Sinop Üniversitesi
Sosyal Bilimler Dergisi
Araştırma Makalesi
ISSN 2547-989X

Sinop Üniversitesi Sosyal Bilimler Dergisi, 9 (2), 1324-1350
Geliş Tarihi:28.08.2025 Kabul Tarihi:29.10.2025
Yayın: 2025 Yayın Tarihi:30.11.2025
https://doi.org/10.30561/sinopusd.1773498
https://dergipark.org.tr/sinopusd

ADAPTATION OF THE MIDDLE SCHOOL FORM OF THE PLAYER TYPES SCALE FOR GAMIFICATION AND EVIDENCE OF MEASUREMENT INVARIANCE

Büşra DİNÇER[*]
İbrahim YILDIRIM[*]
Tuğberk MELEN[*]

Abstract

This study adapts the Player Types Scale for Gamification to the middle school level and examines its measurement invariance across the variables such as gender and technology device ownership. The study sample consists of 773 middle school students including 423 girls, 346 boys, and 4 participants who did not specify their gender. During the adaptation process, permission was initially acquired from the researchers who developed the instrument. In the next step, expert opinions from 10 different specialists, including one Turkish language expert, were collected. A pilot application was conducted with 10 students, revealing an average completion time of 20 minutes. Following the pilot application, the instrument was administered to 773 middle school students. For reliability, internal consistency coefficients α and ω were calculated for the entire scale. The factor structure was examined using CFA. According to the results, fit indices has been found between acceptable limits. Measurement invariance analyses were also conducted via MGCFA for gender and technology ownership variables. The results demonstrated that the scale achieved scalar invariance for both variables, but strict invariance was not supported by any of them.

Keywords: Gamification, Measurement Invariance, Player Types, Scale Adaptation.

[*] Uzman, Milli Eğitim Bakanlığı, Kahramanmaraş İl Milli Eğitim Müdürlüğü, Bozhüyük Şehit Samet Karslı Ortaokulu Müdürlüğü, busrakubra.104@gmail.com, https://orcid.org/0000-0002-7490-8439
[*] Doç Dr., Gaziantep Üniversitesi, Gaziantep Eğitim Fakültesi, Eğitim Bilimleri Bölümü, Eğitimde Ölçme ve Değerlendirme Ana Bilim Dalı, iyildirim84@gmail.com, https://orcid.org/0000-0002-4137-2025
[*] Arş. Gör., Gaziantep Üniversitesi, Gaziantep Eğitim Fakültesi, Eğitim Bilimleri Bölümü, Eğitimde Ölçme ve Değerlendirme Ana Bilim Dalı, https://orcid.org/0000-0003-4374-2736

Oyunlaştırma için Oyuncu Tipleri Ölçeği'nin Ortaokul Formunun Uyarlanması ve Ölçme Değişmezliği Kanıtı

Öz

Bu araştırmada Oyunlaştırma için Oyuncu Tipleri Ölçeği ortaokul seviyesine uyarlanmış ve ölçeğin cinsiyet ve teknolojik araç bulundurma durumuna göre ayrı ayrı ölçme değişmezliği incelenmiştir. Araştırmanın çalışma grubunu 423'ü kız, 346'sı erkek ve cinsiyeti belirtilmemiş dört kişi olmak üzere toplam 773 ortaokul öğrencisi oluşturmaktadır. Ölçeğin uyarlama sürecinde öncelikle ölçeği geliştiren araştırmacılardan izin alınmıştır. Bir sonraki adımda biri Türk dili olmak üzere ve on farklı uzmanın görüşleri alınarak, ölçeğin deneme uygulaması 10 öğrenci ile gerçekleştirilmiş, ölçeğin cevaplanma süresi ortalama 20 dakika olarak belirlenmiştir. Deneme uygulaması sonrasında ölçek 773 ortaokul öğrencisine uygulanmıştır. Güvenirlik için tüm ölçek düzeyinde Cronbach's α ve McDonald's ω değerleri hesaplanmıştır. Ölçeğin faktör yapısı DFA ile incelenmiştir. Analiz sonuçlarına göre model-veri uyumu sağlanmıştır. ÇGDFA ile ölçme değişmezliği analizleri, cinsiyet ve teknolojik araç bulundurma değişkenlerine göre tamamlanmıştır. Değişmezlik analizleri sonucunda ölçeğin her iki değişkene göre biçimsel, metrik ve skaler değişmezliği sağladığı ve katı değişmezliğin ise sağlanmadığı görülmüştür.

Anahtar Kelimeler: Oyuncu Tipleri, Oyunlaştırma, Ölçek Uyarlama, Ölçme Değişmezliği.

1. Introduction

Games have been an indispensable phenomenon throughout human history. Although games such as hide-and-seek and blind man's buff have maintained their presence across generations, the nature of gameplay has evolved considerably due to the influence of digitalization. According to TUIK (2021; 2023) data, digital gaming levels and frequencies are rapidly increasing, especially among children. Games are tools that contribute to individuals' mental, physical, and psychological development while serving multiple purposes such as learning, entertainment, and communication. The use of gamification in education stands out as an approach that increases students' interest in the learning-teaching process and makes these processes more efficient and motivating (Arkün Kocadere & Samur, 2016; Karataş, 2018). Player types constitute one of the fundamental components of gamification design and should be considered to optimize student engagement (Bartle, 1996). Reliable measurement tools used to determine player types are of great importance

in identifying which player type individuals' personality traits are more inclined toward. However, there are few studies in literature developed or adapted to determine player types (Bartle, 1996; Ferro et al., 2013; Nacke et al., 2011; Marczewski, 2015). It is believed that there is a need for scale development and adaptation studies in Türkiye due to the gap in this area. Examining the literature in Türkiye, it has been observed that studies related to gamification mostly focus on high school and higher education levels (Şenocak, 2019; Yıldırım, 2016). This research seeks to localize the player types scale for middle school students within the context of Turkish language and culture, and to validate its applicability across groups by demonstrating measurement invariance. The research includes construct validity obtained through confirmatory factor analysis, measurement invariance findings according to gender and technology ownership variables, and internal consistency reliability in the context of subscales.

1.1. Gamification

Gamification is increasingly influential in many fields of study, including education as well as health, marketing, business, and psychology. In the digitalized world, the need to attract and maintain people's interest and attention and create sustainable interaction has made this concept popular and revealed the need for research (Hamari et al., 2014). Gamification is the practice of applying game-design features to contexts that aren’t games to shape experience and behaviour (Deterding et al., 2011). Kapp (2012) frames gamification as the deliberate integration of game mechanics and aesthetics, guided by game-oriented thinking, to enhance engagement, motivate action, foster learning, and solve problems. In line with earlier definitions, gamification entails the purposeful deployment of game mechanics and elements within non-game environments to promote behavioural change, enhance motivation, and maintain participation. Conducting the educational process in accordance with students' levels can be achieved by increasing students' intrinsic motivation using extrinsic motivational tools like games. This will stimulate the

student's desire to learn willingly. Rather than seeking external reinforcement, positive comments, or any reward, the goal should be for the learning process to occur through the student's own desire. Games are phenomena that everyone, especially children, enjoys and finds engaging. The power of games to change individuals' behaviours also has positive effects on their motivation, attitudes, and achievements. Studies have shown that integrating the concept of games with courses makes the learning process more efficient and contributes positively to student motivation (Arkün Kocadere & Samur, 2016; Karataş, 2018; Özkan & Samur, 2017; Uğurel & Moralı, 2008). Each student's motivation, interest, attitude, and behaviour during the gamification process is unique. Consequently, player types are one of the critical factors that necessitate consideration and emphasis during the planning and preparation of gamification design. Teachers are assisted by player types in determining the emotions and goals of the students as they engage in the games. In gamification, players are considered one of the most important elements (Yılmaz, 2020). The phenomenon where individuals assume different roles and desire to fulfil different tasks during gameplay appears in the literature as player types. It is the reason why every player may have different purposes for playing the game. Researchers have categorized player types into different categories according to their theories (Bartle, 1996; Marczewski, 2015). Frequently cited as a foundational player-type taxonomy, Bartle's model predates and informs the gamification literature, providing a framework on which many later models build. According to Bartle, players are examined in four different categories in the context of their interaction with the environment and people or taking unilateral action. Killers focus more on their opponents than on game elements. Their goal is to defeat other players in the game. Therefore, games featuring leadership, competition, and rivalry may be preferred to ensure killers' active participation in the game process. Achievers focus on accomplishing given tasks sequentially. Since their goal is to complete the assigned task, game environments consisting of stages and elements showing progress may be suitable for ensuring achievers' active participation. Socializers

enjoy meeting, talking, and chatting with other players in the game. Their goals are more about communicating with people than playing the game. Explorers are players who master everything in the game process and are particularly aware of hidden areas. They can be said to have mastery over the entire game.

Marczewski's model, inspired by Bartle, consists of six different player types. These player types form a hexagon and represent different game motivations. The scale addresses gamification according to Marczewski's (2015) classification. According to Marczewski (2015), player types can be classified as philanthropists, socializers, players, achievers, free spirits, and disruptors. Philanthropist players are those who help others without expecting anything in return and focus on the meaning and purpose of the process. They generally prioritize being able to support others' needs. Socializer players value social status. They value teamwork rather than losing or winning; what they care about in the process is establishing dialogue, talking, and socializing. Players focus on the game itself, are motivated by external rewards, and work to win. Their goals are generally to collect rewards, reinforcements, and badges. Achievers fulfil goals and tasks and enjoy overcoming challenges. They are motivated by the feeling of achievement. Free spirits enjoy exploring, like to notice hidden and undiscovered situations in the game, and are open to innovations. Disruptors exhibit change-oriented motivation triggered by fluctuations in game conditions and expressed through efforts to transform the current system.

Players differ markedly in the emotions they experience while playing, the experiences reported during the activity, and the behavioural changes observed afterward. Everyone that plays games, or gamers, may have various expectations about the process. In a group game, for example, some players may choose to aid their friends or communicate with them, whereas others prefer to be the best. As a result, understanding the group with which we will collaborate and the player types inside that group prior to developing the gamification design provides information on the efficiency of the gamification design we will create. It has been discovered

that diverse player types engaging in the same game favourably influence student growth (Bozkurt & Genç Kumtepe, 2014). This is why development mostly occurs individually, and each student has their own development style. Positive behavioural outcomes can be obtained when each student is included in the process or feels like a part of the process.

1.2. Measurement Invariance

In quantitative research in behavioural sciences, abstract properties that cannot be directly observed are generally examined (Imrol, 2024). These properties are called constructs (Nunnally & Bernstein, 1994). In research, comparisons between groups are made to examine relationships between constructs and determine differences. In these comparisons, for us to conclude that the difference stems from groups (Başusta & Gelbal, 2015) or individuals, constructs need to function similarly across different groups both statistically and theoretically (Imrol, 2024; Önen, 2009). Measurement invariance is a psychometric framework that examines how a construct functions across groups (Cheung & Rensvold, 2002). Measurement invariance is typically evaluated within two broad families of models: multi-group confirmatory factor analysis (MGCFA) and IRT-based approaches (DIF, Kıbrıslıoğlu Uysal, 2015). In MGCFA tradition, tests proceed hierarchically as outlined by Meredith (1993): Measurement invariance is typically tested hierarchically as (1) configural invariance, which examines whether groups share the same factor-loading pattern; (2) metric invariance, which imposes equality constraints on factor loadings across groups; (3) scalar invariance, which additionally constrains item intercepts to equality; and (4) strict invariance, which further imposes equality of residual variances in addition to the scalar invariance constraints. In this approach, it cannot be proceeded to a higher stage without completing the previous stage. The level of measurement invariance is determined through tests between stages.

Configural invariance represents the simplest level of measurement invariance; at this level, factor loadings load onto items in the same way as in the original structure. Configural invariance is supported when the same factor structure

holds across groups for the same set of items on the scale (Schmitt & Kuljanin, 2008). Configural invariance is insufficient to conclude that the estimated parameters are identical. This analysis is generally considered as the first stage and a control test. In metric invariance, in addition to the factor pattern and numbers in configural invariance, factor loadings are also controlled (Somer, 2009). Achieving metric invariance means that individuals interpret factor loadings similarly (Byrne, 1998). In scalar invariance the hypothesis that the regression constant does not change across groups is tested (Başusta & Gelbal, 2015). Accordingly, between-group disparities in observed means reflect true differences in the latent factor, rather than measurement artifacts (Uyar & Doğan, 2014). Finally in strict invariance analysis, the equality of error terms across groups is tested (Başusta & Gelbal, 2015). Strict invariance is difficult to achieve in real life and practice due to the restriction of numerous parameters across groups.

1.3. The Present Study

In this study, measurement invariance analyses were conducted regarding the comparison of findings obtained through the application of the scale adapted for the middle school level in different subgroups. Differences in measurement results may stem from group differences as well as from the instrument. Hence, conclusions about group differences are conditional on evidence for the measure's validity and reliability. The process continues if the instrument measures the same characteristic for all groups. Applying, collecting data, and analyzing the instruments according to different variables such as gender, culture, profession, and age can be troublesome for the researcher and may cause certain restrictions after a certain point. For instance, insufficient amount of data may result in the problem of not obtaining healthy results from reliability and validity analyses. As a solution to this and similar problems that may arise, measurement invariance of the instrument can be considered as one of the methods to be used.

The relevant research enriches the existing literature by adapting the User Types Scale for Gamification to the middle school context and examining its measurement invariance across gender and technology ownership variables. The research questions and their corresponding sub-questions are presented below:

1. Can the user types scale for gamification (HEXAD) be validly and reliably adapted to Turkish?
   1.1. Is the reliability evidence of HEXAD user types scale sufficient?
   1.2. Is the validity evidence of HEXAD user types scale sufficient?
2. Do the scores obtained from HEXAD user types scale provide measurement invariance according to gender and technology ownership variables?
   2.1. Which stage(s) of measurement invariance do the scores obtained from the HEXAD user types scale provide according to gender?
   2.2. Which stage(s) of measurement invariance do the scores obtained from the HEXAD user types scale provide according to technology ownership?

When implementing gamification design in the classroom, determining the dominant player type(s) for students in advance can contribute to planning the teaching process. For example, considering the dominant player type(s) in their students before the lesson, the teacher can create activities that form heterogeneous or homogeneous groups in terms of class distribution. Thus, students' active participation into the lesson can be supported. Designing lessons that encourage active student engagement through well-aligned activities provides the potential for enhancing learners' motivation. In this way, a higher quality, motivating, and enjoyable learning process can be created. The teacher can initiate quality and effective communication with their students to identify the environments in which their students will learn most effectively, as indicated by the player types scale. This is because every class is unique. Because every student is different, classroom atmosphere is quite different from one another. Although the student profiles and academic achievements of classes may be similar, each class is different within itself.

Therefore, evidence for the measures' validity and reliability should be established prior to determining students' player types.

In this research, the User Types Scale for Gamification, adapted to Turkish at the university student level by Taşkın and Çakmak (2020), was adapted for middle school students, and then measurement invariance analyses were conducted according to gender and technology ownership variables. A growing body of scholarship has investigated games, gamification, and player typologies (Akgün & Topal, 2018; Hamari et al., 2014; Kırmacı & Kılıç Çakmak, 2022; Klock et al., 2020; Marczewski, 2015; Santos et al., 2022; Taşkın & Kılıç Çakmak, 2020; Tondello et al., 2019). In these studies, it was emphasized that individual differences should be considered in gamification, and the effects of demographic variables such as gender and age or personality traits on gamification design were examined (Kırmacı & Kılıç Çakmak, 2022; Santos et al., 2022).

The scale devised by Tondello et al. (2019) has been adapted in various languages, as evidenced by the literature review (Krath & von Korflesch, 2021; Manzano-Leon et al., 2020; Ooge et al., 2020; Santos et al., 2022). In this line of work, researchers evaluated the scale's factorial structure and reported corresponding reliability and validity evidence. Manzano-León et al. (2020) tested the User Types for Gamification Scale for gender-based measurement invariance and found support for metric (loading) invariance. Santos et al. (2022) found that the scale met scalar invariance across gender. Beyond these studies, prior work has also reported that tendencies towards different player types vary according to gender (Oyibo, Orji & Vassileva, 2017; Tondello et al., 2019).

In Türkiye, it is seen that measurement invariance analyses have not been conducted for the User Types Scale for Gamification, which was adapted to Turkish at the university student level by Taşkın and Çakmak (2020). A review of Turkish gamification studies shows that participant pools have been dominated by secondary- and tertiary-level students, together with professionals in computer- &

technology-related fields (Şenocak, 2019; Yıldırım, 2016; Zeybek, 2021). When the literature was examined, no studies on games and gamification with students studying in high school and below were found. In contrast to prior work, the present study examines games, gamification, and player types using a sample of middle school students. At the same time, the absence of a player types scale prepared for middle school students and the adaptation of the player types scale to middle school level students will contribute to the field by introducing a valid and reliable measurement tool to the literature that reveals the player types of students at this level.

2. Method

This research has sought to adapt the Player Types Scale for Gamification (HEXAD) -originally proposed by Tondello et al. (2016), updated in 2019, and subsequently localized into Turkish by Taşkın and Kılıç Çakmak (2020)- for use with middle-school students. The relevant study presents a scale adaptation that did not previously exist, making it a scale adaptation study. The study group consists of 773 students; 423 girls, 346 boys and four students who didn't specify their gender, studying in different public schools, selected through random sampling. To serve the research purpose and ensure representation of different characteristics, attention was paid to include students from different age groups and those with and without technological devices.

2.1. Adaptation Process

In scale adaptation studies, the scale adaptation steps of Hambleton and Patsula (1999) and the International Test Commission (2017) are frequently preferred guides. In this study, adaptation steps specific to this study were determined since adaptation was made between different age groups rather than different cultures. The following steps were followed in the process:

1. Obtaining necessary permissions for adaptation,
2. Creating a draft form,

3. Obtaining opinions from 9 different experts working in the fields of educational measurement and evaluation, Turkish language, elementary mathematics, basic education, computer and instructional technology, and curriculum and instruction,
4. Obtaining opinions from a language expert on the clarity of items and compliance with grammar rules,
5. Conducting a pilot study,
6. Carrying out the final application and determining the psychometric measurement quality.

2.2. The Adapted Scale

In their study, Tondello et al. (2019) reported satisfactory internal consistency for each subscale (α_s = .82, $\alpha_{ör}$ = .70, α_b = .79, α_y = .80, α_o = .86, α_{ob} = .76) and supported construct validity through EFA.

The Player Types Scale for Gamification, adapted to Turkish at the higher education level by Taşkın and Kılıç Çakmak, is a is a rating instrument composed of 24 items across six subscales. Items are Likert-type statements on a 7-point agreement continuum. The study group of the scale adaptation study consists of 330 university students. The internal consistency of each subscale was presented as reliability evidence. Cronbach's α values for scale subscales range between .62 and .76 (α_s = .72, $\alpha_{ör}$ = .62, α_b = .76, α_y = .76, α_o = .71, α_{ob} = .71). In addition, the researchers conducted item analysis, using the 27% upper and lower groups method and reported item-total correlation. Item-total correlation values range between .34 and .62. CFA was used for validity evidence, factor loadings were found to vary between .40 and .72, and fit indices were determined to be within acceptable limits (χ^2 = 567.41, *df* = 237, *RMSEA* = .04, *SRMR* = .05, *TLI* = .90, *CFI* = .92).

2.3. Analysis of Data

CFA and MGCFA were used to present structural validity evidence, whereas reliability (internal consistency) assessed using α and ω coefficients. Since these are

multivariate statistics, the assumptions were also tested. IBM SPSS Statistics (v.23) was used to test multivariate statistical assumptions. CFA was performed with Mplus (v.8.3). Missing data were examined before testing assumptions to ensure that statistical procedures produced correct results. When examining the data set in the research, it was concluded that missing data constituted 1.22% of the total data set and could be neglected as it was below 5% (Kline, 2015). No changes were made to the data set due to missing data, and testing of assumptions continued. Box and whisker plots were examined in the analysis of univariate outliers. It was considered that extreme values in the relevant graph might be due to missing data, and student responses were analysed. During the examination of univariate outlier variables, it was decided not to remove any participant's data. During the examination of multivariate extreme values, one participant was found to have an extreme value. When analysing the responses of the relevant participant, it was decided to exclude this participant from the analysis as they contained more missing data compared to other participants. For univariate normality, the distribution exhibited skewness -1.22 and kurtosis 2.32; accordingly, it was treated as approximately normal (Kline, 2015). Mplus (v.8.3) was used for multivariate normality, and it was observed that the assumption was not met (SD_{skew} = 101.23, $Mean_{skew}$ = 20.19, S_{skew} = 0.57, p_{skew} < .05, SD_{kurt} = 985.27, $Mean_{kurt}$ = 622.43, S_{kurt} = 2.56, p_{kurt} < .05). Since multivariate normality was not achieved, it was decided to use the robust maximum likelihood (MLR) estimation method, which is robust against the violation of this assumption in statistical calculations (Kline, 2015). After testing the assumptions, reliability analyses were completed, followed by CFA and measurement invariance analyses. In the evaluation of measurement invariance, $\Delta CFI \leq .01$ and $\Delta RMSEA \leq .015$ intervals were used as decision criteria (Chen, 2007).

3. Results

This section presents the findings obtained regarding descriptive statistics, Cronbach's α and McDonald's ω reliability, content validity, CFA, and measurement invariance of the scale.

3.1. Descriptive Statistics

Table 1 presents descriptive statistics for the middle-school adaptation of the scale.

Table 1: *Descriptive Statistics*

Item no.	*n*	$\bar{x}$	S_j^2	*Skew*	*Kurt*	*Min*	*Max*	*Mdn*
1	771	4.36	0.96	-1.93	3.56	1	5	5
2	764	4.21	1.09	-1.53	1.91	1	5	5
3	769	3.91	1.40	-0.99	0.15	1	5	4
4	765	3.90	1.37	-0.98	0.16	1	5	4
5	766	3.76	1.32	-0.77	-0.18	1	5	4
6	768	3.23	1.55	-0.23	-0.87	1	5	3
7	764	3.69	1.74	-0.73	-0.65	1	5	4
8	758	2.03	1.65	1.11	0.07	1	5	2
9	764	3.97	1.45	-1.16	0.42	1	5	4
10	754	3.05	1.87	-0.07	-1.17	1	5	3
11	767	3.96	1.45	-1.06	0.15	1	5	4
12	766	2.49	1.89	0.47	-1.00	1	5	2
13	770	3.87	1.31	-0.96	0.19	1	5	4
14	765	3.88	1.51	-1.00	0.00	1	5	4

Table 2: *Descriptive Statistics*

Item no.	*n*	$\bar{x}$	S_j^2	*Skew*	*Kurt*	*Min*	*Max*	*Mdn*
15	761	4.30	1.28	-1.80	2.40	1	5	5
16	762	4.14	1.33	-1.40	1.10	1	5	5
17	761	4.23	1.20	-1.60	1.90	1	5	5
18	763	3.71	1.56	-0.80	-0.30	1	5	4
19	755	3.79	1.32	-0.83	-0.01	1	5	4
20	762	2.23	2.05	0.82	-0.73	1	5	2
21	760	3.96	1.51	-1.09	0.16	1	5	4
22	753	4.28	1.26	-1.68	1.93	1	5	5
23	766	4.21	1.34	-1.50	1.35	1	5	5
24	771	4.00	1.34	-1.13	0.49	1	5	4

As summarized in Table 1, skewness and kurtosis for the items fall between −1.93 and 3.56, while item means lie between 2.23 and 4.36.

3.2. Reliability Analysis

Cronbach's α and McDonald's ω values were calculated to obtain evidence of reliability for the scale adapted to middle school level. McDonald's ω coefficient was also calculated due to the biased results of Cronbach's α value in reliability

analysis of congeneric items (Yurdugül, 2006). Reliability values obtained at the subscale and whole scale levels are given in Table 2.

Table 3: *Reliability Analysis Results*

Subscales	Item numbers	$\bar{x}$	S	α	ω
Socializer	5, 9, 14, 21	15.38	4.00	.69	.70
Free spirit	2, 6, 16, 19	15.16	3.23	.57	.60
Achiever	4, 11, 17, 22	16.12	3.55	.74	.74
Philanthropist	1, 13, 18, 24	15.85	3.29	.66	.67
Player	3, 7, 15, 23	15.94	3.70	.72	.72
Disruptor	8, 10, 12, 20	9.63	3.61	.57	.58
Total scale		88.06	13.40	.82	.83

Table 2 reports internal consistency estimates for the full scale: α = .82 and ω = .83. The fact that the obtained values are greater than .70 indicates that reliable measurements were made (Büyüköztürk, 2021). When examining the reliability values calculated in the subscales, it was observed that the reliability values in the free spirit, philanthropist, and disruptor subscales were lower than .70. This situation can be attributed to the fact that the subscales consist of a small number of items (Baykul, 2015; Çetin, 2022).

3.3. Content Validity

Content validity analysis was examined qualitatively based on expert opinions from ten different fields. It was concluded with expert consensus that the items that could completely measure the targeted phenomenon were included in the scale.

3.4. Structural Validity

Structural validity findings in the context of psychometric measurement quality have been addressed within the framework of CFA and MI.

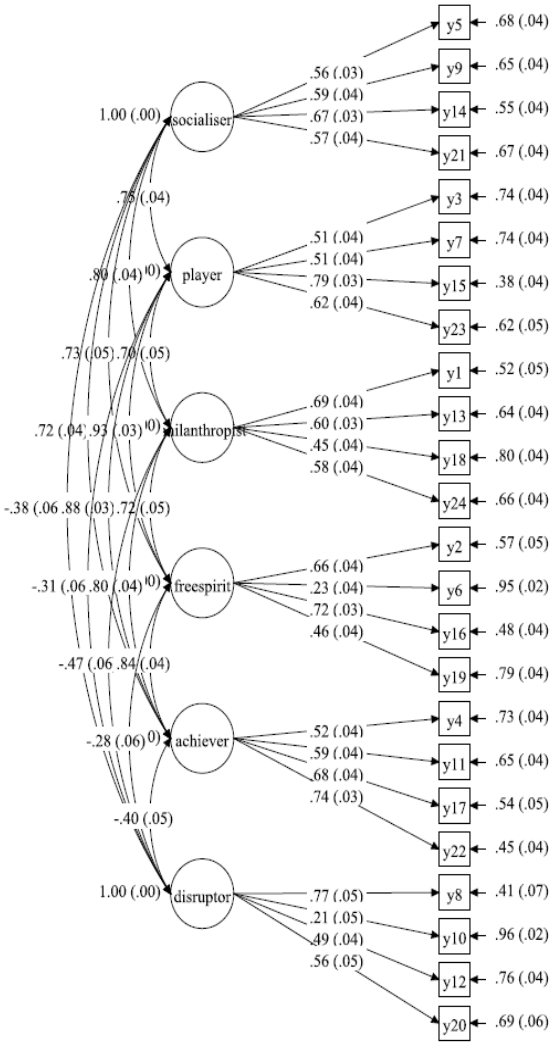

Figure 1: *Measurement model of the Player Types Scale for Gamification*

As depicted at Figure 1, all paths between latent and observed variables are significant at the p<.01 level. Factor loadings range between .21 and .79, while error values range between .38 and .96. The fit indices are $\chi^2 = 567.41$ ($df = 237$, $p < .05$), *SRMR* = .05, *RMSEA* = .04 (.038-.047), *CFI* = .91, and *TLI* = .90, respectively. According to results, the fit indices are at acceptable or excellent levels (Çokluk et al., 2018; Hu & Bentler, 1999). Within the CFA solution, the standardized loadings

for item 10 (λ_{10} = .21) and item 6 (λ_6 = .23) fell below the commonly used .32 criterion (Tabachnick & Fidell, 2007). While some researchers suggest factor loadings should be above 0.32 (Tabachnick & Fidell, 2007), the others focus on sample size for the criterion point. Hence, it was decided not to remove both items from the scale in terms of both statistical and logical inference. For comparing and interpreting the measurements or scores obtained, it is necessary to hierarchically perform four-stage processes that are prerequisites for each other (Çelik & Yılmaz, 2016; Vanderberg & Lance, 2000). In this research, invariance stages were hierarchically examined, and $\Delta CFI \leq .01$ and $\Delta RMSEA \leq .015$ difference values were used as decision criteria in measurement invariance (Chen, 2007). Owing to violations of multivariate normality, parameter estimation in multi-group invariance analyses relied on MLR, and $\Delta\chi 2$ differences between stages were not used as decision criteria. Measurement invariance across gender and technological device ownership was assessed via multi-group CFA, with decisions based on $\Delta CFI \leq .01$ and $\Delta RMSEA \leq .015$ (Chen, 2007). Measurement invariance of the scale according to gender analyses were carried out with the participation of 769 students, including 423 girls and 346 boys. Table 3 presents the results.

Table 4: *Invariance Findings According to Gender*

Invariance	χ^2	*df*	*SRMR*	*TLI*	*CFI*	*RMSEA*	Δ*RMSEA*	Δ*CFI*
Configural	825.708	474	.054	.891	.906	.044 (.039-.049)	-	-
Metric	877.309	492	.065	.885	.897	.045 (.040-.050)	-.001	.009
Scalar	917.803	510	.064	.882	.891	.046 (.041-.050)	-.001	.006
Strict	1001.854	534	.073	.871	.875	.048 (.043-.052)	-.002	.016

When the analysis results in Table 3 are examined, it is found that configural, metric, and scalar invariance stages are achieved. At the configural invariance stage, CFI, RMSEA, SRMR, and TLI fit indices values are at acceptable or excellent levels. The ΔCFI and ΔRMSEA difference values between configural-metric and configural-scalar invariance stages meet the decision criteria ΔCFI≤.01 and

ΔRMSEA≤.015. However, the ΔCFI and ΔRMSEA difference values between configural-strict invariance stages do not meet the decision criteria ΔCFI≤.01 and ΔRMSEA≤.015. Overall, the evidence indicates that the scale provides scalar invariance according to gender but does not provide strict invariance. Measurement invariance analyses were conducted with 767 participants, including 600 who own technological devices and 167 who do not, using the MGCFA technique. Analysis results are given in Table 4.

Table 5: *Invariance Findings According to Technological Device Ownership*

Invariance	χ^2	*df*	*SRMR*	*TLI*	*CFI*	*RMSEA*	Δ*RMSEA*	Δ*CFI*
Configural	895.541	474	.054	.869	.888	.048 (.043-.053)	-	-
Metric	910.175	492	.057	.875	.889	.047 (.042-.052)	-.001	.009
Scalar	932.862	510	.058	.878	.888	.046 (.042-.051)	-.001	.006
Strict	1051.145	534	.068	.858	.862	.050 (.046-.055)	-.002	.016

When the analysis results in Table 4 are examined, it is seen that configural, metric, and scalar invariance stages are achieved. The fit values obtained for configural invariance are at acceptable or excellent levels. Since the ΔCFI and ΔRMSEA difference values at the configural-metric and configural-scalar invariance stages meet the decision criteria $\Delta CFI \leq 0.01$ and $\Delta RMSEA \leq 0.015$, scalar invariance is achieved. However, the decision criteria between configural-strict invariance are not met. Therefore, it can be stated that the scale does not provide strict invariance according to technological device ownership.

4. Discussion and Conclusion

The Player Types Scale for Gamification, which was adapted to Turkish for university level by Taşkın and Kılıç Çakmak (2020), was adapted to middle school level, and multi-group invariance analyses were conducted by gender and by device-ownership status. During the adaptation process, the scale adaptation steps recommended by Hambleton and Patsula (1999) and ITC (2017) were followed,

except for the translation phase. Three research were found in the literature in which the Player Types for Gamification Scale was psychometrically tested on adolescents aged 10 to 19 (Manzano-Leon et al., 2020; Ooge et al., 2020; Santos et al., 2023). Several investigations included participants aged 10–65 (Akgün & Topal, 2018; Krath & von Korflesch, 2021; Santos et al., 2022; Taşkın & Kılıç Çakmak, 2020; Tondello et al., 2019). The Player Types for Gamification Scale has also been adapted for different age levels in Turkish, Spanish, Brazilian Portuguese, German, and Dutch (Claudia et al., 2022; Krath & von Korflesch, 2021; Manzano-Leon et al., 2020; Ooege et al., 2020; Taşkın & Kılıç Çakmak, 2020).

After obtaining opinions from different experts in adapting the scale to middle school level, a pilot application was conducted. On average, respondents completed the questionnaire in about 20 minutes, and there were no unclear expressions in the items. Estimates of Cronbach's α and McDonald's ω were derived for total and subscale scores. The McDonald's ω value obtained at the whole scale level is .83. In the free spirit, philanthropist, and disruptor subscales, the reliability values obtained are below .70. Tondello et al. (2019) reported Cronbach's α values across three research with different participants. In the first study, the researchers got a cut-off value of $\alpha_{freespirit}$ = .70 in the sub-dimensions, and in the second study, $\alpha_{freespirit}$ = .64, $\alpha_{achiever}$ = .61, and $\alpha_{disruptor}$ =.68 in the sub-dimensions, with proposed revisions to the items in these dimensions. Several studies have found comparable results (Santos et al., 2022; Ooege et al., 2020; Taşkın & Kılıç Çakmak, 2020). Santos et al. (2022) reported that $\alpha_{disruptor}$ < .70, Taşkın and Çakmak (2020) reported $\alpha_{freespirit}$ = .62, and Oege et al. (2020) reported $\alpha_{freespirit}$ = .56, $\alpha_{achiever}$ = .61, α_{player} = .66, and $\alpha_{disruptor}$ =.64. It has been suggested that the low α values obtained in these studies conducted in different languages might have caused the less amount of items for sub-dimensions, and improvements should be made for these items, and their internal consistency should be examined using advanced methods such as EFA and CFA (Tondello et al., 2019), can be explained, in part, by the restricted length of the subscales (Baykul, 2015; Çetin, 2022).

Routine diagnostics for missingness, outlier influence, and normality were conducted. The measurement model was fit via CFA and estimated using robust maximum likelihood (MLR) owing to violations of multivariate normality. Previous research has addressed that the factors in the Player Types Scale for Gamification as correlated (Ooge et al., 2020; Tondello et al., 2019), as well as studies that address the factors as uncorrelated (Akgün & Topal, 2018; Manzano-Leon et al., 2020; Taşkın & Kılıç Çakmak, 2020) (Santos et al., 2022). In their research with 421 participants, Santos et al. (2022) conducted two separate CFA studies in which the factors in the Types of Users for Gamification Scale were considered as correlated and uncorrelated. According to the results of the analysis, it was reported that the fit indices in the CFA results where the factors were considered as uncorrelated were out of acceptable values (χ^2=1910.204, p<.001, *RMSEA*=.125 (.120-.130), *CFI*=.70, *TLI*=.673, *SRMR*=.314). In the CFA results where the factors were considered as correlated, the model fit indices fell within commonly accepted thresholds (χ^2=646.836, p<.001, *RMSEA*=.064 (.058-.070), *CFI*=.926, *TLI*=.914, *SRMR*=.073). Therefore, in this study, a CFA analysis was conducted in which the factors were correlated with each other, and the fit indices were found to be acceptable or excellent (χ^2=567.41, p<.05, *SRMR*=.05, *RMSEA*=.04 (.038-.047), *CFI*=.91, *TLI*=.90) (Çokluk et al., 2018; Hu & Bentler, 1999). When the factor loadings are analysed, item 10 (.21) and item 6 (.23) showed a salient factor loading (are lower than .32, Tabachnick & Fidell, 2007). Deciding to remove an item from the scale based only on factor loadings may lead to erroneous results (Erkuş, 2021):

- Item 6: My sense of curiosity influences me while playing (Internal motivation).
- Item 10: I like to criticize the rules (Extrinsic motivation).

On logical inference, both items were retained in the scale. CFA fit indices were acceptable, or excellent results supported the hypothesized factor structure

(Çokluk et al., 2018; Hu & Bentler, 1999), as a result, findings supported the hypothesized factor structure.

Classification of player types was based on the HEXAD subscale means. Therefore, the total score obtained from the scale has no effect on determining the player type of the participant. Since the items in the scale consist of general statements, it is not necessary for the participants to have knowledge about game design and game preferences or to actively play games (Taşkın & Kılıç Çakmak, 2020). Prior studies have examined associations between player-type classifications and age, gender, personality traits, learning styles, and preferences for specific game-design elements among scale respondents (Kırmacı & Kılıç Çakmak, 2022; Krath & von Korflesch, 2021; Manzano-Leon et al., 2020; Ooge et al., 2020; Santos et al., 2022; Santos et al., 2023; Tondello et al., 2016; Tondello et al., 2019). For example, Tondello et al. (2019) examined the relationships between player types and age and gender and found that there were significant relationships between age and sub-dimensions (except for the disruptor sub-dimension) and that intrinsic motivation (socializer, free spirit, achiever, philanthropist) increased with age, while extrinsic motivation (player, disruptor) decreased (effect size $r \leq .20$). In that study, mean comparison tests by gender showed significant differences on the philanthropist, socializer, disruptor, and free spirit subscales ($p < .01$). Analyses indicated that women scored slightly higher than men on all subscales linked to intrinsic motivation, whereas men scored slightly higher on the disruptor subscale. Santos et al. (2022) reported no statistically significant gender differences in player-type classifications and conducted a measurement invariance analysis according to gender. According to the results scalar invariance was tenable. Kırmacı and Kılıç Çakmak (2022), on the other hand, reported that the distribution of gamer types of higher education students is significantly related to gender, and stated male students were more likely to be classified as Explorer and Killer, whereas female students were more likely to be classified as Socializer and Achiever. Ooge et al. (2020) applied the Player Types Scale for Gamification on Dutch-speaking adolescents (13-

19 years old) and evaluated its internal structure using EFA & CFA. As a result of the research, it was recommended to be cautious in the application of the scale on adolescents, and it was stated that the items in the free spirit sub-dimension also gave high loading values in different sub-dimensions. It was stated that personality traits of adolescents such as being more risk-taking and sensitive to their environment can directly affect the player types and therefore the player types in the instrument appears to have not suitability for adolescent samples. Therefore, it was emphasized that new studies to be conducted on adolescents are needed. Manzano-Leon et al. (2020) applied the Player Types Scale for Gamification to 1345 Spanish-speaking adolescents aged 13-18 and tested MI across gender. Analyses indicated that the factor structure of the scale was confirmed and configural invariance was provided according to gender. Santos et al. (2023) conducted a psychometric analysis of the Player Types Scale for Gamification in a study with 110 Brazilian Portuguese-speaking participants between the ages of 13-16 and reported that there were items with relatively low factor loadings in the disruptor and free spirit sub-dimensions because of CFA. It was emphasized that these sub-dimensions are problematic in determining the player types of adolescents and should be improved.

Considering the different studies conducted for the Player Types Scale for Gamification in the literature. Prior studies have reported mixed findings regarding the relationship between player types and gender (Manzano-León et al., 2020; Santos et al., 2022; Tondello et al., 2019). When the findings obtained using a measurement tool are used for comparison purposes for subgroups (gender, language, socio-economic status, etc.), the assumption that there is no error arising from the measurement tool should be examined psychometrically (Uzun & Öğretmen, 2010). Measurement invariance analyses test whether a measure represents the same construct with equivalent model parameters across conditions (e.g., groups or time; Şen, 2020). Horn and McArdle (1992) presented measurement invariance as a prerequisite for making comparisons between groups. Therefore, measurement

invariance analyses should be performed in subgroups of the Player Types for Gamification Scale according to variables such as gender, age, and having technological tools. In the literature, Manzano-Leon et al. (2020) reported that the scale provided metric invariance according to gender, and Santos et al. (2022) reported that the scale provided scalar invariance according to gender.

Kırmacı and Kılıç Çakmak (2022) found no evidence emerged for a significant relationship between learning styles and player types ($p > .05$) in their study, and only a small, positive correlation was observed between conceptualization, one of Kolb's learning stages, and player types ($r = .122$, $p < .05$). Results indicate that learner characteristics should inform design decisions in gamified learning environments. Hamari et al. (2014) examined 24 different experimental studies on gamification and emphasized that gamification has a positive effect on learners, but it should not be forgotten that this effect depends on the subject matter and individual characteristics. Chapman and Rich (2018) stated that gamified learning environments have the effect of increasing student motivation regardless of age group and gender. In their study conducted with university students, they stated that game elements such as scoring assignments, last day bonuses or penalties, stretching the assignment submission date, and current score indicator provide continuous feedback for students' development and increase their motivation towards the course. The study found that 67.7% of participants reported a preference for the gamified learning environment rather than the classical one. Considering these research findings in the literature, it can be stated that the use of the Player Types for Gamification Scale adapted to the level of middle school students in this study will shed light on the future studies between player types and game elements. Thus, gamified learning environments can be designed according to measurements that do not interfere with bias according to gender and technological tool possession variables and contribute positively to students' motivation and performance towards the lesson.

In the literature, there is no measurement invariance study in which the scale is examined according to the variable of having technological tools. In Türkiye, it is seen that the measurement invariance analysis of the User Types for Gamification Scale adapted into Turkish by Taşkın and Kılıç Çakmak (2020) at the level of university students has not been conducted. Therefore, in this study, measurement invariance analyses of the adapted measurement tool were conducted according to gender and technological tool possession variables, and thus, the findings obtained by examining the structure of the scale in different subgroups were presented. Measurement invariance analyses were performed according to the variables of gender and technological tool ownership. Structural, metric, scalar and strict invariance stages were checked hierarchically. Invariance results were found consistent with scalar invariance across both variables, but not with strict invariance. It was concluded that the measurement tool measured the construct in the same way in these subgroups and there was no bias in the measurements. It can be said that comparisons can be made in subgroups to be formed according to gender and technological tool possession variables using the measurement tool.

The scale adapted through the related research can be used in different studies. In this study, the analyses were conducted according to the classical test theory. In another study, a comparative study can be conducted by conducting analyses based on item response theory.

Author Note

This study derives from the first author's MA thesis conducted under the supervision of the second author. This study was presented as an oral presentation at the 9th International Congress on Measurement and Evaluation in Education and Psychology (EPOD).

Funding

This study was supported by Scientific and Technological Research Council of Türkiye (TUBITAK) under grant 1001 (SOBAG) number 122K479. The authors thank TUBITAK for their support.

References

Arkün Kocadere, S., & Samur, Y. (2016). Oyundan oyunlaştırmaya. A. İşman, H. F. Odabaşı & B. Akkoyunlu (Ed.), *Eğitim Teknolojileri Okumaları 2016* (1. Basım, ss. 397-411) içinde. TOJET.

Bartle, R. (1996). Hearts, clubs, diamonds, spades: Players who suit MUDs. *Journal of MUD research*, *1*(1), 19.

Başusta, N. B., & Gelbal, S. (2015). Gruplararası karşılaştırmalarda ölçme değişmezliğinin test edilmesi: PISA öğrenci anketi örneği. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi*, *30*(4), 80-90.

Baykul, Y. (2015). *Eğitimde ve psikolojide ölçme: Klasik test teorisi ve uygulaması* (3. baskı). Pegem Akademi.

Bozkurt, A., & Genç Kumtepe, E. (2014, Şubat). *Oyunlaştırma, oyun felsefesi ve eğitim: Gamification*. 16. Akademik Bilişim Konferansı.

Büyüköztürk, Ş. (2021). Sosyal Bilimler İçin Veri Analizi El Kitabı (29. baskı). Pegem Akademi.

Byrne, B. M. (1998). *Structural equation modeling with LISREL, PRELIS, and SIMPLIS: Basic concepts, applications, and programming*. Psychology Press.

Chen, F. F. (2007). Sensitivity of goodness of fit indexes to lack of measurement invariance. *Structural Equation Modeling: A Multidisciplinary Journal, (14)*3, 464-504. https://doi.org/10.1080/10705510701301834

Cheung, G. W., & Rensvold, R. B. (2002). Evaluating goodness-of-fit indexes for testing measurement invariance. *Structural Equation Modeling, 9*(2), 233–255. https://doi.org/10.1207/S15328007SEM0902_5

Çelik, H. E., & Yılmaz, V. (2016). *LISREL 9.1 ile yapısal eşitlik modellemesi: Temel kavramlar-uygulamalar-programlama*. Anı Yayıncılık.

Çetin, B. (2022). *Eğitimde Ölçme ve Değerlendirme* (2. baskı). Anı Yayıncılık.

Çokluk, Ö., Şekercioğlu, G. & Büyüköztürk, Ş. (2018). *Sosyal bilimler için çok değişkenli istatistik: SPSS ve LISREL uygulamaları.* (5. baskı). Pegem Akademi Yayınları.

Deterding, S., Dixon, D., Khaled, R., & Nacke, L. (2011). From game design elements to gamefulness: Defining "gamification". *Proceedings of the 15th International Academic MindTrek Conference: Envisioning Future Media Environments*, 9-15. https://doi.org/10.1145/2181037.2181040

Erkuş, A. (2021). *Psikolojide ölçme ve ölçek geliştirme I: Temel kavramlar ve işlemler* (5. baskı). Pegem Akademi.

Ferro, L. S., Walz, S. P., & Greuter, S. (2013, September). Towards personalised, gamified systems: an investigation into game design, personality and player typologies. In *Proceedings of The 9th Australasian conference on interactive entertainment: matters of life and death* (pp. 1-6). https://doi.org/10.1145/2513002.2513024

Hamari, J., Koivisto, J., & Sarsa, H. (2014). Does gamification work? – A literature review of empirical studies on gamification. *2014 47th Hawaii International Conference on System Sciences*, 3025-3034. https://doi.org/10.1109/HICSS.2014.377

Hambleton, R. K., & Patsula, L. (1999). Increasing the validity of adapted tests: Myths to be avoided and guidelines for improving test adaptation practices. *Applied Testing Technology Journal*, 1-13.

Hu, L. & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journa*l, *6*(1) 1-55. https://doi.org/10.1080/10705519909540118

International Test Commission. (2017). *The ITC guidelines for translating and adapting tests (Second edition).*

İmrol, F. (2024). *Ölçme değişmezliği: R ile örnek uygulama* (1. bs). EPODDER.

Kapp, K. M. (2012). *The gamification of learning and instruction: game-based methods and strategies for training and education*. John Wiley & Sons. https://doi.org/10.1145/2207270.2211316

Karataş, E. (2018). Oyunlaştırılmış öğrenme etkinliklerinin öğretmen eğitiminde kullanımı. *Ahi Evran Üniversitesi Kırşehir Eğitim Fakültesi Dergisi*, *19*(1), 349-378. https://doi.org/10.29299/kefad.2018.19.010

Kıbrıslıoğlu Uysal, N. (2015). PISA 2012 Matematik Öğrenme Modelinin Kültürlere ve Cinsiyete 476 Göre Ölçme Değişmezliğinin İncelenmesi: Türkiye -Çin (Şangay) - Endonezya Örneği. Yayınlanmamış yüksek lisans tezi. Hacettepe Üniversitesi

Kırmacı, Ö., & Kılıç Çakmak, E. (2022). Oyunlaştırılmış öğrenme ortamı tasarımında bireysel özellikler ve oyuncu tipi ilişkisi. *Ahi Evran Üniversitesi Kırşehir Eğitim Fakültesi Dergisi*, *23*(1), 1119-1160. DOI: 10.29299/kefad.1032536

Klock, A. C. T., Gasparini, I., Pimenta, M. S., & Hamari, J. (2020). Tailored gamification: A review of literature. *International Journal of Human- Computer Studies*, *144*, 102495. https://doi.org/10.1016/j.ijhcs.2020.102495

Krath, J., von Korflesch, H.F.O. (2021). Player Types and Game Element Preferences: Investigating the Relationship with the Gamification User Types HEXAD Scale. In: Fang, X. (eds) HCI in Games: Experience Design and Game Mechanics. HCII 2021. Lecture Notes in Computer Science, vol 12789. Springer, Cham. https://doi.org/10.1007/978-3-030-77277-2_18

Manzano-León, A., Camacho-Lazarraga, P., Guerrero-Puerta, M. A., Guerrero- Puerta, L., Alias, A., Trigueros, R., & Aguilar-Parra, J. M. (2020). Adaptation and validation of the scale of types of users in gamification with the Spanish adolescent population. *International journal of environmental research and public health*, *17*(11), 4157. https://doi.org/10.3390/ijerph17114157

Marczewski, A. (2015). User Types. In *Even ninja monkeys like to play: Gamification, game thinking and motivational design* (1st ed., pp. 65-80). CreateSpace Independent Publishing Platform.

Meredith, W. (1993). Measurement invariance, factor analysis and factorial invariance. Psychometrika, 58(4), 525-543. https://doi.org/10.1007/BF02294825

Nacke, L. E., Bateman, C., & Mandryk, R. L. (2011). BrainHex: Preliminary results from a neurobiological gamer typology survey. In Entertainment Computing–ICEC 2011: 10th International Conference, ICEC 2011, Vancouver, Canada, October 5-8, 2011.

Proceedings 10 (pp. 288-293). Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-642-24500-8_31

Nunnally, J. C., & Bernstein, I. H. (1994). *Psychometric theory*. McGraw-Hill Companies, Incorporated.

Ooge, J., De Croon, R., Verbert, K., & Vanden Abeele, V. (2020). *Tailoring gamification for adolescents: a validation study of big five and hexad in dutch*. In Proceedings of the Annual Symposium on Computer-Human Interaction in Play (pp. 206-218). https://doi.org/10.1145/3410404.3414267

Önen, E. (2009). *Ölçme değişmezliğinin yapısal eşitlik modelleme teknikleri ile incelenmesi*. (Yayımlanmamış Doktora Tezi). Ankara Üniversitesi.

Özkan, Z., & Samur, Y. (2017). Oyunlaştırma yönteminin öğrencilerin motivasyonları üzerine etkisi. *Ege Eğitim Dergisi*, *18*(2), Article 2. https://doi.org/10.12984/egeefd.314801

Santos, A. C. G., Oliveira, W., Altmeyer, M., Hamari, J., & Isotani, S. (2022). Psychometric investigation of the gamification Hexad user types scale in Brazilian Portuguese. *Scientific reports*, *12*(1), 4920. https://doi.org/10.1038/s41598-022-08820-x

Schmitt, N. & Kuljanin, G. (2008). Measurment invariance: Review of practice and implications. *Human Resource Management Review*, 18, 220-222. https://doi.org/10.1016/j.hrmr.2008.03.003

Somer, O., Korkmaz, M., Dural, S., & Can, S. (2009). Ölçme eşdeğerliğinin yapısal eşitlik modellemesi ve madde cevap kuramı kapsamında incelenmesi. *Türk Psikoloji Dergisi*, 24(64).

Şenocak, D. (2019). *Açık ve uzaktan öğrenmede oyuncu tiplerinin motivasyon ve akademik başarı bağlamında incelenmesi* (Yayımlanmamış yüksek lisans tezi). Anadolu Üniversitesi.

Tabachnick, B. G. & Fidell, L. S. (2007). *Using multivariate statistics* (Fifth Edition). Pearson Education.

Taşkın, N., & Kılıç Çakmak, E. (2020). Adaptation of Modified Gamification User Types Scale into Turkish. *Contemporary Educational Technology, 12*(2), ep268. https://doi.org/10.30935/cedtech/7942

Tondello, G. F., Mora, A., Marczewski, A., & Nacke, L. E. (2019). Empirical validation of the gamification user types hexad scale in English and Spanish. *International Journal of Human-Computer Studies*, *127*, 95-111. https://doi.org/10.1016/j.ijhcs.2018.10.002

Tondello, G. F., Wehbe, R. R., Diamond, L., Busch, M., Marczewski, A., & Nacke, L. E. (2016, October). The gamification user types hexad scale. In *Proceedings of the 2016 annual symposium on computer-human interaction in play* (pp. 229-243). https://doi.org/10.1145/2967934.2968082

TÜİK (2021). Çocuklarda bilişim teknolojileri kullanım araştırması. https://data.tuik.gov.tr/Bulten/Index?p=Cocuklarda-Bilisim-Teknolojileri-Kullanim-Arastirmasi-2021-41132

TÜİK (2023). Hanehalkı bilişim teknolojileri kullanım araştırması. https://data.tuik.gov.tr/Bulten/Index?p=Hanehalki-Bilisim-Teknolojileri-(BT)-Kullanim-Arastirmasi-2023-49407

Uğurel, İ., & Moralı, S. (2008). Matematik ve oyun etkileşimi. *Gazi Üniversitesi Gazi Eğitim Fakültesi Dergisi*, *28*(3), Article 3.

Uyar, Ş. & Doğan, N. (2014). PISA 2009 Türkiye örnekleminde öğrenme stratejileri modelinin farklı gruplarda ölçme değişmezliğinin incelenmesi. Uluslararası Türk Eğitim Bilimleri Dergisi, 2014(3), 30-43.

Vanderberg, R. J. & Lance, C. E. (2000). A review and synthesis of the measurement invariance literature: Suggestions, practices, and recommendations for organizational research. *Organizational research methods*, *3*(1), 4-70. https://doi.org/10.1177/109442810031002

Yıldırım, İ. (2016). Oyunlaştırma temelli öğretim ilke ve yöntemleri dersi öğretim programının geliştirilmesi, uygulanması ve değerlendirilmesi (Yayımlanmamış doktora tezi). Gaziantep Üniversitesi.

Yılmaz, E. A. (2020). *Oyunların gücü adına! Oyunlaştırma bilimine giriş* (1. baskı). Epsilon Yayınevi.

Yurdugül, H. (2006). The comparison of reliability coefficients in parallel, tau-equivalent, and congeneric measurements. *Ankara University Journal of Faculty of Educational Sciences*, *39*(1), 15-37.

Zeybek, N. (2021). *Matematik öğretimi için oyunlaştırılmış ders tasarımı model önerisi*. (Yayımlanmamış doktora tezi). Hacettepe Üniversitesi.