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Research Article

Entrepreneurship pedagogical content knowledge (E-PCK): A scale development study

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Abstract: It is important to determine the level of pedagogical content knowledge of teachers regarding skills. The aim of this study is to establish the theoretical framework of skill-specific pedagogical content knowledge and to develop a reliable and valid scale to measure teachers' entrepreneurship pedagogical content knowledge. The draft scale form was applied to 148 teachers, and exploratory factor analysis was performed with the obtained data. As a result of the analysis, a 5-dimensional scale structure consisting of 28 items was obtained. In addition to the Cronbach Alpha internal consistency coefficient, a 27% (lower and upper groups) comparison was made using the item discrimination index calculation. In order to verify this structure, data were collected from 147 teachers, and the 5-factor scale structure was verified according to acceptable fit values with confirmatory factor analysis. It was determined that the verified 5-factor model met the convergent and discriminant validity criteria. The measurement invariance of the scale according to branches was tested, and it was seen that the same structure was measured in different groups. Cronbach's Alpha internal consistency coefficient and composite reliability values showed that sufficient reliability values were obtained for the scale. Therefore, it was concluded that the scale is a valid and reliable scale with sufficient conditions to measure teachers' entrepreneurial pedagogical content knowledge. In addition, it is thought that the developed E-PCK scale and the E-PCK theoretical framework will pioneer PCK research in other skills.

1. INTRODUCTION

Although the 21st century is known as the information age, education today should not only consist of knowledge of the subjects taught; it should also include 21st-century skills such as leadership, responsibility, problem-solving, analytical thinking, communication, entrepreneurship, and creativity (Vilda Ghasya & Kartono, 2022). Education should aim to do more than prepare young people for the world of work; It should equip students with the skills they need to be active, responsible, and engaged citizens (Organization for Economic Co-operation and Development [OECD], 2020). Güneş and Uygun (2016) define skill as the ability to do a job easily and skillfully using an individual's mental and physical resources. In its report

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titled "The Future of Education and Skills 2030", OECD (2019) defined skill as the capacity and ability of an individual to consciously use the existing knowledge he has to achieve a certain goal and divided skills into three different types: Cognitive-meta-cognitive, social-emotional and physical-practical skills. In Türkiye, skills in science education are divided into three skill groups: scientific process skills, life skills, engineering and design skills (Ministry of National Education [MEB], 2018). Skills constitute the basic philosophy of the newly prepared science curriculum in Türkiye. The skills included in the science curriculum are classified as field skills, conceptual skills and social-emotional skills. The newly prepared science course curriculum in Türkiye aims to raise students as individuals who have the skills required by the age and lifelong learning habits, and who can use high-level thinking and scientific process skills (MEB, 2024). So, can the pedagogical content knowledge of the teachers responsible for teaching these skills be measured?

1.1. Skills and Skills Teaching

In Türkiye's curriculum, no evidence has been found as to whether the skills specified in the program have been acquired (Kanmaz, 2021). It is observed that teacher training programs mostly consist of theoretical courses and are not aimed at developing the practical knowledge, skills and perspectives necessary for teaching (Güneş & Uygun, 2016). The number of teacher training programs that aim to teach or develop 21st-century skills is low (Kanmaz, 2021). It is very important to investigate the skills seen within the scope of modeling and measurement of teacher competencies (Njiku *et. al*., 2020). Teachers do not have sufficient knowledge about which life skills can be used for each outcome within the framework of the outcomes (Ursavaş & Karal, 2019). This article deals with entrepreneurship skills. Entrepreneurship skill in the science course curriculum; It was detected as 13.9% in the 3rd grade, 6.9% in the 4th grade, 8.3% in the 5th grade, 6.8% in the 6th grade, 13.4% in the 7th grade and 13.1% in the 8th grade (Ormancı *et al.*, 2022). The conceptual uncertainty surrounding pedagogical entrepreneurship is the reason why teaching entrepreneurship is challenging to implement because teachers are unsure of what they should do, why they should do it, and how they should do it (Haara *et al.*, 2016). Teachers have a great role in teaching student's entrepreneurship skills at an early age.

1.2. Teachers' Pedagogical Knowledge

Teacher training programs focus on teaching teachers a wide range of subjects effectively and efficiently, and then appropriate pedagogical strategies are used (Karkar Esperat, 2022). Shulman (1986) suggested three categories of professional knowledge. There are different aspects of the subject depending on the teacher. These different aspects of content knowledge are pedagogical content knowledge and curriculum knowledge. Shulman defines content knowledge as knowledge of concepts, theories, practices, and approaches to developing knowledge, while pedagogical knowledge includes teaching and learning methods, strategies for assessing students' knowledge, and general pedagogical knowledge and how these are applied. Shulman (1987) later defined seven basic types of knowledge that a teacher should have (1- Content Knowledge, 2- General Pedagogical Knowledge, 3- Curriculum Knowledge, 4- Pedagogical Content Knowledge (PCK), 5- Knowledge and Characteristics of Students, 6- Educational Content Knowledge, 7- Knowledge of Goals, Educational Objectives, and Educational Values). Grossman (1990) based Shulman's proposal on four components (Content Knowledge, General Pedagogical Knowledge, Pedagogical Content Knowledge, and Context Knowledge) to make it organized and useful. Magnusson *et al.*'s PCK Model emerged to represent the core knowledge in Grossman's PCK model, replacing the "purpose understandings of teaching content" in Grossman's model with "orientations toward science teaching" (Fernandez, 2021). According to Lederman *et al.* (1997), science teachers need to know how learning occurs as well as content, curriculum, evaluation and pedagogical knowledge for science teaching.

1.3. Literature Research

When the relevant literature was examined, it was determined that the developed scales were on entrepreneurship and its dimensions and that the scales were applied to candidate teachers and students (Deveci & Çepni, 2015; Yalçın & Uzun, 2017). In the literature, it is seen that there are pedagogical content knowledge (PCK), technological pedagogical content knowledge (TPACK), web pedagogical content knowledge scales, and The E-PCK scale developed for this research is important in terms of evaluating teachers' pedagogical knowledge between theoretical knowledge and practice in skill teaching. In the literature, it is seen that studies conducted with teachers working in the field in pedagogical content knowledge studies are fewer than studies conducted with teacher candidates (Gökçek & Yılmaz, 2019; Köse, 2021). The literature was scanned using keywords such as skill pedagogy, skill pedagogical content knowledge, entrepreneurship, skill PCK scale, etc. As a result of this scan, the skill-focused PCK scale study published by Sipon *et al.* (2018) was found in the literature. While the scale, developed by Sipon *et al,* includes categories such as subject knowledge in entrepreneurship, teaching representative and strategy in entrepreneurship, teaching objective and context in entrepreneurship and students' knowledge of entrepreneurship understanding, the PCK framework and its components were not used.

1.4. Theoretical Framework of Entrepreneurship Pedagogical Content Knowledge

The aim of providing students with entrepreneurial skills is to enable them to take more responsibility for themselves, try to achieve their goals, be creative, see opportunities to explore what exists, and generally cope with complex social order (Seikkula-Leino *et al.,* 2010). Defining entrepreneurship as a dynamic vision and creation process, Tarhan (2021) aims to systematically impart entrepreneurial skills and include this skill in the curriculum. There is no universal strategy for the effectiveness of entrepreneurship education; teachers need to be equipped with skills and appropriate environments need to be provided to improve learning outcomes (Mawonedzo *et al.,* 2020). Using entrepreneurship-specific pedagogical knowledge, in order to achieve contextualization (cases, examples, drawings, problems, and knowledge of a specific discipline or profession) in the entrepreneurial learning process, it is not enough for the educator to only know the subject, but also to know subject knowledge, general pedagogical knowledge, and also theoretical knowledge (Ramsgaard & Blenker, 2022). The inclusion of a skill-focused pedagogical approach also promotes lifelong learning, which is necessary to prepare students for a changing future (Huth, 2021). In addition to being a skill-focused pedagogical content knowledge scale study, it is thought that this study can also provide information to researchers working on the structure of PCK.

In addition, the study is important in terms of developing a theoretical approach to PCK components that are still very important for education. PCK should be examined in terms of the components that make up PCK (Kersting *et al.,* 2020). Today, most researchers state that PCK defines different knowledge clusters and is a special mixture of content knowledge and pedagogical knowledge (Şen, 2023). There are different PCK models used in PCK literature to understand and assess teachers' knowledge (Teacher Knowledge Model (Grossman, 1990); Components of Pedagogical Content Knowledge for Science Teaching (Magnusson *et al.,* 1999); Adapted model for PCK (Rollnick *et al.,* 2008); PCK Summit Model (Helms & Stokes, 2013). In this study, entrepreneurship subcomponents of Ağca and Kurt (2007) and PCK components of Shulman (1986; 1987); Grossman (1990); Magnusson *et al.* (1999) were used in the conceptualization of entrepreneurship pedagogical content knowledge (E-PCK).

The E-PCK model is a model that identifies the intersections between entrepreneurship, pedagogy, and content for effective integration of entrepreneurial skills into teaching. The knowledge dimensions (Factors) of the pedagogical content knowledge scale for entrepreneurship (E-PCK), the subcomponents of these knowledge dimensions are presented in Table 1.

Table 1. *Conceptualized structure of the E-PCK scale, factors, subcomponents and item contents.*

Dimension	Definitions	Subcomponents
Entrepreneurship Knowledge (EK)	It is the knowledge that enables the participants to develop the intention to exhibit entrepreneurial behaviors, whether they are in the education system or not (Liñán, 2004).	• Risk Taking • Proactivity • Autonomy • Strategic Renewal • Competitive Thinking
Content Knowledge (CK)	For students, it is the knowledge of being able to explain subjects and concepts with their reasons both in theory and in practice (Shulman, 1986).	• Content Knowledge • Skill Knowledge • Context Knowledge • Aim and Scopes • Interdisciplinary Perspective Knowledge
Pedagogical Knowledge (PK)	It is the curriculum knowledge, course material knowledge, measurement and evaluation knowledge, and knowledge of teaching methods and techniques that are necessary to overcome students' misconceptions and learning difficulties (Shulman, 1986).	• Teaching Methods and Techniques • Measurement and Evaluation Knowledge • Student Knowledge • Program Knowledge
Entrepreneurship Content Knowledge (ECK)	It is the knowledge to define the relationship between entrepreneurship and content by identifying the needs and problems encountered in daily life related to a subject area.	• Content Knowledge • Context Knowledge • Proactivity • Strategic Renewal • Autonomy
Pedagogical Content Knowledge (PCK)	It is the teacher's knowledge of being able to convey the subjects in his field to students with the most useful teaching methods and techniques (Shulman, 1986).	• Content Knowledge • Measurement and Evaluation Knowledge • Teaching Methods and Techniques • Student Knowledge • Program Knowledge
Entrepreneurship Pedagogical Knowledge (EPK)	It can be defined as the application, learning approaches, teaching methods and technical knowledge that allows students to be much more creative and innovative through an artistic and experiential way of thinking and applying, and at the same time to take ownership of the creation process by establishing the relationship between entrepreneurial knowledge and pedagogical knowledge in educational practice.	• Teaching Methods and Techniques • Student Knowledge • Program Knowledge • Measurement and Evaluation Knowledge
Entrepreneurship Pedagogical Content Knowledge (E-PCK)	It is the knowledge that teachers will impart a subject to students using entrepreneurship knowledge, how to use related method and techniques, how to prepare a lesson plan and activity, how to measure and evaluate knowledge (Samancı, 2021).	• Teaching Methods and Techniques • Student Knowledge • Program Knowledge • Measurement and Evaluation Knowledge • Content Knowledge

The PCK model is a model that identifies the intersections between pedagogy and content. The E-PCK divides a teacher's knowledge in teaching into three broad categories: content knowledge (CK), pedagogical knowledge (PK), and entrepreneurial knowledge (EK). At the intersection of the two categories lie more specific forms of knowledge: pedagogical content knowledge (PCK), entrepreneurial content knowledge (ECK), and entrepreneurial pedagogical knowledge (EPK). At the intersection of all three categories lies entrepreneurial pedagogical content knowledge (E-PCK). At the core of the E-PCK model is the complex intersection of forms of knowledge that teachers must possess as the foundational PCK. Original items were written for these information dimensions (Appendix 1).

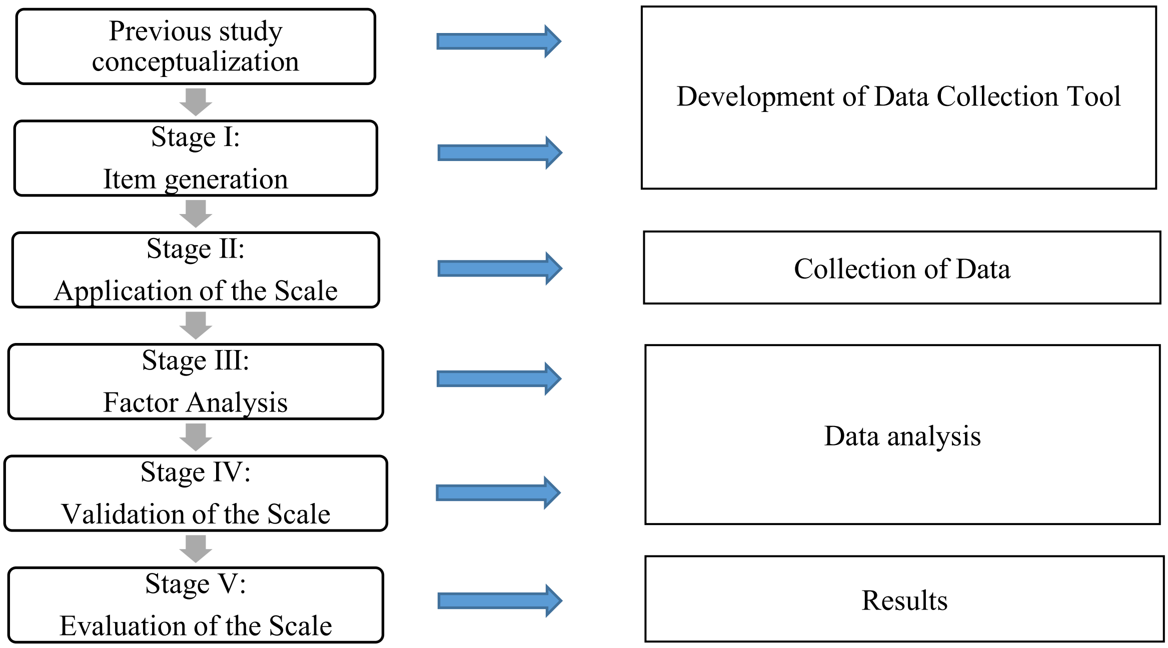
When Table 1 is examined, it is accepted that the subcomponents of entrepreneurship skills related to EK and ECK dimensions are risk taking, proactiveness, autonomy, strategic renewal and competitive thinking. Entrepreneurial knowledge subcomponents include risk taking, making decisions under uncertain conditions and taking strategic actions, proactivity, taking action before problems, needs and changes that may arise, and autonomy, an individual or a team's ability to act independently in putting a determined vision into action (Ağca & Kurt, 2007). Entrepreneurial knowledge is the knowledge that enables them to develop the intention to exhibit entrepreneurial behaviors, whether or not it is within the education system (Liñán, 2004). Original articles were written by the authors for these subcomponents. The subcomponents of the CK dimension are content knowledge (Shulman, 1986), skill knowledge (Kılıç & Selvi, 2025), contextual knowledge (Grosman, 1990). "Knowledge of the goals and objectives of science teaching" (Magnusson *et al.*, 1999) and knowledge of interdisciplinary perspectives (Kılıç & Selvi, 2025) were defined according to the goals and scopes, and original items were written for each subcomponent. The subcomponents related to the PCK, PK, EPK and E-PCK dimensions are: knowledge of science curriculum (Shulman 1986), program knowledge (Magnusson *et al.*, 1999); scientific literacy assessment knowledge (Magnusson *et al.*, 1999), measurement and evaluation knowledge, student knowledge (Magnusson *et al.*, 1999); science teaching strategies (Magnusson *et al.*, 1999) were defined by the authors as knowledge of teaching methods and techniques, and original items were written for both knowledge dimensions and each subcomponent. This measurement tool aims to investigate teachers' knowledge about the skill and their knowledge about the program, teaching methods and strategies for acquiring the skill. It is thought that the designed model will establish a bridge between theory and practice in skill teaching. The subcomponents in the model will help teachers plan lessons, activities and assessments and will provide teachers with information about approaches and assessments. A theoretical framework was created for the E-PCK model, combining categories to examine the teacher's field knowledge, pedagogical knowledge (these are the knowledge dimensions of the PCK framework) and the relationship with the skill. This study addresses the lack of conceptual modeling for teacher education by providing evidence for teachers responsible for skill teaching, not only on the teacher's knowledge of the skill but also on how to effectively apply the relevant skill.

2. METHOD

2.1. Research Model

In this study, the disproportionate stratified handling method was preferred from the random handling methods. It is based on making random selections between these layers by separating the stratified rates from the rates in the universe into non-overlapping layers (Earl, 2004). In disproportionately stratified classes, after determining the number of types selected from each layer, the general representation rate of the layers is selected in equal numbers (Schmidt & Hunter, 2014). The reason for choosing this method is to be able to collect data easily and quickly in terms of time, labor and expense. Based on the advantages and disadvantages criteria of the science and classroom education regions in Ankara, the universe is connected to three districts that are homogeneous within themselves but heterogeneous among themselves. In the study, each district is considered as a layer, and an equal number of science, and classroom teachers are selected and divided into study sections. To develop and validate the E-PCK scale, Bagozzi *et al.* (1991) and Churchill (1979)'s reliable and valid scale development standard process was used (Figure 1). The data analyzed in the study were obtained by applying e-form to the classroom, and science teachers both face-to-face and in a computer environment. SSPS 25.0 was used for exploratory factor analysis, reliability and independent t-test analyses, and Jamovi 2.3.28 program was used for confirmatory factor analysis. Before proceeding to the analysis phase, univariate and multivariate normality assumptions were checked. Skewness and kurtosis coefficients were examined for the univariate normality assumption. Multivariate normality analyses can be performed through various tests. One of these tests is the Mardia test (Mardia, 1970) and according to the result of the Mardia Test, this assumption was not met. In cases where multivariate normality is not provided, it is recommended to use the Robust Maximum-Likelihood (MLR), Weighted Least Squares (WLS), Robust Weighted Least Squares (WLSMV), Nonlinear Least Squares Method (ULS) methods in the analysis of measurement invariance. (Kline, 2016). The MLR method can be used in various data structures by providing a robust, flexible and reliable option against deviations from normality on a wide variety of data sets even if the multivariate normality assumption is violated (Yuan and Bentler, 2000). In this study, the MLR method was used since the number of categories of the Likert-type scale was also taken into account. The MVN package in the R program was used for multivariate normality and the lavaan package (Roesseel, 2012) was used for measurement invariance analyses.

Figure 1. *Entrepreneurship pedagogical content knowledge (E-PCK) scale development stages.*



2.2. Development of Data Collection Tool

2.2.1. *Priority study: Conceptualization*

In the process of writing the items related to the subcomponents of the E-PCK scale (Alpaslan *et al.,* 2021; Deveci & Çepni, 2015; Gökçek & Yılmaz, 2019; Sarı & Bostancıoğlu, 2018), entrepreneurship scales and pedagogical content knowledge scales in the literature were examined. Before starting to write the items, the knowledge dimensions of the E-PCK scale and the subcomponents of these knowledge dimensions were examined. For the entrepreneurship knowledge sub-dimension, Ağca and Kurt (2007) were used, for the pedagogical knowledge, content knowledge, pedagogical content knowledge sub-dimensions, Shulman (1986), Grossman (1990), Magnusson *et al.* (1999) PCK components were used (See Table 1). Original items were written for the E-PCK scale. The scale was designed as a 5-point scale (*strongly agree* = 5, *agree* = 4, *neutral* = 3, *disagree* = 2, *strongly disagree* = 1).

2.2.2. *Phase I: Item creation*

Since the items were written for the subcomponents of the E-PCK scale, a draft scale consisting of 33 items was created. Sample items for the draft scale are given in Table 1. In order to ensure the content validity of the scale, 4 content experts, including 2 faculty members and 2 research assistants with fields of study in the fields of science education, teacher education, pedagogical content knowledge, professional development and science teacher special field competencies, independently evaluated the items of the 33-item draft scale. While the items in the draft scale that showed a high level of compliance with the institutional framework were approved, the draft scale was arranged in a way that would provide field-specific examples in writing items suitable for the sub-dimensions of the knowledge dimensions in accordance with the theoretical framework, ensure that the items were clear and specific, and ensure unity in writing in the items. Since the final version of the draft scale will be applied to teachers working in the field, it was examined in terms of language and expression by 2 Turkish language experts working in the field in order to increase comprehensibility.

2.3. Collection of Data

2.3.1. *II. stage: Application of the scale*

The stratified sampling method was used in sample selection. Stratified sample selection is based on dividing the samples in the universe into non-overlapping layers and making random selections among these layers (Earl, 2004). Table 2 presents the demographic information of the participants.

Table 2. *Distribution of demographic variables of the study groups.*

Participant Characteristics		EFA Working Group	CFA Working Group	Measurement Invariance Group
Variables	Sub-Variables	*n*	*n*	*n*
Branch	Science Teacher	74	73	129
	Class Teacher	74	73	191
Professional Experience	0-5 years	2	3	6
	5-10 years	11	14	25
	10-15 years	20	20	38
	15-20 years	28	24	57
	20-25 years	44	50	103
	25 years over	43	35	91
Gender	Male	30	34	69
	Female	118	112	251
Faculty	Faculty of Education	104	103	229
	Science and Literature	18	27	42
	Other Faculty	26	16	49
Education Level	Bachelors	119	121	261
	Master's Degree	28	24	57
	PhD	1	1	2
	Total	148	146	320

Based on the advantage-disadvantage criterion of the educational regions where the teachers work, the universe was divided into three districts that were homogeneous within themselves but heterogeneous among themselves. It has been stated that if high factor loadings are obtained as a result of the analysis, a sample of 150 people may be sufficient (Tabachnik & Fidell, 2013). If the factor loadings of 4 or more items or variables are greater than .60, reliable results can be obtained regardless of sample size (Guadagnoli & Velicer, 1988). 294 teachers were reached in this study. While the study groups were divided into two equal groups to conduct exploratory factor analysis (EFA) and confirmatory factor analysis (CFA), the number of science and classroom teachers in the study groups was distributed equally. For measurement invariance, the final version of the scale was applied to 320 participants.

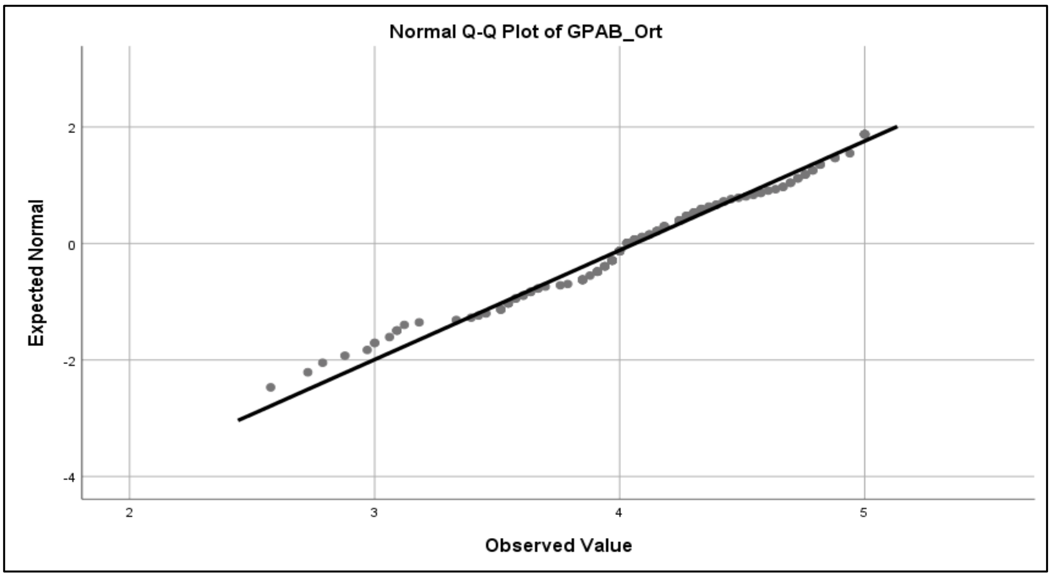
2.4. Data Analysis

2.4.1. *III. stage: Factor analysis*

Before performing factor analysis, the normality assumptions of the data set were checked. The skewness and kurtosis values of the sample group in which the EFA analysis was performed (-0,336 and +0,015) and dividing the skewness and kurtosis values by the standard error shows that the obtained values (-0,200 and +0,380) are appropriate (Büyüköztürk *et al.*, 2011; Tabachnick & Fidell, 2013). The 66th data point, which is the outlier value that prevents the normal distribution of the data set and healthy inferences, was removed from the analysis by checking the z scores (+3, -3) (Dayanıklı, 2021). Before the analysis, the KMO statistic must be at least 0.7 to ensure that the variables are suitable for factor analysis and for a good analysis (Çolakoğlu & Büyükekşi, 2014). Just like KMO, when measuring the strength of the relationship between variables in Bartlett's test, sig should be < 0,05 (Karaalioğlu, 2015). The fact that the sample group in which the EFA analysis was conducted was (KMO = 0.92 and (χ^2 = 4813.906, df = 528, sig =.00 < 0.05) shows that the data set is suitable for factor analysis. As seen in Figure 2, the points were close to the 45-degree reference line on the Q-Q plot.

In factor analysis, principal component analysis (PCA) was used to explain the variance created by variables at the maximum level, and maximum likelihood method is used for the purpose of producing theory by revealing the relationship between hidden variables, if the variables meet the assumption of normality (Çolakoğlu & Büyükekşi, 2014). Two different rotation strategies are used: orthogonal rotation when there is no relationship between the factors, and oblique rotation when a relationship between the factors is assumed (Çolakoğlu & Büyükekşi, 2014). It is stated that the total variance percentage is at least 0.60 (Alpar, 2013) and that the explained variance rate is 50% acceptable (Güriş & Astar, 2015).

Figure 2. *Q-Q plot graph.*



2.4.2. *IV. stage: Validation of the scale*

The sample group on which the CFA analysis was performed showed that the skewness and kurtosis values were (-0.163 and -0.149) and the values obtained by dividing the skewness and kurtosis values by the standard error (-0.81 and -0.37) were appropriate. The data numbered 65 and 66, which were extreme values in the data set, were removed from the analysis one by one by checking their *z* scores (+3, -3). The fact that the sample group on which the CFA analysis was performed was suitable for factor analysis (KMO = 0.93 and (χ^2 = 4126.866, *df* = 378, sig = .00 < .05) shows that the data set is suitable for factor analysis. Values of 0.90 and above for NNFI (TLI) and CFI indicate acceptable fit (Tabachnick & Fidell, 2013), while values of 0.060 and below for RMSEA indicate very good fit (Hu & Bentler, 1999). RMSEA values below 0.08 indicate a good fit for the model (Jöreskog & Sörbom, 2004). A χ^2/df value below 3 indicates that the model is perfect (Kline, 2005). For convergent validity, which shows that the expressions related to the variables are related to each other and the factor they form. The AWE value is expected to be greater than 0.5 (Yaşlıoğlu, 2017). If the CR value is greater than 0.60, it is stated that convergent validity is achieved (Shrestha, 2021), and it is also emphasized that the CR coefficient should be greater than 0.70 (Hair *et al.,* 2014).

3. RESULTS

In this section, the findings regarding the reliability and validity are presented respectively.

3.1. Findings for EFA Analysis

The EFA method, which is a statistical technique, is used to determine how the items created for a scale will be shaped, how many latent structures (factors) there are, which items are collected under which factors, and variance analysis (which items are useful) (Orçan, 2018). Since the factors are related, oblimin was used as the rotation method, PCA analysis was the most commonly used factor extraction method, and the maximum likelihood method was used since the normality assumption was met. When determining the significance of the factor loading values, according to the sample size (*N* = 120; factor loading 0.50); (*N* = 200; factor loading 0.40; (*N* = 350; factor loading 0.30) can be considered significant (Akın & Aşçı, 2021). Since the sample size was close to 200 and according to Tabachnick and Fidell (2013), the factor loading of an item to a factor should be at least 0.32, the factor loading was taken as the minimum value of 0.40.

As a result of the EFA analysis, when PCA was used as the factor extraction method, items i7 (I can explain skills specific to the Science course.) and i8 (I can explain that the science course is influenced by culture and beliefs.) in the 33-item scale were removed from the data set one by one because they loaded on more than one factor, while items i13 (I can detect students' misconceptions.) and i25 (I can use teaching methods and techniques that develop entrepreneurship (product, advertisement, poster, brochure, logo, product package, scenario writing (business scenario), interview, etc.) were not loaded on any factor as item loadings. The variance value of the PCA method was 75.91%, item loadings varied between 0.57 and 0.87, and a five-factor structure was formed; the lowest item loading was i9, the highest item loading was i16. When the maximum likelihood method was used as one of the factor extraction methods, items i7, i8, i13, i19 (I can produce projects, designs, materials, etc. related to entrepreneurship in the Science course.) and i20 (I can explain the topics and concepts in Science class.) were removed from the analysis one by one because they did not load on any factor as item loading. The total variance value was 76.24%, item loadings varied between 0.40-0.97, and a five-factor structure was formed; the lowest item loading was i14, and the highest item loading was i22. Due to the high level of exploratory variance analysis and the purpose of revealing the relationship between latent variables and generating theory, confirmatory analysis was continued with the results of the maximum likelihood method (Rotation-Oblimin), one of the factor extraction methods (see Table 3).

Table 3. *Exploratory factor analysis results for the scale.*

Items	Factor Loadings 1	2	3	4	5	Corrected Item-Total Correlation
i29	.890					.843
i32	.888					.896
i33	.871					.821
i31	.843					.884
i30	.818					.830
i28	.757					.809
i27	.687					.828
i26	.482					.804
i25	.403					.719
i22		.974				.872
i21		.913				.795
i23		.643				.659
i24		.586				.749
i9		.451				.646
i6		.423				.658
i2			.948			.881
i3			.872			.849
i4			.749			.833
i5			.728			.786
i1			.664			.776
i16				-.941		.864
i17				-.769		.861
i15				-.671		.723
i18				-.658		.760
i11					.842	.781
i10					.792	.741
i12					.529	.559
i14					.400	.631

When the data in Table 3 is examined, the first factor consisting of nine items is α = .96, the second factor consisting of six items is α = .90, the third factor consisting of five items is α = .93, the fourth factor consisting of four items is α = .91, the fifth factor consisting of four items is α=0.85, and the Cronbach's alpha (α = .96) value of the entire scale is high, indicating that our scale is reliable. The item-total correlation should be above .5 (Field, 2006). It was determined that the item correlation and total item correlation values of the scale varied between 0.559-0.895 for the first factor, while the smallest item correlation was i25 and the highest item correlation was i32; for the second factor, while the smallest item correlation was i9 and the highest item correlation was i22; for the third factor, while the smallest item correlation was i1 and the highest item correlation was i2, for the fourth factor, while the smallest item correlation was i15 and the highest item correlation was i16; for the fifth factor, the smallest item correlation was i12 and the highest item correlation was i11.

Other alternative methods for determining the number of factors are Horn's (1965) parallel analysis technique. It is based on Horn's (1965) parallel analysis, by subjecting a random serial correlation matrix containing the same number of participants and variables as the real data to principal component analysis and calculating the average of the eigenvalues. The parallel analysis method should be used to verify the determination of the number of factors and to be evaluated together with the results of factor extraction methods (Koçak *et. al.*, 2016).

Table 4. *Eigenvalues, variances and total variances of five factors and parallel analysis.*

	Maximum Likelihood Rotation technique: Oblimin			Parallel Analysis		
Factor	Eigenvalue	% Variance	% Cumulative	Root	Means	Percentile
Factor 1	14.23	49.07	49.07	1	.27	.40
Factor 2	3.42	11.50	60.58	2	.12	.19
Factor 3	1.89	6.72	67.29	3	.01	.07
Factor 4	1.32	4.72	72.01	4	-.08	-.02
Factor 5	1.19	4.23	76.24	5	-.18	-.12

In the parallel analysis method, by comparing the eigenvalue with the random eigenvalue, those whose initial eigenvalue is greater than the random eigenvalue are accepted as factors. When we look at Table 4, it is supported that the number of factors is five because the eigenvalues of the factors obtained by the maximum likelihood factor extraction method are greater than the random eigenvalues obtained from parallel analysis.

The first factor is named as entrepreneurship pedagogical content knowledge (E-PCK) because it consists of subcomponents of E-PCK and EPK knowledge dimensions. The second factor is named as pedagogical content knowledge (PCK). After all, it consists of subcomponents of PCK knowledge dimension, the third factor is named as entrepreneurship knowledge (EK) because it consists of subcomponents of EK knowledge dimension, the fourth factor is named as entrepreneurship content knowledge (ECK) because it consists of subcomponents of ECK knowledge dimension and the fifth factor is named as field knowledge (CK) because it consists of subcomponents of CK knowledge dimension.

Another method used in item validity is to determine the top and bottom 27% groups after ranking the total scale scores of the lower and upper end groups of 27% from the smallest to the largest and comparing the items in the scale with an independent t-test (Flanagan, 1952).

Table 5. *E-PCK scale 27% upper and lower group independent groups t-test results.*

27% Groups	*n*	$\bar{X}$	*s*	*t*	*sd*	*p*	95% Confidence
Upper Group	40	136.35	6.38	19.89	65	.000	42.31
Sub Group	40	97.90	10.43				34.59

$p < .05$

When Table 5 is examined, in the upper 27% (40) and lower 27% (40) score sections of the E-PCK scale; The upper group mean score is $\bar{X}$ = 136.35 and the lower group mean score is $\bar{X}$ = 97.90, $t(65) = 19.89$ and $p = .000$, that is, $p < .05$, making the difference in question 27% in favor of the upper group. In other words, the factors can distinguish between the upper and lower 27% groups.

3.2. Findings for CFA Analysis

The 28-item, 5-factor structure resulting from the EFA analysis was tested with confirmatory factor analysis (CFA). When Table 6 is examined, the model fit index results support the acceptability of the scale. RMSEA 90% CI was found to be between [.071 - .093]. Initially, the standardized estimate values of i12 (I can evaluate students' learning levels with different measurement and evaluation tools (readiness tests, rubrics, etc.), i6 (In science class; I can explain the basic concepts of physics, chemistry, biology, astronomy and earth science.) and i4 (I can notice innovations that may arise in areas I am interested in.) were determined to be

0.399, 0.592 and 0.693, respectively. Since standard estimate values are expected to be 0.70 and above, items i12, i6 and i4 were removed from the analysis one by one.

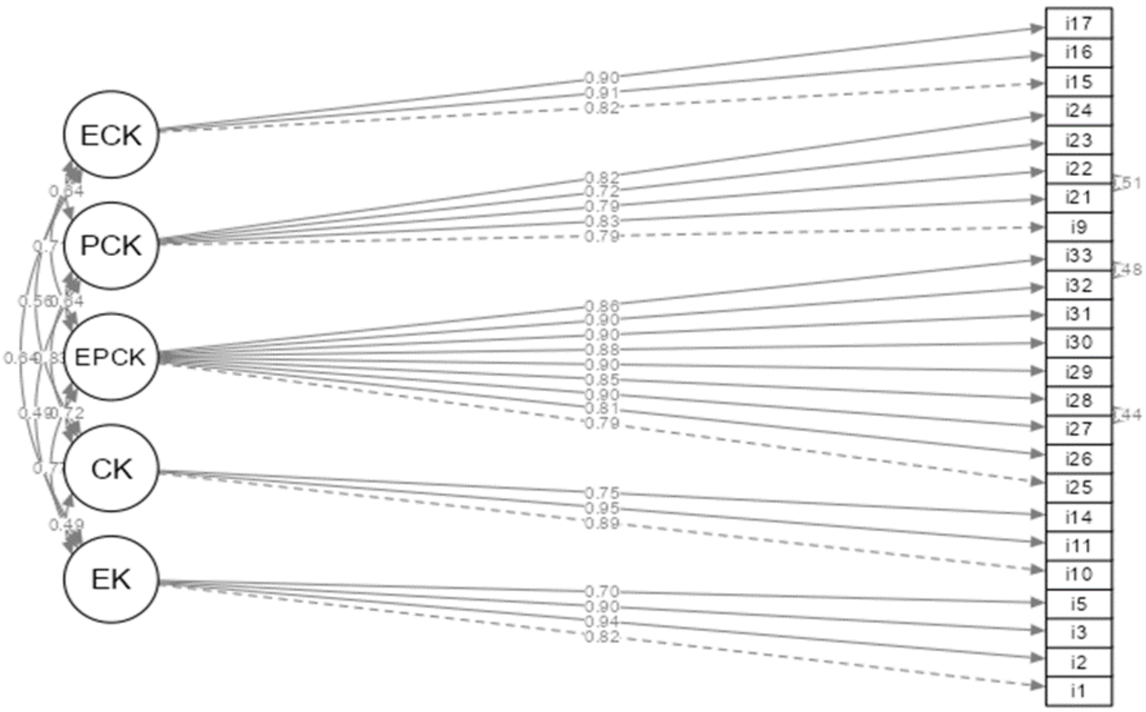
Table 6. *Model fit indices for the E-PCK scale (n = 146).*

Fit values	Good fit values	Acceptable fit values	E-PCK scale fit values	Result
χ^2/df	$0.00 < (\chi^2/df) < 3.00$	$3.00 < (\chi^2/df) < 5.00$	1.98	Good fit
CFI	95 < CFI < 1.00	.90 < CFI < .95	.93	Acceptable fit
NNFI (TLI)	.95 < NNFI < 1.00	.90 < NNFI < .95	.92	Acceptable fit
SRMR	.00 < SRMR < .05	.05 < SRMR < .10	.057	Acceptable fit
RMSEA	.00 < RMSEA < .05	.05 < RMSEA < .10	.082	Acceptable fit

Note. TLI = Tucker-Lewis Index; CFI = Comparative Fit Index; RMSEA = Root Mean Square Error of Approximation; AIC = Akaike information criterion (Hu & Bentler, 1999); BIC = Bayesian Information Criterion. AIC = 5059; BIC = 5312). $\chi^2 = 473$; $df = 239$, $p < .001$.

Byrne (2001) states that if the absolute values of most of the standardized covariances of the residuals are less than three, the model is correct, and if the covariance is greater than three, it should be deleted. Therefore, while article i18 was removed, it was observed that three modification suggestions emerged between i22-i21, i27-i28, i32-i33. Modification processes were carried out among the items that were predicted to make a high contribution to the model, respectively. Figure 3 shows the path diagram of the complex-related multidimensional CFA results of the E-PCK scale.

Figure 3. *Five factor confirmatory factor analysis model of the scale.*



The data obtained as a result of AVE and CR analysis according to the categorical variable of the scale's branch (Science-Class) are presented in Table 7. When Table 7 is examined, When the first structured model consists of both classroom and science teachers, it is seen that for all factors (except EK), CR values are greater than .70 and AVE values are greater than .50. When the second structured model consists of only science teachers, it is seen that for all factors (except EK), CR values are greater than .70 and AVE values are greater than .50. When the third structured model consists of only classroom teachers, it is seen that for all factors (except EK and CK), CR values are greater than .70 and AVE values are greater than .50. These estimates show that the scale has discriminant validity. Therefore, although the scale measures similar concepts conceptually, it is seen that the measurements are sufficiently different from each other. Both Cronbach's Alpha and CR values show that all factors have high reliability.

Table 7. *Fit values of models related to the factor structure of the E-PCK scale.*

Model	Variable	α	ω_1	ω_2	ω_3	AVE	CR
Configural model Science Teacher (*N* = 73) Class Teacher (*N* = 73)	EK	.904	.911	.911	.914	.723	.593
	CK	.890	.903	.903	.910	.759	.750
	E-PCK	.965	.960	.960	.971	.761	.844
	PCK	.900	.878	.878	.874	.625	.705
	ECK	.906	.907	.907	.908	.766	.813
Configural model Science Teacher (*N* = 129)	EK	.874	.873	.873	.829	.643	.602
	CK	.885	.892	.892	.932	.734	.804
	E-PCK	.929	.928	.928	.886	.812	.733
	PCK	.911	.885	.885	.834	.637	.703
	ECK	.953	.946	.946	.927	.695	.870
Configural model Class Teacher (*N* = 191)	EK	.866	.895	.895	.949	.690	.458
	CK	.865	.854	.854	.810	.662	.644
	E-PCK	.889	.890	.890	.902	.730	.785
	PCK	.883	.888	.888	.995	.632	.758
	ECK	.956	.950	.950	.961	.715	.780

Note. α = Cronbach Alpha; AVE = Average Variance Extracted; CR = Composite Reliability, $p < .001$

3.3. Measurement invariance

In order to learn whether the latent variables in a model established using CFA with multi-group applications create differences between groups, Chen (2007) recommends the ΔCFI ≤ .01 criterion instead of chi-square (due to its statistical weakness due to sample size (Vandenberg & Lance, 2000). Chen (2007) states that ΔCFI ≤ -.010 and ΔRMSEA ≤ .015 values are good cut-off points for invariance decisions for samples larger than 300. SRMR value of .08 indicates an acceptable fit, and a SRMR value of less than .05 indicates a perfect fit (Hu & Bentler, 1999). RMSEA of less than .08 is considered an acceptable fit (Browne & Cudeck, 1993).

In this study, while the CFI differences were found for formal invariance, metric invariance, scalar invariance and strict invariance, measurement invariance types were examined, the χ^2/df ratio, and RMSEA indices were reported at the end of each invariance test to obtain information about the model data fit. The model in which factor loadings, factor correlations and error variances are free, which is defined as configural invariance; the model in which factor loadings are fixed, factor correlations and error variances are free, which is defined as metric invariance; the model in which factor loadings and factor correlations are fixed, and error variances are free, which is defined as scalar invariance; and the model in which factor loadings, factor correlations and error variances are fixed, which is defined as strict invariance (Alparslan *et al.*, 2023; Yiğiter, 2023). The findings of the four models established for testing the measurement invariance of the E-PCK scale according to the branch variable are given in Table 8. When Table 8 is examined, it is seen that the goodness of fit indices calculated for the structural invariance model of the scale (SRMR = .067 < .08; RMSEA = .076 < .08) show an acceptable fit. For this reason, it can be said that the structural invariance model is provided. Since structural invariance is provided, it can be interpreted that the scale has the same factor structure in subgroups according to the branch variable and that the items in this scale measure the same structure in branch subgroups. Since evidence was obtained that structural invariance was provided, the metric invariance stage was passed. In order to decide on the measurement invariance between groups, a more limited number of models were compared with other models and the difference values of fit indices (ΔCFI) and (ΔRMSEA) were examined.

Table 8. Measurement invariance fit indexes (*N* = 320).

Models	χ^2	*df*	χ^2/df	SRMR	TLI	CFI	RMSEA	ΔCFI	ΔRMSEA
Configural	916.23	478	1.92	.067	.907	.920	.076	-	-
Metric	942.70	497	1.90	.075	.909	.918	.075	-.002	-.001
Scalar	1007.48	516	1.95	.076	.904	.910	.077	-.008	.002
Strict	1054.50	540	1.95	.077	.900	.902	.077	-.004	.000

It is seen that the goodness of fit indices calculated in the metric invariance model stage (SRMR = .075 < .08; RMSEA = .075 < .08) show good fit. In order to evaluate the metric invariance model, ΔCFI, ΔRMSEA values between the structural invariance model and the metric invariance model were examined. The calculated values (ΔCFI = -.002, ΔRMSEA = -.001) support the evidence that metric invariance was achieved. Since metric invariance was achieved, it was determined that the factor loadings of the E-PCK scale were equal in the subgroups categorized according to the gender variable and the items in this scale were interpreted similarly in the branch subgroups. Since evidence was obtained that metric invariance was achieved, the scalar invariance stage was passed.

It is seen that the goodness of fit indices calculated in the scalar invariance model stage (SRMR = .076 < .08; RMSEA = .077 < .08) show good fit. In order to evaluate whether evidence for the scalar invariance model was obtained, the ΔCFI, ΔRMSEA values between the metric invariance model and the scalar invariance model were examined. Scalar invariance was achieved (ΔCFI = -.008, ΔRMSEA = .002). According to these findings, it was found that the constants in the regression equations created for the items as well as the item and factor groups of the model in the branch sub-dimension did not change. After the scalar invariance stage was completed, the stage of examining strict invariance was passed.

In the strict invariance model, in addition to the limitations in scalar invariance, the condition that error variances are equal in subgroups is also imposed. It is seen that the goodness of fit indices calculated in the strict invariance model stage (SRMR = .077 < .08; RMSEA = .077 < .08) show good fit. In order to understand whether evidence for the strict invariance model was obtained, the ΔCFI and ΔRMSEA values between the scalar invariance model and the strict invariance model were examined. Findings indicating that strict invariance was achieved were obtained (ΔCFI = -.004, ΔRMSEA = .000).

4. DISCUSSION and CONCLUSION

The E-PCK scale was developed to measure the pedagogical content knowledge required for science and classroom teachers who implement the science curriculum to provide students with entrepreneurial skills. Thanks to this research, factor structures with high validity and reliability and items specific to factor structures were created. The E-PCK scale developed in the study was designed as 33 items consisting of 7 factors, namely entrepreneurship knowledge (EK), content knowledge (CK), entrepreneurship content knowledge (ECK), pedagogical knowledge (PK), entrepreneurship pedagogical knowledge (EPK), pedagogical content knowledge (PCK), and entrepreneurship pedagogical content knowledge (E-PCK). In addition to the most commonly used PCA method during factor analysis, maximum likelihood factor extraction methods were used since normality assumptions were met. It is recommended to use more than one technique instead of a single method in factor analysis and to select the one that gives the best results (Thompson, 2008). Therefore, in the EFA analysis, rotation techniques (obliman and varimax) were used. In this context, as a result of the analysis performed, it was found that the number of factors was the same in both methods, and i7, i8, and i13 were removed from the data set in both factor extraction methods. While i25, which was deleted in the PCA analysis, fell under the E-PCK factor in the maximum likelihood method i19, which was deleted from the maximum likelihood analysis, fell under the ECK factor in the PCA analysis. Finally, as a result of the EFA maximum likelihood analysis, the total variance value of the 28-item, five-factor structure was found to be 76.24%. Since the percentage of explaining the desired feature was higher than PCA, CFA analysis was performed using these analysis results. When the assumptions of factor analysis are met, the maximum likelihood method gives the best results (Huck, 2012).

The parallel analysis method was also used to determine the accuracy of the factor number. The variance value of the scale items explaining entrepreneurship pedagogical content knowledge was determined as 76.24%. By deleting 4 items with CFA analysis, the structure was transformed into a 5-factor 24-item structure. The factors were named as entrepreneurship knowledge (EK), content knowledge (CK), entrepreneurship content knowledge (ECK), pedagogical content knowledge (PCK), and entrepreneurship pedagogical content knowledge (E-PCK). While the pedagogical knowledge (PK) and entrepreneurship-pedagogical knowledge (EPK) knowledge dimensions were not formed separately as factors in the EFA analysis, it was determined that all items of the EPK knowledge dimension were included under the E-PCK factor. In addition, items i6, i7, and i8 in the PK knowledge dimension were removed from the data set during the analysis, while i9 was included under the PCK factor. It is thought that the reason for the transformation of the scale designed as a 7-factor structure into a 5-factor structure is the similarity of the subcomponents of PK with PCK and EPK with E-PCK. This situation shows that the structure validation of PCK is challenging, and since factor combination is a frequently encountered problem in the structure validation presented, it was determined that the three-factor PCK framework could not be recreated in the analysis performed using EFA (Archambault & Crippen, 2009; Koh *et al.,* 2010). It has been stated that the overlapping components of PCK are fuzzy (Graham, 2011). PCK is difficult to define, which weakens its accuracy and makes PCK analysis difficult (Gess-Newsome, 1999; Aydın & Boz, 2012). Research indicating that the information categories and components constituting PCK are intertwined also supports this situation (Kersting *et al*., 2020).

In CFA, in addition to the χ^2/df value (Kline, 2005), which is frequently used in the literature, the fit indices that should be taken into consideration in determining model fit are RMSEA and SRMR (Hu & Bentler, 1999) and CFI and TLI (Tucker & Lewis, 1973). Therefore, these fit indices were used in model evaluation in the study. As a result of the analysis of AVE, CR and the square root of AVE and correlation coefficients between factors obtained with CFA, it was seen that the scale met the convergent and discriminant validity conditions. In the reliability analysis of the scale, Cronbach's alpha coefficient and CR values were examined, and the fact that these values were above .80 indicates that sufficient conditions for reliability were met. The scale was compared to 27% (Lower-Upper Group) to test the extent to which the items discriminate.

The scale was compared to 27% (Lower-Upper Group) to test the extent to which the items discriminate. The factors can distinguish the lower and upper groups of 27%. The 95% confidence interval for the difference in arithmetic means was calculated as [42.31 to 34.59]. In the 95% confidence interval, the difference between the mean scores of the two groups indicates that there is a significant difference between these two groups. When the validity and reliability evidence of the scale are evaluated together, it can be said that the scale can be used safely to determine the entrepreneurship pedagogical field knowledge of teachers. The fact that the entrepreneurship knowledge CR values are less than 0.70 shows that the teacher's knowledge of EK is not sufficient. The scale is supported by the study finding that the reason for the CRs of the CK values of only classroom teachers being less than 0.70 is that they lack curriculum knowledge and subject matter knowledge and continue to use traditional approaches in the teaching process (Başar, 2013).

According to the analysis results made with the MG-CFA method, measurement invariance has been provided according to the branch. According to the obtained results, the item factor structure and factor loadings, variances, covariances and error variances are equivalent according to the branch variable. When the metric invariance of the E-PCK scale is compared with its configural invariance (ΔCFI = -.001 and ΔRMSEA = -.001), it can be stated that science and classroom teachers use the same conceptual perspectives when answering the scale items, the relationships between the measured features and the E-PCK dimensions are similar and the factor loadings are equivalent in terms of teacher groups. When the fit indexes regarding scalar invariance (ΔCFI = -.008 and ΔRMSEA = .002) are taken into consideration. It was concluded that there was no item-based bias for the groups and scalar invariance was achieved. With the data obtained at the strict invariance stage (ΔCFI = -.004 and ΔRMSEA = .001), it was assumed that the specific error terms related to the items constituting the measurement tool were equal/invariant between the comparison groups.

According to the EFA and CFA results, it was seen that the resulting structures were compatible and the reliability of the internal consistency coefficients was high for both the entire scale and the sub-factors. It consists of items aimed at measuring PCK components. The scale developed in this study allowed us to examine all components of PCK according to Shulman (1986), Magnusyon *et. al.* (1999), Grossman (1990). However, transferring the information content to PCK components and revealing the common points between PCK blurs the boundaries of PCK components and cause difficulties in PCK analysis (Şen, 2023). Determining dimensions such as EK, CK, EK, PCK and E-PCK is important in terms of developing the E-PCK framework for entrepreneurship knowledge, as it integrates entrepreneurship with content knowledge and presents entrepreneurship with appropriate teaching methods and techniques. It is stated that PCK, which is developed as a component of teachers' professional knowledge and as a result of classroom experiences, is a structure acquired through teaching experiences (Van Driel *et al*., 1998). It has been stated that if we want to promote students' entrepreneurial learning in real-life contexts, we need to understand the perspectives of those who are responsible for pedagogical solutions in schools (Sommarström *et al*., 2020). A guiding educational content for entrepreneurship in science education can associate entrepreneurship with science and increase the importance of using this skill in the field (Deger *et al*., 2023). The concept of entrepreneurship should be emphasized in accepted teacher training programs and pedagogical entrepreneurship, which is associated with students' active learning methods and learning strategies (Haara *et al.,* 2016). Entrepreneurship can open new horizons for the development of science teaching and learning by examining the components of PCK and taking these components into consideration. In skill-oriented scale development studies, researchers can be advised to work with three knowledge dimensions: skill knowledge, skill pedagogical content knowledge, and pedagogical content knowledge. There are studies in the literature that conducted DIF and item bias studies among measurement invariance analyzes (Gören *et al*., 2024). For this reason, it will be very useful to conduct DIF and item bias studies of this scale in the later stages.

4.1 Limitations

Although this study has some limitations, it will be useful in terms of providing research opportunities. Teachers working in Türkiye participated in 2023. Therefore, the content of the scale reflects the realities of the time when the responses were collected (school environment, teacher motivation, professional knowledge, etc.) and the pedagogical content knowledge of teachers regarding entrepreneurship. The results can be reviewed by comparing the analysis results by applying it to different teacher groups. It can be applied to a larger sample group of participants to check the factor structure. Therefore, its validity needs to be verified in various regions for global applicability. It is important to evaluate the E-PCK scale by taking into account more than one of its components.

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Declaration of Conflicting Interests and Ethics

The authors declare no conflict of interest. This research study complies with research publishing ethics. The scientific and legal responsibility for manuscripts published in IJATE belongs to the authors. **Ethics Committee Number**: Gazi University, 07.02.2023/02-113.

Contribution of Authors

Berna Kılıç: Investigation, data collection, data analysis, resources, visualization, software, statistical analysis, and writing-original draft. **Mahmut Selvi**: Methodology, supervision and validation.

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APPENDIX

Appendix 1. *Entrepreneurship Pedagogical Content Knowledge Scale (Turkish Version of The Scale).*

Madde No	Bilgi Boyutu	Maddeler	Kesinlikle Katılıyorum	Katılıyorum	Kararsızım	Katılmıyorum	Kesinlikle Katılmıyorum
1	Girişimcilik Bilgisi	Bir problemin çözümündeki fırsatları iş fikrine dönüştürebilirim.					
2		Bir ürünün pazarlaması için gerekli iş planını oluşturabilirim.					
3		Bir ürünün pazarlaması ile ilgili süreci açıklayabilirim.					
4		İlgi duyduğum alanlarda ortaya çıkabilecek yeniliklerin farkına varabilirim.					
5		Yaptığım işle ilgili fırsatları görebilirim.					
6	Pedagojik Bilgi	Sınıf ortamında farklı öğretim yaklaşımlarını (5-E öğretim modeli, kavramsal değişim yaklaşımı vb.) kullanabilirim.					
7		Öğrencilerin öğrenme düzeylerini farklı ölçme ve değerlendirme araçları ile (Hazırbulunuşluk testleri, dereceli puanlama anahtarı vb.) değerlendirebilirim.					
8		Öğrencilerin kavram yanılgılarını tespit edebilirim.					
9		Öğretim programında yer alan kazanımları biliyorum.					
10	Alan Bilgisi	Fen Bilimleri dersinde; fizik, kimya, biyoloji, astronomi, yer bilimi ile ilgili temel kavramları açıklayabilirim.					
11		Fen Bilimleri dersine özgü becerileri açıklayabilirim.					
12		Fen Bilimleri dersinin kültür ve inançlardan etkilendiğini açıklayabilirim.					
13		Fen Bilimleri dersinde bilimsel araştırma yöntemlerini kullanırım.					
14		Fen Bilimleri dersindeki konu ve kavramları disiplinlerarası bakış açısıyla anlatabilirim.					
15	Girişimcilik Alan Bilgisi	Fen Bilimleri ders içeriğindeki girişimcilik konularını (Madde ve Doğası, Basit Makineler vb.) biliyorum.					
16		Günlük hayatta karşılaşabileceğimiz problemlerin çözümlerini girişimcilik ile ilişkilendirebilirim.					
17		Öğrencilere konunun öğretim sürecinde girişimcilik örnekleri verebilirim.					
18		Fen Bilimleri projelerini (Basit makine yapımı ve pazarlama stratejisi vb.)girişimcilik ile ilişkilendirebilirim.					
19		Fen Bilimleri dersinde girişimcilik ile ilgili proje, tasarım, materyal vb. etkinlikler üretebilirim.					
20	Pedagojik Alan Bilgisi	Fen Bilimleri dersindeki konu ve kavramları açıklayabilirim.					
21		Dersin öğrenme hedeflerine uygun, ölçme ve değerlendirme araçları kullanabilirim.					
22		Konuya uygun öğretim yöntem ve teknikleri kullanabilirim.					
23		Sınıf içerisindeki bireysel farklılıkları gözeterek dersi yürütebilirim.					
24		Fen Bilimleri dersi öğretim programına ait kazanımları açıklayabilirim.					
25	Girişimcilik Pedagojik Bilgisi	Girişimciliği geliştirici öğretim yöntem ve tekniklerini (ürün, reklam, afiş, broşür, logo, ürün paketi, senaryo yazımı (iş senaryosu), röportaj vb.) kullanabilirim.					
26		Girişimcilik çalışmalarında öğrencileri teşvik ederim.					
27		Girişimcilik becerisini gerektiren Fen Bilimleri dersi kazanımlarını biliyorum.					
28		Öğrencilerin girişimcilik becerilerini uygun ölçme-değerlendirme araçları ile değerlendirebilirim.					
29	Girişimcilik Pedagojik Alan Bilgisi	Fen Bilimleri dersi öğretim programında yer alan girişimcilik ile ilgili kazanımlara örnekler verebilirim.					
30		Fen Bilimleri derslerinde girişimciliğe özgü “mini şirket, işletme ziyareti, iş planı yarışması düzenlemesi vb.” öğretim teknikleri kullanabilirim.					
31		Fen Bilimleri dersi ünitelerinde girişimcilikle ilgili konularda öğrencilere rehberlik yapabilirim.					
32		Fen Bilimleri dersindeki girişimcilik becerisine yönelik konuları açıklayabilirim.					
33		Girişimcilik becerisine uygun ölçme ve değerlendirme araçlarını (derecelendirme ölçekleri, durumsal yargı testleri, performans değerlendirmeler ve simülasyonlar vb.) kullanarak değerlendirebilirim.					