (2023) explored the innovations implemented (teaching strategies, learning assessment, school management, and projects) and administrative support provided by senior high school science teachers in the Philippines. Carungay and Tsuruoka (2002) investigated the innovativeness and innovation processes of exceptional secondary school science teachers in the Philippines. However, there are a limited number of studies on the innovativeness of pre-service science teachers. Geçikli (2022) examined the levels of individual innovativeness among pre-service science teachers in terms of various variables, including gender, grade level, and daily internet usage time. Yenice and Yavaşoğlu (2018) examined the levels of individual innovativeness among pre-service science teachers and the correlation between their individual innovativeness levels and their individual creativity. There are a few studies regarding online experimental research aimed at enhancing the individual innovativeness of pre-service science teachers in the national and international literature. In this sense, some researchers emphasize that the innovativeness of pre-service science teachers should be developed in science teacher education. Carungay (2003) recommends that the innovativeness of secondary science teachers should be developed through pre-service and in-service training programs. Similarly, Carungay and Tsuruoka (2002) emphasize that teacher education programs must develop innovativeness in order to produce future science innovators. Çelik (2013) recommends that pre-service teachers be encouraged to utilize innovative techniques more effectively and frequently. Moreover, Geçikli (2022) recommends directing pre-service science teachers towards activities and projects that will enable them to gain experience in innovation. Additionally, according to Geçikli (2022), there is a need for research on improving the innovativeness of pre-service science teachers. Bautista et al. (2018) recommend improving the individual innovativeness of pre-service teachers through seminars, workshops, personalized consultancy programs, and similar training. In the current research, online entrepreneurial project training was considered as a way to enhance the individual innovativeness of pre-service science teachers. The purpose of this research is to examine the effect of online entrepreneurial project training on the individual innovativeness of pre-service science teachers.

Method

A one-group pretest–posttest experimental design was used to investigate the impact of online entrepreneurial project training on the individual innovativeness of pre-service science teachers. One-group pretest-posttest experimental design is research in which one group is measured or observed before and after being exposed to an

intervention (Fraenkel et al., 2012; Johnson & Christensen, 2019). The reason for choosing the one-group pretest-posttest experimental design is that there was no control group available for comparison at the university where the research was conducted. The one-group pretest-posttest design has several weaknesses, but it can be utilized in educational institutions when a control group is not feasible (Mertens, 2019).

Contexts and the Participants

The bachelor's degree program in education faculties in Türkiye lasts for four years. Pre-service science teachers receive education in basic sciences (physics, chemistry, biology, environment) and pedagogical fields (science teaching, teaching principles and methods, etc.). Pre-service science teachers are also offered elective field education courses, such as "entrepreneurship in science education." The current research was conducted by the author as part of the entrepreneurship in science education course. The pilot study involved 24 third-grade pre-service science teachers (20 girls and 4 boys, aged 21-23), while the basic study included 33 fourth-grade senior pre-service science teachers (23 girls and 10 boys, aged 21-24). In experimental designs, it is generally considered sufficient to have at least 30 participants per group in educational research (Lodico et al., 2006). In the current study, the number of participants was adequate for the basic study but insufficient for the pilot study. Participants were selected using a convenient sampling method for both the pilot and basic study. In certain situations, researchers may not be able to randomly choose or systematically select participants or groups. In such cases, researchers may resort to convenience sampling (Fraenkel et al., 2012, p. 269). Convenient sampling is based on selecting participants who are suitable for the study (Fraenkel et al., 2012, p. 269).

Implementation Process

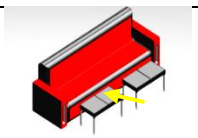
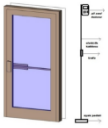
Both pilot and basic studies were conducted at different times. The pilot study was conducted during the spring semester of 2019-2020, and the basic study was conducted during the spring semester of 2020-2021. The author conducted both the pilot study and the basic study. Throughout the intervention, participants utilized the distance learning management system of Kahramanmaras Sutcu Imam University to upload various documents (such as Word, PowerPoint, and other file formats) that were relevant to the project tasks. With the official announcement made on March 16, 2020, distance education due to the COVID-19 epidemic started in universities across Türkiye. Thus, due to the COVID-19 pandemic, the pilot research process was conducted for 2 weeks using face-to-face education, and the remaining 9 weeks were conducted using distance education. The author conducted the basic study synchronously using the ZOOM platform. The intervention process for the pilot and basic study is detailed in the following paragraphs.

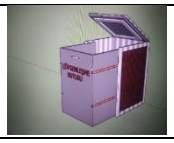
Pilot Study: Participants worked in groups of 3 to 5. The implementation process consists of a total of nine groups. The pilot study was conducted for 11 weeks. ***1st stage***: The participants researched problems that could create value. ***2nd stage***: The participants identified the problem that would create value. They developed solutions to address the problem. ***3rd stage***: The participants decided on a solution and then explained the difference between the problem and the solutions from the previous attempts. ***4th stage***: Participants explored potential economic contributions that their ideas could make to the country. ***5th stage***: Participants explained who their project ideas were aimed at, that is, the target group that would benefit from them. ***6th stage***: Participants decided on the tools and equipment they needed to bring their project ideas to life (for digital prototypes). ***7th stage***: Participants created a plan for the idea/design of the product (prototyping). ***8th stage***: Participants calculated the cost of their project ideas. If the idea was service-oriented, the cost of implementing the service-oriented idea was calculated. If the idea was for profit, the estimated cost and sales price were determined. ***9th stage***: Participants determined the number of target audiences that will benefit if their ideas are oriented towards service. If their idea is commercial, they set estimated daily, monthly, and annual sales targets. ***10th stage***: Participants advertised their project ideas and developed marketing strategies. ***11th stage***: Participants pitched their project ideas convincingly. Participants presented their projects as electronic posters. They used electronic posters as a presentation tool (e-poster-ppt). The pilot study gave the researcher experience on how to conduct entrepreneurial projects online during a sudden transition to distance education. Thus, the researcher conducted the basic study in a more rigorous manner.

Basic Study: The basic implementation process was carried out through distance education (synchronous) using Zoom. The basic study was conducted in 11 stages, and participants worked in groups of 3 to 5, consisting of a total of 13 groups. During the implementation process of the research, all of the participants' project tasks were carried out digitally. The research was conducted using a Word document, images were created using PowerPoint, a prototype was developed using www.tinkercad.com, marketing was done through wix.com, and the project presentation was prepared as an e-poster. ***1st stage***: The researcher presented sample problem situations to the

participants and explained that they were required to identify multiple solutions to each problem. In addition, the researcher presented national and international sample entrepreneurial project ideas to the participants. Additionally, the researcher informed the participants that their project ideas (product or service) could be either commercial or focused on social responsibility. Participants were allowed to think freely during the problem identification phase and were not guided. The participants researched problems that could create value. In preparation for the upcoming stage, the researcher asked the participants to identify at least three problematic situations for the purpose of developing entrepreneurial projects. ***2nd stage***: The participants identified the problem that would create value. The researcher randomly selected one of the group members and asked him or her to explain the problem situations they identified. During this process, participants expressed their opinions on whether the problem situations presented were innovative or not and whether they created value. This process took place in the form of a discussion and question-and-answer session. They developed solutions to address the problem. The researcher asked the participants to develop multiple solution proposals for the problem situations they clarified for the upcoming stage. ***3rd stage***: The working groups presented solutions to solve the problems they identified. The researcher and the participants asked questions about the innovativeness and feasibility of the solutions offered by each group. The participants reached a decision. The researcher asked the participants to explain the differences between their project ideas (solutions) and previous similar products in terms of originality and analysis of similar ideas for the following week. ***4th stage***: One of the group members explained the difference between their project ideas and previous similar projects using visuals. Participants also presented their research on the originality of their project ideas. The researcher asked the participants to explain the contribution of their projects to the country's economy and their target audience. ***5th stage***: Participants explored what kind of economic contributions their ideas could make to the country. In addition, other participants in each group expressed their thoughts on the potential impact of the project ideas. For the next stage, the researcher asked the participants to explain the target audience for their project ideas. ***6th stage***: Participants explained who their project ideas were aimed at, that is, who would benefit from them (target audience). The groups especially drew attention to the value-creation aspect of their project ideas. For the next phase, the researcher asked the participants to identify tools to develop (prototype) their project ideas. ***7th stage***: Participants decided on the tools and equipment they needed to bring their project ideas to life (digital prototype). For the next stage, the researcher asked the participants to create prototypes of their project ideas using Tinkercad (www.tinkercad.com) or similar platforms in the digital environment, with their own efforts. ***8th stage***: The researcher explained to the participants what a prototype is and its importance. Participants created a plan for the idea/design of the product (prototyping). At this stage, some project groups prototyped their designs using Tinkercad and Solidworks, while others used simpler environments such as Paint or Word. Participants benefited from the free versions of these platforms. It was stated that participants were free to use the paid versions if they wished. Table 1 shows some of the digital prototypes.

Table 1. Digital designs of several prototypes

Project Name	Goal of the Project	Slogan of the Project	Digital Prototype
Mask Recycling Machine (Group 1)	Designing a machine to prevent pollution caused by discarded masks.	Bring the old one. Take the new one!!!	
The most practical car tent (Group 4)	Designing an affordable and practical tent to protect cars from the harmful effects of the sun in sunny weather.	Cars need protection too!!!	
Hidden Coffee Tables (Group 7)	Designing a coffee table integrated into both sides of sofa beds.	Hide coffee tables!!!	
Foot Pedal Doorbell (Group 10)	Designing a mechanism to ring bells using your feet, without the need for hands, during the pandemic period.	Doorbells are becoming history!!!	

Width-adjustable garbage pail (Group 12)	Designing a trash can with adjustable volume to prevent it from filling up quickly.	As you throw away garbage, I expand!	

9th stage: Participants reported the estimated cost of their project ideas. If the idea was service-oriented, the cost of implementing the service-oriented idea was calculated. If the idea is for profit, the estimated cost and sales price are determined. Additionally, at this stage, the researcher asked them to come up with an eye-catching slogan (see Table 1) for their project idea. ***10th stage***: The researcher provided participants with information about advertising and marketing strategies. Groups designed websites (using platforms like wix.com) to promote their project ideas. The groups designed their website using Wix.com, which is free to use. ***11th stage***: The researcher explained to participants how to create an effective presentation for the draft e-poster. Participants pitched their project idea convincingly. Group spokespersons or a volunteer from among the group members presented the project ideas on an e-poster. Each group was given approximately five minutes to pitch their project ideas.

Data Collection Tool

The Individual Innovativeness Scale was administered to pre-service science teachers before and after the intervention in both the pilot and basic studies. The original version of the individual innovativeness scale used in the research was developed in English by Hurt et al. (1977). This scale was adapted into Turkish by Kılıçer and Odabaşı in 2010. The Individual Innovativeness Scale determines the levels of innovativeness in individuals and the categories of innovativeness they belong to (Kılıçer & Odabaşı, 2010). Kılıçer and Odabaşı (2010) conducted validity and reliability studies during the process of adapting the scale. They collected data from pre-service teachers in the 1st, 2nd, 3rd, and 4th grades at the faculty of education. The items of the individual innovativeness scale are scored as a 5-point Likert type as a result of the adaptation study. The scale consists of 20 items, with 12 of them being positive (1, 2, 3, 5, 8, 9, 11, 12, 14, 16, 18, and 19) and 8 being negative (4, 6, 7, 10, 13, 15, 17, and 20). By calculating the total score, researchers can evaluate the participants' overall tendencies towards innovativeness (Kılıçer & Odabaşı, 2010). Additionally, the formula for the innovativeness category is (total score from positive items - total score from negative items) + 42, which is used to calculate the participants' individual innovativeness category (Kılıçer & Odabaşı, 2010). With this calculation, individuals' innovativeness categories can be interpreted as **Innovator** with over 80 points, **Early Adopter** between 69 and 80 points, **Early Majority** between 57 and 68 points, **Late Majority** between 46 and 56 points, and **Laggard/Traditionalist** with scores below 46 points (Kılıçer & Odabaşı, 2010). Kılıçer and Odabaşı (2010) found the Cronbach's Alpha reliability coefficient of the scale to be 0.82. In the current study, the Cronbach's Alpha reliability coefficient of the individual innovativeness scale was calculated as 0.78 for the pilot study pre-test, 0.91 for the pilot study post-test, 0.90 for the basic study pre-test, and 0.90 for the basic study post-test. A Cronbach's Alpha reliability coefficient of over 0.70 (Lavrakas, 2008) is considered sufficient. Finally, many researchers have used this scale as a data collection tool in their studies, proving its reliability (Atak & Çaka, 2023; Manbaki & Küçüksüleymanoğlu, 2024; Suer & Kınay, 2019).

Data Analysis

The researcher undertook data analysis using the SPSS software package, which provides a descriptive, interpretative, and reliability analysis of the processes used in this research. Before proceeding with the analysis of the research data, the normality assumptions of the data sets were examined. Firstly, the kurtosis and skewness values were examined to assess the assumption of normality in the pilot study pre-test (skewness=1.004, kurtosis=0.725), pilot study post-test (skewness=-0.217, kurtosis=-0.996), basic study pre-test (skewness=0.418, kurtosis=-0.566), and basic study post-test (skewness=0.226, kurtosis=-0.216). Kurtosis and skewness values for data sets should fall within the range of -2.0 to +2.0, as these limits are considered acceptable for a normal distribution (George & Mallery, 2016; pp. 114-115). In addition, since the study group was less than 50 ($n<50$), the Shapiro-Wilk test results for the data sets were not statistically significant (p-value, pilot study pre-test, pilot study post-test, basic study pre-test, and basic study post-test were 0.882, 0.258, 0.432, and 0.195, respectively). These results indicate that the data was normally distributed (Greasley, 2008). Since the data sets were normally distributed, the paired sample t-test was used to compare the pre-test and post-test scores for both the pilot and the basic study. The significance level of 0.05 was considered statistically significant. The effect size was calculated to determine the effect size of the statistical significance. The effect size for the t-statistic was calculated by converting the t value into the r value. Thus, the formula $r=\sqrt{(t2 / (t2+ df)}$ was used to calculate the effect size

(Connolly, 2007). According to Cohen (1988), the effect size levels of the correlation coefficient are as follows: r = 0.10 indicates a small effect, r = 0.30 indicates a medium effect, and r = 0.50 indicates a large effect.

Research Ethics

At the beginning and end of the intervention process, participants wrote their code names on the measurement tool. In this way, no information that could reveal the identity of the participants was reported. In addition, the researcher avoided any attitudes, behaviors, or statements that could potentially influence the participants during the intervention process (Lodico et al., 2006). Additionally, since there was no control group in the study, no group was deprived of education at the end of the intervention process. While administering the data collection tools, the researcher informed the participants that they were not obligated to complete the scales if they chose not to participate in the research. In this way, participants were able to voluntarily contribute to the research. For example, this is evidenced by the fact that the number of participants enrolled in the course in which the research was conducted (pilot = 30, basic = 48) is different from the number of participants who voluntarily filled out the data collection tools (pilot = 24, basic = 33).

Ethics approval

Ethical approval for this study was obtained from the Kahramanmaras Sutcu Imam University Ethics Committee (Approval Number: E-92405296-100-65552, 08.10.2021, and Meeting Number 7154).

Results

In the study results, first and foremost, the analysis of the dependent sample t-test is presented to examine the impact of the intervention. Then, the results regarding the participants' pre-intervention and post-intervention innovativeness categories are presented in both the pilot study and the basic study. Table 2 displays the results of the dependent sample t-test for the mean scores of the pretest and posttest.

Table 2. Dependent sample t-test results regarding the pre-test and post-test means

Tests		N	Mean	Std. Deviation	Degree of Freedom	t value	p	Effect Size
Pilot study	Pre-test	24	66.00	6.92	23	-0.66	0.51	r=0.13
	Post-test	24	67.00	6.07				
Basic study	Pre-test	33	64.33	7.89	32	-3.31	0.00*	r=0.50
	Post-test	33	67.00	7.25				

*P<0.05

For the pilot study, Table 2 shows that there is no statistically significant difference between the mean scores of pre-service science teachers before and after the online entrepreneurial project training ($p > 0.05$, $t = -0.66$, $df = 23$). For the basic study, the mean score for innovativeness among pre-service science teachers significantly increased after completing the online entrepreneurial project training. The mean score at the end of the training is higher than the mean score at the beginning ($p < 0.05$, $t = -3.305$, $df = 32$). The effect size of this difference in mean scores is a large effect ($r = 0.50$). Table 3 displays the categories of participants' individual innovativeness before and after the pilot study.

Table 3. Categories of individual innovativeness before and after the pilot study

Pilot study participants[1]	Pre-test	Post-test	Pilot study participants	Pre-test	Post-test
[1]P1	Early Majority *	Innovator	P13	Innovator **	Early Adopter
P2	Early Adopter *	Innovator	P14	Early Majority ***	Early Majority
P3	Early Adopter **	Early Majority	P15	Early Majority *	Innovator
P4	Early Majority *	Early Adopter	P16	Early Adopter **	Late Majority
P5	Early Majority *	Early Adopter	P17	Early Majority ***	Early Majority
P6	Early Adopter *	Innovator	P18	Early Adopter ***	Early Adopter
P7	Early Majority ***	Early Majority	P19	Early Majority ***	Early Majority
P8	Early Majority **	Late Majority	P20	Early Adopter *	Innovator
P9	Early Majority *	Early Adopter	P21	Early Majority ***	Early Majority
P10	Early Majority *	Early Adopter	P22	Early Majority **	Late Majority
P11	Early Adopter ***	Early Adopter	P23	Innovator**	Early Adopter
P12	Early Majority **	Late Majority	P24	Early Adopter ***	Early Adopter

*Upgrade =9; **Downgrade =7; ***Same=8

Table 3 shows that before the pilot application, 2 pre-service teachers were in the innovators category, 8 pre-service teachers were in the early adopter's category, and 14 pre-service teachers were in the early majority category. After the pilot application, 5 pre-service teachers were in the innovators category, 9 pre-service teachers in the early adopter's category, 6 pre-service teachers in the early majority category, and 4 pre-service teachers in the late majority category. Additionally, Table 3 shows that after the pilot study, the innovativeness of 9 pre-service teachers upgraded to the next higher adaptation category, the innovativeness of 8 pre-service teachers remained the same, and the innovativeness of 7 pre-service teachers was downgraded. Table 4 shows the categories of participants' individual innovativeness before and after the basic study.

Table 4. Categories of individual innovativeness before and after the basic study

Basic study participants[1]	Pre-test	Post-test	Pilot study participants	Pre-test	Post-test
[1]B1	Early Majority*	Early Adopter	B18	Early Majority*	Early Adopter
B2	Early Adopter***	Early Adopter	B19	Innovator***	Innovator
B3	Early Adopter*	Innovator	B20	Early Adopter**	Early Majority
B4	Early Majority**	Late Majority	B21	Innovator***	Innovator
B5	Early Majority*	Early Adopter	B22	Early Adopter***	Early Adopter
B6	Early Majority*	Early Adopter	B23	Early Adopter*	Innovator
B7	Early Majority**	Late Majority	B24	Late Majority *	Early Majority
B8	Early Majority**	Late Majority	B25	Early Adopter*	Innovator
B9	Early Majority*	Early Adopter	B26	Early Adopter*	Innovator
B10	Early Adopter***	Early Adopter	B27	Early Majority***	Early Majority
B11	Early Majority*	Early Adopter	B28	Early Majority*	Early Adopter
B12	Early Majority*	Early Adopter	B29	Early Adopter*	Innovator
B13	Early Majority***	Early Majority	B30	Innovator***	Innovator
B14	Innovator**	Early Majority ı	B31	Early Majority*	Early Adopter
B15	Early Majority***	Early Majority	B32	Late Majority*	Early Majority
B16	Innovator***	Innovator	B33	Early Adopter***	Early Adopter
B17	Early Majority*	Early Adopter			

*Upgrade =17; **Downgrade =5; ***Same=11

Table 4 shows that before the basic study, 5 pre-service teachers were in the innovators category, 9 pre-service teachers in the early adopter's category, 17 pre-service teachers in the early majority category, and 2 pre-service teachers in the late majority category. After conducting the basic study, it was found that 9 pre-service teachers fell into the innovators category, 14 pre-service teachers fell into the early adopter's category, 7 pre-service teachers fell into the early majority category, and 3 pre-service teachers fell into the late majority category. Additionally, Table 4 shows that after the basic study, the innovativeness of 17 pre-service teachers upgraded to the next higher adaptation category, the innovativeness of 11 pre-service teachers remained the same, and the innovativeness of 5 pre-service teachers was downgraded.

Discussion and Conclusion

This research examined the effect of online entrepreneurial project training on the innovativeness of pre-service science teachers. Results of the pilot research showed that online entrepreneurial project training did not lead to a statistically significant difference in the individual innovativeness of pre-service science teachers. On the other hand, results of the basic study were striking. The basic study results showed that online entrepreneurial project training had a statistically significant positive impact on the individual innovativeness of pre-service science teachers. The effect size value shows that online entrepreneurial project training has a large impact on the individual innovativeness of pre-service science teachers. This means that online entrepreneurial project training positively contributes to the development of individual innovativeness among pre-service science teachers.

One possible reason for the lack of a statistically significant difference in the pilot study could be attributed to the abrupt transition to online education during the Covid period. The researcher's search for suitable digital environments and tools for online entrepreneurial project training during the sudden transition to online education established an infrastructure for the main study. During the pilot study process, the researcher provided online

training for entrepreneurial projects for the first time. This process increased the researcher's knowledge and experience in delivering this training.

The pre-service science teachers' individual innovativeness profiles changed before and after the pilot study as well as before and after the basic study, which is noteworthy. When the participants were evaluated individually, nine pre-service teachers in the pilot study transitioned from their current group to a more innovative group; seven pre-service teachers transitioned to less innovative than their current groups; and eight pre-service teachers retained their current profiles. In the basic study, 17 pre-service teachers transitioned from their current group to a more innovative group; five pre-service teachers transitioned to less innovative than their current groups; and 11 pre-service teachers retained their current profiles. The fact that the number of participants who transitioned from their current group to a more innovative group in the basic study was higher indicates that the implementation process of the basic study had a greater impact on the individual innovativeness of the participants compared to the pilot study. The individual innovativeness profiles of most pre-service teachers fall into the early majority category before both the pilot and basic applications. It is noteworthy that in the literature on quantitative causal comparative or descriptive studies, in which participants are not exposed to a specific intervention, pre-service teachers generally fall into the early majority group. For instance, Bautista et al. (2018) found that primary pre-service teachers generally fall into the early majority group among their innovativeness groups. Similarly, Yüksel (2015) discovered that most pre-service teachers from various undergraduate programs fell into the early majority category of individual innovativeness profiles. Geçikli (2022) determined that the majority of pre-service science teachers exhibit a medium level of individual innovation. The individual innovativeness of pre-service teachers was categorized within the early majority group prior to their exposure to specialized training related to innovation. This categorization can be attributed to their educational background, which supported their placement in this group. After the experimental application, there was an increase in the number of pre-service teachers falling into the innovator and early adopter categories in both pilot and basic studies.

In the literature, there is a limited number of studies on interventions aimed at improving the individual innovativeness of pre-service teachers. Supporting the current research results, Bautista et al. (2021) concluded that the KINANG Project improved the innovativeness of pre-service secondary school teachers in the fields of biological science, English, Filipino, and mathematics. The KINANG Project consists of four stages. The first phase of the project is a seminar-workshop on innovative and effective teaching in the 21st century. The second phase of the project is an orientation program that focused on classroom innovations and empowering teachers. The third phase of the project is the Fixation Ceremony (morale-boosting), which is held to further strengthen their commitment to being innovative teachers. The fourth phase of the project involves creating a visit program that includes focus group discussions. Bautista et al. (2021) conducted an intervention aimed at enhancing the individual innovativeness of pre-service teachers in their study. However, it is important to note that this intervention process differs significantly from the online entrepreneurial project training implemented in the current research. The intervention process of the current study consists of eleven stages. In this sense, the significant and large effect of online entrepreneurial project training on the individual innovativeness of pre-service science teachers in the basic study of the current research can also be attributed to the difference in educational content. In the current research, the processes that enable pre-service science teachers to identify problems, develop solution proposals, create slogans, design digital prototypes, articulate the originality of their ideas, and produce original web designs may have had a positive impact on their ability to adapt to innovation. This effect size is a convincingly large effect. In another study, Cholifah et al. (2019) concluded that online project-based learning has a positive effect on the innovativeness of pre-service elementary teachers. Cholifah et al. (2019) point out that the critical factors influencing the impact of online project-based learning on pre-service elementary teachers' innovativeness are the utilization of projects and information and communications technology (ICT). In another experimental study, Baki (2024) found that the close reading strategy significantly enhanced the individual innovativeness of pre-service Turkish language teachers. Studies on interventions related to innovation in the literature show that individual innovativeness of pre-service teachers can be improved. In this sense, the web tools (Tinkercad, digital poster, website design/Wix.com) used within the scope of information and communication technologies in the current research may have contributed to the individual innovation of pre-service science teachers.

Innovation always requires creativity, but not every creative endeavor leads to an innovative outcome (Nasierowski & Arcelus, 2012). This means that processes aimed at enhancing creativity can indirectly contribute to innovative thinking. Within the scope of the current research, many stages in online entrepreneurial project training require pre-service science teachers to utilize their creativity. The current research focuses on the processes that enable prospective teachers to identify problems, develop solution suggestions, explain the originality of their project ideas, design digital prototypes, devise advertising strategies, come up with slogans for their project ideas, and deliver effective presentations. These processes require them to utilize their creativity.

Recommendations

As a result of the research, online entrepreneurial project training had a positive impact on the individual innovativeness of fourth-grade pre-service science teachers. In the basic study, the categories of individual innovativeness among pre-service science teachers were examined before and after the online entrepreneurial project training, further supporting this conclusion. These conclusions can be generalized with certain limitations. The absence of a control group in the current study limits attributing the results to the intervention. In future studies, it would be beneficial to conduct a similar study that includes a control group in order to compare the results. Additionally, this research was conducted within the constraints of online education. In future research, the impact of face-to-face entrepreneurial project training on the innovativeness of science teacher candidates can be examined. The original individual innovation scale used in this research was developed by Hurt, Joseph, and Cook in 1977. The adaptation scale used in the current research was introduced to the literature by Kılıçer and Odabaşı in 2010. The results of the research conducted using a recently developed innovation scale can be compared with the results of the current research. Based on the results of the current research, educators can benefit from entrepreneurial project training to enhance the individual innovativeness of pre-service science teachers. Educators can examine the effect of face-to-face entrepreneurial project training, a novel type of project, on the innovativeness of pre-service science teachers.

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Author (s) Contribution Rate

The author confirms sole responsibility for the conception and design of the study, data collection, analysis and interpretation of results, and manuscript preparation.

Ethical Approval

Ethical approval for this study was obtained from the Kahramanmaras Sutcu Imam University Ethics Committee (Approval Number: E-92405296-100-65552, 08.10.2021, and Meeting Number 7154).

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