Development of Attitude Scale Towards the Use of Technology in Primary School Science Course

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Abstract

The aim of this research is to determine the attitudes of 3rd and 4th grade students towards the use of technology in science lessons during the 3rd and 4th centuries. The study utilised a quantitative research method employing a survey design. An attitude scale comprising 30 items was developed using a 3-point Likert scale, including options such as "yes," "no," and "sometimes," suitable for primary school students. After the preliminary application and expert opinions, the items of the scale were revised, resulting in a reduced scale consisting of 23 items. The 23-item scale was administered to a sample of 269 students randomly selected from 3rd and 4th grade students attending Konya Central Primary Schools. Following the analysis of the collected data, the scale was further reduced to 10 items. The Kaiser-Meyer-Olkin value, which assesses the applicability of the scale to factor analysis for determining construct validity, was found to be 0.95. The scale items exhibited factor loads ranging from 0.72 to 0.90, indicating a unidimensional structure that accounted for 67% of the total variance. To evaluate the reliability of the scale, the internal consistency coefficient (Cronbach's alpha) was computed and yielded a value of =0.944, indicating high reliability. Consequently, a valid and reliable attitude scale was successfully developed to assess the attitudes of 4th grade students in primary schools towards the use of technology in science lessons, contributing to the existing literature in this field.

Keywords: attitude scale, science course, primary school students, use of technology in science

İlkokul Fen Bilimleri Dersinde Teknoloji Kullanımına Yönelik Tutum Ölçeği Geliştirilmesi

Özet

Bu araştırmanın amacı, 3. ve 4. Sınıf öğrencilerinin fen bilimleri dersinde teknoloji kullanımına yönelik tutumlarını belirlemeye yönelik geçerli ve güvenilir bir tutum ölçeği geliştirmektir. Araştırma, nicel araştırma yöntemi desenlerinden tarama desenine kullanılarak gerçekleştirilmiştir. 30 maddeden oluşan tutum ölçeği ilkokul öğrencilerinin seviyesine uygun olacak şekilde 3'li likert ve ''Evet'' , ''Hayır'', ''Bazen'' şeklinde tasarlanmıştır. Hazırlanan taslak ölçeğin maddeleri ön uygulama ve uzman görüşleri doğrultusunda tekrar düzenlenmiş ve ölçek 23 maddeye düşmüştür. 23 maddelik ölçek Konya merkez ilkokullarında öğrenim gören 3. ve 4. sınıf öğrencileri arasında tesadüfî örnekleme yöntemiyle seçilen 269 öğrenciye uygulanmıştır. Uygulama doğrultusunda yapılan analizler sonucu ölçek 10 maddeye indirilmiştir. Yapı geçerliğini belirlemek için yapılan faktör analizine ölçeğin uyguluk durumunu belirleyen Kaiser-Meyer-Olkin değeri 0.95 bulunmuştur. Ölçek maddeleri faktör yüklerinin 0.72-0.90 arasında değişen tek faktörden oluştuğu ve varyansın toplamda %67'sini açıkladığı görülmektedir. Ölçeğin güvenirliğini tespit etmek amacıyla ölçülen iç tutarlık katsayı (Cronbach alpha) değerinin α=0.944 olduğu görülmüştür. Bu bağlamda ilkokul 4. sınıf öğrencilerinin fen bilimleri dersinde teknoloji kullanımına yönelik tutumlarını tespit için alanyazına fayda sağlayacak geçerli ve güvenilir bir tutum ölçeği elde edilmiştir.

Anahtar Kelimeler: tutum ölçeği, fen bilimleri dersi, ilkokul öğrencileri, fen bilimlerinde teknoloji kullanımı

Introduction

The rapid advancements in modern science and technology have had far-reaching consequences for various aspects of human life (Demirci, 1993). These effects have permeated numerous domains and led to groundbreaking reforms in research, healthcare, defence, industry, and trade. Education is one such domain where the integration of technology is expected to meet the needs of society. Consequently, the use of technology in education has become increasingly common with the establishment of new techniques for learning, teaching, assessment, and activities (Smith, 1993). Distance education, in particular, has

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greatly benefited from these developments (Akpınar, 2003; Şimşek & Tuncer, 2016; Akyürek, 2020).

The incorporation of technology into the instructional process has prompted numerous domestic and international studies to explore its contributions to education. For instance, UNESCO's report titled "Innovative Use of Technology in Education," published in 2022, investigates the quality of education and training activities in educational institutions that utilise technology (UNESCO, 2022). These studies have yielded various findings. According to Somyürek (2014), the use of technology-based educational materials in schools facilitates the embodiment of abstract ideas in a way that students can comprehend, playing a significant role in the educational process. Similarly, Doğan et al. (2012) argue that integrating diverse technologies into instruction makes knowledge acquisition easier by introducing variety to the learning environment.

When analysing the scientific curriculum of our country, it becomes evident that various aspects of the programme emphasise the incorporation of technology into everyday life (MEB, 2018). This emphasis stems from the fact that the scientific curriculum often deals with abstract ideas, necessitating the use of a wide range of technological resources in the teaching process (Bal, 2015). Providing primary school students with a science education that utilises technological tools such as smart boards, tablets, multimedia, animations, and laboratory equipment is crucial for explaining abstract concepts in an accessible manner, enhancing learning retention, and improving students' cognitive abilities (Pekdağ, 2005). For example, teaching "Movements of Our World," a topic within the science curriculum that explores the universe, utilising various technological tools like smart boards, animations, simulations, and tablets can significantly enhance the significance and durability of learning. According to Akpınar et al. (2005), the majority of students perceive better performance in classes organised in this manner.

Attitudes can be regarded as phenomena that influence individuals' decision-making behaviours and enable them to direct their actions in a specific way. Attitudes are phenomena that affect individuals decision-making behaviors and enable individuals to direct these behaviors in a certain way. (Morgan et al., 2010). Considered learned behavioural tendencies (Demirel, 2003), attitudes serve as indicators of individuals' positive or negative reactions towards objects, ideas, and groups that they individually adopt (Koballa, 1988; Gay et al., 2000). Attitudes are also shaped by our relationships with individuals in our immediate environment, with various experiences over time leading to gradual shifts in perspective, while unexpected encounters can bring about rapid changes in attitudes (Arslan, 2006). Developing attitude scales, particularly for measuring attitude formation, development, and change, is of utmost importance (Cabı, 2016). Such scales enable researchers to determine whether students' attitudes towards the educational process are favourable or unfavourable, empowering educators to take appropriate measures for an effective course. Effective selection of instructional resources by teachers can be significantly improved by understanding students' sentiments towards instructional materials related to the subject at hand. Understanding students' attitudes towards incorporating technology into their science classes is crucial for optimising the learning experience.

A comprehensive review of the literature reveals that numerous large-scale studies have been conducted to assess attitudes towards science and technology courses. These studies have focused on determining individuals' preferences and attitudes towards science and technology. Various scales have been developed specifically to measure attitudes towards science classes, such as the attitudes of 1st–8th grade students towards science lessons (Genç, 2001; Oğuz, 2002; Demirci, 2003) and the attitudes of teacher candidates towards science lessons (Nuhoğlu, 2008; Yaşar and Anagün, 2008; Balım et al., 2009; Biçer, 2011; Kenar & Balcı, 2012; Keçeci & Zengin, 2015; Taşkın & Aksoy, 2019; Özcan & Koca, 2020). Similarly, there are scales developed to assess students' attitudes towards technology and teacher candidates' attitudes towards the use of technology in education (Frantom et al., 2002; Öztürk, 2006; Yavuz, 2006; Yavuz & Coşkun, 2008; Sarıtaş & Süral, 2008; Harman & Alat, 2015; Bilgin & Arıkan, 2019).

However, it is important to note that the existing body of academic research lacks scales that specifically measure students' perspectives on the use of technology in science lectures. This research aims to fill this gap in the literature by developing a valid and reliable attitude scale to assess the attitudes of class students, specifically 3rd and 4th graders, towards the various technologies employed in science lessons.

In conclusion, this study seeks to contribute to the existing literature by developing a specialised attitude scale that focuses on students' attitudes towards the integration of technology in science education. By bridging this research gap, the scale aims to support future studies and research in this area.

Method

Research Model

Within the realm of quantitative research designs, this particular study made use of a survey design. The survey design is a pattern that is used to determine the interest, skills, attitudes, and abilities of the study group regarding a subject or event. This pattern is carried out with large samples, but its purpose is to determine these characteristics. (Fraenkel & Wallen, 2006).

Sample

The study group was carried out in 2022–2023 in Konya Province in 269 primary schools in the 3rd and 4th grades. The class is made up of students. In order to show the homogeneity of the group, students were randomly and voluntarily processed. The necessary permissions for the implementation of the scale in the determined schools were obtained from the Konya Provincial Directorate of National Education. In the study to be carried out for the validity and reliability of the scale, there were initially 310 students, but 41 were removed from the scope of the research after it was found that most of the items were blank and marked incorrectly. According to Child (2006), the recommended number of students for the application of the factor analysis technique to the study group is five times the number of items. According to Tavşancıl (2014), the recommended number of study groups should be 5 or 10 times the size of the number of articles. In this context, it is understood that the study group for the research is sufficient.

Development of the Measurement Tool

While preparing our study, the following scale development stages were taken into consideration (DeVellis, 2014).

a. ***Creation of the Substance Pool***

In the process of preparing the scale, a large literature review was carried out primarily to measure attitudes and define the specified concepts. After being examined in other scale studies carried out in the context of the research topic, an open-ended test of five questions was created. This open-ended test was applied to 10 students, and they were asked to write an essay that included their own thoughts about the use of technology in science class. As a result of the review of the literature and the content analysis of the written compositions, a draught scale of 60 items, including positive and negative items related to the subject of attitude, was created.

b. Seeking Expert Opinion

The draught scale created ranks 3rd and 4th in primary schools in terms of compliance with the subjects and content of science lessons. It was presented to 3 classroom teachers who taught the classes, 2 academicians working in higher education in terms of competence and accuracy of attitude items, and 1 person who worked as a Turkish teacher in terms of grammar. In line with the opinions and feedback of the field experts, revisions and removals of some articles were carried out at the draught scale.

c. Pre-Trial Phase

In the trial phase, the draught scale is 14 primary school students, 11 elementary school students, and 3. It was applied to a total of 25 students. The application lasted about 30 minutes, and the items that the students did not understand or misunderstood were identified. Some of the detected items were regulated, and some of them were removed from the scale.

d. Main Implementation Phase

After the article editing and removal stages carried out on the draught scale, 23 items remained on the scale. Items on the scale are "no", "sometimes", and "yes". It is arranged as a 3-point Likert-type rating scale. In the main implementation phase of the scale, 269 primary schools studied in different schools in Konya Provinces 3 and 4. It was applied to the class student.

e. Validity and Reliability Calculation Stage

In the developed attitude scale, scope validity and construct validity were examined for validity control. While examining the validity of the scope, the opinions of six field experts were consulted. For the validity of the structure, basic component analysis is used.
An explanatory factor analysis (EFA) was performed. Factor analysis is a statistical method used to determine significant relationships within a wide set of variables and reveal the structures or factors measured by scale items (Büyüköztürk, 2002). Cronbach's alpha coefficient was calculated for the reliability control of the developed scale. The obtained data were analysed with the SPSS 23 programme.

Results

Findings of Validity

EFA and Confirmatory Factor Analysis (CFA) were performed to determine the construct validity of the scale, the sub-dimensions, and the factor loads.

Findings of the Explanatory Factor Analysis

Before performing this analysis, it is necessary to determine whether the scale is suitable for EFA. The suitability of the data set obtained from the study group to the factor analysis can be understood by the Kaiser-Meyer-Olkin (KMO) coefficient and Bartlett sphericity test results (Tavşancıl, 2014). It is stated that the KMO value should be greater than 0.60 and that the value is at a perfect level as it approaches 1.00 (Kaiser, 1974). The Barlett sphericity test is expected to be significant (Pallant, 2011). Since the BMO value of this scale is 0.962 and the Barlett value is. <.001 it is accepted at an excellent level, and it is seen that the number of study groups obtained is suitable for factor analysis.

Table 1: *(KMO) Sample Measurement and Barlett's Test Results*

(KMO) Sample Measurement Value Proficiency		0.96
Spherical Barlett Test	Value of Chi-Squared	2036. 6
	df	45
	p	.000

When Table 1 is examined, it is understood that the KMO value of the Attitude Scale towards the Use of Technology in the Primary School Science Course is 0.96 and the Barlett value is 2036.6. The high results detected show the applicability of factor analysis and the correlation of the items.

Principal Components Analysis was selected as the method to determine the factor pattern of the Attitude Scale towards the Use of Technology in Primary School Science Lessons. As for the rotation method, the equal maximum (equamax) method was selected from the vertical rotation methods. In the exploratory factor analysis performed to determine the factor pattern of the attitude scale, the factor load values were set at 0.30. Tavşancıl (2014) states that when performing factor analysis, values of 0.30 to 0.40 can be taken as the lower cut-off point for factor loads. As a result of the examination of the total correlations of the substances, no substance with a value below 0.30 was found. Care has been taken to ensure that the difference between the factor charge value of a substance and the charge values of other factors is at least 0.10. However, it was determined that some items did not comply with this situation, and some items were removed from the scale in order to separate the items into as few factors as possible. According to Dağ (2002), in order to determine an item that needs to be removed from the scale, the item should first be deleted, and the change in the alpha coefficient and the mean of the scale should be monitored. In this direction, items distributed across more than one factor were deleted from the scale, and the processes were repeated in this way. Among the 3 questions in the attitude scale: 2nd, 3rd, 5th, 6th, 7th, 8th, 9th, 14th, 18th, 19th, 25th, 29th, 30th The substances were deleted, and thus more effective results were achieved.

Table 2 shows the eigenvalues, variance percentages, and total variance percentages related to a specified factor.

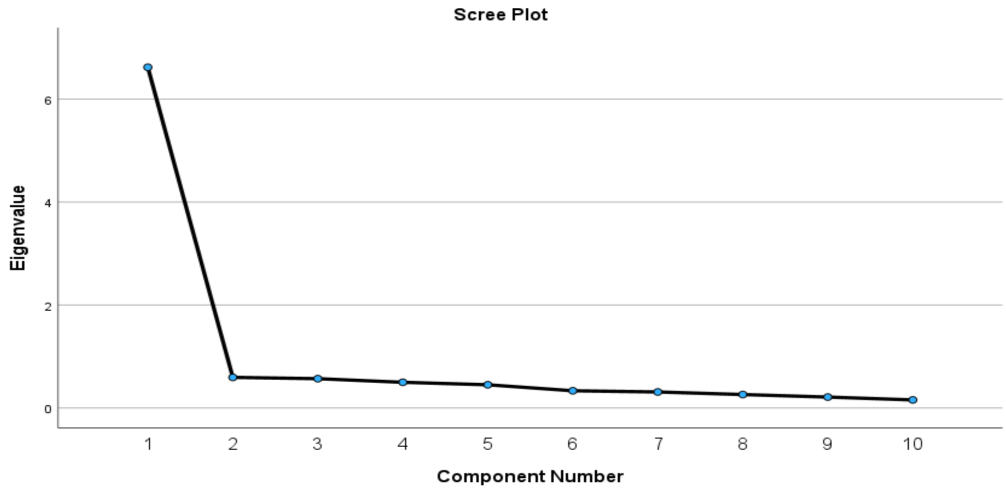
Table 2: *Findings Regarding Factors as a Result of Factor Analysis*

	Total	% Variance	Cumulative %	Total	% Variance	Cumulative %
1	7.64	66.11	66.1	6.618	66.183	66.183

As a result of the exploratory factor analysis performed again by sifting the items one by one, it was seen that the substances were collected in a single factor with an eigenvalue greater than 1. With EFA, it is suggested that the total variance requested to be explained by the factors should have a value of 50% or more (Thompson, 2004). The total amount of variance explained by the only factor determined on the scale is 66.1 percent. It is understood that the value of 66.1% on the attitude scale is suitable to explain the total variance.

A line (screen) test was performed to determine the number of factors. The graph indicating the maximum number of significant factors is shown in Figure 1.

Figure 1. *Scree Test Chart*



In the line chart, which is created by combining factors based on their eigenvalues, significant and rapid declines represent important factors, while factors close to a horizontal line represent factors with similar levels of contribution to variance. When the "Scree" test graph in Figure 1 is examined, the point at which the curve suddenly declines shows the location of the first factor. Later in the graph, it is observed that the curve is moving in almost the same direction. In light of these findings, it was concluded that the number of factors on the scale should be limited to one.

Table 3: *Attitude Scale Towards the Use of Technology in Primary School Science Lesson Factor Item Load values*

Substances	Factor Load Values
Item 1	0.72
Item 2	0.70
Item 3	0.71
Item 4	0.75
Item 5	0.82
Item 6	0.84
Item 7	0.84
Item 8	0.89
Item 9	0.88
Item 10	0.90

When Table 2 is examined, it is seen that the scale has a single-factor structure and consists of 10 items. Substance factor loads are between 0.72 and 0.90. (Büyüköztürk, 2015) According to, the factor load of a substance must be at least 0.30. In this context, it is understood that the item factor loads of the attitude scale are at a sufficient level.

Findings of Confirmatory Factor Analysis

Confirmatory factor analysis, which is performed to verify a previously obtained structure, is used to determine the validity of the scale (Sümer, 2000). After the exploratory factor analysis was performed, the only available size of the scale and the verification test of the scale structure consisting of 10 items were performed.

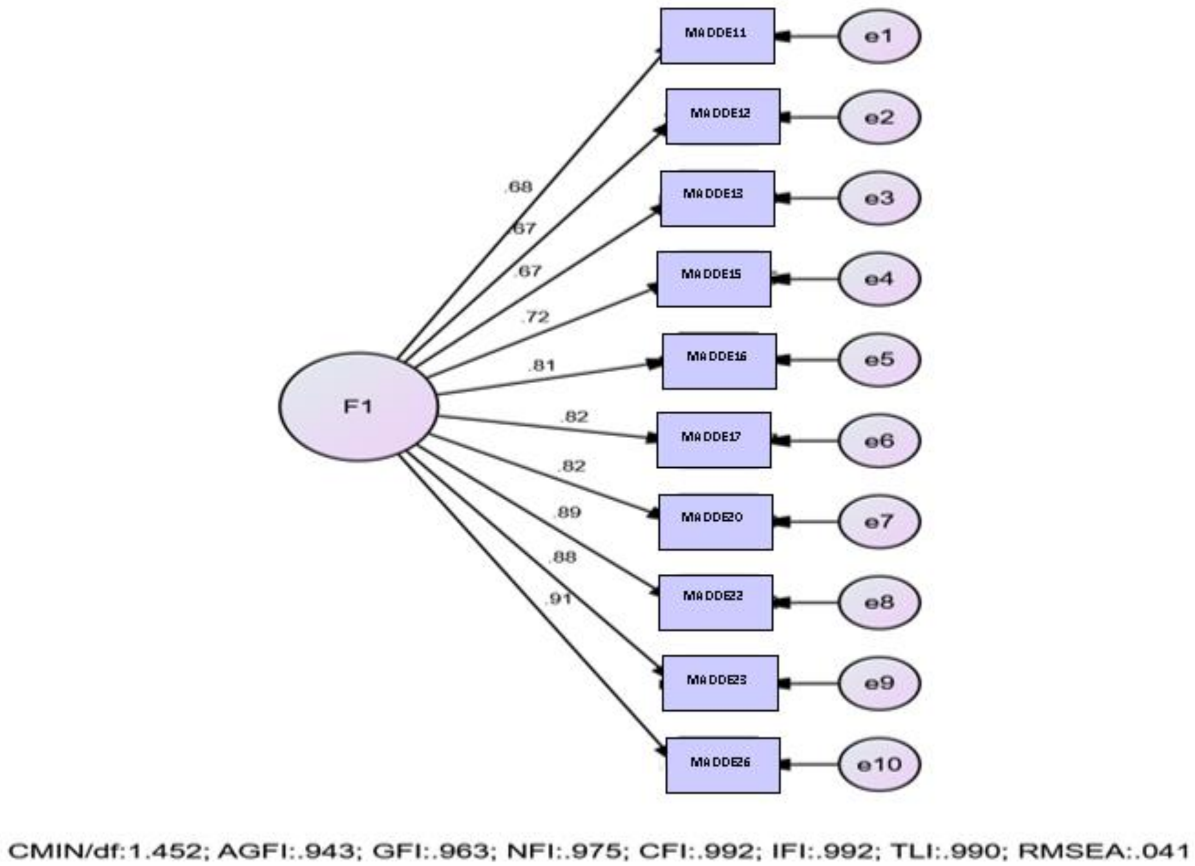


Figure 2. *Confirmatory Factor Analysis Path Diagram*

Confirmatory factor analysis was performed on the scale items to determine the compatibility of the single-factor structure performed by exploratory factor analysis. The data set of 269 people analysed in the exploratory factor analysis was transferred to the AMOS programme. For the 10-item (11,12,13,15,16,17,20,22,23,26) one-dimensional scale, path diagrams and goodness of harmony values were revealed. It turned out that the t values of the hidden variables to explain the determined variables were 0.00, and the observed variables did not have high error variances (Çokluk et al., 2010).

After examining the initial outputs of the confirmatory factor analysis, modification recommendations were made in order to improve the additional-dimensional scale. The AMOS programme proposed the association of error variances between M5 and M10 with M4 and M7. After examining the contents of the substances, the modification proposed by the programme was carried out. It was found that the values improved after modification. After the one-dimensional model was tested again, the path diagram and goodness of fit values of the scale were determined.

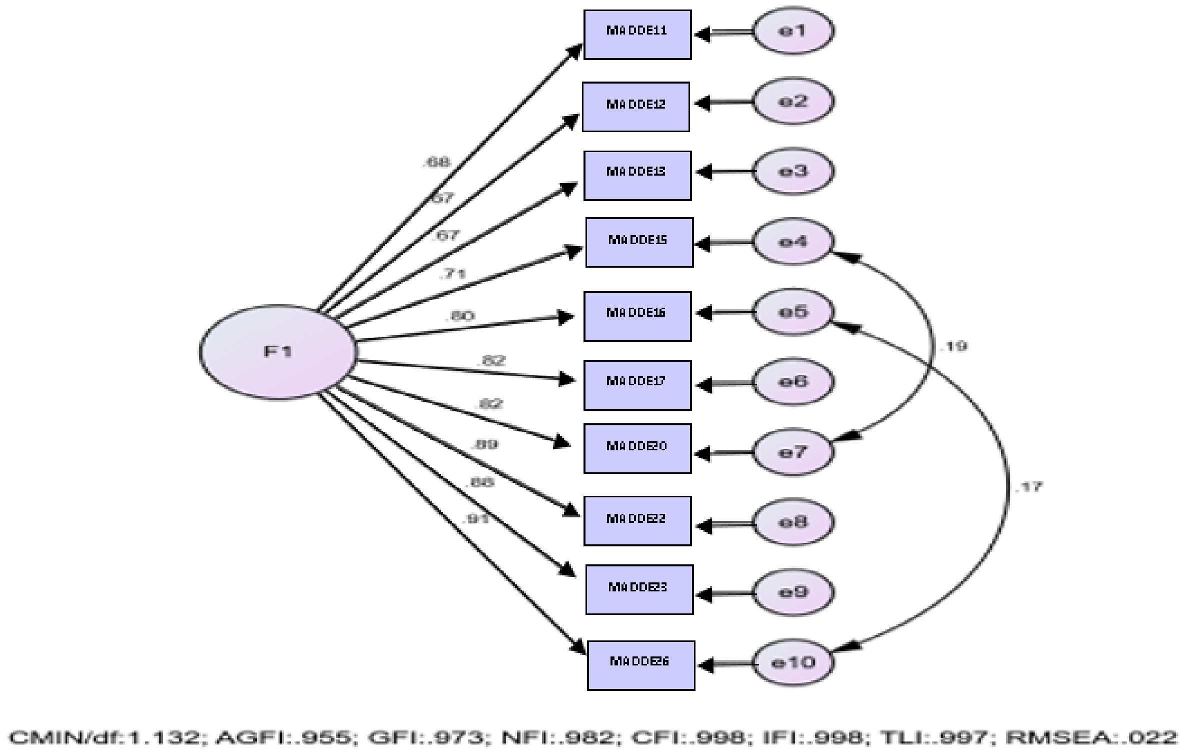


Figure 3. *Confirmatory Factor Analysis Modified Path Diagram*

After the detected variables were correlated, the main result was revealed, and it was seen that the significance and compliance coefficients of the model were at the desired level. After the modification process, it was understood that the goodness of fit values for the scale reached excellent values, and therefore the single-factor structure of the measurement tool was confirmed.

Table 4: *Confirmatory Factor Analysis Model Fit Indices*

Fit index	Value Before Modification	Value After Modification	Acceptable Fit	Perfect Fit	Resulting Verdict
CMIN/df	1.452	1.132	≤5	≤3	Excellent
AGFI	0.943	0.955	≥0.85	≥0.90	Excellent
GFI	0.963	0.973	≥0.85	≥0.90	Excellent
NFI	0.975	0.982	≥0.90	≥0.95	Excellent
CFI	0.992	0.998	≥0.95	≥0.97	Excellent
IFI	0.992	0.998	≥0.90	≥0.95	Excellent
TLI	0.990	0.997	≥0.90	≥0.95	Excellent
RMSEA	0.041	0.022	≤0.08	≤0.05	Excellent

When Table 4 was examined, the confirmatory factor analysis results were determined as CMIN/df = 1.132, AGFI = 0.955, GFI = 0.973, NFI = 0.982, CFI = 0.998, IFI = 0.998, TLI = 0.997, and RMSEA =.036. After the analysis, it is seen that all the values specified in the table have perfect match values (Hu, 1999; Schermelleh-Engel et al., 2003; Hooper, 2008; Kline, 2011; Kline, 2015; Karagöz, 2019). The attitude scale towards the use of technology in one-dimensional sciences that emerged with exploratory factor analysis was confirmed by confirmatory factor analysis.

Findings Related to Reliability

In order to determine the level of reliability in Likert-type attitude scales, the Cronbach Alpha coefficient developed by Cronbach is used. This coefficient is accepted as a measure of internal consistency and is widely used as a method to determine the reliability of the scale (Tavşancıl, 2014). (DeVellis, 2014), the Cronbach alpha reliability coefficient is among the frequently used measurement tools to determine the reliability of measurement tools. The Cronbach's alpha coefficient of the single-factor attitude scale consisting of 10 items was determined to be 0.94. It is understood that the internal consistency coefficient of the attitude scale developed according to Şencan (2005) is high. When the reliability coefficient of the Attitude Scale for the Use of Technology in a Science Course is examined, the consistency of the relationship between the items on the scale shows that the scale reflects the attitude desired by the scale to a high degree.

Scoring the Scale

On a 10-item 3-point Likert scale of the "Yes-No-Sometimes" type, participants rate their responses to each item as "Yes," "No," and "Sometimes." In this case, the maximum score that can be received for each item is 2. Options are considered 2 points for "yes,", 0 points for "no,", and 1 point for "sometimes.". These scores are added together to obtain the total score of the scale, and this total score represents a value that reflects the attitude or thought of the participant. In this way, in assessments using the "Yes-No-Sometimes" 3-point Likert scale, a maximum of 2 points can be scored for each item, and the total score can go up to a maximum of 20. The minimum score that can be taken from the attitude scale is 0.

Research Materials

In Table 4, there are some items of the attitude scale towards the use of technology in science lessons.

Table 5. *Sample Materials*

Item No.	Article Sentence
1	I find science subjects that are taught using technological tools more interesting.
2	When we use technological tools in science class, I think that I have learned the subject completely.
4	I would like to ask more questions in science class where technological tools are used.
7	In science class, I like to solve the problems caused by technological tools.
10	In science class, experiments and observations using technological tools are enjoyable.

Discussion, Conclusion and Recommendations

In the study, a one-dimensional scale consisting of 10 items was developed to assess attitudes towards the use of technology in science lessons. The suitability of the initial scale for factor analysis was determined by examining the results of the KMO test and Bartlett's test of sphericity. The analysis indicated that the data were suitable for factor analysis, as evidenced by a KMO value of 0.95 and a significant result in the Bartlett test ($p < 0.001$) (Büyüköztürk, 2015). The scale has a maximum score of 20 and a minimum score of 0. Higher scores on the scale indicate positive attitudes towards the use of various technologies in science lessons. Scoring for the scale assigns 2 points for "yes," 0 points for "no," and 1 point for "sometimes," without any items requiring reverse-coding. The high internal consistency coefficient of Cronbach's alpha (0.94) demonstrates that the scale items are consistent with each other, while the results of factor analysis EFA and confirmatory factor analysis CFA provide evidence for the validity of the scale.

In the current technological age, the impact of technology in the field of education, as well as other areas, is undeniable. Particularly for students in primary education who may have limited technology literacy, it is crucial to emphasize the importance of raising a generation that is aware of and adept at utilizing technology. Students need to harness technology in a positive manner during their lessons to fully benefit from its numerous advantages, which can enhance the education system, teachers, and learning outcomes. When examining the curriculum objectives of the science course, it becomes evident that, unlike other subjects, many of these objectives can be more easily and clearly conveyed to students through the use of technological tools. As technology continues to advance and new technologies emerge, it is anticipated that these objectives will be incorporated into new teaching technologies in the coming years. Science, due to its nature, has a strong relationship with technology and offers distinct advantages compared to other subjects. While we cannot bring a fossil into the classroom, we can showcase a hologram of the fossil. With augmented reality glasses, we can simulate the presence of a tiger or an elephant in the classroom. By utilizing projection, we can vividly explain the movements of the Earth and the Sun on the classroom wall. While students cannot physically descend into the layers of the Earth, the use of smart boards allows for effective teaching of the characteristics of each layer. In addition to these examples, each simple technological tool employed in the classroom can contribute to effectively teaching science concepts. Therefore, it is crucial to assess student attitudes to ensure maximum benefit from these technological advantages. Having high and positive attitude levels among students is of utmost importance. Conducting preliminary studies to foster positive attitudes towards the technological tools used in the science course can greatly enhance students' learning experiences.

In conclusion, the developed scale is considered a valid and reliable measurement tool for assessing the attitudes of 3rd and 4th grade primary school students towards the use of technology in science lessons. It is anticipated that this scale will make a valuable contribution to the existing literature in the field.

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Conflict of Interest

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