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Development Of The Game-Based Teaching Method Effectiveness Scale: A Validity And Reliability Study[1]

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[1]This research is a revised section from a master's thesis titled " Investigatıon Of Students' Opınıons On The Effectıveness Of Game Teachıng Method In Terms Of Mathematıcs Self-Efficacy Perceptıon And Mathematıcs Attıtude

***Abstract*—This study is a methodological research aiming to develop a valid and reliable scale to measure primary school 4th-grade students' opinions regarding the effectiveness of the game-based teaching method. Within the scope of the study, a comprehensive literature review was first conducted and an item pool of 40 statements was created; the number of items was reduced to 31 in line with expert opinions. To determine the construct validity of the scale, exploratory factor analysis (EFA) was applied using data obtained from 400 primary school 4th-grade students in Diyarbakır; the KMO value was found to be .89 and Bartlett's test was significant, resulting in a four-factor, 27-item structure. Based on item content, these factors were labeled "interest," "reluctance," "domain of effect," and "motivation," and the total explained variance was calculated as 41.35%. The overall Cronbach's Alpha reliability coefficient of the scale was found to be .86, indicating high internal consistency. The obtained structure was tested through confirmatory factor analysis (CFA) using data collected from a separate sample (401 students); six items causing cross-covariance were removed, resulting in a final 21-item structure, and the model showed excellent-to-good fit indices ($\chi^2/df=1.71$; RMSEA=.04; CFI=.93). As a result, it was concluded that the developed scale is a valid and reliable instrument capable of measuring students' opinions regarding game-based teaching.**

Keywords—Game-based teaching, game-based learning, scale development, validity and reliability, exploratory and confirmatory factor analysis

INTRODUCTION

Play is an activity as old as human history itself (Dağdelen & Kösterelioğlu, 2015). Many thinkers and educators have sought to explain the function of play in children's lives and in education. Freud (1961) defined play as a set of movements through which the child unconsciously reflects experiences and desires (Çakaroğlu & Ömür, 2020); Piaget described it as a behavior that instills a sense of responsibility, while Erikson conceptualized it as an ego function that helps children overcome the crises of psychosocial developmental stages (Hanbaba, 2011). According to another definition, play is a means through which children investigate, explore, learn, and make sense of the world (Boz, 2018). For children, play is the totality of rule-bound and rule-free activities that foster the development of abilities, awareness of interests, and intelligence; it is a cognitive-affective activity in which emotions and thoughts are best reflected and which makes learning enjoyable (Dağdelen & Kösterelioğlu, 2015; Karataş, 2021).

History of Play

The history of play is as old as childhood itself. A statue in the British Museum dating back to 800 BC shows children playing with a spoon; games have been transmitted from culture to culture and have survived to the present day (Kaçar, 2016). Toys such as dolls, ropes, and balls have been found in ancient Egyptian wall paintings (Kahya-Canlı & Demirarslan, 2020), and wheel-shaped toys have been discovered belonging to the Cucuteni-Trypillian culture dating from 5500–2750 BC (Vatandaş, 2020). In Turkish culture as well, play dates back to 4000 BC; games such as horsemanship, archery, Gökbörü, Çöğen, and Cirit occupy an important place (Dumangöz & Çavuşoğlu, 2022). Children's games are mentioned in Kaşgarlı Mahmut's Dīwān Lughāt al-Turk (Turhan, 2004). Al-Ghazali argued that play increases learning motivation (Teke & Avşaroğlu, 2022); Ibn Sina emphasized that play is indispensable for the child and enriches the imagination. Erzurumlu İbrahim Hakkı and Ibn al-Hajj al-Abdari also drew attention to the importance of play in education, noting that it eliminates laziness, reduces stress, and fosters socialization (Özen, 1999).

Characteristics of Play

Play supports children's cognitive, affective, psychomotor, and social development (Öztemiz &

Önal, 2013); it enhances permanent learning and interest in lessons, and prevents lessons from becoming monotonous by ensuring active participation (Boz, 2018). It allows children to reflect their inner world (Boyraz & Serin, 2016), and to develop team spirit (Altun, 2016), creativity, and social interaction (Korkusuz & Karamete, 2013). By placing the child at the center, it enables learning by doing and experiencing, exploring the environment, concretizing abstract concepts, and reaching conclusions through observation and inquiry (Dağdelen & Kösterelioğlu, 2015; Yazıcıoğlu & Çavuş-Güngören, 2019). It also contributes to relating other subjects to one another and to classroom discipline (Babayiğit & Gültekin, 2019). Play is both rule-governed and free, and it develops the capacity for imitation (Tural, 2005); it helps the individual achieve self-actualization and develop a sense of self-sacrifice (Çakaroğlu & Ömür, 2020). It is a way in which hidden human energy is released (Uluğ, 2007; cited in Gürpınar, 2017) and constitutes a process of discovery (Karataş, 2021). It helps children internalize rule-following and reduces tension (Atasoy, 2019); technology-based games support the acquisition of technical knowledge (Kaya & Elgün, 2014), while play in general supports language development (Dönmez, 2017).

Education and Play

Education is the process of developing an individual's mental, physical, emotional, and social skills and behaviors in a desired direction; it continues both inside and outside of school (Gazezoğlu, 2007). In order to create environments in which students participate with enthusiasm and willingness, the teaching-learning process is supported with games, thereby creating game-based instructional environments (Yaman, 2020). Game-based instruction is effective and enjoyable because it reveals students' abilities, offers diverse instructional environments, and appeals to multiple senses (Cop & Kablan, 2018). The student is active throughout the process; they recognize their own mistakes and exchange ideas with peers, and since assessment is largely conducted through self- or peer-evaluation, they take an active role across all levels of the cognitive domain (knowledge, comprehension, application, analysis, synthesis, evaluation) (Gürpınar, 2017). As it relies on a trial-and-error process, it also supports creativity and personal development (Dönmez, 2017).

Games distance children from stress while instilling a sense of responsibility; taking on different roles increases the permanence of knowledge, and out-of-classroom activities make it possible to learn from primary sources (Hoşgör, 2010) and reduce misconceptions and incomplete or faulty learning (Karamustafaoğlu, Pazar, & Karamustafaoğlu, 2018).

Play and Child Development

Play is an important tool for personality development and for the child's adaptation to the environment and society; attitudes and reactions displayed during play contribute to the shaping of character (Atasoy, 2019). Play environments offer rich experiences and enable students to reach the correct answer through feedback and correction on their own, to learn with peers, and to develop verbal communication skills (Gürpınar, 2017; Kaya & Elgün, 2014). According to Yavuzer (1984), play is a method through which the child learns, on their own, what no one else could teach them (cited in Kaya & Elgün, 2014).

Cognitive development: Play is a mental process and a form of problem-solving; the student makes meaning by questioning, exploring, and relating new information to prior learning (Tural, 2005). During play, skills such as questioning, analysis, classification, reasoning, establishing cause-effect relationships, synthesis, and evaluation develop (Burgaz-Uskan & Bozkuş, 2019), and over time these skills become part of the individual's personality traits (Savaş & Gülüm, 2014).

Affective and social development: Play arouses curiosity and increases motivation, imagination, and social interaction with peers (Tural, 2005). A child who reaches an answer develops self-confidence, and an introverted student becomes more outgoing (Kaya & Elgün, 2014); repeated games make learning more permanent (Dönmez, 2017). By assuming various roles, the child experiences emotions such as happiness, sadness, and love, thereby coming to know both themselves and their peers (Burgaz-Uskan & Bozkuş, 2019). Group games develop cooperation, sharing, team responsibility, and communication skills; the child comes to realize that what is gained is not only a reward but also knowledge (Yıldırım, 2015).

Psychomotor development: Children have a need for movement, and they release this energy through play (Tural, 2005). Movements such as walking, running, jumping, and catching develop fine and gross motor skills and increase bodily awareness and self-confidence (Hoşgör, 2010; Gürpınar, 2017).

Linguistic development: Language first develops receptively and then expressively in children (Gazezoğlu, 2007). During play, children learn new words and establish communication (Hoşgör, 2010); a child who participates in social settings learns to speak without hesitation (Kaçar, 2016). In dramatic play, vocabulary develops, while in symbolic play, improvisation and intonation skills develop (Hoşgör, 2010); syntactic structures are learned by modeling peers and teachers (Gözalan & Koçak, 2014), and interaction and social skills increase (Tural, 2005).

Types of Play

Imaginative play is played alone up to age 3 and with peers thereafter; the child puts themselves in the place of other characters and makes various comparisons with any given object (Hoşgör, 2010). Cluster games, seen at ages 5–6, have specific rules and content and are generally sung and competitive; they develop a sense of responsibility (Hoşgör, 2010;

Hanbaba, 2011). Classroom games are played indoors with limited movement; outdoor games (such as tag and hide-and-seek) develop children cognitively, affectively, psychomotorically, and socially (Hoşgör, 2010). Individual games are effective in building self-confidence; group games are generally played under teacher guidance and are rule-based and repetitive (Hoşgör, 2010). Dramatic games enable the child to explore their inner world and to seek solutions to real-life problems by taking on adult roles (Kaçar, 2016). Construction/building games develop fine and gross motor skills, self-confidence, and creativity, and can be played both indoors and outdoors (Kaçar, 2016).

Theoretical Views on Play

The first theories concerning play developed in the late 19th century. According to Lazarus, play is a spontaneous activity that arises on its own and produces happiness, without a specific goal; according to Hall, children experience cultural development through play (Songur, 2006). Plato argued that play reveals children's talents, while al-Ghazali maintained that play renews and rests the memory (Koçyiğit, Tuğluk, & Kök, 2007). Comenius drew attention to personality and moral development, Fröbel to play as a necessity, and Salzmann to the idea that a person unfamiliar with play cannot be an educator. Piaget's cognitive theory and Vygotsky's views are among the most widely discussed theories on the relationship between play and education (Bağlı, 2004).

Piaget: Play is related to cognitive development; it progresses from simple to complex, from imaginative play to rule-based play (Kaçar, 2016), and constitutes a form of adaptation (Atasoy, 2019). It is a means through which the child establishes a connection with the outside world; it is examined in three stages: practice games, symbolic games, and rule-based games (Ercanlı, 1997).

Freud: Every behavior has a cause; children reflect their emotions through play, and play is therefore a reflection of personality (Hoşgör, 2010; Kaçar, 2016). Play is an activity that helps children gain experience in coping with difficult situations; feelings not accepted by society are expressed through play, and traumas can be overcome, which is why Freud argued that play could be used in psychological treatment (Gazezoğlu, 2007; Kaçar, 2016). Since defense mechanisms have not yet developed, play can alleviate anxiety-inducing situations (Hanbaba, 2011); the child abandons play once critical-logical thinking develops (Hoşgör, 2010).

Erikson: Play is a mirror of the eight-stage psychosocial development theory; the need for play becomes particularly evident during the four stages corresponding to childhood (trust vs. mistrust, autonomy vs. shame, initiative vs. guilt, industry vs. inferiority) (Kaçar, 2016; Koçyiğit, Tuğluk, & Kök, 2007). Play is an ego function that helps overcome developmental crises (Şirin, 2011); the child plays in order to prepare themselves for negative situations (Songur, 2006). Erikson argued that self-development is achieved through social experiences and that play meets the child's needs by combining past, present, and future situations (Şirin, 2011; Hanbaba, 2011).

Vygotsky: According to sociocultural theory, play is a formative process; the child uses real-life situations to produce new outcomes through cause-and-effect relationships and to become free of negative thoughts. Play begins with tension and continues with controlled happiness; it is a highly motivated behavior (Şirin, 2011). Genuine play begins around age 3 in a social-dramatic form; play is an important opportunity for expanding the child's world in terms of cognitive development (Songur, 2006).

Implementation of Game-Based Teaching in the Classroom

In the classroom setting, play is effective in helping students move from passive to active participation and in creating a reinforcing and enjoyable learning environment (Cop & Kablan, 2018). Play enables the child to communicate with their environment, to question without becoming bored, and to remain open to learning (Atasoy, 2019); it supports intellectual development, attention span, and problem-solving skills. In practice, individual differences should be respected, games should be designed in accordance with learning outcomes and curricula, and they should not be reduced to a mere means of temporary entertainment (Hanbaba, 2011; Fırat, 2013). In competitive games, an encouraging level should be maintained, students' opinions should be taken into account, roles should be distributed equally in team games, and games should be selected in accordance with developmental level. Rote-based games should be avoided, and participation should be voluntary (Hoşgör, 2010); materials should be appropriate for the classroom setting, safe, and appealing to multiple senses (Gazezoğlu, 2007).

The Teacher's Role in Selecting Effective Games

Organizing learning experiences, classroom management, and students' active participation are largely the teacher's responsibility (Sünbül, 1996). Teachers should select games that attract attention, include reticent students, and provide a peaceful classroom environment (Altınbulak, Emir, & Avcı, 2006); attention should be paid to ensuring that the game is compatible with the subject of the lesson and with students' language structure, culture, and developmental level. The child should be encouraged to participate in the game voluntarily, rules should be clearly stated from the outset, and socially supportive games should be included (Hanbaba, 2011). Games should be selected so as to support multifaceted rather than one-dimensional development (Karamustafaoğlu, Pazar, & Karamustafaoğlu, 2018), rewards should be given without delay (Gürpınar, 2017), and games should not be limited to spaces outside the classroom (Boz, 2018). Because the play

environment provides freedom, teachers can get to know their students more intimately (Hanbaba & Bektaş, 2007), which in turn creates a positive learning environment (Korkusuz & Karamete, 2013).

Advantages of Game-Based Teaching

Game-based learning contributes to children's educational process and to their becoming successful individuals (Pesen-Duman & Cumart, 2024). Its main advantages include directing attention to the subject and fostering self-awareness (Kaynar, 2020); enabling enjoyable participation, skill development, and permanent learning (Ülküdür, 2016); facilitating teachers' efforts to achieve learning outcomes and helping to establish connections between prior and new learning (Yıldırım, 2015); reinforcing the subject matter and increasing student-student and student-teacher interaction (Burgaz-Uskan & Bozkuş, 2019); and instilling awareness of everyday rules, freedom of movement, multifaceted development, and positive attitudes (Atasoy, 2019). It also develops leadership qualities (Kaynar, 2020), facilitates the understanding of abstract or complex information, and fosters respect for individual differences (Ülküdür, 2016; Atasoy, 2019).

Disadvantages of Game-Based Teaching

Because it requires higher-order skills, game-based teaching may challenge some students and, by deviating from its purpose, may create a competitive atmosphere (Yıldırım, 2015). It may lead to a loss of time, and active participation may not be achieved when the game is not suited to students' level; implementation may also be difficult in crowded classrooms (Ülküdür, 2016). Some students may view play merely as a form of entertainment, and material preparation may be time-consuming (Kaynar, 2020). Inadequate physical conditions may limit implementation, and involving passive students may prove difficult (Atasoy, 2019; Yıldırım, 2015). Teachers' potential lack of competence in this area, the economic infeasibility of materials, and the risk of students developing negative attitudes after experiencing failure are also among the disadvantages (Ülküdür, 2016; Burgaz-Uskan & Bozkuş, 2019; Atasoy, 2019).

Measurement and Evaluation in Game-Based Teaching

Measurement and evaluation serve to determine whether the education provided has achieved the intended success; in game-based teaching, this also reveals the adequacy of materials and time (Gürpınar, 2017). The aim is to understand the student's true personality, strengths and weaknesses, and interests and abilities (Ergül & Doğan, 2022). Traditional assessment tools may be insufficient because they evaluate the student from only one perspective; therefore, the use of multifaceted tools such as observation, video recording, interviews, scales, and questionnaires is recommended (Tural, 2005; Gürpınar, 2017). In evaluation, not only the student but also the teacher should engage in self-reflection; objectivity should be maintained, and evaluation should be carried out together with students whenever possible (Gürpınar, 2017). Observation should be conducted carefully and thoroughly without the student's awareness, and cognitive, affective, and psychomotor dimensions should be considered together (Tural, 2005). Filing evaluation results contributes to the teacher's ability to track changes in the student over time and to get to know the student more accurately (Tural, 2005).

METHOD

Research Model

Since this research is a scale development study aiming to determine the level of effectiveness of the game-based teaching method, the methodological research model, one of the quantitative research designs, was used. Methodological research focuses on the development and adaptation of measurement instruments and on determining their validity, reliability, and psychometric properties (Polit & Beck, 2017). The main purpose of such research is to ensure that the measurement instruments to be used in research are valid, reliable, and usable (DeVellis & Thorpe, 2021). Conducting content validity, construct validity, and reliability analyses is among the fundamental characteristics of methodological research in scale development and adaptation studies (Boateng et al., 2018). Accordingly, in the present study, exploratory and confirmatory factor analyses were performed to determine the construct validity of the scale, while internal consistency reliability was examined through Cronbach's Alpha coefficients.

Population and Sample

The population of the study consists of 4th-grade primary school students in the province and districts of Diyarbakır. Two separate study groups were used for the sample of the research. First, in order to establish the construct validity of the Game-Based Teaching Method Effectiveness Scale through exploratory factor analysis and reliability analysis, 470 4th-grade students attending different schools in central Diyarbakır and its districts were reached. Students were selected using convenience sampling due to factors such as the central location of the schools included in the sample and ease of access. After forms that were incompletely or carelessly filled out by these students were eliminated, validity and reliability analyses were conducted with the remaining 400 forms.

In order to determine the confirmatory factor analysis of the scale, opinions were again obtained from 500 4th-grade primary school students attending different primary schools in central Diyarbakır and its districts. Students were selected using convenience sampling due to factors such as the central location of the schools included in the sample and ease of access.

After 99 incompletely or carelessly filled-out forms were eliminated, the remaining 401 forms were used in the research.

Data Analysis

In the process of developing the Game-Based Teaching Method Effectiveness Scale, exploratory factor analysis, confirmatory factor analysis, and Cronbach's Alpha reliability analysis, which determines the scale's internal consistency reliability, were applied using statistical software.

Game-Based Teaching Method Effectiveness Scale

For this scale prepared by the researcher, a comprehensive literature review was first conducted. Based on the information obtained, an item pool consisting of 40 statements was created. After the item pool for a scale has been created, expert opinion is sought to determine whether the items ensure face and content validity (İlhan, Güler, & Taşdelen-Teker, 2020). For this reason, the scale items created were submitted for review to 2 faculty members specializing in curriculum development and 3 classroom teachers. Following expert opinion, 9 items were removed from the pool of 40, reducing the number of items to 31. In the study, the 31 items on the scale were structured using a five-point Likert-type rating scale. The five-point Likert-type rating scale was scored and evaluated as follows: 1 = strongly disagree, 2 = disagree, 3 = undecided, 4 = agree, 5 = strongly agree. In addition, the level of agreement corresponding to the arithmetic mean value was evaluated as follows:

1–1.80: do not agree at all 1.81–2.60: disagree 2.61–3.40: undecided 3.41–4.20: agree 4.21–5: strongly agree

The scale was administered to a total of 470 4th-grade primary school students. Of these, 70 were excluded from evaluation because they had filled out the scales incorrectly or incompletely. The remaining 400 were included in the evaluation.

FINDINGS

Findings Regarding Exploratory Factor Analysis

Exploratory Factor Analysis was conducted to determine the construct validity of the Game-Based Teaching Method Effectiveness Scale. As a result of the factor analysis, items with a factor loading below 0.40 were eliminated, and the remaining 27 items were renumbered. After the renumbering, items 10, 13, 15, and 19 were reverse-coded, and accordingly the arithmetic mean was calculated and reversed in the level-of-agreement column in the "Students' Opinions Regarding the Effectiveness of the Game-Based Teaching Method" table presented in the findings.

Table 1. Kaiser-Meyer-Olkin Coefficient and Bartlett's Test of Sphericity Results

Kaiser-Meyer-Olkin (KMO) Coefficient		0.89
Bartlett's Test of Sphericity	Chi-Square Value	2539.397
	df	351
	p	.00
Number of Valid Items		27

When Table 1 is examined, the Kaiser-Meyer-Olkin (KMO) sampling adequacy value was found to be 0.89, indicating that the sample size is sufficient for exploratory factor analysis. A KMO value between 0.5–0.7 is considered mediocre; between 0.7–0.8, good; between 0.8–0.9, very good; and above 0.9, superb (Çolakoğlu & Büyükekşi, 2014). The result of Bartlett's Test of Sphericity showed $p < 0.05$, indicating a high degree of correlation among the items.

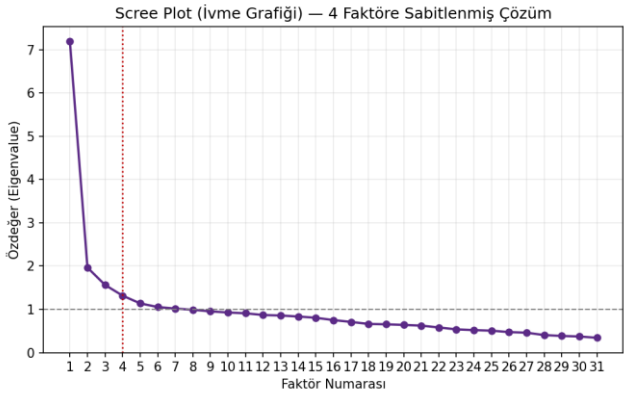


Figure 1. Scree Plot

When the Scree Plot in Figure 1 is examined, it is seen that the scale consists of 4 factors. Accordingly, the items in the first factor were labeled "interest" because they included expressions such as "desire, excitement, enjoyment, self-confidence." The items in the second factor were labeled "reluctance" because they contained expressions such as "waste of time, quick forgetting, fatigue." The items in the third factor were labeled "domain of effect" because they included expressions such as "following rules, everyone's participation, learning on one's own." The items in the fourth factor were labeled "motivation" because they contained expressions such as "not easily forgetting, curiosity, desire, excitement." The distribution of the scale items across the factors and their factor loadings are presented in Table 2.

Table 2. Factor Analysis Table for the Construct Validity of the Game-Based Teaching Method Effectiveness Scale

Item	Factor 1 (Interest)	Factor 2 (Reluctance)	Factor 3 (Domain of Effect)	Factor 4 (Motivation)
30. I fulfill the tasks assigned to me in lessons taught by my teacher using games.	.68			
29. I want to actively participate in lessons in which my teacher uses games.	.67			
31. I can express myself more comfortably in lessons taught by my teacher through games.	.65			
28. My self-confidence increases in lessons taught by my teacher using games.	.63			
23. I do the homework assigned in lessons taught with games on my own.	.57			
24. I answer eagerly the questions asked by my teacher in lessons taught with games.	.55			
25. I am more successful in the exams of lessons taught by my teacher through games.	.52			
18. I both have fun and learn in lessons in which my teacher uses games.	.46			
22. I excitedly wait for my turn in lessons taught by my teacher with games.	.46			
2. I enjoy doing my homework in lessons taught by my teacher through games.	.43			
15. I consider it a waste of time when my teacher teaches lessons with games.		.73		
13. My teacher's teaching lessons with games tires me physically.		.63		
10. I quickly forget the subject because I focus on the game in lessons in which my teacher uses games.		.61		
14. It is very enjoyable when my teacher plays group games in lessons.		.54		
19. The games in lessons taught by my teacher through games do not attract my attention.		.41		
9. My teacher's teaching lessons through games makes me more respectful of my friends' opinions.			.67	
6. I follow the rules of the game in lessons taught by my teacher through games.			.61	
16. I can easily solve questions on topics taught with games regardless of how much time has passed.			.48	
8. Playing together with my classmates in lessons taught by my teacher through games makes me happy.			.42	
11. The whole class participates in lessons taught by my teacher with games.			.41	
7. I learn the subjects taught by my teacher through games on my own.			.41	
4. I learn the subjects taught by my teacher through games on my own.			.41	
1. I am more willing to attend lessons in which my teacher uses games.				.64
5. I do not easily forget the subjects taught by my teacher through games.				.52

12. The whole class participates in lessons taught by my teacher with games.	.48
26. I feel more competent in lessons taught by my teacher through games.	.47
3. My teacher's teaching lessons by playing games excites me.	.47

As a result of the factor analysis, items with a factor loading below 0.40 (items 17, 20, 21, and 27) were eliminated. As a result, 27 items remained.

Table 3. Total Explained Variance and Eigenvalues for the Sub-Factors

Variance	Factor 1	Factor 2	Factor 3	Factor 4	Total Variance
% Variance	24.23	6.86	5.64	4.60	41.35

When Table 3 is examined, it is seen that the 1st factor of the Game-Based Teaching Method Effectiveness Scale explains 24.23% of the total variance; the 2nd factor explains 6.86%; the 3rd factor explains 5.64%; and the 4th factor explains 4.60%, with a total explained variance of 41.35%.

Table 4. Reliability Analysis Table for the Game-Based Teaching Method Effectiveness Scale

	Cronbach's Alpha	Number of Items
Factor 1 – Interest	.82	10
Factor 2 – Reluctance	.66	5
Factor 3 – Domain of Effect	.66	7
Factor 4 – Motivation	.55	5
Overall Scale	.86	27

When Table 4 is examined, it is seen that Factor 1 consists of 10 items, Factor 2 of 5 items, Factor 3 of 7 items, and Factor 4 of 5 items. As a result of the application, the Cronbach's Alpha coefficient of the Game-Based Teaching Method Effectiveness Scale was calculated. After the items with a factor loading below 0.40 were eliminated as a result of factor analysis, the Cronbach's Alpha reliability coefficient of the remaining items was found to be .86. Since a coefficient of 0.70 is generally considered sufficient for reliability, the obtained value indicates that the scale's reliability is high (İlhan, Güler, & Taşdelen-Teker, 2020). The Cronbach's Alpha reliability coefficients were found to be .82 for Factor 1, .66 for Factor 2, .66 for Factor 3, and .55 for Factor 4.

Findings Regarding Confirmatory Factor Analysis

Confirmatory factor analysis was carried out to test the accuracy of the structure consisting of 27 items and four dimensions obtained as a result of the exploratory factor analysis. Confirmatory factor analysis is an analysis used to confirm a structure determined by EFA (Karagöz, 2017). The findings regarding the first-order CFA results are presented in Figure 2.

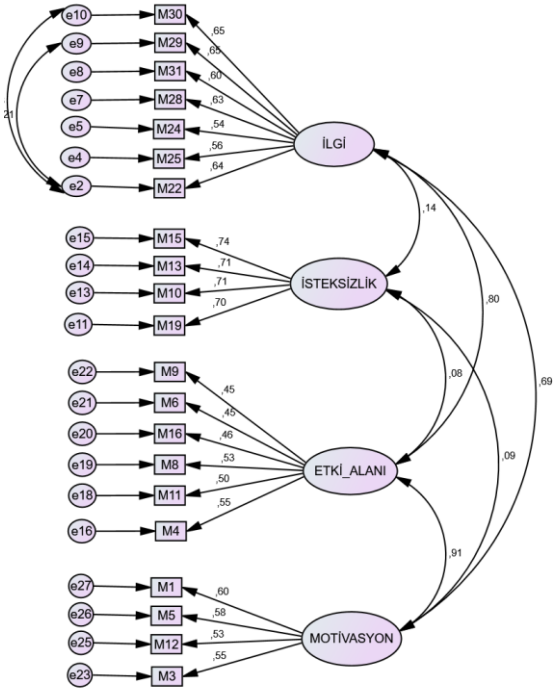


Figure 2. Confirmatory Factor Analysis of the Game-Based Teaching Method Effectiveness Scale

In the confirmatory factor analysis performed on the data for the 27-item scale, items M23, M18, and M2 in the interest dimension of the scale, item M14 in the reluctance dimension, item M7 in the domain-of-effect dimension, and item M26 in the motivation dimension were removed from the scale because they formed covariances with multiple items across different dimensions. As a result of the confirmatory factor analysis, all paths for the 21 remaining items in the Game-Based Teaching Method Effectiveness Scale were found to be statistically significant at the .001 level. The explained communality values of the items in the sub-factors of the scale were found to range between 0.45 and 0.74.

Table 5. Standardized Factor Loading Values (SFLV)

1st Sub-Factor	SFLV	2nd Sub-Factor	SFLV	3rd Sub-Factor	SFLV	4th Sub-Factor	SFLV
M30	0.65	M15	0.74	M9	0.45	M1	0.60
M29	0.65	M13	0.71	M6	0.45	M5	0.58
M31	0.60	M10	0.71	M16	0.46	M12	0.53
M28	0.63	M9	0.70	M8	0.53	M3	0.55
M24	0.54			M11	0.60		
M25	0.56			M14	0.55		
M22	0.64						

The standardized factor loading values (SFLV) presented in Table 5 are important evidence of the degree to which the items represent the construct to which they belong in the scale development process. According to the classification of Comrey and Lee (1992), values above .71 are considered "excellent," .63–.70 "very good," .55–.62 "good," and .45–.54 "fair." When the table is examined, items M15 (.74), M13 (.71), and M10 (.71) in the 2nd sub-factor fall within the very good-to-excellent range; items M30, M29, M31, and M28 (.60–.65) in the 1st sub-factor and all items in the 4th sub-factor (.53–.60) fall within the good range, whereas M9 and M6 (.45) in the 3rd sub-factor remain only at the fair level. Hair et al. (2019) state that a value of .50 is a practical minimum threshold in scale development, while .70 represents the ideal level; when evaluated against this criterion, it can be said that the scale as a whole provides acceptable convergent evidence.

Average Variance Extracted (AVE) and Composite Reliability (CR)

The average variance extracted (AVE) and composite reliability (CR) values for each factor were calculated based on standardized factor loadings and are presented in Table 6 (Fornell & Larcker, 1981).

Table 6. Average Variance Extracted (AVE) and Composite Reliability (CR)

Factor	Number of Items	AVE	CR	Evaluation
F1	7	0.374	0.806	AVE below .50; CR acceptable
F2	4	0.512	0.807	AVE above .50; CR acceptable
F3	6	0.242	0.655	AVE below .50; CR acceptable
F4	4	0.320	0.653	AVE below .50; CR low

In terms of reliability, the model produced generally satisfactory results overall. Composite reliability (CR) values ranged from 0.653 to 0.807; while the Interest (CR = 0.806) and Reluctance (CR = 0.807) factors showed high reliability, the Domain of Effect (CR = 0.655) and Motivation (CR = 0.653) factors remained below the 0.70 threshold, although they stayed above the acceptable minimum threshold of 0.60.

Findings regarding convergent validity are more limited. Only the Reluctance factor (AVE = 0.512) met the 0.50 threshold; the Interest (AVE = 0.374), Motivation (AVE = 0.320), and especially the Domain of Effect (AVE = 0.242) factors remained considerably below this threshold. The low AVE value in the Domain of Effect factor suggests that the items belonging to this construct have a weak capacity to explain shared variance and that the item pool should be revisited. Nevertheless, as emphasized by Fornell and Larcker (1981), the fact that CR values remain at a sufficient level suggests that AVE falling below the threshold does not entirely invalidate construct validity.

The fit index values obtained from the confirmatory factor analysis of the Game-Based Teaching Method Effectiveness Scale are presented in Table 7.

Table 7. Fit Index Values of the Game-Based Teaching Method Effectiveness Scale in CFA

Fit Index	Excellent Fit Values	Good Fit Values	Value	Fit Level
χ^2/df	$0 \leq \chi^2/df \leq 3$	$3 < \chi^2/df \leq 5$	1.71	Excellent Fit
GFI	$.95 \leq GFI \leq 1.00$	$.90 \leq GFI < .95$	.93	Good Fit
AGFI	$.90 \leq AGFI \leq 1.00$	$.85 \leq AGFI \leq .90$	.91	Excellent Fit
CFI	$.95 \leq CFI \leq 1.00$	$.90 \leq CFI < .95$	.93	Good Fit
IFI	$.95 \leq IFI \leq 1.00$	$.90 \leq IFI < .95$	.93	Good Fit
RMSEA	$0 \leq RMSEA \leq .05$	$.05 \leq RMSEA \leq .08$	.04	Excellent Fit
SRMR	$.00 \leq SRMR \leq .05$	$.05 \leq SRMR \leq .10$	.04	Excellent Fit

When Table 7 is examined, it can be said that, based on the fit index values obtained from the first-order confirmatory factor analysis of the Game-Based Teaching Method Effectiveness Scale, the model achieves excellent fit values (χ^2=309.7, df=181, χ^2/df=1.71, GFI=.93, AGFI=.91, CFI=.93, IFI=.93, RMSEA=.042, SRMR=.047).

DISCUSSION AND CONCLUSION

Discussion

In this study, exploratory and confirmatory factor analyses were conducted to determine the construct validity and reliability of the Game-Based Teaching Method Effectiveness Scale. The fact that the KMO sampling adequacy coefficient (.89) obtained as a result of the exploratory factor analysis (EFA) was at a "very good" level, and that Bartlett's test of sphericity was significant ($p < .001$), reveals that the dataset was suitable for factor analysis and that a sufficient degree of relationship existed among the variables for the analysis (Çolakoğlu & Büyükekşi, 2014). This finding is important in that it shows that the first and most fundamental condition of the scale development process was met, since factor analysis conducted without adequate sampling would threaten the stability and generalizability of the resulting factor structure (Hair et al., 2019).

When the scree plot examination and the Kaiser criterion were evaluated together, it was determined that the scale exhibited a four-factor structure; the factors were labeled "interest," "reluctance," "domain of effect," and "motivation" based on their item content. This four-dimensional structure can be said to be consistent with the multidimensional nature frequently emphasized in the game-based learning literature. Prensky (2001) states that game-based learning can elicit both positive (interest, motivation, engagement) and negative (fatigue, distraction, reluctance) reactions in students, while Gee (2003) also emphasizes that game-based learning environments increase student engagement while producing varying levels of response depending on individual differences. In this context, the coexistence of both positive (interest, motivation) and negative (reluctance) dimensions in the scale confirms that student opinions regarding game-based teaching exhibit a multifaceted rather than a unidimensional structure. On the other hand, Vygotsky's (1978) theoretical framework, which treats play as a tool for cognitive and social development, along with Malone's (1981) theory of intrinsic motivation, also contribute to the theoretical grounding of the "domain of effect" and "motivation" dimensions.

The fact that the factor analysis explained 41.35% of the total variance, while being at the lower boundary of the 40%–60% range generally accepted for multi-factor scales in the social sciences, is nonetheless considered acceptable (Tabachnick & Fidell, 2013). The overall Cronbach's Alpha reliability coefficient of the scale being .86 indicates that the scale as a whole has high internal consistency (İlhan, Güler, & Taşdelen-Teker, 2020). However, when examined at the sub-factor level, it is seen that the reliability coefficients of the Reluctance and Domain of Effect factors (.66) and, in particular, the Motivation factor (.55) remained below the .70 threshold. This can be explained by the small number of items in these sub-dimensions (4–5 items), since Cronbach's Alpha is a statistic directly affected by the number of items and tends to be lower in sub-scales with fewer items (Nunnally & Bernstein, 1994).

During the confirmatory factor analysis (CFA) stage, the removal from the model of six items (M23, M18, M2, M14, M7, M26) that formed cross-covariances with multiple dimensions shows that the item-purification process continued not only at the exploratory stage but also at the confirmatory stage, and that the final structure of the scale was subjected to a stricter statistical filtering process. The fact that all paths for the remaining 21 items were statistically significant ($p < .001$) provides evidence that each item reliably represents the factor to which it belongs (Karagöz, 2017). When the model fit indices are examined, the fact that the χ^2/df ratio (1.71), GFI (.93), AGFI (.91), CFI (.93), IFI (.93), RMSEA (.04), and SRMR (.04) values all fall within excellent or good fit boundaries reveals that the established four-factor model exhibits a strong fit with the data (Hu & Bentler, 1999). This result can be interpreted as indicating that the factor structure obtained at the EFA stage was independently confirmed and that the scale provides strong evidence for construct validity.

When the standardized factor loading values (Table 5) are examined, it is seen that the great majority of items load within the "fair" to "excellent" range (.45–.74) according to the classification of Comrey and Lee (1992), indicating that the items statistically represent, at a significant level, the latent construct to which they belong. The fact that the average variance extracted (AVE) values remained below the .50 threshold across all four factors (.242–.512) can be considered a limitation in terms of

convergent validity; however, the fact that all composite reliability (CR) values exceeded .60, and exceeded .70 for three factors, suggests, as also noted by Fornell and Larcker (1981), that low AVE does not entirely invalidate construct validity in cases where CR is sufficient. This pattern is one frequently encountered—and discussed in the literature—particularly in sub-dimensions with few items and moderate loadings (Domain of Effect, Motivation) (Hair et al., 2019).

Overall, the findings obtained show that the four-factor, 21-item structure of the Game-Based Teaching Method Effectiveness Scale is statistically supported at both the exploratory and confirmatory levels, that the overall reliability of the scale is high, and that the model exhibits a near-perfect fit with the data. Although the limitations in the convergent validity indicators (AVE) do not eliminate the scale's usability, they indicate that enriching the items belonging particularly to the Domain of Effect and Motivation dimensions in future revision studies (by adding new items or strengthening item wording) could further increase the scale's psychometric quality.

Conclusion

In this study, the construct validity and reliability of a measurement instrument developed to assess the effectiveness of the game-based teaching method on students were tested through exploratory and confirmatory factor analyses. The findings obtained show that a structure consisting of four sub-dimensions—"Interest," "Reluctance," "Domain of Effect," and "Motivation"—and a total of 21 items can be used as a valid and reliable measurement instrument. When the high KMO value, the significant Bartlett's test, the acceptable explained variance ratio, the high overall reliability coefficient (α = .86), and the near-perfect CFA fit indices are considered together, it is concluded that the scale is an instrument that can be confidently used in educational research to evaluate the effect of game-based teaching practices on students.

These results are consistent with studies in the literature that draw attention to the positive effects of game-based learning on student motivation and classroom participation (Prensky, 2001; Gee, 2003); at the same time, by revealing that this process is not a uniform experience for all students and may lead to negative reactions such as reluctance in some students, the study contributes to the literature by offering an instrument that quantitatively measures the multidimensional nature of game-based teaching.

From the perspective of practitioners, it is recommended that teachers, when planning classroom game-based activities, consider not only increasing students' interest and motivation but also monitoring possible signs of reluctance (fatigue, distraction, the perception of wasted time). This scale holds practical value in that it offers teachers and researchers the opportunity to systematically monitor this multidimensional effect.

This study has certain limitations. First, the fact that the AVE values of the scale remain below the .50 threshold indicates that the items belonging particularly to the Domain of Effect and Motivation dimensions should be reviewed in future studies. Furthermore, since the study is limited to a specific sample and educational level, it is recommended that the scale be retested with different age groups, subject areas, and cultural contexts, that measurement invariance be tested, and that the scale be supported by criterion-related validity studies. Finally, testing a second-order factor model in future studies could contribute to determining whether the four sub-dimensions' merge under a single higher-order construct ("the overall effectiveness of game-based teaching").

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