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Adapting and Validating Cognitive and Learning Style Inventories in Turkey: Insights into Cultural and Educational Influences

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ABSTRACT

This study investigates the adaptation and validation of Turkey's Cognitive Style and Learning Style Inventories, highlighting cultural and educational impacts on cognitive and learning styles. By utilising SPSS and the Multidimensional Item Response Theory via R programming, this study assesses these tools among the 185 Turkish participants. A key finding is the prevalence of a split cognitive style among participants, suggesting the Turkish educational system's influence in fostering a blend of systematic and intuitive thinking rather than distinct cognitive styles. Challenges with specific learning style items (4 and 9) indicate a need for revision to enhance the inventory's accuracy. This study affirms the utility of cognitive and learning style inventories in identifying learning and cognitive styles, offering insights into educational strategies tailored to diverse learner needs.

Keywords:
Cognitive style, learning styles, inventories, factor analysis, the Multidimensional Item Response Theory, R

1. Introduction

In the evolving landscape of educational psychology, exploring cognitive and learning styles has emerged as a pivotal area of study, underscoring the sophisticated ways individuals engage with and process information. This paper adapts and validates the Cognitive Style Inventory (CSI) and Learning Style Inventory (LSI) for the Turkish context, emphasising the significant influence of cultural and educational frameworks on cognitive processes and learning preferences. Cognitive style, embodying the interplay between intellectual and personality dimensions, reflects individual differences in organising and processing information, serving as a heuristic that guides individuals' interactions with their environment. These styles, ranging from systematic, analytical approaches to more intuitive, synthetic strategies, influence perceptions, learning, decision-making and interpersonal relationships, underscoring the diversity in human cognition.

Similarly, the learning style concept at the heart of individual learning preferences encompasses the preferential way individuals absorb, process and retain information. Influenced by cognitive, emotional and environmental factors, as well as one's prior experience, learning styles represent a spectrum accommodating a range of preferences and approaches to learning. The seminal framework of Kolb (1999) on learning styles suggests that learning preferences can be mapped along two bipolar dimensions, forming distinct learning styles that combine to inform individual learning approaches.

This study, underpinned by a rigorous methodology, including the employment of SPSS and the Multidimensional Item Response Theory (MIRT) using the R programming language, seeks to establish the reliability and validity of the CSI and LSI in Turkish students. By examining the cognitive and learning styles

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prevalent among Turkish participants, this study illuminates the profound influence of the Turkish educational system on these styles. A notable finding from the CSI was the prevalence of a split cognitive style among the majority of the participants, diverging from a typical distribution. This observation suggests a potential overarching impact of cultural and educational systems, which may not fully support the development of distinct cognitive styles but instead encourage a hybrid cognitive style.

This paper aims to contribute significantly to educational psychology by offering validated tools for educators and psychologists, enhancing educational strategies and promoting cognitive diversity in the Turkish educational landscape and beyond. Through this exploration, we endeavour to pave the way for future research to understand and nurture diverse learners with distinguished cognitive and learning styles in educational and organisational settings.

1.1. Cognitive Style

Cognitive style, a multidimensional construct, reflects the interplay of intellectual and personality aspects in shaping human behaviour (Volkova & Rusalov, 2016). Defined as consistent individual differences in organising and processing information, cognitive styles serve as heuristics guiding individuals through their interactions with the environment (Kozhevnikov, 2007; Messick 1984).

Cognitive style encompasses diverse perspectives on how individuals perceive, think, learn, solve problems and relate to others (Hunt et al., 1989; Witkin et al., 1977). According to Messick (1984), cognitive styles are stable attitudes, preferences or habitual strategies influencing perception, learning, problem-solving, decision-making, communication and creativity. Messick (1984) described cognitive style as consistent individual differences in preferred ways of organising and processing information and experience. Researchers, including Witkin et al. (1977) and Hunt et al. (1989), emphasise cognitive style as an individual's unique approach to perceiving, thinking, learning, problem-solving and interpersonal relationships. These styles, identified by researchers, extend beyond traditional measures of intelligence, with Kozhevnikov (2007) noting their potential to predict success in specific situations better.

Researchers have proposed numerous cognitive style dimensions, expanding the conceptual landscape. Field dependence–independence (Witkin et al., 1977), levelling–sharpening (Holzman & Gardner, 1960) and impulsivity–reflectivity (Kagan, 1966) is just a few among them (Kozhevnikov 2007). Historical dimensions such as tolerance for instability, breadth of categorisation and field articulation are complemented by modern classifications such as holist–serialist (Pask, 1976), verbaliser–visualiser (Jonassen & Grabowski, 2012) and locus of control (Paivio, 1971). Messick's (1976) attempt to organise these dimensions resulted in a comprehensive list of 19 cognitive styles, later expanded by Keefe (1988) to 40.

The two primary cognitive styles are often described in opposition: analytical, deductive, rigorous, constrained, convergent, formal and critical vs. synthetic, inductive, expansive, unconstrained, divergent, informal, diffuse and creative (Cools & Van den Broeck, 2007). However, ongoing debates surround the unidimensional nature of these models. Recent discussions by Hodgkinson and Sadler-Smith (2003) propose separating analysis and intuition into distinct dimensions, challenging the bipolar unidimensional approach.

Understanding cognitive styles necessitates considering cultural influences. Volkova and Rusalov (2016) argued that cognitive styles not only are individual but also are shaped by cultural contexts. Thus, it is imperative to explore cultural differences in the manifestation and interpretation of cognitive styles to ensure the validity of the assessments across diverse populations. Cognitive styles, embodying stable individual differences, play a pivotal role in shaping human cognition. The rich tapestry of dimensions and ongoing debates in the field highlight the complexity of this construct. As we embark on translating and validating cognitive style inventories in the Turkish context, this literature review serves as a foundation for understanding the intricacies and significance of cognitive styles in the realm of learning and human behaviour.

1.2. Learning Style

Learning style, a concept central to understanding individual learning preferences, has been extensively studied in educational research. Learning styles refer to the preferential way in which individuals absorb, process and retain information. They are influenced by various factors, including cognitive, emotional and environmental factors, as well as one's prior experience. Learning styles are often viewed as a spectrum rather than fixed categories, accommodating a range of preferences and approaches to learning.

Kolb's model, proposed in (1999), is a seminal framework for understanding learning styles. It suggests that learning preferences can be mapped along two bipolar dimensions: active experimentation vs. reflective observation, and concrete experience vs. abstract conceptualisation. These dimensions combine to form four distinct learning styles: diverging, assimilating, converging and accommodating. Kolb (1999) developed the LSI in 1971 as a tool for identifying an individual's preferred learning style based on his model. The LSI prompts individuals to respond to scenarios and situations, categorising their responses to determine their dominant learning style. Although the LSI has been influential, it faces criticisms regarding its validity and reliability. Sims et al. (1986) raised concerns regarding the psychometric properties of the LSI. Willcoxson and Prosser (1996) determined the high internal consistency of the LSI scales and some evidence of validity. Besides et al. (1980) found that the LSI items correlated with the proposed dimensions, but the factor loadings were relatively low, explaining only a modest proportion of the total variance. This raises questions regarding the comprehensiveness and accuracy of the LSI in measuring learning styles (Sadler-Smith, 2001).

In response to these criticisms, subsequent revisions and alternative assessments have been developed (Kolb, 2005, 2007). Researchers continue to refine the instrument to enhance its validity and reliability. In addition, there is an ongoing debate in educational psychology regarding the practical application of learning styles in instructional design and the extent to which teaching a specific learning style can enhance the learning outcomes. Understanding and acknowledging the diversity of learning styles are crucial in developing effective educational strategies and fostering an inclusive learning environment.

1.3. Relationship between Cognitive and Learning Styles

Cognitive and learning styles are distinct yet interconnected constructs that play a significant role in how individuals process information and engage in learning activities. Although cognitive style refers to how individuals think, perceive and remember information, learning style describes their preferred method of learning.

One of the pivotal contributions to understanding the relationship between cognitive and learning styles is Curry's layered 'onion' model (Curry, 1983). This model visualises individual difference constructs in layers, akin to an onion, with each layer representing different aspects of how individuals approach learning and process information (Sadler-Smith, 2001). The onion model assumes that learning styles are stable across time and context (Severiens & Ten Dam, 1994).

According to Sadler-Smith (2001), the central personality dimensions lie at the core of Curry's model. These are the most stable and ingrained aspects of an individual, less susceptible to change or external influence. These core personality traits fundamentally influence both cognitive and learning styles. As one moves outward from the core, the first layer encountered is cognitive style. This layer represents deep-seated approaches to perceiving, processing and organising information. Although cognitive styles are somewhat malleable, they are still relatively stable and less influenced by immediate contexts compared with learning styles.

The learning style layer lies beyond the cognitive style layer. This layer is more flexible and context-dependent than cognitive style. Learning styles are influenced by both the inherent cognitive styles of individuals and their personal experiences, educational background and environmental factors. They represent the preferences in the approach to learning, such as a preference for visual, auditory or kinesthetic learning modalities. This refers to individuals using intellectual processes and procedures to assimilate, organise, and make sense of information (Bonham & Boylan, 1993).

The outermost layer of Curry's model consists of learning preferences. These are the most flexible and context-dependent aspects of how individuals engage with learning. Learning preferences can change based on specific situations, tasks or environments and are the most accessible to introspection and conscious alteration.

The relationship between cognitive and learning styles is dynamic and complex. Cognitive style influences learning style (Chen & Chang, 2016), but learning preferences, the most superficial and adaptable layer, can also feedback to shape an individual's approach to learning (Riding, 1997; Sadler-Smith, 2001). Understanding this relationship is crucial for educators and psychologists in designing effective learning environments and strategies that cater to the diverse needs of learners (Basheer et al., 2016). Curry's model provides a valuable framework for conceptualising these constructs and their interplay, emphasising the layered nature of how we process and engage with information and learning tasks.

1.4. Measurement Methods for Determining Cognitive and Learning Styles

In the realm of education, the exploration of cognitive styles has burgeoned into a diverse field, particularly in the context of learning styles. The endeavour to comprehend individual differences in learning processes has led to the proliferation of various styles, ranging from cognitive styles to decision-making styles, learning styles and personal styles (Rayner, 2001). However, this expansion has brought about a challenge in providing clear definitions and distinctions among these diverse constructs.

Cognitive styles, as identified in previous research, have evolved beyond their foundational definitions, extending into decision-making, learning and personal styles. To empirically study these styles, it becomes imperative to scrutinise the intricate relationship between cognitive styles and personality aspects. Volkova and Rusalov (2016) proposed three potential combinations: exclusive cognitive styles, exclusive personality traits and a synthesis known as cognitive–personality styles (CPS).

In the pursuit of understanding cognitive and learning styles, researchers employ various measurement methods. These methods delve into the intricate interplay of cognitive processes and individual preferences. Commonly used techniques include questionnaires and inventories, analytic observation, neuroscientific measures, task analysis or a digitally enhanced version of these methods.

Self-report instruments, such as the Cognitive Style Indicator (Cools & Van den Broeck, 2007), assess individual preferences in information processing, problem-solving and decision-making. Instruments such as Kolb's LSI (Kolb, 2007) analyse an individual's preferred learning style based on his or her responses to diverse learning scenarios.

Direct observation of an individual's behaviour in cognitive tasks can provide insights into their preferred cognitive approaches (Baumeister et al., 2007). In addition, observing the learners in educational settings aids in identifying patterns of engagement and preferred learning modalities (Tacgin, 2020).

Furthermore, advancements in neuroscience allow researchers to explore cognitive styles using techniques such as functional magnetic resonance imaging (fMRI) or electroencephalography (EEG). Advanced neuroscience methods like fMRI or EEG combine cognitive and emotional aspects, providing a holistic view of an individual's learning style (Yen et al., 2023).

Undoubtedly, the LSI of Kolb is one of the most popular instruments. Originating from Kolb's model, the LSI assesses an individual's learning style preferences based on four quadrants: diverging, assimilating, converging and accommodating. Honey and Mumford's Learning Styles Questionnaire (Honey, 2001) based on Kolb's model identifies learners' preferences based on four learning styles: activist, reflector, theorist and pragmatist. In addition, the Visual, Auditory, Reading/Writing, Kinesthetic questionnaire focuses on sensory modalities and helps in identifying learning preferences, aiding educators in tailoring instructional methods (Fleming, 1995). Cognitive style analysis utilises various tasks and scenarios to evaluate an individual's cognitive processing preferences, encompassing dimensions such as analytical vs. synthetic and reflective vs. impulsive. The Myers–Briggs Type Indicator (MBTI) (Briggs, 1974) is primarily a personality assessment tool for providing insights into cognitive preferences, offering a comprehensive view of an individual's cognitive–personality styles. These are the last but not least measurement techniques.

The dynamic interplay between cognitive styles and personality traits necessitates a comprehensive approach. Volkova and Rusalov's (2016) concept of CPS suggests the integration of measurement methods targeting both cognitive and personality aspects. This holistic approach aims to capture the nuanced relationship between these two dimensions.

As the exploration of cognitive and learning styles expands, employing a combination of measurement methods becomes crucial. The integration of diverse tools allows researchers and educators to gain a comprehensive understanding of individual differences, fostering more effective and tailored learning experiences. The ongoing evolution of measurement methods in this field promises to unravel further insights into the intricate interplay of cognitive and learning styles.

1.5. Cultural Differences regarding Cognitive and Learning Styles

Understanding how cultural differences influence cognitive and learning styles is crucial, particularly in the context of organisational dynamics (Riding &d Rayner, 2013). As individuals from diverse cultural backgrounds bring unique perspectives, preferences and approaches to learning and problem-solving, acknowledging these variations becomes essential for effective collaboration and organisational success.

Cognitive styles, as identified by Hayes and Allinson (1994), play a pivotal role in organisational settings. The application of cognitive styles spans various dimensions in organisations, including recruitment, task and learning performance, internal communication, career guidance and counselling, team composition and team building, conflict management and training and development (Kozhevnikov, 2007; Van den Broeck et al., 2003).

Cultural differences in cognitive styles affect the recruitment process, shaping how organisations identify and select individuals who resonate with the organisational culture (Cools et al. 2009). Tailoring recruitment strategies to align with cultural nuances enhances the likelihood of selecting candidates whose cognitive styles complement the organisation's values and objectives (Allinson & Hayes, 2000).

In multicultural workplaces, acknowledging and accommodating diverse learning styles become imperative for optimising learning performance. Organisations can enhance training programmes by considering cultural variations in cognitive and learning styles (Kozhevnikov et al., 2014; Yamazaki, 2005), fostering an inclusive and effective learning environment for employees from different cultural backgrounds.

Effective internal communication hinges on an understanding of cultural differences in cognitive styles (Allinson & Hayes, 2000; Armstrong et al., 2012). Organisations need to develop cross-cultural competence, recognising how individuals process and interpret information based on their cultural backgrounds. This awareness fosters clearer communication channels and minimises misunderstandings in a culturally diverse workforce (Armstrong et al., 2012; Kozhevnikov et al., 2014). Cultural differences influence individuals' career aspirations and decision-making processes (Akosah-Twumasi et al., 2018). Career guidance and counselling programmes should incorporate cultural sensitivity, recognising how cognitive styles may shape career preferences and trajectories in diverse cultural contexts.

Diverse teams often bring various cognitive and learning styles. Acknowledging and leveraging these differences positively affects team composition, conflict management and training initiatives. Organisations that embrace diversity in cognitive styles foster innovation, creativity and effective problem-solving in their teams (Kozhevnikov, 2007; Van den Broeck et al., 2003).

As organisations increasingly operate in a globalised world, the awareness and accommodation of cultural differences in cognitive and learning styles become integral for success. Embracing diversity in these styles not only enriches organisational dynamics but also contributes to a more inclusive, adaptable and resilient workforce. Recognising and navigating cultural nuances in cognitive and learning styles open avenues for organisational growth and effectiveness in an ever-evolving global landscape.

1.6. Representation of the Selected Cognitive and Learning Style Instruments

1.6.1. Cognitive Style Inventory: The CSI (Martin, 1998) serves as a foundational tool for identifying patterns of behaviour associated with individuals' approaches to critical activities such as thinking, learning, problem-solving and decision-making. Diverging from conventional single-dimensional structures, such as Witkin et al. (1977) proposals, this modern inventory takes a multidimensional approach.

In contrast to traditional models, the CSI is built upon the widely accepted systematic and intuitive styles, linking these cognitive dimensions to studies on left–right brain dynamics. Martin (1998) advocated for the existence of a multidimensional model that scales systematic and intuitive tendencies across a low-to-high spectrum, as illustrated in the accompanying figure. The CSI employs a comprehensive model that categorises individuals into five distinct cognitive styles: systematic, intuitive, integrated, undifferentiated and split.

Through the assessment of the responses to problem-solving and learning situations, the CSI unveils potential strengths and challenges associated with individuals' cognitive preferences.

The inventory comprises 20 items for defining systematic and intuitive thinking styles, covering aspects of thinking, learning, problem-solving and decision-making. Total scores are calculated over 40 items, categorising individuals into the aforementioned cognitive styles. Despite its Likert-like structure, participants manually score each item on a scale from 1 to 5.

The CSI serves a multitude of purposes in organisational development. It raises awareness of cognitive styles and their impact, facilitates the development of underutilised or weaker styles and trains facilitators and advisers to bridge cognitive differences. In addition, it aids in examining interaction points, establishing group guidelines, forming specialised task forces for creative designs and assessing organisational cognitive style specialisation.

Although the CSI demonstrates face validity, its limited validation beyond discussion purposes should be acknowledged. Consideration of cultural nuances in diverse organisational settings is essential for broad applicability. Recognising the dynamic nature of cognitive styles, including transitions and adaptability, suggests potential areas for further exploration in the model.

1.6.2. Learning Style Inventory: The LSI developed by Jacobs (1998) builds upon Johnson's field-dependent and field-independent dimensions, integrating a new category for collaborative tendencies. This tool aims to furnish insights into both the learning style preferences of trainees and the preferred training styles of trainers. For this study, we focused solely on translating and evaluating the trainers' version, comprising 36 statements that delineate three learning preferences: dependent/directive, collaborative and independent/delegative.

The participants in the study marked statements aligning with their peak learning experiences, circling the most significant statement if 10 or more checks were present in a column. The tool then computed total scores for dependent, collaborative and independent preferences, defining eight distinct learning styles: Dci, DCi, DCI, DcI, dcI, dCi, dCI and dci.

The LSI is versatile for data collection in any learning environment. The gathered information can be employed to (a) refine course or training designs, (b) serve as a pre- and post-test when the objective is to enhance flexibility in learning styles and (c) assess teacher or trainer effectiveness, identifying potential challenges if their preferences clash with student preferences. Additional uses encompass the following: (d) identifying the need for expectation clarification, particularly when learners seek collaborative work and the instructor plans to lecture; (e) incorporating mini designs when the majority of the course aligns with one preferred style but learner preferences indicate a diverse mix; and (f) fostering group discussions on scores and/or providing individual counselling based on the interpretation of the scores. The instrument also finds applications in academic advising and professional development work. Educators or trainers exhibiting a strong preference in one style may opt for additional training or experience in other styles.

Owing to the divergent scoring structure of the LSI, applying parametric statistical analysis to assess its validity is challenging. We posit that this may explain the absence of explicit mention of validity by the authors, who instead offer a guide for calculating learning styles as categorical variables.

2. Methodology

In this study, the goal was to adapt the cognitive style (Martin, 1998) and learning style inventories (Jacobs 1998) from English to Turkish by following a systematic process documented in relevant literature. The method followed is outlined under several headings as follows:

2.1. Research Sample

Owing to time and cost constraints, a convenience sampling method was selected for this study. Convenience sampling is frequently used in social science research because it enhances accessibility (Gürbüz & Şahin, 2017). The study was conducted with 185 volunteers accessible to the researchers. The volunteer participants were associate and bachelor's degree students aged 18 to 28.

2.2 Data Collection Tools and Procedure

The survey technique was employed as the data collection method. The survey form used included systematic and intuitive cognitive styles and learning style inventories. Each cognitive style sub-item contained 20 statements. Responses were evaluated using a five-point Likert-type scale (5: strongly disagree; 1: strongly agree). The learning styles inventory consisted of 36 statements in total, measuring dependent, independent and collaborative learning styles.

Adaptation of the Scales to Turkish: The adaptation process of the inventories to Turkish was conducted following the recommended phases in the literature (Bayık & Gürbüz, 2016; Brislin, 1976; Seçer, 2015). Initially, the statements were translated from English to Turkish by a language expert. Then, the translated statements were reviewed and corrected by researchers, a different language expert and a measurement and evaluation expert. In the third phase, another language expert translated the Turkish statements back to English to check for any loss of meaning. The final phase involved consulting an expert in the field to finalise the form of the statements for use in the study. The inventories were shared either face-to-face or via Google Forms considering the preference and accessibility of the participants.

2.3 Data Analysis

Cognitive Style Inventory (CSI): Factor analysis was conducted using SPSS 24 software to test the validity and reliability of the Turkish adaptation of the systematic and intuitive cognitive style scales. The Cronbach's alpha coefficients were also calculated. Learning Style Inventory (LSI): Statistical modelling and analysis were performed using the MIRT framework, employing the mirt R package. This sophisticated framework allows for a detailed examination of item properties and the latent traits that they measure. An iterative algorithm was applied to the dataset, which went through 67 iterations, indicating the progressive refinement of the model (Log-Lik: −12417.571; Max-Change: 0.00009) and ensuring that a stable solution was achieved. This process involved calibrating item difficulties, discrimination parameters and other model factors to assess the LSI's quality.

2.4 Ethical

The author would like to thank the Marmara University Social Science Institute Ethics Committee for the ethical approval of this study (2022-5/2) and the participants who willingly took part in this study, dedicating their time and effort. The author acknowledges their valuable contributions to the study.

3. Findings

3.1 Findings for the CSI

The findings from the analyses conducted to test the validity and reliability of the CSI are presented in Tables 1 and 2. This study utilised the alpha method to assess reliability, which denotes the consistency of the results upon repeated measurements. The alpha method evaluates the degree of homogeneity, similarities and closeness among the statements measuring the subject, determining whether they form a meaningful whole. For a scale to be considered reliable, the calculated Cronbach's alpha coefficient should be at least 0.60, with values above 0.80 indicating very high reliability (Nakip, 2006). In light of this information, the values presented in the tables show that both the systematic (0.906) and intuitive (0.849) cognitive style items exhibit very high reliability for each sub-dimension and overall inventory.

The most commonly used criteria for validity in relevant literature, which represents the degree to which what is intended to be measured is measured, are content validity, criterion validity and construct validity. Content validity involves determining the appropriateness of the scale's statements for the measurement objective and their representation of the area to be measured based on expert opinion. Criterion validity is the harmony between the measurement and real-life reflections. Construct validity is based on the validity of the fundamental theories that the measurement relies on and is linked to a previously accepted possible cause–effect relationship. Construct validity can be determined using factor analysis or comparison techniques with a measurement tool known for its validity (Karasar 2014). Although the original forms of the scales for intuitive and systematic cognitive styles (Martin 1998) contain findings related to content validity, findings related to construct validity are not encountered. In this study, the construct validity of the Turkish forms of the scales was examined using factor analysis with the varimax axis rotation technique.

Table 1. *Systematic Items of the CSI*

Statements	Factor loadings			
	F1	F2	F3	F4
S1	,698			
S2	,698			
S3	,690			
S4	,662			
S5	,651			
S6	,599			
S7	,576			
S8	,561			
S9	,542			
S10	,532			
S11	,508			
S12	,439			
S13		,743		
S14		,614		
S15		,545		
S16			,739	
S17			,674	
S18			,565	
S19				,756
S20				,572
Explained total variance: %56,314; KMO: ,906; Bartlett Test Chi-square: 1536,610; sd: 190; p: ,000; Cronbach's Alfa: 0,906				

As shown in the values in Table 1, the significance of the Bartlett's test of sphericity ($p < 0.05$) for the systematic cognitive style scale factor analysis indicated that the matrix of relationships among the variables subjected to factor analysis was sufficient for factor analysis (Gürbüz & Şahin, 2017). The Kaiser–Meyer–Olkin (KMO) measure is used to determine sample adequacy for factor analysis, with values above 0.5 expected and those above 0.7 considered very good (Kalaycı, 2017). The KMO value obtained from the analysis (0.906) showed that the sample was quite satisfactory for factor analysis. The total variance explained by the four dimensions formed by the scale statements was 56%, which was above the accepted threshold in social science research (Hair et al., 2010). The factor loadings of the statements in the scale were above the generally accepted threshold value of 0.32 (Gürbüz & Şahin 2017).

Table 2. *Intuitive Items of the CSI*

Statements	Factor loadings			
	F1	F2	F3	F4
I1	,725			
I2	,715			
I3	,682			
I4	,597			
I5	,593			
I6	,518			
I7	,479			
I8		,857		
I9		,800		
I10		,776		
I11		,553		
I12		,513		
I13		,498		
I14			,760	
I15			,692	
I16			,499	
I17			,413	
I18				,626
I19				,612
I20				,488
Explained total variance: %52,823; KMO: ,825; Bartlett Test Chi-square: 1253,212; sd: 190; p: ,000; Cronbach's Alfa: 0,849				

As shown in the values in Table 2, the significant Bartlett's test result ($p < 0.05$) from the factor analysis for the intuitive CSI was suitable for factor analysis considering the correlation matrix among the variables (Gürbüz & Şahin, 2017). The KMO value reached in the analysis was 0.825, showing that the sample was adequate for factor analysis. The total variance explained by the four dimensions formed by the scale statements was 52.8% above the threshold accepted in social science research (Hair et al., 2010). The factor loadings of the statements in the scale were generally above the accepted threshold value of 0.32 (Gürbüz & Şahin, 2017). On the basis of the findings obtained from the factor analysis, it is possible to say that the Turkish adaptations of the overall CSI, including both systematic and intuitive items, are a valid and reliable measurement tool.

3.2 Findings for LSI

The estimation process revealed that the model's log-likelihood improved with each iteration, reflecting a better fit to the observed data. The final iteration registered a Max-Change of 0.00009, suggesting the stabilisation of the model's parameters and indicating convergence. A summary of the model's fit yielded factor loadings across three dimensions (denoted as D, I and C), suggesting distinct latent traits being measured by the inventory. The h2 statistics provided insights into the proportion of variance in item responses explained by these factors.

Table 3. *The output of the multidimensional model of the 'mirt' package of R*

ID	Dependent	Independent	Collaborative	h2
D1	0.6387	0.00	0.00	0.408
D2	0.6731	0.00	0.00	0.453
I3	0.0496	0.604	0.00	0.368
C4	0.1184	0.00	0.754	0.582
C5	-0.1471	0.00	0.770	0.614
D6	0.7717	0.00	0.00	0.596
C7	-0.0343	0.00	0.610	0.374
I8	0.0000	0.764	0.00	0.584
I9	0.0000	0.694	0.00	0.481
I10	0.0000	0.615	0.00	0.378
C11	0.0000	0.00	0.761	0.579
D12	0.7775	0.00	0.00	0.605
I13	0.0000	0.822	0.00	0.676
D14	0.8322	0.00	0.00	0.693
C15	0.0000	0.00	0.700	0.490
I16	0.0000	0.607	0.00	0.369
I17	0.0000	0.766	0.00	0.587
C18	0.0000	0.133	0.597	0.374
I19	0.0000	0.697	0.00	0.486
C20	0.0000	0.00	0.759	0.576
C21	0.0000	0.00	0.843	0.711
I22	0.0000	0.752	0.00	0.566
C23	0.0000	0.00	0.736	0.542
D24	0.7423	0.00	0.00	0.551
I25	0.0000	0.756	0.00	0.571
D26	0.7632	0.00	0.00	0.582
D27	0.4217	0.00	0.00	0.178
D28	0.6284	0.00	0.00	0.395
D29	0.6938	0.00	0.00	0.481
C30	0.0000	0.00	0.615	0.378
D31	0.7153	0.00	0.00	0.512
D32	0.6873	0.00	0.00	0.472
I33	0.0000	0.799	0.00	0.639
C34	0.0000	0.00	0.762	0.581
I35	0.0000	0.623	0.00	0.388
C36	0.0000	0.00	0.714	0.510

SS loadings: 5.964 6.106 6.257; Proportion Var: 0.083 0.085 0.087; Factor correlations: D I C; D 1; I 0 1 ; C 0 0 1

The findings from the summary statistics elucidated the nuanced character of the items, where each had varying degrees of association with the underlying dimensions of learning style preferences. For instance, some items exhibited a strong association with the 'D' factor, which could be interpreted as a specific learning preference, and others showed a higher loading on 'I' or 'C', indicating different facets of learning styles.

For the factor loadings (D, I and C columns), the numbers represent how strongly each item (e.g. D1, I3 and C4) is associated with each factor. A higher absolute value indicates a stronger association. For example, D1 has a strong loading on factor D (0.6387), implying that it significantly measures what factor D represents. Items such as I3, which have high loadings on factor I (0.604), are strongly related to what factor I represents. The h2 column shows the uniqueness of how much of the item's variance is explained by the factors. For example, item D1 has an h2 value of 0.408, which means that 40.8% of its variance is explained by the factors included in the model.

The evaluations at the end of Table 3 consist of SS loading proportion variance and factor correlations. SS loadings represent the total variance explained by each factor. The higher the value is, the more variance that factor explains across all items it is associated with. Proportion variance indicates the proportion of total variance explained by each factor. These values suggest that each factor explains a relatively small portion of the total variance, indicating that the items may be measuring diverse aspects of the constructs. Factor correlations show the relationships between factors, where 1 indicates a perfect correlation and 0 indicates no correlation. Here, factors D, I and C are orthogonal (uncorrelated), suggesting that they measure distinct constructs.

A warning regarding items with a large number of categories was noted, which may have implications for estimation stability and interpretability. The items in question needed to be reviewed to confirm their conformity with the survey's design and their necessity for the analysis.

The Test Information Function (TIF) from the Item Response Theory (IRT) provides valuable information on the precision of a test or questionnaire across different levels of the underlying trait (often denoted by theta, θ).

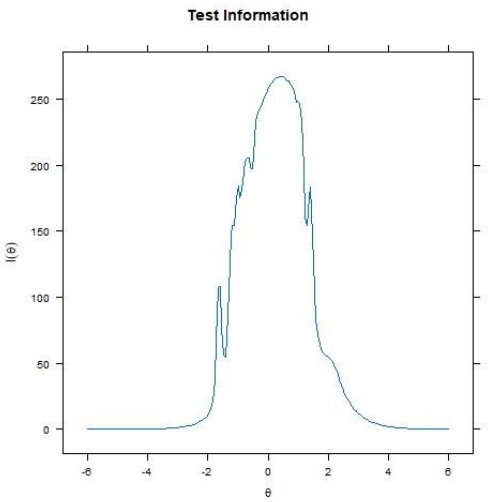
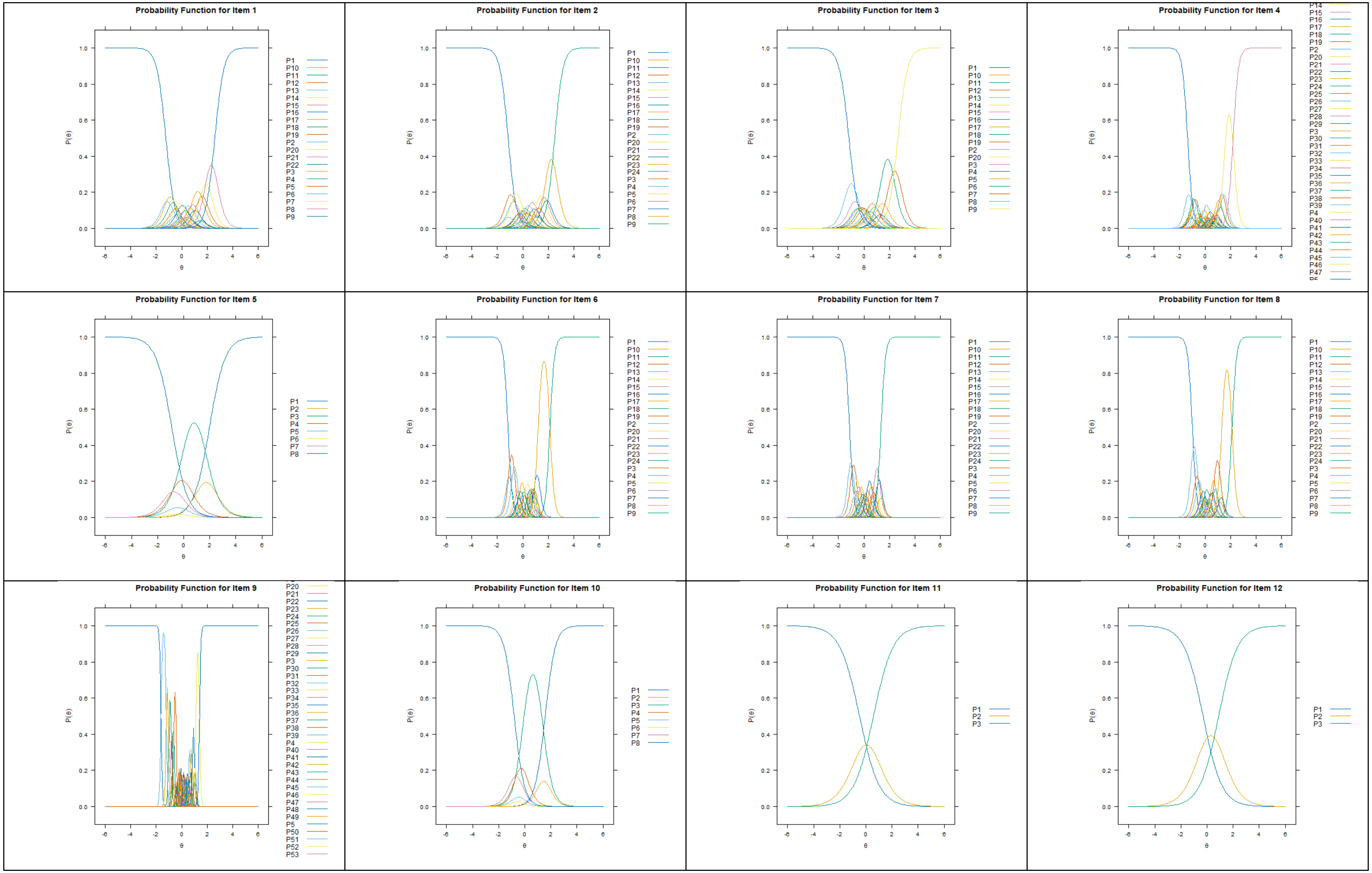


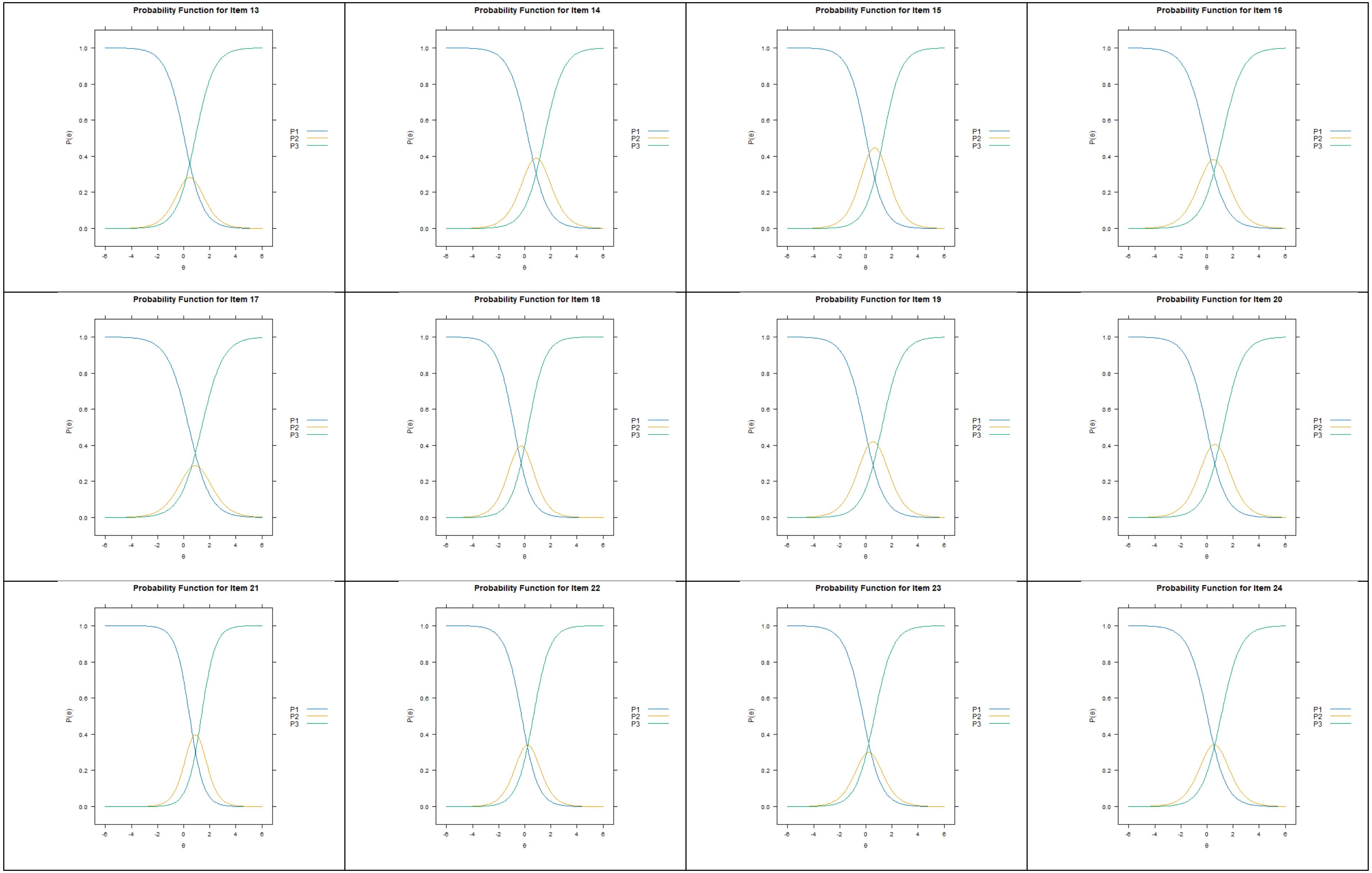
Figure 1. *Test Information Function (TIF) from the Item Response Theory (IRT)*

In Figure 1, the X-axis (θ) represents different levels of the underlying trait or ability that the test is designed to measure. The range here is from −6 to +6, indicating a wide range of trait levels. In practice, θ often ranges from approximately −3 to +3, but this depends on the specific context of the test and the population being tested. The Y-axis (I(θ)) axis shows the amount of information provided by the test at each trait level. The shape of the curve indicates where the test provides the most and least information. In this case, the curve peaks around a θ of 0, suggesting that the test is most informative for individuals with an average level of the underlying trait. The peak's height suggests that the LSI is very precise around this average level.

The test provides information around the peak of the curve, which appears to be around a θ of 0. This suggests that the test is most accurate around the average level of the trait being measured. The test provides less information for respondents with very low or very high levels of the trait, as indicated by the tails of the curve nearing the bottom of the graph. Moreover, the fluctuations or 'wiggles' seen in the curve may suggest areas where certain items or sets of items are contributing more or less information. This can sometimes indicate issues with item fit or calibration, or it could simply be a characteristic of the test design.

In addition, the graded response model provided nuanced insights into the assessment's psychometric properties. To test convergence and model fit, the final log-likelihood was −14982.315 after 183 iterations, suggesting an adequate model fit. The maximum change in parameter estimates diminished to 0.00010, demonstrating parameter stability. In addition, items were evaluated for discrimination and difficulty. As seen in Figure 2, some items exhibited a large number of response categories, with items 4 and 9 flagged for potential estimation challenges due to their complexity.


Probability Function for Item 1
Probability Function for Item 2
Probability Function for Item 3
Probability Function for Item 4
Probability Function for Item 5
Probability Function for Item 6
Probability Function for Item 7
Probability Function for Item 8
Probability Function for Item 9
Probability Function for Item 10
Probability Function for Item 11
Probability Function for Item 12
P(θ)
θ


Probability Function for Item 13
Probability Function for Item 14
Probability Function for Item 15
Probability Function for Item 16
Probability Function for Item 17
Probability Function for Item 18
Probability Function for Item 19
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Probability Function for Item 22
Probability Function for Item 23
Probability Function for Item 24
P(θ)
θ
P1
P2
P3

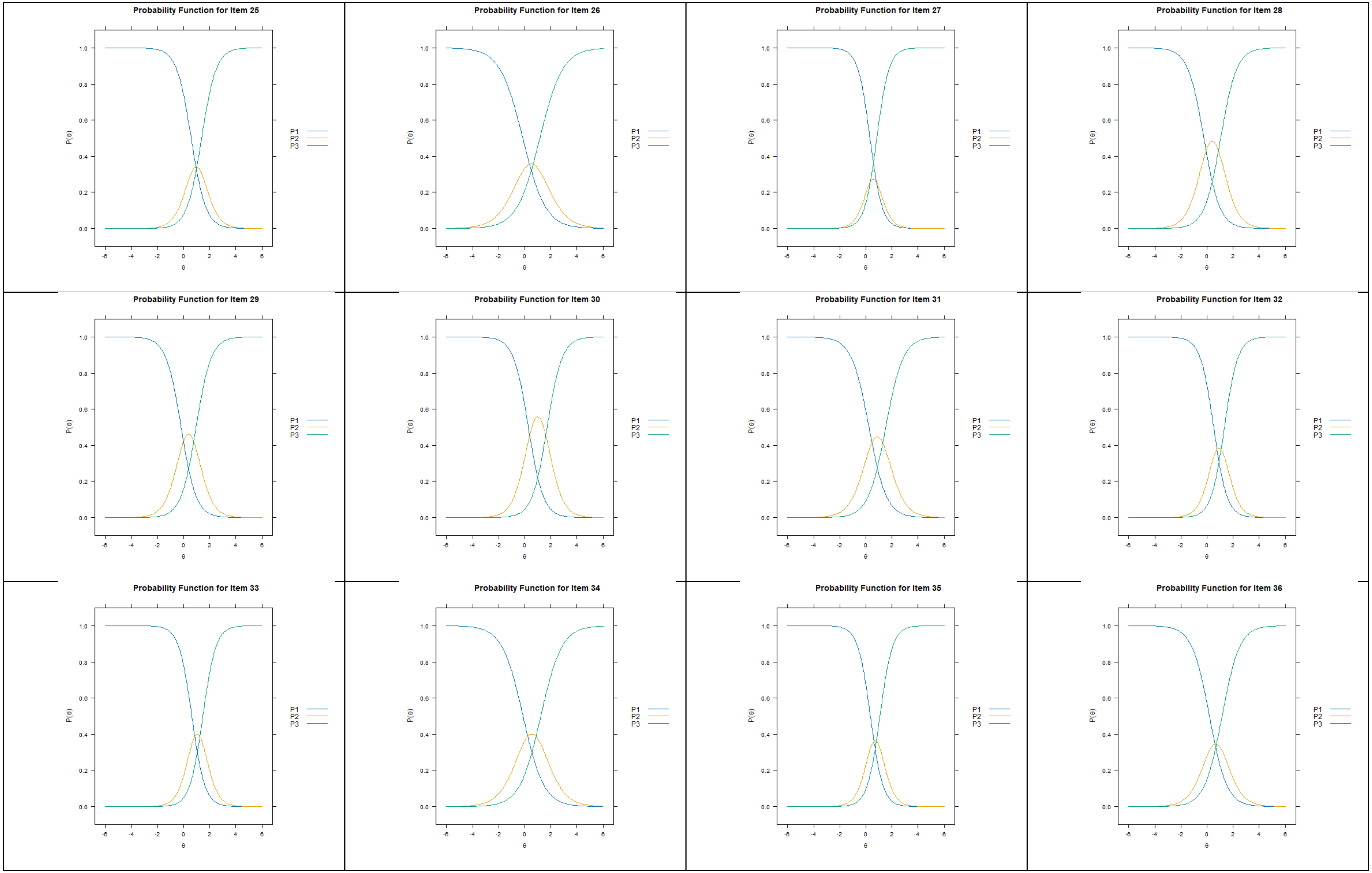

Figure 2. *Item plots to explain probability*

4. Discussion and Conclusion

In this study, we undertook the task of adapting and validating the CSI and LSI for the Turkish context, emphasising the critical role of cultural nuances in cognitive and learning style assessment. Using a meticulous methodology, including a convenience sample of 185 participants and the application of both SPSS and the MIRT using the R programming language, we established the reliability and validity of these adapted instruments. The analyses revealed nuanced insights into the cognitive and learning styles prevalent among Turkish participants, signifying the profound influence of the Turkish educational system on these styles.

The systematic and intuitive scales of the CSI exhibited high reliability (Cronbach's alpha: 0.906 and 0.849, respectively) and validity, supported by factor analysis. Similarly, the LSI analysis utilising MIRT identified specific concerns with items 4 and 9, suggesting their removal or revision to ensure the inventory's integrity. This recommendation stemmed from the necessity to maintain the inventory's ability to accurately reflect learning styles without distortion.

The findings from the CSI indicated a prevalent split cognitive style among Turkish participants, diverging from a typical distribution. This observation indicates a possible significant impact stemming from cultural influences and the educational system, which may not adequately foster or might even alter the development of distinct cognitive styles (Guild 1994). Rather than promoting a singular cognitive approach, the educational practices observed might encourage a composite cognitive style, mirroring trends seen in diverse cultures, such as Singapore (Ho and Kozhevnikov 2023). Therefore, learners spanning systematic to intuitive types can utilise their capabilities with the assistance of an educational framework.

This trend holds considerable implications for future workforce development, highlighting the necessity for organisations to cultivate a diverse array of thinkers. In the dynamic and interconnected world of the 21st century, the ability to generate novel ideas and drive innovation is paramount (Ghafar 2020; Tan and Ng 2021). As educational systems around the globe adapt to the evolving landscape, the emphasis on nurturing various cognitive styles becomes crucial. This diversity not only enriches the intellectual fabric of society but also ensures that organisations are well equipped with individuals capable of thinking outside the box, solving complex problems and contributing to the innovative engine driving global progress.

Results highlight the need for educational reforms that cater to diverse cognitive styles, ensuring that individuals can develop in alignment with their natural inclinations. Addressing the educational dynamics in Turkey is crucial for nurturing a diverse cognitive landscape among future generations. Such diversity is essential for enhancing problem-solving, creativity and innovation in the work field (Kozhevnikov et al. 2014; Yamazaki 2005).

In conclusion, this study contributes significantly to the understanding of cognitive and learning styles in the Turkish context, offering validated tools for educators and psychologists. The findings highlight the critical need for educational practices that acknowledge and support diverse cognitive styles, paving the way for a workforce capable of innovative thinking and adaptability. Future research should explore the long-term impacts of educational strategies on cognitive style development and their implications for academic and professional success. By fostering an educational environment that values cognitive diversity, we can enrich the intellectual fabric of society and enhance the dynamism in various professional sectors.

5. Recommendations

Educational institutions should incorporate diverse cognitive and learning styles into their teaching strategies to enhance student engagement and learning outcomes. Curriculum developers are encouraged to include activities and materials that appeal to different cognitive styles, ensuring that all students are challenged and supported. Professional development for educators should include training on accommodating various cognitive and learning styles, enabling teachers to address individual student needs effectively.

Further research is recommended to explore the long-term impacts of educational strategies tailored to diverse cognitive styles, particularly on how these strategies influence academic achievement and cognitive development. In addition, revisions to the LSI should be made to address identified issues, improving its reliability and validity.

Considering cultural influences on cognitive styles is essential when adapting psychological instruments for different populations. By implementing these recommendations, educators and researchers can better support diverse learning needs and can develop more effective educational practices.

Disclosure statement

The LSI and CSI used in this paper for educational and non-commercial purposes were reproduced from The Preiffer Library CD-ROM. Copyright (c) 1998 by Jossey-Bass/Preiffer, San Francisco, California depending on the permission on https://home.snu.edu/~jsmith/library/front/credits.pdf.

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