ORIGINAL ARTICLE

Investigating the Effectiveness of Life Skills Training Guide on Pre-service Science Teachers' Development of Professional Knowledge Regarding Entrepreneurship Skills¶

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***Abstract**: The present study aims to examine the effect of the life skills training guide on the development of pre-service science teachers' professional knowledge of entrepreneurial skills. The study included 82 pre-service science teachers studying in the third year of a public university in Turkey during the 2019-2020 academic year. The data of the study, which was conducted with a one-group pre-test-post-test experimental design, were collected using the entrepreneurship skills professional knowledge test. The data were analyzed using the professional knowledge assessment rubric and entrepreneurship skill indicators. The results of the study revealed that there was a significant difference between the pre-and post-test scores of the pre-service teachers in favor of the post-test scores. Following the experimental process, their professional knowledge about entrepreneurship increased. However, the number of pre-service teachers who were able to improve their professional knowledge scores to a high level was limited. Furthermore, following the experimental process, there was an increase in the number of pre-service teachers who were able to develop appropriate activities for students to gain entrepreneurial skills and to prepare tools for measuring and evaluating students' entrepreneurial skills in a way to include stressed indicators. Consequently, the present study provides science teacher educators with educational activities that they can model within the scope of teaching professional knowledge of entrepreneurship skills to pre-service science teachers.*

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Introduction

INCREASING the number of entrepreneurial individuals through training contributes to accelerating socioeconomic renewal and reducing poverty (Hoppe et al., 2017; Jones & Iredale, 2014). In globalizing economies, entrepreneurship is the key skill that motivates individuals to innovate and compete (Aldianto et al., 2018). Entrepreneurship is a life skill and has an essential place in the acquisition of other life skills (Birdthistle et al., 2023). For instance, entrepreneurial skill is a key element in the acquisition of skills such as teamwork (Amorim Neto et al., 2020), communication (Škare kare et al., 2022), analytical thinking (DeCoito & Briona, 2023), creative thinking (Durnali et al., 2023; Fillis & Rentschler, 2010) and decision making (Sanda & Sallama, 2023). Entrepreneurship is a skill that not only facilitates the teaching of life skills but also science process skills and engineering-design skills (Apaivatin et al., 2021; Bhakti et al., 2020; Deveci & Seikkula-Leino, 2023; Ribeiro et al., 2023; Saboorizadeh et al., 2023). It is very crucial for science education that such skills are integrated under the umbrella of entrepreneurship skills (Kirman-Bilgin, 2021). Therefore, entrepreneurship education has become a topic of worldwide interest in recent years. Entrepreneurship education aims to provide students with the necessary knowledge and skills to become entrepreneurs and to encourage them towards entrepreneurship (Badri & Hachicha, 2019). It is acknowledged that entrepreneurship education should be included in programs in all fields and levels of education (European Commission, 2012, 2013). Integrating entrepreneurship education with science courses is regarded as very crucial for the acquisition of this skill (Bolaji, 2012; Olokundun et al., 2014; Shahin et al., 2021). Effective teaching of such a skill in science courses is only achieved by teachers who have developed their professional knowledge in the field. Our teachers require model practices that demonstrate how to integrate traditional activities into their teaching process within the framework of innovations such as entrepreneurship skills (Van de Oudeweetering & Voogt, 2018).

Entrepreneurship education is a new learning domain for science teacher education (Achor & Wilfred-Bonse, 2013; Bacanak, 2013; Deveci & Seikkula-Leino, 2016). However, Seikkula-Leino et al. (2021) and Nwambam et al. (2018) revealed that the lack of activity in programs impedes effective entrepreneurship education. This indicates that teachers and preservice teachers require more guidance to promote the adoption and implementation of entrepreneurship education in science education. Stenholm et al. (2021) concluded that teachers who are unfamiliar with entrepreneurship are unable to create opportunities for their students, inspire them to be driven and motivate them to take action. Deveci and Çepni (2017) emphasized that science teachers can acquire professional knowledge of entrepreneurship through in-service training. Teachers must be taught effective and appropri-

ate teaching methods during their pre-service years in order to raise students as entrepreneurial individuals (Seikkula-Leino et al., 2012). Lackeus (2015) underlines that learning activities that will ensure the development of entrepreneurial skills can be achieved through entrepreneurship-based assignments in which students themselves assume full responsibility. Avcı et al. (2022) discuss that differentiated educational activities can improve students' entrepreneurial skills. In order for science teachers to be able to utilize such ideas, they require professional knowledge of entrepreneurship. Köken and Çelik (2021) found that science teachers have awareness of teaching entrepreneurship skills, but they need training for practical teaching. The fact that entrepreneurship is a skill that can be acquired at an early age (Marques & Albuquerque, 2012) indicates the necessity of training teachers with professional knowledge and competence in entrepreneurship skills. On the other hand, there is also a need for model activities that include professional knowledge on how to teach entrepreneurship skills in science courses (İnaltekin et al., 2019; Kirman-Bilgin, 2019; Bal-İncebacak, 2022). The present study aims to contribute specifically to the science education literature in order to improve pre-service science teachers' professional knowledge of entrepreneurial skills in line with the same purpose. Accordingly, the following research question (*RQ*) was addressed:

> *RQ: What is the effect of the Life Skills Training Guide (LSTG) on the improvement of pre-service science teachers' professional knowledge of entrepreneurship skills?*

Literature Review

Entrepreneurship Skill in Science Education

Entrepreneurship is a dynamic and lengthy process that entails undertaking the activities of acquiring resources and seizing opportunities (Wei et al., 2019). Entrepreneurship skill has an essential role in developing skills such as problem-solving and taking responsibility (Partnership for 21st Century Skills, 2008; Gautam & Singh, 2015; Joensuu-Salo et al., 2020; Elo & Kurten, 2020; Fejes et al., 2019; Hoppe, 2016). Individuals with this skill have characteristics such as risk-taking, effective marketing, time management, a positive attitude towards change, and the ability to formulate the right strategy to reach the goal (Olokundun et al., 2014; Shane & Venkataraman, 2001; Lambing & Kuehl, 2000; Wickham, 2006; Fisher, Graham & Compeau, 2008). One of the most suitable fields to comprehend the characteristics of such a skill is science (McKinney, 2013). Acquiring entrepreneurial skills prepares individuals for the future and science education activities to serve for this purpose (Mbanefo & Eboka, 2017; Onwuachu & Okoye, 2012). The

current education system in schools of Türkiye is based on an exam-oriented approach (Çetin & Ünsal, 2019; Mustafa & Buldur, 2021). However, this prevents individuals from being equipped with life skills such as entrepreneurship, which are needed in today's societies (Hoppe et al., 2017). The science education process aims to provide students with innovative skills such as non-traditional entrepreneurship (Pounder, 2016). The prominence of STEM (Science, Technology, Engineering, Mathematics) education in meeting the innovative skills deficit in the future has enabled STEM to be regarded as a tool for comprehending entrepreneurship skills (Eltanahy et al., 2020; Ezeudu et al., 2013; Kelley et al., 2020; Sarı et al., 2022; Winkler et al., 2015). Another prominent subject is the development of students' entrepreneurial skills in agriculture and husbandry in science courses and enabling them to make career plans for being an entrepreneur (Purwanto & Supriadi, 2019). Such activities are carried out to economically empower disadvantaged populations, especially in rural areas (Oluremi & Gbenga, 2011). When the literature on entrepreneurship education in science education is examined, it is observed that there are studies on professional entrepreneurship knowledge of teachers and candidates in very few European countries, especially in Finland (Deveci & Seikkula-Leino, 2016; Seikkula-Leino et al., 2012; Seikkula-Leino et al., 2010; Seikkula-Leino et al., 2021; Seikkula-Leino et al., 2015). These studies stress the need for professional development that enables teachers to associate entrepreneurship with science subjects. In Africa, especially in Nigeria, professional development practices on agriculture-based entrepreneurship education for pre-service science teachers have been implemented (Abdulmumini et al., 2020; Achor & Wilfred-Bonse, 2013; Blimpo & Pugatch, 2019; Eltanahy et al., 2020; Fejes et al., 2019; Pan & Akay, 2015). Some studies revealed that both conceptual knowledge (Aslan, 2021; Deveci, 2016; Deveci & Çepni, 2017; Inaltekin & Kirman-Bilgin, 2019; Samanci et al., 2020) and professional knowledge (İnaltekin et al., 2019) of pre-service science teachers in Türkiye of entrepreneurship are weak. Bayram and Çelik (2022) stated that the weak conceptual knowledge of entrepreneurship of pre-service science teachers can be enhanced through Technopark visits, while Kirman-Bilgin and İnaltekin (2022) found that it can be enhanced through both theoretical and practical training. Inaltekin and Kirman-Bilgin (2022) also stress that science teachers and pre-service science teachers require professional knowledge that can measure entrepreneurship skills. Based on the results and recommendations of these studies, we designed LSTG to conduct the present study and explored the extent to which it affects pre-service science teachers' professional knowledge of entrepreneurship skills.

Method

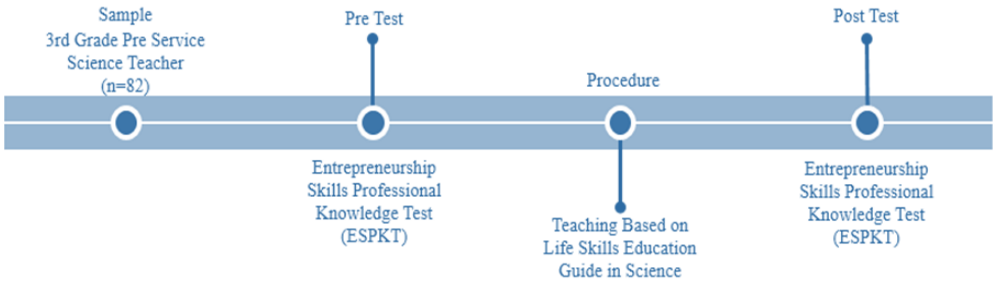

Figure 1. Single Group Pre and Post Test Experimental Design of the Study.

Research Design

The present study was a one-group pre-test-post-test experimental design. In this context, the effect of LSTG was tested on a single group. The experimental process for the study is illustrated in **Figure 1**.

Participants

The present study was conducted with 82 (65 female and 17 male) pre-service teachers studying in the third year (Class A and Class B) of the science education program of a public university in 2019-2020. The courses taken by the third-grade pre-service science teachers participating in the study before the study were Introduction to Educational Science, Atatürk's Principles and History of Turkish Revolution 1-2, Foreign Language 1-2, Turkish Language 1-2, Computer 1-2, General Physics 1-2-3, General Physics Laboratory 1-2-3, General Chemistry 1-2-3-4, General Chemistry Laboratory 1-2, General Biology 1-2, General Biology Laboratory 1-2, General Mathematics 1-2, Educational Psychology, Teaching Principles and Methods, Measurement and Evaluation, Introduction to Modern Physics, Science Technology Program and Planning, Chemical Analysis Methods. The courses they take during the study are Instructional Technologies and Material Design, Special Topics in Physics, Special Topics in Chemistry, Human Anatomy and Physiology, Statistics, Science Teaching Laboratory Practices 1, History of Turkish Education, and Scientific Research Methods. One of the researchers attended the Instructional Technology and Material Design course as an uninvolved observer. Based on these observations, it was concluded that the Instructional Technology and Material Design course did not cover the relevant content in parallel with the content of the experimental process. Pre-service teachers use the professional knowledge they have acquired up to their senior year in their internship during their senior year.

Therefore, it can be stated that the most suitable period for the study is the third grade. Moreover, pre-service science teachers take the Public Personnel Selection Examination in the fourth grade in order to be able to serve in the public sector after graduation. Considering that the pace and stress of studying for the exam would lead to a cognitive burden on the pre-service teachers, it was determined that the study was not suitable for the last grade level.

Research Context

Entrepreneurship education has become quite popular in Türkiye owing to both societal interest and political initiatives. Additionally, apart from training in institutional bodies such as the Small and Medium Enterprises Development Organization, various levels of education have been included in the system since 2018 (Ministry of National Education [MoNE], 2018). In 2018, domain-specific skills were added to the science curriculum as life skills (creative thinking, analytical thinking, entrepreneurship, communication, decision-making, and teamwork). These skills were introduced in the science curriculum from Grade 5 onwards, all subjects included activities to enable students to actively develop entrepreneurship skills under the title "Science, engineering and entrepreneurship practices". This revised curriculum emphasizes the necessity for students to acquire the awareness of contributing to the economy through the use of their scientific knowledge. It is further stressed that students create innovations by using scientific knowledge to meet the challenges of life and that this aims to add value to societies, develop material culture and serve economic life (MoNE, 2018). Therefore, the acquisition of life skills based on entrepreneurship skills became one of the fundamental purposes of the science curriculum. Based on this purpose, preservice science teachers must be equipped with the professional knowledge that will enable them to teach these skills to their students when they start working.

Research Procedures

In the present study, the first step was to finalize the procedures for the development of the LSTG. In this regard, interviews were initially conducted with 21 science educators from 11 universities, three from each of the seven regions, voluntarily. The types of activities and suggestions of the academicians participating in the study were identified to gain entrepreneurship skills professionally in the courses they conduct (Kirman-Bilgin et al., 2023). The draft activities were discussed with the participation of 21 science educators from the universities mentioned in the "Life Skills Education in Science Education Workshop" held in 2018, and the content of LSTG (Kirman-Bilgin, 2019) was finalized and made ready for the pilot scheme within the

framework of the suggestions given. The pilot schemes were conducted with 69 students studying in the third-year science teaching program of a different public university in the spring semester of the 2018-2019 academic year. Following the pilot schemes, the LSTG was finalized. The main study was carried out in a total of 14 weeks within the scope of the "Science Teaching and Laboratory Practices-I" course, which has 4 weekly hours. In the main study, all the activities specified in the content of the practice were fulfilled and there was no timing problem. The stages of pre-service science teachers' teaching process based on LSTG are shown in **Table 1**.

The first week of the experimental process started with a discussion of the types of life skills and their place and importance in the secondary school science curriculum. Furthermore, LSTG was introduced and the tasks within the practice process were assigned. From the second week onwards, professional knowledge on the six life skills was introduced. Each week, pre-service teachers followed the guide to understand the type of life skill of that week, plan activities to help their students acquire this skill when they start their profession and work on measuring and evaluating the skill. The practiced LSTG aimed to enable pre-service teachers to approach entrepreneurship, which is related to other life skills, from a holistic perspective.

Data Collection

"Entrepreneurship Skills Professional Knowledge Test (ESPKT)" was implemented to determine the professional knowledge of pre-service science teachers on entrepreneurship. The test is designed by considering professional knowledge indicators for entrepreneurship skills. These indicators are as follows (Kirman-Bilgin, 2019, p.14):

- I1. Defines entrepreneurship skills.
- I2. Explain the characteristics of individuals with entrepreneurship skills.
- I3. Comprehends the indicators of entrepreneurship skills.
- I4. Designs materials on how to teach entrepreneurship skills to students in science courses.
- I5. Designs a measurement tool for how to measure entrepreneurship skills in science courses.
- I6. Designs an assessment tool for how to evaluate entrepreneurship skills after they are measured.

Based on the above-mentioned indicators, the ESPKT consists of 6 open-ended questions. There is one question for each indicator.

The questions in the test were developed by a science educator and subjected to validity studies by a science educator and a science teacher. Reliability studies were conducted with senior pre-service science teachers

Table 1. LSTG Teaching Process.

Week	Subject	Course Content
1	Life Skills	Introducing the skill learning area, discussing its place and importance in the science curriculum, explaining the problem-solving process, giving tasks to the pre-service teachers
2	Communication and Teamwork Skills	Defining communication and teamwork skills and discussion of their indicators
3		Discussion of model activities for teaching communication and teamwork skills to students
4		Discussion of the relevance of the activities designed by the pre-service teachers (Task 1) within the scope of the indicators
5		Discussion of model assessment and evaluation tools to measure these skills of students
6	Decision-Making and Entrepreneurship Skills	Defining decision-making and entrepreneurial skills and discussion of their indicators
7		Discussion of model activities for students to acquire decision-making and entrepreneurship skills
8		Discussion of the relevance of the activities designed by the pre-service teachers (Task 2) within the scope of the indicators
9		Discussion of model assessment and evaluation tools to measure these skills of students
10	Analytical Thinking and Creative Thinking Skills	Defining analytical thinking and creative thinking skills and discussion of their indicators
11		Discussion of model activities for teaching analytical thinking and creative thinking skills to students
12		Discussion of the relevance of the activities designed by the pre-service teachers (Task 3 and 4) within the scope of the indicators
13 14		Discussion of model assessment and evaluation tools to measure these skills of students
Tasks	Task 1: Design an original worksheet based on entrepreneurship skills to help your students develop communication and teamwork skills. Task 2: Design an original worksheet based on entrepreneurship skills to help your students develop decision-making and entrepreneurship skills. Task 3: Design an original worksheet based on entrepreneurship skills to help your students develop analytical thinking skills. Task 4: Design an original worksheet based on entrepreneurship skills to help your students develop creative thinking skills. Tasks 1 and 2 were carried out individually by pre-service teachers and Tasks 3 and 4 were carried out by teams.	

Table 2. Validity and Reliability Study of ESPKT Questions.

Prior to the Validity Study	Post Validity Study	Post Reliability Study
1. What is entrepreneurship?	1. What is entrepreneurial skill?	1. What is entrepreneurial skill?
2. What are the features of entrepreneurship?	2. What are the characteristics of individuals with entrepreneurial skills?	2. What are the characteristics of individuals with entrepreneurial skills? 3. What are the indicators of entrepreneurship skills?
3. Design an activity that can provide this skill.	3. What kind of activity would you use to teach entrepreneurship skills? Design your activity.	4. What kind of activity would you use in science classes to teach entrepreneurship skills? Design your activity.
4. How do you measure and assess this skill?	4. What kind of a tool would you use to measure entrepreneurship skills? Design your tool.	5. What kind of measurement tool would you use to measure your students' entrepreneurial skills? Design your tool.
	5. What kind of a tool would you use to assess entrepreneurial skills? Design your tool.	6. What kind of assessment tool would you use to assess your students' entrepreneurial skills after measuring them? Design your tool.

(n=21). The information on how the questions in the ESPKT evolved during the validity and reliability studies is given in **Table 2**:

ESPKT was finalized and ready for the main study after the necessary adjustments.

Data Analysis

The data obtained from the ESPKT were subjected to content analysis. The secondary school science course entrepreneurship skill indicators (Kirman-Bilgin, 2019, p.16) used to measure how much the objective was achieved within the scope of questions 3, 4, and 5 of the ESPKT are as follows.

1. Business idea development
2. Emphasizing that the business idea is different from other business ideas
3. Setting short-term goals
4. Setting the market share target
5. Identifying potential customers
6. Perform competitor analysis
7. Determining the channels of reaching the customer
8. Drawing a workflow chart
9. Determining the duties and responsibilities of the personnel
10. Calculating the expenses of your business
11. Calculating the income of your business
12. Calculating the profit of your business
13. Marketing your product
14. Considering these indicators, a rubric was prepared to analyze the data obtained from the ESPKT. The rubrics for the assessment of professional knowledge of entrepreneurship skills in science prepared within the scope of this research are as in **Table 3** and **Table 4**.

The lowest possible score on the ESPKT is 0 and the highest possible score is 61. The pre-and post-test answers of the student coded P_{29} (preservice teacher number 29) to question 1 of the GBMBT are shown below:

A sociable, outspoken person who can easily adapt to environments (P_{29}'s pre-test response)

The ability to generate business ideas. The ability to further develop in a way that is beneficial to society, useful, economical, and does not damage the natural balance (P_{29}'s post-test response)

P_{29} received a score of "0" because his pre-test answers to the first question of the test did not cover the key concepts of seizing opportunities

Table 3. Criteria and Scoring Systematics for the Analysis of Data Obtained from the ESPKT.

Question	Analysis
1	Opportunity and economy codes need to be specified in the definition. One point is awarded for each code. The maximum possible score for the question is 2.
2	Feature 1: Assertive-Attack / Feature 2: Persuasive-Confident / Feature 3: Has Teamwork Skills / Feature 4: Has Problem-Solving Skills / Feature 5: Has Decision-Making Skills / Feature 6: Has Communication Skills / Feature 7: Risk Takes- Courageous / Feature 8: Curious-Observes / Feature 9: Has Creative Thinking Skills / Feature 10: Has a plan One point is awarded for each answer indicating each feature. The maximum possible score for the question is 10.
3	One point is awarded for each indicator of entrepreneurship skill. The maximum possible score for the question is 13.
4	It is considered that the designed activities consist of drawing attention or introducing, implementing, and assessing the activity. Considering these features, 1 point is given for attracting attention or introducing the activity, 2 points for implementing the activity, and 1 point for assessing the activity. One point is given for associating the activity with daily life. One point is awarded for each indicator covered by the designed activity (13 points in total). Writing only the name of the activity is awarded 0 points. The maximum possible score for the question is 18.
5	One point is given for each indicator of entrepreneurial skill addressed in the measurement tool. One point is awarded for meaningful categories created. One point is awarded for meaningful scoring of categories. One point is awarded for indicating the highest and lowest score. The maximum possible score for the question is 16.
6	A classification based on the lowest and highest possible score (e.g., a classification such as "demonstrated entrepreneurial skills at the desired level" - "demonstrated entrepreneurial skills at the desired intermediate level" - "did not demonstrate entrepreneurial skills at the desired level") is awarded 1 point. The answer emphasizing the point range of the classification is awarded 1 point. The maximum possible score for the question is 2.

Candidates are awarded 0 points for a meaningless answer, an irrelevant answer, or no answer for each question.

Table 4. Rubric of Development Level of Candidates' Professional Knowledge of Entrepreneurship Skills.

Score Interval	Assessment	Code
0-11	Professional knowledge of the skill is quite inadequate.	A
12-23	Professional knowledge of this skill is at a weak level.	B
24-35	Professional knowledge of this skill is at a moderate level.	C
36-48	Professional knowledge of this skill is at a good level.	D
49-61	Professional knowledge of this skill is at a very good level	E

and the economy. The post-test response was awarded "2" points as it emphasized both key concepts.

The rubric in which the total score of the development level of preservice teachers' professional knowledge of entrepreneurship skills is assessed is shown in **Table 4**.

Table 5. Wilcoxon Signed-Rank Test Results of the Data Obtained from ESPKT.

Posttest - Pretest	n	Mean Rank	Rank Sum	z	p
Negative rank	0	00.00	00.00	7.86	.000
Positive rank	82	41.50	3403.00		
Equal	0				
* Based on Negative Rank					

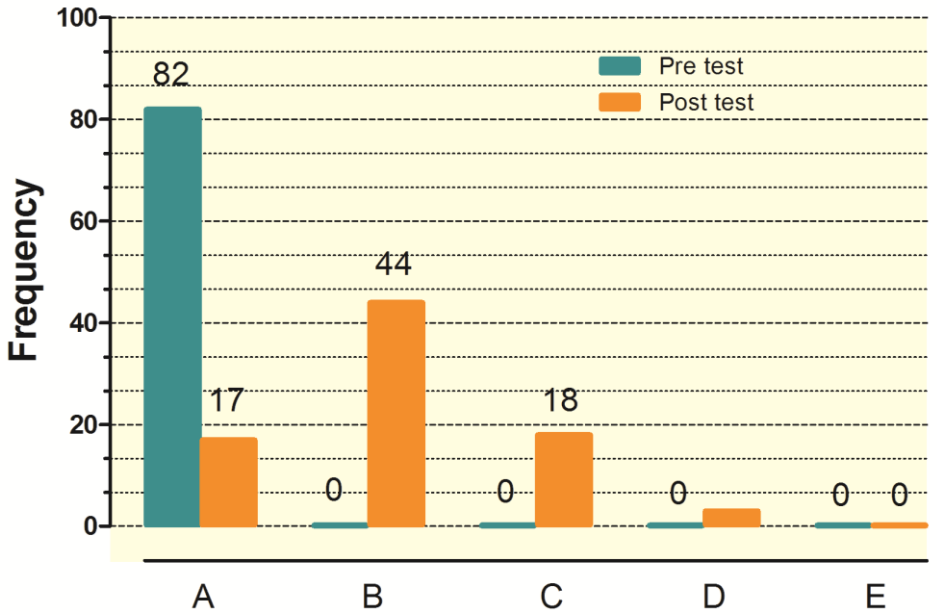

Figure 2. The Level of Professional Knowledge of Pre-service Science Teachers for Entrepreneurship Skills. *A: Professional knowledge of the skill is quite insufficient. B: Professional knowledge of the skill is at a weak level. C: Professional knowledge of the skill is at a moderate level. D: Professional knowledge of the skill is at a good level. E: Professional knowledge of the skill is at a very good level.*

In this regard, the data obtained from the ESPKT as pre-test and post-test were initially scored. The data obtained were analyzed using the Wilcoxon signed-rank test for related measures. Subsequently, the pre-and post-study progress of the pre-service teachers who participated in the study in the context of each question of the ESPKT was displayed in the form of graphs.

The graphs were accompanied by direct quotations from the pre-service science teachers' opinions (See Appendix A). In the data analysis using content analysis, pre-service teachers were coded as P_1, P_2.

Results

In order to find an answer to the research question "What is the effect of the life skills training guide in science on the development of third-year pre-service science teachers' professional knowledge of entrepreneurship skills?", the Wilcoxcon signed-rank test analysis findings of the pre-test and post-test scores of the pre-service science teachers are presented in **Table 5**.

The results of the analysis demonstrate that there is a significant difference between the pre-and post-experiment ESPKT scores of the candidates participating in the study ($z = 7.86$, $p < 0.05$). When the rank averages and sums of the difference scores are taken into consideration, it is revealed that the difference is in favor of the post-test score. The findings of the analysis of the effect of LSTG-based education on the development of pre-service science teachers' professional knowledge of entrepreneurship skills are presented in **Figure 2**.

When **Figure 2** is examined, it is evident that all of the pre-service science teachers' professional knowledge of entrepreneurship skills was quite inadequate before the implementation of the LSTG. After the application of the LSTG, it was observed that more than half of the pre-service teachers ($f = 44$) improved their professional knowledge level to a weak level. It was concluded that some of the pre-service teachers ($f = 18$) improved their professional knowledge to a moderate level and very few ($f = 3$) to a good level. However, at the end of this experimental process, it was realized that none of the pre-service science teachers were able to improve their professional knowledge of entrepreneurship skills to a very good level. The findings from each question of the test are presented in more depth as follows. The analysis findings obtained from the first question of the ESPKT are presented in **Figure 3**.

It was detected that 56 pre-service teachers used the key concept of seizing opportunities before the study and 81 pre-service teachers used it after the study (**Figure 3**). It was detected that 16 pre-service teachers used the key concept of the economy before the study and 53 pre-service teachers used it after the study it is apparent that there was a significant decrease in the number of candidates who gave meaningless answers and those who did not answer at all after the experimental process. The findings of the analysis obtained from the second question of the ESPKT are presented in **Figure 4**.

When the pre-test and post-test findings of the LSTG were analyzed, the number of pre-service teachers who emphasized the feature "has com

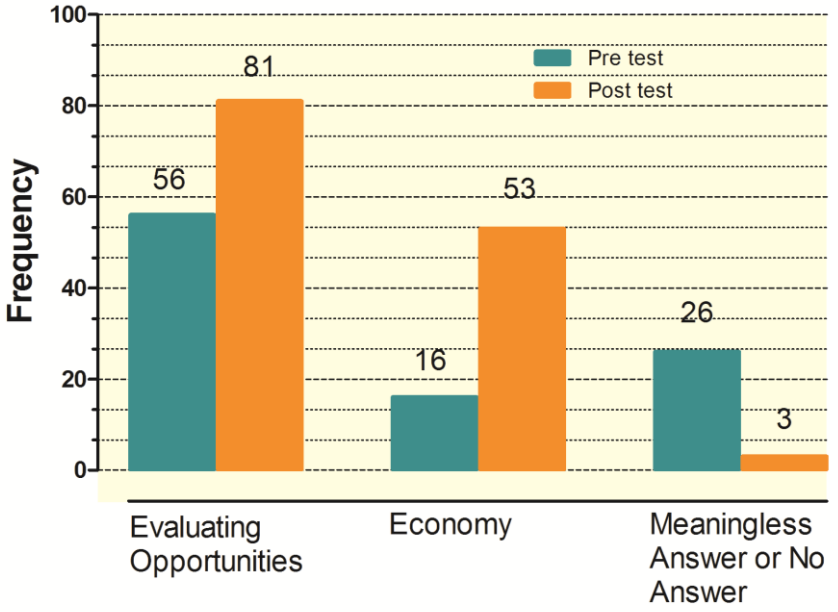

Figure 3. The Analysis Results of Related to Changes in Definitions of Entrepreneurial Skills of Pre-service Science Teachers.

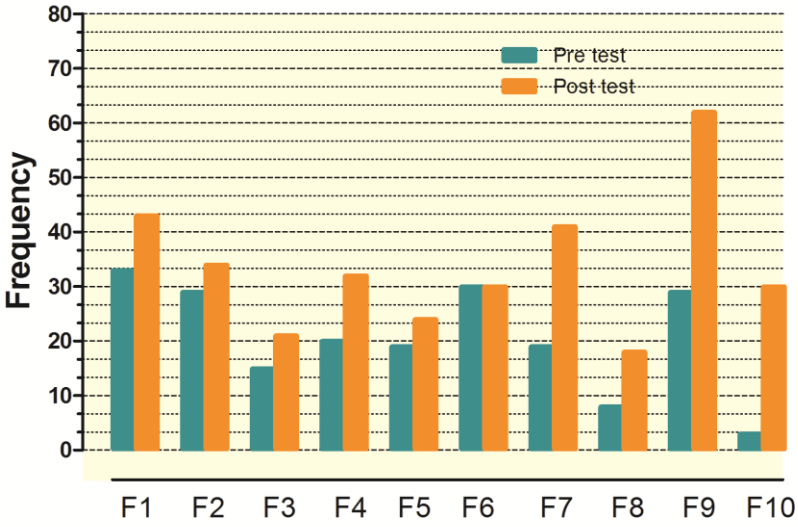

Figure 4. The Analysis Results of Related to Changes of Pre-service Science Teachers in Defining the Characteristics of Individuals with Entrepreneurial Skills. *Note: A pre-service teacher may have responded to more than one code in their answer. Feature 1: Assertive-Attack / Feature 2: Persuasive-Confident / Feature 3: Has Teamwork Skills / Feature 4: Has Problem-Solving Skills / Feature 5: Has Decision-Making Skills / Feature 6: Has Communication Skills / Feature 7: Risk Takes- Courageous / Feature 8: Curious-Observes / Feature 9: Has Creative Thinking Skills / Feature 10: Has a plan.*

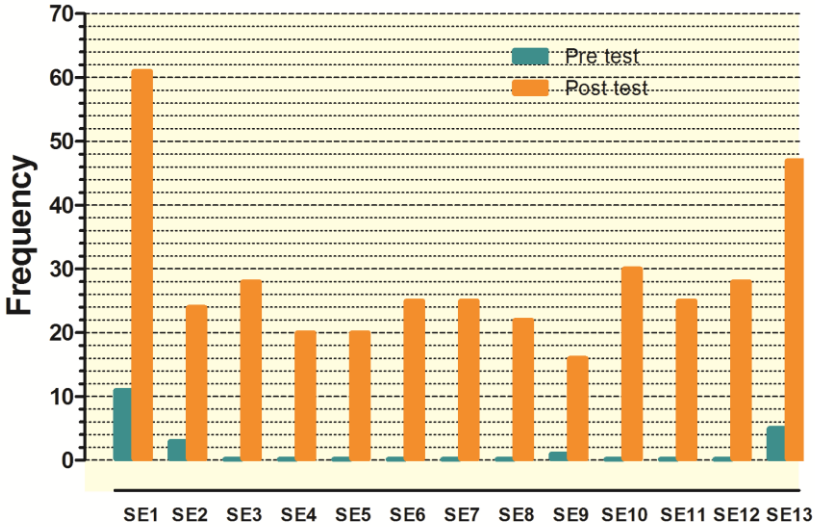

Figure 5. The Analysis Results of Regarding Changes in Defining Indicators of Entrepreneurial Skills of Pre-service Science Teachers. *Note: A pre-service teacher may have responded to more than one code in their answer. Indicators: SE1. Business idea development; SE2. Emphasizing that the business idea is different from other business ideas; SE3. Setting short-term goals; SE4. Setting the market share target; SE5. Identifying potential customers; SE6. Perform competitor analysis; SE7. Determining the channels of reaching the customer; SE8. Drawing a workflow chart; SE9. Determining the duties and responsibilities of the personnel; SE10. Calculating the expenses of your business; SE11. Calculating the income of your business; SE12. Calculating the profit of your business; SE13. Marketing your product.*

munication skills" did not change (**Figure 4**). The most striking increase in the number of pre-service teachers expressing the features of entrepreneurial individuals was in "has creative thinking skills" and "has a plan". The findings of the analysis obtained from the second question of the ESPKT are presented in **Figure 5**.

When **Figure 5** is analyzed, the increase in the number of pre-service teachers emphasizing the indicators "Business idea development and Marketing your product" at the end of the experimental process is higher than the other indicators. The findings of the analysis obtained from the second question of the ESPKT are presented in **Figure 6**.

When **Figure 6** is analyzed, there was a significant increase in the number of pre-service teachers who included attention-grabbing and active engagement sections in the activities designed after the experiment. However, it is noteworthy that no pre-service teacher addressed the evaluation section before and after the experiment. Before the experimental process, it was observed that only one pre-service teacher designed an activity related to daily life. After the implementation of LSTG, it was seen that 45 pre-service

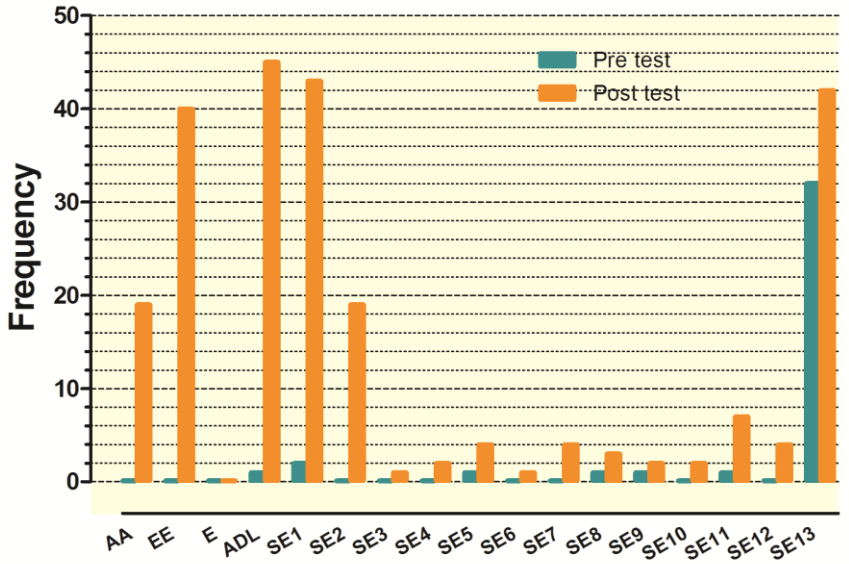

Figure 6. The Analysis Results of Regarding Changes in the Activities Designed to Gain Entrepreneurial Skills for Students of Pre-service Science Teachers. *AA: Attracting Attention / EE: Efficient Engagement / E: Evaluation / ADL: Associating with Daily Life / SE1. Business idea development; SE2. Emphasizing that the business idea is different from other business ideas; SE3. Setting short-term goals; SE4. Setting the market share target; SE5. Identifying potential customers; SE6. Perform competitor analysis; SE7. Determining the channels of reaching the customer; SE8. Drawing a workflow chart; SE9. Determining the duties and responsibilities of the personnel; SE10. Calculating the expenses of your business; SE11. Calculating the income of your business; SE12. Calculating the profit of your business; SE13. Marketing your product.*

teachers included activities associated with daily life. After the experiment, there was a significant increase in the number of pre-service teachers who included the indicators "*Develops a business idea (f = 43) and Emphasizes that the business idea is different from other business ideas* (f = 19)" in their activities. The findings obtained from the fifth question of the ESPKT are shown in **Figure 7**.

When **Figure 7** is analyzed, it was found that there was a significant increase in the number of pre-service teachers who addressed the indicators of entrepreneurship skills in the measurement tool they prepared after the experimental process. Furthermore, there was a significant increase in the number of pre-service teachers who indicated the lowest and highest scores that could be obtained from the measurement tool, categorization, and scoring processes after the implementation of the LSTG. The findings obtained from the last question of the ESPKT are shown in **Figure 8**.

When **Figure 8** was analyzed, it was seen that there was a remarkable increase in the number of pre-service teachers who designed an assess

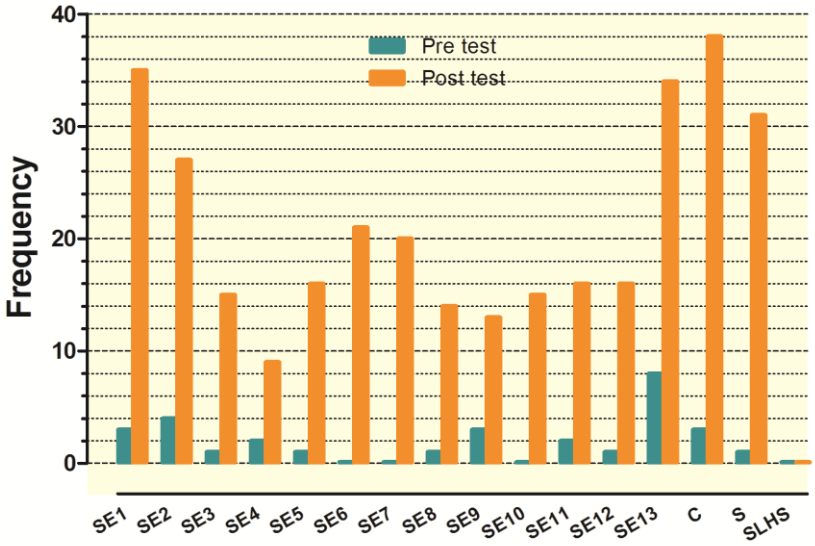

Figure 7. The Analysis Results of Regarding Changes in Tools Designed to Measure Students' Understanding of Entrepreneurial Skills of Pre-service Science Teachers. *C: Categorization / S: Scoring / EDEYPB: Specifying the Lowest and Highest Score; SE1. Business idea development; SE2. Emphasizing that the business idea is different from other business ideas; SE3. Setting short-term goals; SE4. Setting the market share target; SE5. Identifying potential customers; SE6. Perform competitor analysis; SE7. Determining the channels of reaching the customer; SE8. Drawing a workflow chart; SE9. Determining the duties and responsibilities of the personnel; SE10. Calculating the expenses of the enterprise; SE11. Calculating the income of your business; SE12. Calculating the profit of your business; SE13. Marketing your product.*

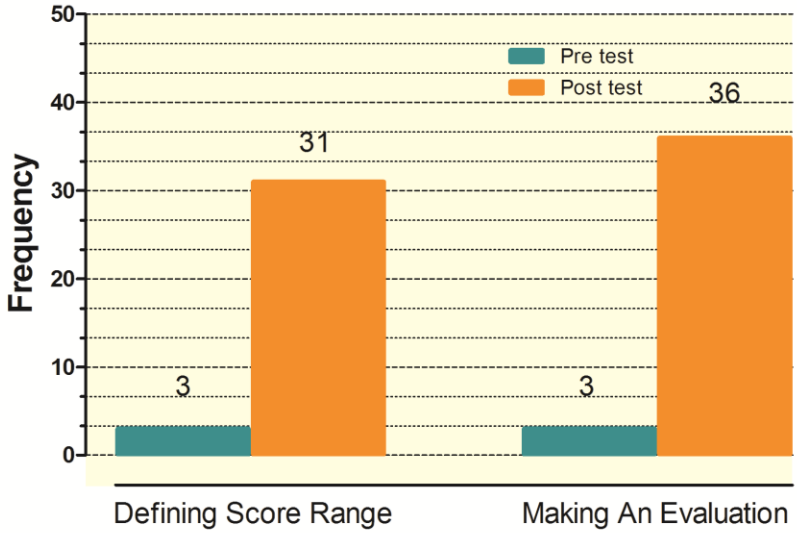

Figure 8. The Analysis Results of Regarding Changes in Tools Designed to Assess Students' Understanding of Entrepreneurial Skills of Pre-service Science Teachers.

ment tool with the features of "specifying a score range and making an evaluation" at the end of the experimental process.

Discussion and Results

This study provides evidence for the effectiveness of a guide that can be used to improve pre-service science teachers' professional knowledge of entrepreneurship skills. Quantitative findings showed that the implementation of the LSTG increased pre-service science teachers' professional knowledge of entrepreneurship skills. Presentation of sample activities and measurement tools on entrepreneurship skill professional knowledge in the experimental process, pre-service teachers` designing activities to develop this skill, and having in-class discussions can be seen as the main factors in increasing their professional knowledge. However, the qualitative findings showed that at the end of the experimental process, the pre-service science teachers did not increase their professional knowledge to good and very good levels (**Figure 2**). It can be said that this result indicates that it is difficult for pre-service science teachers to gain professional knowledge of entrepreneurship skills in a 14-week period. Scriven (1994) emphasizes that acquiring professional knowledge in the teaching profession is a long-lasting process. Bolaji (2012) and Inaltekin et al. (2019) found that pre-service science teachers have characteristics with low professional knowledge on entrepreneurship. The researchers emphasize that the reason for this is the lack of resources to comprehend professional knowledge about entrepreneurship skills in science teacher training programs. There is also a similar situation when the science teacher training program in Türkiye is examined. Although life skills are targeted to be acquired by students in the secondary school science curriculum, there is no professional knowledge course on life skills in the teacher training program. This situation stands out as the biggest deficiency of this program. Therefore, it can be concluded that the implemented guideline offers rich theoretical and practical content in developing pre-service teachers' professional knowledge on entrepreneurship skills. However, it was also revealed that the guideline proposed in this study should be implemented over a longer period and its content should be enriched. The reason was that although the quantitative data showed that the pre-service teachers' professional knowledge increased, the qualitative data showed that the experimental process was not sufficient. Another reason why pre-service science teachers' professional knowledge about entrepreneurship skills did not increase to a good or very good level may be due to insufficient prior knowledge. Because insufficient prior knowledge is a factor that makes it difficult to learn new information (Otero & Nathan, 2008), entrepreneurship skill, which is a life skill, was included in the curriculum of science education in Türkiye in 2013. Therefore, science educators have also started to work on this concept

as of this year. The insufficient knowledge of science educators about entrepreneurship skills can also be seen as another reason for the weak prior knowledge of the pre-service teachers. Aslan (2021), Bayram and Çelik (2022), and Samanci et al. (2020) found that pre-service science teachers' conceptual knowledge of entrepreneurship was insufficient. The same situation also emerged in the current study. The findings obtained from the second question of the test, which probed conceptual knowledge on entrepreneurship, showed that at the end of the experimental process, the pre-service science teachers had difficulty in listing the characteristics of entrepreneurial individuals. This situation may have negatively affected the pre-service teachers' professional knowledge acquisition process. The reason is that a pre-service teacher's lack of knowledge about a concept makes it difficult for him/her to use his/her professional knowledge to teach this concept (Gess-Newsome et al., 2019). Tiernan (2016) emphasizes that when field-specific entrepreneurship education is provided, pre-service teachers develop positive attitudes towards entrepreneurship. When we consider that this guide covers a training content for entrepreneurship in science education, the fact that the pre-service teachers can associate entrepreneurship with science and understand the importance of using this skill in the field can be seen as another reason for the increase in their professional knowledge. Because pre-service teachers' inability to internalize entrepreneurship (Chen et al., 2015; Gautam & Singh, 2015; Pihie & Bagheri, 2011; Seikkula-Leino et al., 2010; Ruskovaara & Pihkala, 2013) makes it difficult to acquire professional knowledge (Flores, 2015).

One of the results of the research is that there was a significant increase in the number of pre-service teachers who emphasized the indicators for entrepreneurial skills after the experiment. It was found that the number of pre-service teachers who emphasized the indicators "*develops a business idea*" and "*markets the product*" was higher than the number of pre-service teachers who emphasized the other indicators. The same result was also found in the activities prepared by the pre-service teachers to develop students' entrepreneurial skills. In Türkiye, it is recommended to organize year-end entrepreneurship festivals in the curriculum of science education courses (MoNE, 2018). In such festivals, students market the products they develop within the scope of the course. Therefore, the reason why the pre-service teachers addressed the indicators of "*develops a business idea*" and "*markets the product*" may be due to the emphasis in the program. Another result of the study showed that the guide was very effective in linking science outcomes with entrepreneurship-based daily life problems in the worksheets designed by the pre-service teachers. It was found that the pre-service teachers did not include evaluation (assessment of the learning outcome) as the third part in the worksheets they designed to develop students' entrepreneurship skills. It can be said that this situation indicates that their professional

knowledge about designing worksheets is also weak. When **Figures 6** and **7** were analyzed comparatively, it was found that although the number of pre-service teachers using entrepreneurship skill indicators in their activities was low, it was more than those using them in the measurement tool. During the experimental process, the pre-service teachers also took the Instructional Technology and Material Design course. Therefore, the pre-service teachers were involved in the process of designing an activity for the first time with this course. This may be the reason why the pre-service teachers had difficulty in designing the entrepreneurship-based worksheet and adapting the indicators in this study. Pektaş and Çelik (2021) found that pre-service science teachers were good at directing students to innovate in the activities they designed but lacked in directing students to take risks. The current study also showed that the number of pre-service science teachers (SE2) who paid attention to creating original work ideas in the worksheets they designed after the experimental process increased. However, the current study did not provide any professional training on risk-taking. This can be seen as a limitation of the study. The implemented guideline had a positive effect on the number of pre-service teachers who emphasized the features of scoring, categorizing, indicating score ranges, and making evaluations when designing assessment and evaluation tools. However, the number of pre-service teachers emphasizing these features was still less than half of the participants. The LSTG did not have any effect on the pre-service teachers' process of indicating the lowest and highest score. Although the candidates took the measurement and evaluation course in the second year, this result may be an indication that the candidates had difficulty in designing measurement instruments. The fact that the measurement and evaluation process is inherently difficult (Wilson & Martinussen, 1999) may be the reason why the pre-service teachers also had difficulties.

Implications

This study showed that the professional knowledge of teachers about teaching entrepreneurship can be developed by pre-service science teachers through theoretical and practical training, although not at the desired level. Based on this result of the study, science educators are recommended to enrich the content of LSTG and extend the training process. The content of LSTG can be enriched by giving more space to activity development activities that aim to integrate the entrepreneurship skill indicators of the pre-service teachers with science activities. It is seen that the one-week (four hours) content in the guide for measuring entrepreneurship skills is not sufficient to develop pre-service teachers' professional knowledge in this field. At the same time, in the content of the measurement and evaluation course, only subject-oriented procedures are carried out. Therefore, education poli-

cymakers may be advised to add the skills learning area to the content of this course. Science educators are advised to make applications for the entrepreneurship skills of the pre-service science teachers in other professional knowledge courses. In order for science teacher candidates to develop their conceptual knowledge about entrepreneurship and to internalize the subject, activities that bring together entrepreneurs and pre-service science teachers can be organized in science teacher education programs.

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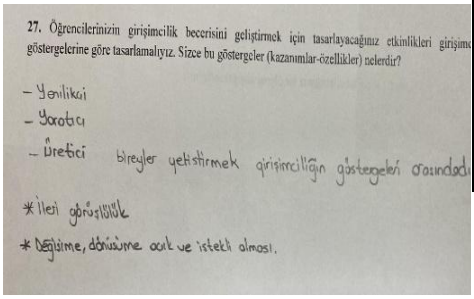
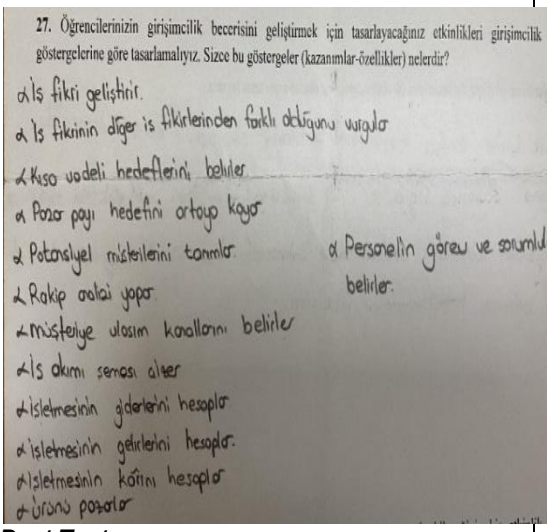
Appendix A:

Excerpts from the Pre- and Post-Test Responses of Pre-Service Teachers to the ESPKT

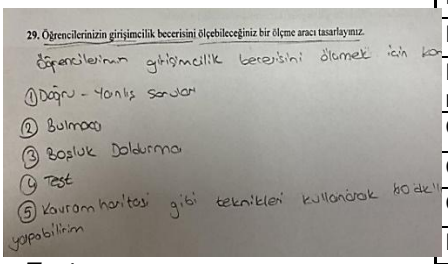
Excerpts from Pre-Service Teachers' Identification of Indicators of Entrepreneurship Skills (Excerpts from the Pre- and Post-Test Answers of the pre-service teacher coded P_{54} to Question 3 of the ESPKT)	
27. The activities you design to develop your students' entrepreneurship skills should be designed according to the indicators of entrepreneurship skills. What do you think these indicators (gains features) are?	27. The activities you design to develop your students' entrepreneurship skills should be designed according to the indicators of entrepreneurship skills. What do you think these indicators (gains features) are?
To raise individuals who are -Innovative, -Creative -Productive is among the indicators of entrepreneurship. *Forward-thinking, *Open to change	*Develops a business idea; *Emphasizes that the business idea is different from other business ideas; *Determines short-term goals; *Sets a market target; identifies potential customers; *Makes competitor analysis; *Determines transportation channels; *Draws a business plan; *Calculates the expenses of the business; *Calculates the income of the business; *Calculates the profit of the business; *Markets the product and determines the duties and responsibilities of staff
 27. Öğrencilerinizin girişimcilik becerisini geliştirmek için tasarlayacağınız etkinlikleri girişimcilik göstergelerine göre tasarlamalıyız. Sizce bu göstergeler (kazanımlar-özellikler) nelerdir? – Yenilikçi – Yaratıcı – Üretici bireyler yetiştirmek girişimciliğin göstergeleri arasındadır *İleri görüşlülük *değişime, dönüşüme açık ve istekli olması.	 27. Öğrencilerinizin girişimcilik becerisini geliştirmek için tasarlayacağınız etkinlikleri girişimcilik göstergelerine göre tasarlamalıyız. Sizce bu göstergeler (kazanımlar-özellikler) nelerdir? İş fikri geliştirir. İş fikrinin diğer iş fikirlerinden farklı olduğunu vurgular Kısa vadeli hedeflerini belirler Pazar payı hedefini artırıp koyar Potansiyel müşterilerini tanımlar Rakip analizi yapar müşteriye ulaşım kanallarını belirler İş akımı şemasını çizer İşletmesinin giderlerini hesaplar İşletmesinin gelirlerini hesaplar. İşletmesinin karını hesaplar Ürünü pazarlar Personelin görev ve sorumlu belirler.
Pre-Test P_{54}'s answer to this question in the post-test: "To raise individuals who are innovative, creative, forward-thinking, open to change,and productive."	***Post Test*** P_{54}'s answer to this question in the post-test: "Develops a business idea; emphasizes that the business idea is different from other business ideas; determines short-term goals; sets a market target; identifies potential customers; makes

competitor analysis; determines transportation channels; draws a business plan; calculates the expenses of the business; calculates the income of the business; calculates the profit of the business; markets the product and determines the duties and responsibilities of the staff."

Excerpts from the Tools Designed by the Pre-Service Teachers to Measure Whether Secondary School Students Acquire Entrepreneurship Skills (Excerpts from the Pre- and Post-Test Answers of the Pre-Service Teacher Coded P_{66} to the 5th Question of ESPKT)

29. Design an assessment tool to measure your students' entrepreneurship skills.
In order to measure students' entrepreneurial skills, I can make a 60-minute exam on the subject by using techniques such as;

1. True – False Questions
2. Puzzles
3. Gap-filling
4. Multiple Choice
5. Mind Map

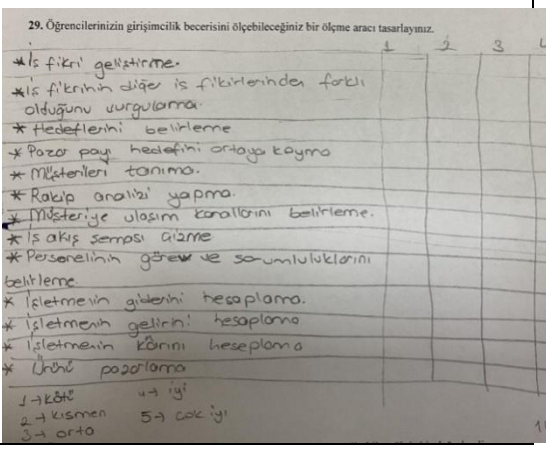


Pre-Test

P_{66}'s answer to this question in the pre-test: "In order to measure students' entrepreneurial skills, I can make a 60-minute exam on the subject by using techniques such as true and false questions; puzzles; gap-filling; multiple choice and mind map."

29. Design an assessment tool to measure your students' entrepreneurship skills.

	1	2	3	4
Developing a business idea				
Emphasizing that the business idea is different from other				
Setting goals				
Setting the market share				
Getting to know customers				
Competitor analysis				
Determining customer access				
Drawing a workflow chart				
Determining the duties and responsibilities of staff				
Calculating business				
Calculating business income				
Calculating business profit				
Marketing the Product				
Poor Fair Average Good Very good				



	Post Test P66's answer to this question in the post-test: "Developing a business idea; emphasizing that the business idea is different from other business ideas; setting goals; setting market share target; getting to know customers; competitor analysis; determining customer access channels; drawing a workflow chart; determining the duties and responsibilities of staff; calculating business expenses; Calculating business income; calculating business profit and marketing the product." "Scoring: poor (1 point); fair (2 points); average (3 points); good (4 points) and very good (5 points)"