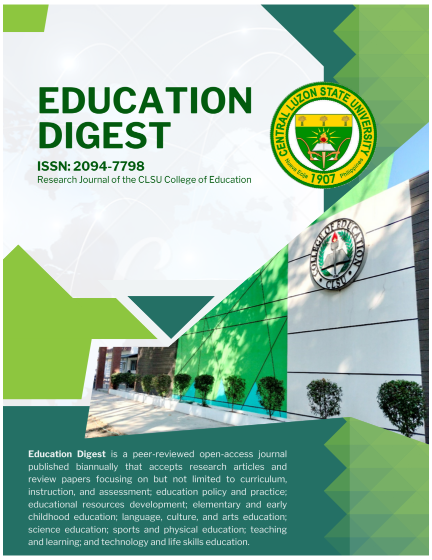

Development of a Scale for Individualized Physical Activity-Based Methods in the Education of Gifted Students

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Abstract: This study developed a valid and reliable scale to evaluate individualized physical activity-based methods in the education of gifted students. The positive effects of physical activity on learning processes in cognitive, affective, social, and psychomotor domains are emphasized. It is highlighted that standard educational methods may be insufficient for gifted students, and the importance of individualized and movement-based learning approaches is underscored. During the scale development process, expert opinions, a pilot study, and factor analyses were employed to establish a multidimensional structure of the scale. The scale consists of four subdimensions: "Thinking Through Physical Activity," "Adaptation to Individual Learning," "Sensory and Kinesthetic Stimulation," and "Motivational Engagement and Enjoyment." The findings suggest that physical activity-based methods are effective in enhancing the motivation, attention, and academic achievement of gifted students. It is recommended that these approaches be supported in educational policies.
Keywords: *inclusive education, individualized learning, scale development*

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Introduction

In recent years, there has been a growing interest in integrating physical activity into educational environments and exploring how this approach can support the cognitive, affective, and psychomotor development of students. This multifaceted approach is particularly significant for gifted students, as they often exhibit advanced thinking skills, high energy levels, and learning preferences that go beyond traditional teaching models (Pfeiffer, 2015; Subotnik et al., 2011; Tomlinson & Imbeau, 2023). In traditional classroom settings, gifted students often report experiencing boredom, frustration, or disengagement due to the slow pace of instruction and limited opportunities for movement or creative expression (Reis & Renzulli, 2010). For instance, a gifted learner with strong kinesthetic tendencies may struggle to maintain attention in lecture-based environments that restrict physical activity or rely heavily on rote memorization (Pfeiffer, 2015). These real-world challenges underscore the need for more dynamic and responsive teaching strategies that align with each individual's learning profile.

Although numerous studies have demonstrated the positive effects of physical activity on executive functions and learning outcomes (Donnelly et al., 2016; Hillman et al., 2008; Stillman et al., 2020), there remains a significant gap in the literature: valid and reliable measurement tools to systematically assess how gifted students engage in physical activity-based individualized learning processes are limited. Most existing scales are either aimed at general education contexts or focus on a single dimension, such as motor development or motivation, which fails to address the multifaceted needs of gifted individuals (Jung, 2022).

Moreover, empirical research increasingly suggests that the absence of movement-based strategies may negatively impact the motivation, attention, and emotional regulation of gifted learners (Gil-Madrona, 2021; Ratey, 2008). Without adequate physical engagement, these students may underperform academically, despite their high potential, due to mismatches between instructional design and their cognitive and sensory needs. While the necessity of individualized instruction for gifted individuals is strongly emphasized in the literature (Engüdar, 2022; Robinson & Tabler, 2021; Tomlinson, 2017), there is a lack of empirical research on how this approach can be integrated with embodied learning strategies. This highlights a two-layer research gap: (1) the lack of a theoretically comprehensive teaching model and (2) the absence of measurement tools that can evaluate applications based on this model.

Study Objectives

The study developed a valid and reliable scale to assess the level of engagement of gifted students in cognitive, affective, social, and psychomotor dimensions within individualized physical activity-based teaching methods. By filling this gap, the study seeks to provide a practical tool for both researchers and educators while also integrating individualized education and embodied learning theories in gifted education. As the effects of physical activity-based teaching strategies on the learning processes of gifted individuals become increasingly important, a significant lack of scales exists to measure the validity and effectiveness of these applications in this field. Most existing scales are aimed at general student groups, failing to adequately account for the unique characteristics of gifted individuals, such as speed, learning style, and sensory sensitivity. This study offers a multidimensional and psychometrically robust scale that evaluates physical activity-based individualized teaching methods for gifted students, providing a unique assessment tool for both practitioners and academic researchers. By doing so, it also addresses growing empirical concerns about the adverse outcomes of neglecting physical movement in the education of gifted learners, including reduced executive functioning, increased behavioral issues, and decreased motivation. Additionally, by integrating contemporary learning theories such as embodied cognition and self-determination theory into the context of gifted education, it provides innovative contributions not only in terms of measurement and assessment but also at the theoretical and modeling levels.

Theoretical Framework

This study is grounded in three interconnected theoretical frameworks: individualized instruction, embodied cognition theory, and self-determination theory, which collectively support the cognitive, affective, and psychomotor development of gifted students. Individualized instruction emphasizes tailoring teaching methods to students' readiness, interests, and learning styles, enabling gifted learners to maximize their potential (Kaplan, 2023; Tomlinson, 2017). Despite its widespread acceptance, practical guidelines and tools for integrating physical activity within individualized learning remain limited (Dunn & Dunn, 1993). Embodied cognition theory posits that learning is not solely a mental process but is deeply intertwined with bodily experiences and physical interaction with the environment (Glenberg et al., 2013; Wilson, 2002). This approach is particularly relevant for gifted students who often exhibit heightened sensory sensitivities and advanced kinesthetic intelligence, suggesting that movement can enhance cognitive engagement and creative thinking. Self-determination theory offers a motivational framework that emphasizes the importance of fulfilling psychological needs—autonomy, competence, and relatedness—in fostering intrinsic motivation among learners (Samsen-Bronsveld et al., 2024). Physical activity-based, student-centered learning environments naturally support these needs by allowing learners to control their pace and engage actively.

The positive impact of physical activity on executive functions, such as attention, working memory, and self-regulation, is well-documented (Diamond & Ling, 2016; Donnelly et al., 2016; Hillman et al., 2008). Additionally, physical activity contributes to emotional regulation and motivation, which are critical for sustained learning (Kanevsky, 2011; Stillman et al., 2020). However, most research to date has focused on general populations, and few studies have specifically addressed gifted learners, who may benefit even more given their unique cognitive and sensory profiles (Jung, 2022; Plucker & Callahan, 2021). A notable gap in the literature is the limited integration of individualized instruction and physical activity-based learning in gifted education. Existing studies often treat these domains separately, and assessment tools that capture their combined effects in a valid, reliable, and multidimensional manner are scarce (Uğurlu, 2022). While some pilot implementations exist, particularly in Turkey's Science and Art Centers (SAC), evaluations primarily rely on qualitative or observational data.

This study aims to address these gaps by developing a theoretically grounded scale that assesses individualized physical activity-based teaching methods across four key dimensions: cognitive engagement through physical activity (embodied cognition), adaptation to individual learning needs (differentiated instruction), multisensory stimulation, and motivational engagement (self-determination theory). By doing so, it seeks to provide both a practical measurement tool and contribute to the theoretical understanding of effective gifted education practices.

Limitations of Existing Assessment Tools

Existing tools developed to evaluate physical activity-based teaching processes fall short in addressing the multifaceted and unique learning needs of gifted students. These tools have three main limitations. First, most scales are designed for general student populations and do not account for the distinctive characteristics of gifted individuals, such as rapid learning, deep thinking, and heightened sensory awareness (Jung, 2022; Vaivre-Douret, 2011). Second, many of the existing instruments focus on a single dimension, such as physical engagement or motivation, which fails to capture the simultaneous development across cognitive, affective, social, and psychomotor domains exhibited by gifted learners. Lastly, very few measurement tools are structured in alignment with contemporary learning theories (e.g., embodied cognition or self-determination theory), which complicates the pedagogically meaningful interpretation of the data obtained.

Conceptual Model

This study is based on a conceptual model consisting of four main theoretical constructs aimed at evaluating physical activity-based individualized teaching methods developed for gifted students:

1. Individualized Instruction: Tailoring teaching to suit the individual needs, interests, and pace of learning of the student.
2. Embodied Cognition: The direct relationship between physical movement and cognitive processes.
3. Multisensory Stimulation: Engaging multiple senses (visual, auditory, kinesthetic) simultaneously during the learning process.
4. Self-Determination and Motivation: The student's active participation in the learning process with intrinsic motivation, supported by autonomy, competence, and relatedness.

These four constructs are directly related to the subdimensions of the developed scale (Figure 1). Each element of the conceptual model works together to inform the design and evaluation of teaching methods for gifted students, ensuring that physical activity-based learning is not only engaging but also cognitively enriching and motivating. This multi-faceted approach aims to create a well-rounded educational experience that meets the unique needs of gifted individuals.

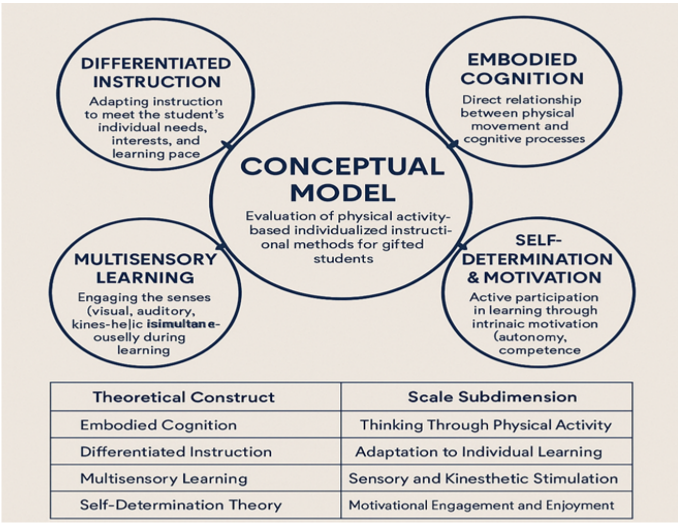

Figure 1. Conceptual model.

Methodology

Research Design and Sample

This study was designed within the framework of descriptive survey and scale development models, aiming to develop a scale for assessing individualized, physical activity-based instructional approaches for gifted students. The scale development process involved stages such as item pool generation, expert consultation, pilot testing, and conducting validity and reliability analyses to produce a psychometrically robust and valid/reliable instrument (DeVellis & Thorpe, 2021; Espinosa, 2023). During the pilot phase, 100 students identified as gifted through intelligence tests administered by the Turkish Ministry of National Education participated. For the Confirmatory Factor Analysis (CFA) phase, 300 gifted students identified via the same procedure and selected from different cities across Turkey's seven geographical regions were included. The participants were aged between 10 and 14 years. A convenience sampling method was employed due to practical considerations, including time constraints, cost, and accessibility (Golzar et al., 2022). Although convenience sampling presents limitations regarding generalizability, efforts were made to minimize bias by including participants from diverse geographical regions and varied demographic backgrounds (Doebel & Frank, 2024). Furthermore, participation was entirely voluntary, which may limit the representativeness of the sample and should be considered when interpreting the findings (Wang & Yang, 2025). The participants were enrolled in Science and Art Centers (SAC) and officially recognized as gifted. These students exhibited individual differences in learning pace and styles. The pilot study data were used to examine the scale's validity and reliability, followed by confirmatory factor analysis conducted on data from 300 students selected from a broader and more diverse sample to establish structural validity (DeVellis & Thorpe, 2021).

Data Collection and Instruments

The "Physical Activity-Based Individualized Method Scale (PAIMS)" developed for this study was designed to evaluate the role of physical activity in individualized instructional strategies for gifted students. The scale consists of 34 items and is structured using a 5-point Likert-type format, ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). The initial item pool was developed based on the relevant literature (Bailey, 2006; DeVellis & Thorpe, 2021; Kaplan, 2016; Nunnally & Bernstein, 1994) and the specific pedagogical needs of gifted learners. The items cover various thematic areas, including physical activity-based learning, individualization, motivational impact, mind-body interaction, sensory diversity, and alignment with learning styles. To minimize the effect of social desirability bias in student responses, several measures were implemented. First, the scale was administered anonymously to reduce the pressure to respond in socially acceptable ways. Furthermore, participants were explicitly instructed on the importance of honest and sincere responses, assuring them that there were no right or wrong answers and that their responses would remain confidential. These precautions aimed to encourage authentic responses and enhance the validity of the collected data (Fisher, 1993).

Data Collection Procedure

The data collection process in this research consisted of the following stages:

1. Item Pool Development: Initially, a 42-item draft item pool was developed based on a literature review and relevant scholarly resources. This process followed guidelines established in test development literature (DeVellis & Thorpe, 2021; Nunnally & Bernstein, 1994). The literature review focused on examining the items and structures of similar scales.

2. Expert Review: Content validity of the item pool was ensured through feedback from field experts. A total of 10 experts were consulted, including five special education specialists, one physical education expert, two measurement and evaluation experts, and two experts in gifted education. Utilizing expert opinions is a crucial step in ensuring content validity (AERA, 1999).

3. Preliminary Application: After content analysis and expert reviews, the developed scale was administered to 100 gifted students. The initial application aimed to assess the comprehensibility of the scale's language and structure (Furr, 2021).

4. Revision: Based on the preliminary results, necessary modifications were made to improve the clarity and structure of the items. This step was crucial in enhancing the reliability of the scale (Brown & Gao, 2015).

5. Large-Scale Implementation: In the final stage, the revised scale was administered to 300 randomly selected gifted students from different provinces. This large-scale implementation enabled the confirmatory factor analysis (CFA), meeting the sample size requirements to test the scale's validity (Hair et al., 2010).

All implementations were conducted in accordance with confidentiality and voluntary participation, and ethical approval was secured. Informed consent and assent were obtained from the minor participants and their parents or legal guardians prior to the study. The purpose, scope, and voluntary nature of the research were clearly explained to all participants. Participant rights were strictly protected throughout the study, with careful attention given to confidentiality and data security measures.

Data Analysis

Validity and reliability analyses of the scale were conducted using SPSS and LISREL software. Exploratory Factor Analysis (EFA): Conducted on pilot data to assess the construct validity. The following criteria were used: KMO ≥ 0.80, Bartlett's Test of Sphericity must be significant, and factor loadings ≥ 0.40. Confirmatory Factor Analysis (CFA): Performed on the larger sample to confirm the model structure. Fit indices: RMSEA ≤ .08, CFI ≥ .90, GFI ≥ .90. Reliability Analysis: Cronbach's Alpha coefficients were calculated for the overall scale and subdimensions. Acceptable level: ≥ 0.70. Item-total correlations were examined, and items that performed poorly were removed. Content Validity Index (I-CVI and S-CVI): Content validity was assessed at both the item and scale levels based on expert ratings (Polit & Beck, 2006).

Results

Suitability of Data for Factor Analysis

To determine the factor structure of the scale, the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity were performed.

Table 1. Kaiser-meyer-olkin (KMO) and bartlett's test of sphericity.

Type of Analysis	Value	Interpretation
KMO	0.889	0.80–0.89: "Excellent" level of sampling adequacy
Bartlett's Test	$\chi^2 = 4876.412$, df = 861, $p < .001$	Indicates suitability of data for factor analysis

KMO value of 0.889 indicates a very good level of sampling adequacy for factor analysis (Tabachnick & Fidell, 2013). The significance of Bartlett's test ($p < .001$) shows that there are sufficient correlations among the items, making factor analysis appropriate.

Exploratory Factor Analysis (EFA) Results

EFA was conducted to explore the underlying factor structure of the scale. Prior to analysis, the assumption of normality was tested and found to be acceptable. Varimax rotation was applied, yielding the following results:

1. Initial number of items: 42
2. Number of items included in the analysis: 34
3. Elimination criterion: Items with factor loadings < 0.40 were removed (8 items)
4. Number of emergent factors: 4
5. Total variance explained: 67.41%

Table 2. Exploratory factor analysis.

Factor Name	Number of Items	Variance Explained (%)	Example Item
1. Thinking through Physical Activity	10	21.34	"Activities involving physical movement help me think more easily."
2. Individual Learning Adaptation	9	18.22	"Moving at my own learning pace motivates me more."
3. Sensory and Kinetic Stimulation	8	14.77	"Activities that engage my senses accelerate my learning."
4. Motivational Engagement and Enjoyment	7	13.08	"Movement-based activities make lessons more enjoyable."

The four-factor structure provides a meaningful framework for explaining gifted students' responses to physical activity-based individualized learning approaches. The total variance explained (67.41%) is considered sufficient in social sciences (Hair et al., 2010). Each factor addresses distinct themes relevant to the unique learning needs of gifted students.

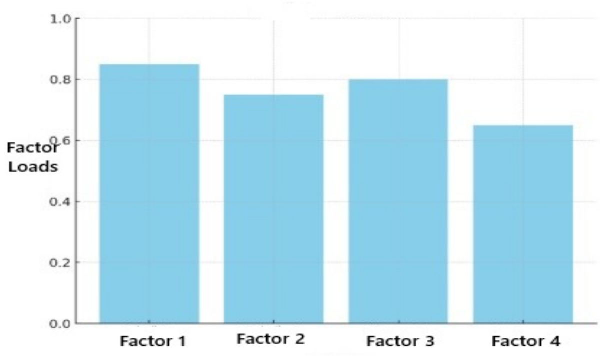

Figure 2. Factor loadings graph.

In general, factor loadings of 0.70 or higher indicate a strong association between the variable and the factor, reflecting a robust structure in terms of validity (Tabachnick & Fidell, 2013). In Figure 2, all factors exhibit loading values above 0.65, suggesting that each can be considered a meaningful and reliable component of the structure. Factor 1 and Factor 3 stand out as the core elements of the construct due to their stronger explanatory power. Although Factor 4 has a marginal loading, it remains within an acceptable range and contributes to the overall diversity of the structure.

Confirmatory Factor Analysis (CFA) Results

The four-factor structure identified through EFA was tested using confirmatory factor analysis (CFA). The model fit indices obtained via LISREL are presented below.

Table 3. Confirmatory factor analysis.

Fit Index	**Value**	**Acceptable Threshold**	**Interpretation**
χ^2/df	2.41	≤ 3	Good fit
RMSEA	0.058	≤ 0.08	Acceptable fit
CFI	0.94	≥ 0.90	Excellent fit
GFI	0.92	≥ 0.90	Excellent fit
SRMR	0.048	≤ 0.08	Good fit

The CFA results indicate that the four-factor model provides a good fit to the data obtained from gifted students. This supports the conclusion that the scale aligns well with the theoretical structure and demonstrates psychometric consistency.

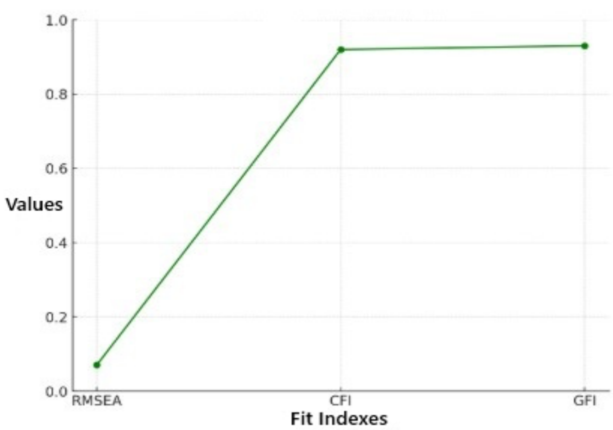

Figure 3. Fit indices.

RMSEA (Root Mean Square Error of Approximation): Values of 0.08 or lower generally indicate a good fit, while values below 0.05 suggest excellent fit. The value of 0.07 in this graph falls within the acceptable fit range. CFI (Comparative Fit Index): Values of 0.90 or higher indicate acceptable fit, and values of 0.95 or higher indicate good fit. The value of 0.93 in this graph represents an acceptable level of model fit. GFI (Goodness-of-Fit Index): Values of 0.90 or higher typically indicate an acceptable model fit. The 0.94 value shown here confirms this level of fit. The presented graph indicates that the model's fit indices are generally within acceptable limits. The CFI and GFI values demonstrate that the model fits the data well, while the RMSEA value remains within an acceptable range.

Reliability Analysis

The reliability of the scale was tested using Cronbach's Alpha coefficient. The values obtained for each subdimension and the overall scale are presented below.

Table 4. Reliability analysis.

Factor Name	Cronbach's Alpha	Interpretation
Thinking Through Physical Activity	0.87	High reliability
Adaptation to Individual Learning	0.83	High reliability
Sensory and Kinesthetic Stimulation	0.81	High reliability
Motivational Engagement and Enjoyment	0.84	High reliability
Overall Scale	0.91	Very high reliability

All subscales have reliability coefficients above .80, indicating a high level of internal consistency among the items (DeVellis & Thorpe, 2021). These findings confirm that the scale can be reliably used with students only.

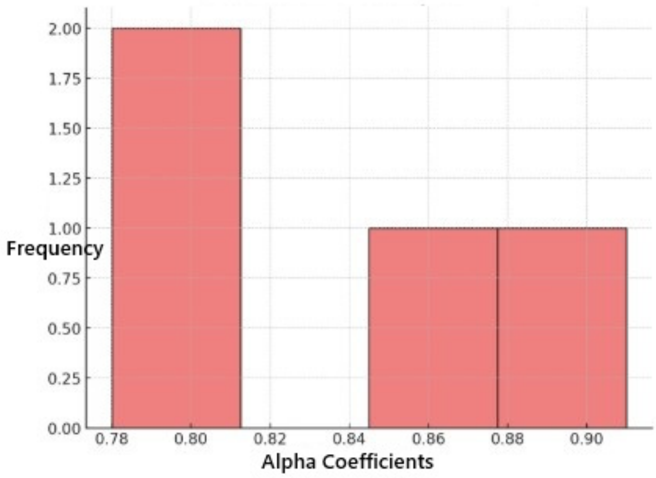

Figure 4. Alpha coefficients.

According to the graph, the Alpha coefficient range of 0.78 to 0.81 was observed twice. The range of 0.84 to 0.87 appeared once, as did the range of 0.87 to 0.90. This figure illustrates the distribution of Cronbach's Alpha coefficients. Generally accepted thresholds for Cronbach's Alpha are as follows: 0.70 and above: Acceptable reliability. 0.80 and above: Good reliability. 0.90 and above: Excellent reliability. All values in the graph range from 0.78 to 0.90, indicating that the internal consistency of the scale is generally in the good to excellent range. Given that values above 0.80 appear frequently (with the highest frequency seen in the 0.78–0.81 range) and that higher values above 0.84 are also present, the reliability of the analyzed scale can be considered high. The highest frequency in the 0.78–0.81 range suggests that the reliability level is predominantly good. Additionally, the presence of higher Alpha values (0.84–0.90) indicates that the scale demonstrates very good to excellent reliability at times. This histogram indicates that the scale's reliability levels are generally above the acceptable threshold and that it exhibits adequate internal consistency for research purposes.

Example Subgroup Analyses: Participants from 7 Regions of Turkey (N=100, Ages 10-14)

Table 5. *Factor mean scores by age groups.*

Age Group	N	Factor 1 Mean (SD)	Factor 2 Mean (SD)	Factor 3 Mean (SD)	Factor 4 Mean (SD)
10-11	35	4.25 (0.45)	4.00 (0.50)	4.10 (0.40)	3.85 (0.60)
12-13	40	3.95 (0.55)	3.85 (0.60)	3.80 (0.55)	3.70 (0.55)
14	25	3.75 (0.60)	3.60 (0.65)	3.60 (0.60)	3.50 (0.65)

Table 6. Factor mean scores by regions.

Region	N	Factor 1 Mean (SD)	Factor 2 Mean (SD)	Factor 3 Mean (SD)	Factor 4 Mean (SD)
Marmara	15	4.10 (0.50)	3.95 (0.55)	4.00 (0.50)	3.90 (0.55)
Aegean	12	3.95 (0.55)	3.80 (0.60)	3.85 (0.55)	3.75 (0.60)
Mediterranean	14	3.90 (0.55)	3.70 (0.60)	3.80 (0.60)	3.65 (0.60)
Central Anatolia	14	3.85 (0.60)	3.70 (0.65)	3.75 (0.60)	3.60 (0.60)
Black Sea	12	3.75 (0.65)	3.65 (0.60)	3.65 (0.65)	3.50 (0.65)
Eastern Anatolia	13	3.70 (0.65)	3.55 (0.70)	3.60 (0.65)	3.45 (0.70)
Southeastern Anatolia	10	3.65 (0.70)	3.50 (0.70)	3.55 (0.70)	3.40 (0.70)

Table 7. Factor mean scores by gender.

Gender	N	Factor 1 Mean (SD)	Factor 2 Mean (SD)	Factor 3 Mean (SD)	Factor 4 Mean (SD)
Male	52	3.95 (0.55)	3.80 (0.60)	3.85 (0.60)	3.70 (0.60)
Female	48	4.00 (0.50)	3.85 (0.55)	3.80 (0.55)	3.75 (0.55)

By Age Groups: Factor 1 (Thinking Through Physical Activity) scores decrease with age (mean 4.25 for ages 10-11, mean 3.75 for age 14). ANOVA results show that this difference is statistically significant ($F_{(2,97)} = 5.12$, $p < .01$). This suggests that younger students have a more positive attitude towards learning that is supported by physical movement. Regional Differences: Students from the Marmara region scored slightly higher on Factors 1 and 4 compared to students from other regions. These differences may be attributed to regional educational resources and opportunities. ANOVA results indicated significant differences across regions for various factors (e.g., Factor 1: $F(6,93) = 3.45$, $p < .01$). By Gender: There was no statistically significant difference between male and female students (t-test, $p > .05$). However, female students had slightly higher average scores on motivation and engagement (Factor 4).

Discussion

Within the scope of this study, the "Physical Activity-Based Personalized Learning Scale" was developed to determine gifted students' attitudes toward individualized learning processes. Analyses were conducted solely using data collected from the student group. The results confirmed the four-factor structure of the scale, and both the validity and reliability levels of each sub-dimension were found to be high. This finding indicates that learning processes supported by physical activity can serve as a significant educational strategy, particularly for gifted individuals.

The inclusion of the "Thinking Through Physical Activity" factor in the scale structure suggests that learning is not solely a cognitive process but also an activity shaped by physical experiences. This aligns with the theory of embodied cognition. Wilson (2002) argued that the body is not merely a carrier but an active component in cognitive processes. Glenberg et al. (2013) also demonstrated that physical movement facilitates abstract thinking. Given the high-level abstract thinking abilities of gifted students, it can be inferred that these skills may be further enhanced through physical activities. Furthermore, studies conducted by Dewi et al. (2025) emphasize the positive effects of physical activity on students' executive functions and attention spans, particularly noting that this effect is more pronounced in students with high cognitive potential. In this context, integrating movement into the learning process may serve as a tool to balance cognitive load, especially for gifted students with advanced cognitive processing skills.

The "Adaptation to Individualized Learning" factor is directly related to theories of differentiated instruction. Tomlinson (2001) stated that students with varying levels of readiness can learn more effectively through teaching strategies tailored to their individual learning styles. Gifted students often have learning needs that exceed the expectations for their age group. Johnsen and VanTassel-Baska (2022) also argued that talented students may experience boredom, a loss of motivation, and low engagement when subjected to rigid instructional models; therefore, they should be supported through activities that are differentiated in terms of pace, content, and product. In this regard, individualized activities structured with physical movement offer opportunities for students to adjust to their own learning pace, increasing both cognitive and affective engagement. This highlights the practical importance of this sub-dimension, which has been developed within the scale.

The emergence of the "Sensory and Motor Stimulation" sub-dimension highlights the importance of multisensory input in the learning process. Jensen (2005) indicated that the brain responds more actively to multisensory stimuli during learning and that such input facilitates the transfer of information into long-term memory. Various studies have shown that activities supported by visual, auditory, and kinesthetic stimuli enhance both retention and meaning-making (Shams & Seitz, 2008). Gifted students are often recognized for performing exceptionally well across multiple intelligences and may exhibit heightened activity in certain sensory systems (Gardner, 2011). Therefore, providing learning environments that stimulate both sensory and motor skills can deepen and enrich learning for these students.

The "Motivational Engagement and Enjoyment" factor emphasizes that learning is not only a cognitive process but also an affective and social one. Renzulli (2021) stated that the motivational characteristics of gifted students are critical to realizing their potential. These students tend to become quickly bored with traditional instructional methods and are more inclined toward engaging and active learning experiences. Learning environments structured through physical activity can help students form an emotional connection to the learning process. Especially in game-based or project-based activities, integrating physical movement into learning can enhance intrinsic motivation (Ryan & Deci, 2000), which in turn makes learning more lasting and meaningful.

In this study, the factor structure of the physical activity-based personalized learning scale was examined in relation to demographic variables using data collected from gifted students aged 10-14 from seven different regions of Turkey. Analyses by age groups revealed that younger students (ages 10-11) had a more positive attitude towards learning approaches supported by physical activity, with significantly higher factor scores in this group. This finding aligns with developmental psychology and learning theories, indicating that concrete experiences at early ages enhance learning effectiveness and that physical movement-based learning increases motivation, especially among younger age groups (Glenberg, 2013). Regarding regional differences, students from the Marmara region scored higher than those from other regions, particularly on the factors "Thinking through Physical Activity" and "Motivational Engagement and Enjoyment." This may be related to regional socioeconomic and educational resource disparities (Demir & Yıldırım, 2022). Balancing resource distribution to reduce regional inequalities in educational policies is essential for the broader adoption of such learning methods.

Gender analyses revealed no significant differences between male and female students; however, female students obtained slightly higher average scores on the motivation and engagement dimensions, consistent with the literature suggesting differences in learning motivation and participation between genders (Aguillon et al., 2020). This highlights the importance of designing instructional strategies with a gender-sensitive approach. These results suggest that physical activity-based learning methods have a positive impact on the cognitive, affective, and motivational processes of gifted students, highlighting the need to adapt these approaches to different demographic groups (Renzulli, 2021; Tomlinson, 2017). It is recommended that educators consider this diversity when designing lessons and structuring learning environments. In line with the validity and reliability analyses of the scale, it is suggested that future studies conduct more comprehensive comparative analyses considering variables such as age, gender, and regional differences. Additionally, integrating these findings into national gifted education strategies would help policymakers and educational leaders enhance learning processes by promoting physical activity-supported individualized learning (MoNE, 2021).

Conclusion and Recommendations

The "Physical Activity-Based Personalized Learning Scale" developed in this study measures the attitudes of gifted students toward individualized learning processes. It concretely demonstrates the importance of physical activity in educational practices. Beyond being a theoretical tool, the scale enables teachers and school administrators to enrich learning processes by supporting students' diverse sensory and motor skills. In this context, it is recommended that teachers integrate physical movement into their lesson designs, organize classroom layouts to accommodate increased space for movement, and adapt instructional pacing to meet students' individual needs flexibly. School administrators should encourage the implementation of these approaches by providing teachers with ßappropriate environments and resources. Additionally, educational policies need to align with national gifted education strategies by integrating physical activity-supported learning models into curricula and teacher training programs. Thus, innovative practices that holistically develop both cognitive and physical learning skills can be expanded, effectively supporting the potential of gifted students.

This study was conducted within certain limitations. The scale development process was applied only to gifted students registered in Science and Art Centers (BİLSEM) across different provinces in Turkey during the 2024–2025 academic year. This limits the generalizability of the scale to a specific sample group. Furthermore, the data collection process relied solely on student opinions, and perspectives from teachers, parents, or experts were not considered. Therefore, the scale was developed based on students' self-efficacy perceptions and attitudinal statements. It is recommended that the developed scale be applied to gifted students in different age groups to test its structural validity. Testing the scale in various cultural contexts would be beneficial for evaluating its cross-cultural validity. Experimental studies can be conducted using this scale to examine the effects of physical activity-based personalized methods on academic success, learning motivation, and affective outcomes. Mixed-methods studies supported by qualitative methods could provide an in-depth analysis of students' experiences with physical activity-based learning. In the context of teacher training, correlating the scale with teachers' professional attitudes in different applications could contribute to developing a comprehensive learning-teaching approach.

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Appendix

Scale of Physical Activity-Based Individualized Method in the Education of Gifted Students

Factor Name	Item Count	Item	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. Thinking Through Physical Activity	10	1. Activities involving physical movement make it easier for me to think.	☐	☐	☐	☐	☐
		2. Physical activities enhance the permanence of learning.	☐	☐	☐	☐	☐
		3. Activities involving movement accelerate my thinking processes.	☐	☐	☐	☐	☐
		4. Activities involving body movements make learning more concrete.	☐	☐	☐	☐	☐
		5. Physical activities increase my interest in lessons.	☐	☐	☐	☐	☐
		6. Movement-based activities facilitate concept learning.	☐	☐	☐	☐	☐
		7. Physical activities develop problem-solving skills.	☐	☐	☐	☐	☐
		8. Active learning methods increase student participation.	☐	☐	☐	☐	☐
		9. Physical activities improve students' analytical skills.	☐	☐	☐	☐	☐
		10. Physical movement supports higher-order thinking.	☐	☐	☐	☐	☐
2. Adaptation to Individual Learning	9	11. Moving at my own learning pace motivates me more.	☐	☐	☐	☐	☐
		12. Physical activities boost my self-confidence.	☐	☐	☐	☐	☐
		13. I feel more successful in lessons involving physical activities.	☐	☐	☐	☐	☐
		14. Activity-based learning attracts my interest.	☐	☐	☐	☐	☐
		15. Physical activities reduce my anxiety about learning.	☐	☐	☐	☐	☐
		16. Physical movements assist me in the learning process.	☐	☐	☐	☐	☐
		17. Progressing at my own pace contributes more to my learning.	☐	☐	☐	☐	☐
		18. Physical activities help me focus better on learning.	☐	☐	☐	☐	☐
		19. Body movements enrich the learning experience for me.	☐	☐	☐	☐	☐
3. Sensory and Kinesthetic Stimulation	8	20. Activities that stimulate my senses accelerate my learning.	☐	☐	☐	☐	☐
		21. Physical movement accelerates my learning process.	☐	☐	☐	☐	☐
		22. Activities provide sensory stimulation and facilitate learning.	☐	☐	☐	☐	☐
		23. Physical activities increase my participation in the learning process.	☐	☐	☐	☐	☐
		24. Sensory activities strengthen my memory.	☐	☐	☐	☐	☐
		25. Physical activities help me concentrate better on lessons.	☐	☐	☐	☐	☐
		26. Physical activities make lessons easier to understand.	☐	☐	☐	☐	☐
		27. Movement-based activities improve my sensory perception.	☐	☐	☐	☐	☐
4. Motivational Engagement and Enjoyment	7	28. Movement-based activities make lessons more enjoyable.	☐	☐	☐	☐	☐
		29. Physical activities increase my interest in the lesson.	☐	☐	☐	☐	☐
		30. Physical activities increase students' motivation for the lesson.	☐	☐	☐	☐	☐
		31. Movement-based activities improve my attitude toward learning.	☐	☐	☐	☐	☐
		32. Lessons involving physical activities become enjoyable.	☐	☐	☐	☐	☐
		33. Physical activities increase students' desire to learn.	☐	☐	☐	☐	☐
		34. Movement-based activities improve my overall attitude toward the lesson.	☐	☐	☐	☐	☐