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# Comparative study of the use of online reading strategies in the L1 and L2

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**Introduction:** Online reading skills are essential for learning English. Thus, this article aims to examine the relation between online reading strategies used in the native language (L1) and English as a foreign language (L2) among young Hungarian readers.

**Methods:** Using the Online Survey of Reading Strategies (OSORS) questionnaire, data were collected from 1,214 lower secondary school students. The measures for construct validity and differential item functioning via Rasch analysis demonstrate that the instruments were reliable and valid.

**Results and discussion:** The results show that the students most frequently used global reading strategies in the L1 and support-reading strategies in the L2. Using R programming, correlation analysis finds no significance in students' reading strategy use between their L1 and L2, although the study notes the significant positive impacts of the three reading strategies on their L1 and L2. Through multivariate analysis of variance, the study proposes that there exists a moderate relation between students' attitudes toward language and their use of online reading strategies. Lastly, regression analyses using MPlus8 illustrate that global and support reading strategies had positive and significant effects on the students' reading comprehension achievement. Therefore, the results could be beneficial to language teachers and students.

## KEYWORDS

online reading strategies, reading comprehension, L1, L2, lower secondary school students

## Introduction

In the modern era, information and communication technology (ICT) has created rapid changes in people's learning processes after the evolution of various devices around them (e.g., smartphones, laptops, notebooks, and tablets) (Omar et al., 2022). Therefore, people have changed their readings from printed media to digital pages (online texts; Pardede, 2022), and online reading strategies have become essential for reading comprehension (Yaghi, 2021). Online reading strategies are approaches that readers use when interacting with digital/online text to achieve complete comprehension (Pradita, 2020). Researchers (Erni, 2021; Laeli et al., 2022; Rofi'i and Noermanzah, 2021) have proposed various classifications of online reading strategies. Among them, Anderson's (2003) widely adopted framework, which consists of global, problem-solving, and support reading strategies, has gained prominence due to its empirical validation across multiple educational levels. Global strategies include setting purposes and predicting content; problem-solving strategies involve adjusting reading speed and re-reading complex and difficult sections; and support strategies consist of using tools

like dictionaries and highlighting important information (Freihat, 2022; Jose, 2021). Despite the existence of alternative strategies, such as socio-effective, synthesizing, and scanning strategies (Erni, 2021; Rofi'i and Noermanzah, 2021), we employ Anderson's three-category model (global, problem-solving, and support strategies) due to its alignment with metacognitive theory and its robust psychometric properties.

Various authors (Erni, 2021; Freihat, 2022; Laeli et al., 2022; Pradita, 2020; Rofi'i and Noermanzah, 2021) use diverse measurements to investigate the measures of different online reading strategies. However, the most common instrument that can effectively measure the use of online reading strategies among students is the Online Survey of Reading Strategies (OSORS) questionnaire (Al-Seghayer, 2014; Anggraini and Cahyono, 2020; Azmuddin et al., 2017; Freihat, 2022; Do and Phan, 2021; Pradita, 2020). It has the ability to assess the three major reading (global, problem-solving, and support) strategies, which are crucial and fundamental for students' online reading comprehension achievement (Anggraini, 2022). Global reading strategies are knowledge-based and rely on students' abilities to predict and retrieve background information, whereas support strategies are indirect reading ones that use different types of support, such as consulting dictionaries, underlining important ideas, and circling crucial concepts (Jose, 2021). Lastly, problem-solving strategies are students' methods to minimize reading difficulties by adjusting reading speed, solving upcoming reading problems, and paying close attention to difficulties (Anggraini and Cahyono, 2020).

Many studies (Anggraini, 2022; Anggraini and Cahyono, 2020; Jose, 2021; Mudra, 2018; Rianto, 2021) have examined the three types of online reading strategies, focusing on their use by university students or teachers. In Hungary, only Tary (2022) has investigated the use of online reading strategies among teachers, but no one has highlighted this use among upper secondary school students or compared the use of online reading strategies in the native language (L1) and English as a foreign language (L2). To address this research gap, the current research aimed to elucidate this aspect by investigating comparative studies on the use of online reading strategies among Hungarian middle school students in the L1 and L2.

## Literature review

### Online literacy

Online literacy means the ability to effectively read, write, and communicate using various forms of electronic screens. It includes the use of diverse electronic multimedia information, which relies on computer systems and access to online resources (Park and Kim, 2011). Various online sources through the World Wide

Web, containing computer-mediated communication, hypertext, hypermedia resources, and multimedia, are promoting online literacy and replacing printed screens in this modern era (Jose, 2021). Hypertext in online literacy denotes a type of informational place, where different types of textual materials, concepts, and ideas are linked to other information by a number of links (Coiro and Dobler, 2007; Seong and So, 2024). In fact, online literacy is typically based on nonlinear, interconnected, and inclusive forms of multimedia. The rich and deep information resources, which are linked with large volumes of related information, characterize online literacy (Amer et al., 2010; Senyüz, 2024). With the rapid change and development in technology in this area of knowledge, engaging in online reading is crucial for learners according to their learning objectives (Ahmadian, 2017).

Online literacy is currently one of the best methods for solving problems in the learning process by using different online reading strategies (Mudra, 2018). Online literacy is entirely different from printed literacy due to its updated links to different online pages, multimedia, and tools. Furthermore, online readers require specific skills to gain access to online literacy, such as locating the required information, achieving comprehension, synthesizing and assessing various information sources, determining the efficient use of these sources, and using the digital data correctly. Unlike printed media, these skills involve navigating hyperlinks, evaluating the credibility of online sources, and integrating multimedia content (Cheng, 2016; Seong and So, 2024). Furthermore, a digitally or electronically literate person must possess certain ICT skills to understand, assess, communicate, and fabricate electronic information effectively (Azman et al., 2017). Thus, these characteristics of online literacy encompass readers' diverse strategies and skills to sufficiently understand various online texts (Ahmadian, 2017; Jose, 2021).

### Online reading strategies in the L1 and L2

A reading strategy is broadly defined as any mental procedure used by the reader before, while, and after reading, which helps in the comprehension of reading passages (Ghahari and Basanjideh, 2017). In the online learning process, when reading contexts differ (from traditional paper-based pages to online pages with hyperlinks and hypermedia), students should use various types of online reading strategies to understand the multiple layers of online reading passages (Li, 2020). For example, Laeli et al. (2022) employed six online reading strategies: inferring, skimming, translating, locating, synthesizing, and saving strategies. Moreover, Piasecka (2019) used an online reading model involving several strategies: identifying key questions and locating, analyzing, synthesizing, and communicating information.

Anderson (2003) introduced a three-dimensional model, consisting of global, problem-solving, and support strategies, which has become a foundational framework in the field due to its empirical robustness and alignment with metacognitive theory. Studies using the OSORS consistently use this categorization (Al-Seghayer, 2014; Freihat, 2022). Therefore, this study also adopts this model for comparability, theoretical coherence, and psychometric reliability.

**Abbreviations:** AVE, Average variance extracted; CFI, Comparative fit index; CR, Composite reliability; DIF, Differential Item Functioning; MANOVA, Multivariate analysis of variance; NFI, Normed fit index; ORSI, Online Reading Strategy Inventory; OSORS, Online Survey of Reading Strategies; RMSEA, Root mean square error of approximation; SD, Standard deviation; SORS, Second Language Online Reading Strategies; SORS, Survey of Online Reading Strategy.

In their native language (L1) and in English as a foreign language (L2), skilled readers perform fundamental tasks, such as defining the reading objectives, discovering the key aspects of reading passages, considering related information, addressing related activities after comprehending the text, reflecting by self-testing, modifying if necessary, and re-planning for better comprehension (Cheng, 2016; Lemnaru, 2024). Meanwhile, a few significant differences exist between L1 and L2 reading processes, such as the various systems of languages and diverse socio-cultural and economic backgrounds, while readers decode information from text (Habók and Magyar, 2019; Marx et al., 2015).

Therefore, readers use varying online reading strategies for reading comprehension. In the case of online reading strategies in the L1 and L2, Park and Kim (2017) observed that learners employ common strategies during the online reading process, such as accessing web pages, adjusting reading speed, using aids or taking notes to aid in comprehension, observing comprehension progress, linking reading objectives and progress using technical skills and devices, using references, and consulting sources of information. Furthermore, the other online reading strategies that readers use for online reading texts are “predicting, previewing, scanning, skimming, reading for details, and speed reading” (Rofi'i and Noermanzah, 2021, p. 93).

It is essential to compare online reading strategies in the L1 and L2 because reading behavior does not always transfer directly between languages. Differences in linguistic systems, proficiency levels, and cognitive load can affect how students use strategies across languages (Habók and Magyar, 2019; Habók et al., 2024). Understanding whether students adjust their strategic approaches based on language context helps clarify whether strategy use is universal or language-specific. This comparison is particularly relevant in bilingual education, where students must perform in both languages across digital reading tasks.

Furthermore, Tary (2022) conducted an online study to assess teachers' use of online reading strategies in the L1 and L2. The study found that teachers used three types of online reading strategies: global, problem-solving, and support reading strategies. In addition, the authors noted that they employed online reading strategies more in the L1 than they did in the L2. Moreover, some studies (e.g., Habók et al., 2024; Habók and Magyar, 2019) investigated the importance of online reading strategies for students. They highlight the use of various digital tools and the transformation of traditional reading to digital reading of online texts among learners. Additionally, these studies emphasize the significance of specific reading strategies, global, problem-solving, and support reading strategies, in improving reading comprehension achievement.

Investigating the effect of gender and reading proficiency level on the use of online reading strategies in the L2, Al-Seghayer (2014) observed the use of three online reading strategies: global, problem-solving, and support reading strategies. Furthermore, these online metacognitive reading strategies also emerged in Yaghi (2021), which investigated the online reading dispositions of L2 learners in Saudi Arabia. Many studies on online reading (Barrot, 2016; Chen, 2019; Cheng, 2016; Erni, 2021; Habók et al., 2024; Huang, 2013; Mukhlif and Amir, 2017; Öztürk, 2018; Taki and Soleimani, 2012) have examined participants' online

reading strategies. These studies, which mainly used the OSORS questionnaire, noted that students typically use the three types of online reading strategies noted above: global, problem-solving, and support reading strategies.

## Global reading strategy

The global reading strategy involves a set of processes aimed at understanding the overall structure and main ideas of a text. Readers employ a strategic plan that includes establishing reading objectives, pre-reading the text for an overview, deciding on the focus of reading, anticipating potential reading problems, and making predictions about the content (Do and Phan, 2021; Mukhlif and Amir, 2017). This strategy includes several activities that collectively help readers navigate and comprehend complex texts effectively.

## Problem-solving strategy

The problem-solving strategy involves using context clues and prior knowledge to understand unfamiliar words and resolve difficulties during reading. Readers may adjust their reading speed, focus on key messages, and pause to reflect when needed (Erni, 2021; Taki and Soleimani, 2012). While using context can sometimes aid in comprehension, research indicates that it is not always reliable, and readers often need to consult a dictionary or may continue reading without fully understanding the word (Barrot, 2016). This strategy highlights the dynamic and adaptive nature of reading, where readers employ various tactics to enhance their understanding of the text.

## Support reading strategy

The support reading strategy pertains to readers' use of other aids or tools to enhance reading comprehension, such as reference materials, notes, highlights, and dictionaries (Ahmadian, 2017). Using these strategies, readers can use any type of learning aid from outside, which may enhance reading comprehension (Öztürk, 2018).

## Findings on online reading strategies and attitudes

Out of the three reading strategies, Mudra (2018) in Indonesia and Ramos (2003) in Thailand found that students most frequently used global reading strategies followed by problem-solving and support strategies. These studies employed the OSORS questionnaire and semi-structured interviews for data collection. The authors concluded that these online reading strategies were effective. Specifically, online reading gives students more enjoyment; thus, their attitude toward it is gradually developed, which promotes online reading comprehension. Laeli et al. (2022) also suggested that teachers should create additional online reading strategies for the development of students' online reading skills. Apart from their attitude toward language, encouragement from parents exerted a significant and positive impact on their online

reading strategy use and reading comprehension achievement (Park and Kim, 2017). Furthermore, one study (Cancino and Ubilla, 2021) investigated the relation between L1 and L2 reading attitudes in primary school students. The authors suggest that L1 background and L2 proficiency level play significant roles in influencing L2 reading strategies. Moreover, the findings show that learners' attitudes toward L1 reading can be transferred to the L2 and that L1 literacy performs as a cut-off to L2 achievement for learners who are academically underperforming. Habók et al. (2024) also found that the use of online reading strategies has positive effects on students' reading comprehension achievement. Additionally, their study showed that students' positive attitudes toward their L1 significantly influenced their use of online reading strategies and performance in language arts, and indirectly affected reading comprehension skills. Similarly, another study (Nureldeen et al., 2024) showed that the use of metacognitive strategies is linked to more positive attitudes toward reading in the L2. These strategies, global, problem-solving, and support strategies, are significantly related to reading proficiency and positive reading attitudes. Students who have positive attitudes toward reading are likely to use more metacognitive reading strategies (Kim, 2016). Research in the L2 context (Cancino and Ubilla, 2021) has also shown that the role of reading attitude is as important as the nature of the reading strategies used for reading comprehension. Moreover, students with positive attitudes toward their language tend to use reading strategies more effectively. For instance, students who view their L1 as a resource are more likely to employ translation strategies when reading in their L2 (Kamhi-Stein, 2003). Similarly, positive attitudes toward L2 learning correlate with higher usage of reading strategies among L2 learners (Habók et al., 2024). Conversely, students who perceive their L1 negatively may struggle with employing effective reading strategies in their L2 (Gottardo et al., 2021; Kamhi-Stein, 2003).

Al-Seghayer (2014) administered TOEFL reading comprehension texts to students and used the SORS questionnaire to inquire about their online reading strategies. Using the Online Reading Strategies Inventory, the authors found that male and female students at a private university in Indonesia mainly preferred the problem-solving strategy. Specifically, the female students were more skillful at using support reading strategies (Acar-Erdol and Akin-Arikan, 2022; Al-Seghayer, 2014). Moreover, Anisah and Widiantoro (2019) demonstrated that female research participants frequently used problem-solving strategies more than male participants did. The authors proposed that all students preferred to read a text repeatedly by underlining or circling reading passages. However, Al-Seghayer (2014) conducted a study in Saudi Arabia and found contrasting results: learners most frequently employed online reading strategies in the following order: support reading, problem-solving, and global reading strategies.

In the Survey of Reading Strategies (SORS) conducted by Do and Phan (2021), the findings showed that problem-solving strategies were employed most often, followed by support and global reading strategies. Moreover, the authors pointed out that these reading strategies were crucial for students' reading comprehension achievement. Similarly, Azmuddin et al. (2017) investigated students' online reading strategies through the OSORS.

The authors found that students most frequently used problem-solving strategies and then the global and support reading strategies in reading English texts. In another online study of university students in Saudi Arabia, Freihat (2022) observed students' reading strategies through the SORS. Freihat observed that students largely employed problem-solving strategies, followed by moderate use of support and problem-solving strategies. These studies mostly used the OSORS questionnaire supplemented by interviews to collect qualitative data.

In a study of metacognitive online reading strategies (MORS), Yaghi (2021) demonstrated that learners' online reading strategies exerted a significant effect on their disposition toward online reading. Furthermore, Yan et al. (2022) found that online MORS could improve online reading and autonomous learning among college students. In Hungary, Nikolov and Csapó (2010) highlighted the importance of English as a foreign language (L2) in Hungary since the political shift that occurred in 1989. The authors proposed that a significant moderate correlation exists between the L1 and L2 reading comprehension processes. In a similar vein, Tary (2022) compared the online reading strategies employed by teachers in the L1 and L2 using the Metacognitive Awareness of Reading Strategies Inventory questionnaire. The author noted that teachers use more reading strategies in their L1 compared to their L2, suggesting a difference in the frequency or intensity of strategy use rather than entirely different strategies. This means that while teachers may employ similar types of strategies (global, problem-solving, and support) in both languages, they tend to use them more frequently or perhaps more effectively in their L1. As regards background variables, the research found no significant relationship between any background variable and reading strategy use in the L1. This indicates that factors like gender, qualifications, and teaching experience do not significantly influence how teachers use reading strategies in the L1.

## The present study

For this comparative study on the L1 and L2, it is necessary to describe the socio-educational context. Hungary is located in Central Europe, where English as a foreign language (L2) is currently of great importance to students because Hungarian (their L1) is uncommon in other countries (Nikolov and Csapó, 2010). In Hungary's educational curriculum, students begin learning a foreign language in the lower primary grades (at approximately 10 years old). However, they begin learning a foreign language at 6–8 years due to pressure from parents and the great demands of online learning (Nikolov, 2006). In recent decades, students have preferred learning English or German; however, an increasing number of students enjoy learning more than one foreign language and take more intensive courses (Nikolov, 2009).

## The rationale for the study

While many prior studies have investigated the use of online reading strategies with tools such as SORS and OSORS (e.g.,



Azmuddin et al., 2017; Do and Phan, 2021; Freihat, 2022), their designs and target populations vary widely. For instance, most have focused on university-level EFL learners, often in Asian or Middle Eastern contexts, thus limiting generalizability to younger learners or other cultural settings. Few studies have explicitly compared strategy use in the L1 and L2 within the same sample or examined how learner attitudes might influence strategy development. Moreover, studies seldom provide an analysis of how digital reading environments may affect metacognitive regulation differently across languages. These limitations highlight a need for research that directly compares L1 and L2 strategy use, incorporates affective factors like attitudes, and focuses on younger EFL learners in unexplored educational contexts, such as Hungarian middle schools.

Specifically, we noted that many studies (Al-Seghayer, 2014; Anisah and Widyantoro, 2019; Azmuddin et al., 2017; Do and Phan, 2021) involved the three main types of online reading strategies, global, problem-solving, and support strategies, and compared them to determine which one students most prefer. These strategies have been consistently identified as crucial components of effective reading comprehension, especially in the context of online reading. Therefore, the reviewed literature provides context for the first objective of the study: investigating which learning strategy is most favored by Hungarian students in Hungarian and English. Second, many of these studies (Al-Seghayer, 2014; Anisah and Widyantoro, 2019; Azmuddin et al., 2017; Erni, 2021; Do and Phan, 2021; Mudra, 2018) examined the employment of online reading strategies. Specifically, they concentrated on the effect of these online reading strategies on reading comprehension achievement. However, they did not clearly define the relationship between these online reading strategies and between the use of reading strategies in the L1 and L2. Therefore, the study intends to clear the dust from the ideas of investigating the relationship between the use of the L1 and L2 online reading strategies. Third, we reviewed several studies on the use of online reading strategies (Al-Seghayer, 2014; Anisah and Widyantoro, 2019; Laeli et al., 2022). However, only Laeli et al. (2022) illustrated the importance of these strategies on reading comprehension and attitudinal development in the relationship between readers' online reading strategies and attitudes in their L2 but not in their L1. Attitude has been shown to influence engagement and strategy adoption, particularly in online contexts, where motivation and self-direction are essential (Laeli et al., 2022; Park and Kim, 2017). Students who enjoy or value the target language are more likely to invest effort into understanding texts and selecting appropriate strategies. Therefore, examining how language attitudes correlate with strategy use helps clarify motivational influences, especially in L2 settings where anxiety or low confidence may suppress strategic behavior. This focus adds a valuable affective dimension to the study's findings. Fourth, only Tary (2022) conducted a study in Hungary and examined the use of online reading strategies among university students in the L1 and L2. Similarly, Nikolov and Csapó (2010) conducted a study in Hungary and compared the comprehension of high school students in their L1 and L2. However, the study overlooked the use of online reading strategies. Therefore, filling these research gaps is necessary to investigate the use of online reading strategies among middle school students in Hungarian and English.

## Theoretical framework

The theoretical framework guiding this study is based on metacognitive theory, which emphasizes the role of metacognitive strategies in reading comprehension. Metacognition refers to the awareness and regulation of one's cognitive processes (Flavell, 1979). This framework stresses the role of planning, monitoring, and evaluating one's cognitive processes during learning activities.

Anderson's (2003) model of reading strategies, consisting of global, problem-solving, and support strategies, maps directly onto the key dimensions of metacognitive control. Global strategies involve planning (e.g., setting reading goals), problem-solving strategies involve monitoring and adjusting (re-reading or slowing down), and support strategies are associated with regulating comprehension through external aids (e.g., highlighting or using a dictionary). The literature on online reading strategies (Yaghi, 2021; Yan et al., 2022) further supports the use of metacognitive strategies to enhance reading comprehension and autonomous learning.

In this study, we use the term "online reading strategies," based on Anderson's (2003) framework (global, problem-solving, and support strategies), which are considered metacognitive in nature because they involve active control over reading processes. While some literature distinguishes between "strategies" and "meta-strategies," our usage aligns with the broader conceptualization of strategies as metacognitive tools that support goal-oriented reading, especially in the complex environment of digital texts. This theoretical lens supports our investigation into both the cognitive (strategy) and affective (attitude) influences on reading comprehension across L1 and L2. By framing the study within this theory, we can systematically investigate how Hungarian students employ these metacognitive strategies across L1 and L2 contexts and how they relate to reading outcomes and language attitudes.

Based on these objectives, the study poses four research questions.

**RQ1:** What are the most frequently employed online reading strategies in the L1 and L2 among lower secondary students?

**RQ2:** What are the significant connections between students' use of online reading strategies in the L1 and L2?

**RQ3:** What are the relationships between students' attitudes toward the L1 and L2 and between these attitudes and online reading strategies for online reading?

**RQ4:** What impact does students' online reading strategy use have on their reading comprehension outcomes in the L1 and L2?

## Methods

### Participants

The study recruited a total of 1,214 secondary school students in Grades 5 (11-year-olds) and 8 (14-year-olds). Students in Grade 5 started lower secondary school in the same school year, whereas Grade 8 students are spending their last academic year at this school level. Grade 5 is particularly challenging for students due to the increased number of subjects and homework compared to previous years. The difficulty with Grade 8 is that it is the final academic year in lower secondary school. In the following year, these students will

continue their studies at a new school level, upper secondary school. They need to submit their school certificate for admission, which will determine their entry into the best possible upper secondary school. The Review Board at the Doctoral School of Education (University of Szeged) thoroughly reviewed and approved the study. The students' parents or legal representatives provided written consent, which was managed by the schools involved in the research. The authors ensured that the students' data remained anonymous and unavailable to third parties.

Students study a foreign language as a compulsory school subject from Grade 3 onwards. Thus, the students in Grades 5 and 8 have been learning English for three and six years, respectively. Hungarian language arts is part of the curriculum from the first school year onward.

## Instruments

### Online survey of reading strategies (OSORS) questionnaire in L1 and L2

The Online Survey of Reading Strategies (OSORS) questionnaire was developed by [Anderson \(2003\)](#). Although the previous version of the questionnaire analyzed the students' reading strategies, the modified version investigates online reading strategies. The students filled in the two versions of the questionnaire: English and Hungarian versions. The questionnaire was slightly modified to adapt to the English language and distinguish between the two versions. The Hungarian version was intended for reading Hungarian texts. A sample item in the English version is, "I take an overall view of the online text in English to see what it is about before reading it." The Hungarian version was unchanged, translating to: "I take an overall view of the online text to see what it is about before reading it." The OSORS questionnaire is composed of 38 items based on three categories: global or overall reading strategies (18 items; e.g., "I take an overall view of the online text to see what it is about before reading it"), problem-solving strategies (11 items; e.g., "When online text becomes difficult, I pay closer attention to what I am reading"), and support reading strategies (nine items; e.g., "When online text becomes difficult, I read aloud to help me understand what I read"). The statements were rated using a five-point Likert-type scale ranging from "never" to "always". [Anderson \(2003\)](#) confirmed the reliability of the questionnaire (Cronbach's  $\alpha = 0.93$ ) in previous research.

### Reading comprehension test in L1

The Hungarian Reading Comprehension Test was self-developed, consisting of two main tasks for a total of 44 items. The tasks were based on the cloze test, where the students were required to recognize the semantics of words. The tasks focused on words and phrases significant to the comprehension of learning course materials (26 items). The second task involved reading a short continuous text, followed by 18 comprehension questions/items requiring students to interpret context, infer meaning, and make connections between ideas within the passage. In this case, the instructions and all the items were written in Hungarian.

### Reading comprehension test in L2

The study also investigated online reading comprehension in English. The test was self-developed, consisting of 47 items divided into two major tasks. In the first section, the test inquired about the semantics of words and sentences using a cloze test (24 items). The items were intended to examine the comprehension of words and phrases at the A-level. The second section presented a short continuous text, followed by 23 comprehension questions/items that required students to interpret the overall meaning of the passage, select contextually appropriate words, and integrate sentence-level information to construct meaning.

### Assessment of attitudes toward L1 and L2

For assessing students' attitudes toward L1 and L2, a single item of a four-point Likert scale was used for both versions of L1 and L2. The attitude question is: *How much do you like the Hungarian/English language?* Students responded using these scales: 1 = Not at all, 2 = Somewhat, 3 = Satisfied, and 4 = Very Satisfied.

As the justification for using instruments in this study, the OSORS questionnaire was chosen for its proven reliability and comprehensive assessment of online reading strategies across various educational levels, including elementary schools. Studies ([Cancino and Ubilla, 2021](#); [Habók et al., 2024](#); [Huang, 2013](#)) have successfully employed the OSORS with primary and secondary students, supporting its validity in this context. The smile icon test (the happiest and saddest faces), on the other hand, is used to explore students' attitudes toward language learning, presenting a visually engaging and intuitive format suitable for our younger participants. Additionally, our study employs the Online Reading Comprehension Test in English and the Hungarian Language Arts Reading Comprehension Test to evaluate students' comprehension skills in both their L2 and L1, respectively. These tools, combined with a background questionnaire, offer a clear view of students' reading strategies, comprehension skills, and influencing factors, ensuring a thorough and contextually rich analysis.

## Data collection procedure

First, the study issued a call for schools to participate in the research, which included a brief summary of the research. Schools were then able to inform the authors of their intention to participate in the research and register via the eDia system. The system is an online platform operated by the University of Szeged Centre for Research on Learning and Instruction ([Csapó and Molnár, 2019](#)). To complete the measurement tools, the students log in with their official identification codes, which were uploaded to the eDia system by the schools. The researchers cannot see the students' names or identification codes to ensure anonymity. The students completed the measurement instruments in two school lessons during the school time provided by their schools. First, they completed the reading test and questionnaire on online reading strategies in their L2, followed by their L1. They received all the information required to complete the online tasks and questionnaire on the platform and were able to work individually.

In the case of technical problems, the students contacted their supervising teachers.

## Data analysis

In this study, IBM SPSS version 22.0 was employed for the descriptive analyses. We used WINSTEPS Rasch Analysis for the reliability measures of the research instruments. We also used WINSTEPS Rasch Analysis to examine students' use of online reading strategies in both their L1 and L2. Third, for correlation analyses between the L1 and L2 and students' use of online reading strategies, the study used R programming with scatter plots. Furthermore, for other correlational analyses of students' attitudes and their use of online reading strategies, we used multivariate multiple regression for the L1 and L2. Eta squared values were also described according to the categories recommended by Józsa et al. (2022): 0.01 for a small effect, 0.10 for a medium effect, and 0.15 for a large effect. Fourth, for the item difficulty and discrimination of the reading comprehension tests, 2-Parameter Logistic (2PL) model was run. The recommended values for item difficulty measures in logits were between  $-2.0$  and  $+2.0$ . For item discrimination, a point-measure correlation (PTMEAS) was detected. Its recommended values [PTMEAS  $> 0.40$  = very good,  $0.30$ – $0.39$  = acceptable,  $0.20$ – $0.29$  = low, and  $< 0.20$  = poor (consider for reviewing/removing)] were considered in the analyses (Oo et al., 2023).

Fifth, the study conducted a path analysis to explore the direction of the effects of the variables (reading strategies) on reading comprehension achievements in L1 and L2. Model fit was assessed using various fit indices to verify the structure of the regression models for the L1 and L2 versions. The study used the MPlus8 software package for this analysis. Goodness-of-fit was evaluated through the various indices, such as the Chi-squared test, comparative fit index (CFI), normed fit index (NFI), Tucker–Lewis index (TLI), and root mean square error of approximation (RMSEA). For CFI, NFI, and TLI, thresholds  $\geq 0.90$  indicated that the model had a good fit to the data. For RMSEA, values  $\leq 0.08$  suggested an appropriate fit (Kline, 2016).

## Results

### Validation of instruments

#### Validation of online survey of reading strategy questionnaires in L1 and L2

The mean measures (logit) of the items in the Hungarian version (L1) and English version (L2) of the questionnaires (five-point scale) are 0.00 with positive standard deviation (SD) values (0.35 and 0.38, respectively), indicating that the sample data adequately reflect students' use of online reading strategies. For both versions, the mean measures for students are 0.15 and 0.09 logits, suggesting that the students actively used online reading strategies (Boone et al., 2014). However, the SD for students (persons) is relatively low (0.77) for both versions, implying that the variation in learners is acceptable for data analysis.

For both versions, the outfit mean squares (MNSQ) are 1.05 and 1.02 for students and 1.05 and 1.04 for items, indicating that the model-data fit was acceptable for both students and items, based on recommended MNSQ thresholds (1.0–1.5). In this context, the term “outfit” refers to the assessment of extreme or unexpected responses concerning the predictions of the model. Moreover, the outfit z-standardized (ZSTD) measures of both versions were  $-0.3$  and  $-0.2$  for students and  $-0.3$  and  $-0.1$  for items. These values are consistent with the recommended values (ranging from  $-2$  to  $+2$ ; Andrich, 2018). The  $\chi^2/df$  ratio was less than 3, indicating an acceptable model fit (Engelhardt, 2013; Linacre, 2020). Item and person reliabilities were relatively good (Table 1). The internal consistency reliability (Cronbach's alpha, KR-20) values for learners and items in the L1 and L2 versions are relatively high ( $>0.9$ ), indicating strong reliability (Fisher, 2007).

The unidimensionality of the instruments was analyzed for the presence of local dependency effects to ensure validity. Explained variances by measure for the L1 and L2 versions were 56.5 and 66%, respectively [ $>30\%$ , as suggested by Chou and Wang (2010) and Linacre (1998)]. In other words, the L1 and L2 versions were unidimensional. Furthermore, the item raw score-to-measure correlation was  $-0.10$  for both versions [ $<0.3$ , as recommended by Christensen et al. (2017) and Hagell (2014)], which illustrates that no local dependency effect can be observed from the instruments. Therefore, the study concludes that both versions of the instrument are valid and reliable.

We investigated convergent and discriminant validity to determine the construct validity of both versions of the questionnaires. For convergent validity, the study computed internal consistency reliability (Cronbach's alpha), composite reliability (CR), and average variance extracted (AVE) and confirmed them with recommended values (\*). First, we detected sampling adequacy using the Kaiser–Meyer–Olkin (KMO) value. The study obtained a KMO value of 0.967, which is higher than the value ( $>0.70$ ) recommended by Kline (2016). The convergent validity (internal consistency values; Cronbach's alpha, CR, and AVE) for both instruments was good (Table 2). Therefore, the results reinforce that the instruments have strong internal consistency and reliable measurement properties, as the true score variance closely aligns with the total variance across items and respondents/participants. Moreover, the value measured for each factor (global, problem-solving, and support strategies) in both versions was consistent with the recommended values (\*) in Table 2. Thus, the study interprets the results as follows: all factors in both versions are closely related to other factors.

In assessing discriminant validity measures, we examined the square root of AVE and the correlations between components for both versions (Table 3). The instruments indicated that the square root of the AVE values (\*) was higher than those of other component correlations. Indeed, the results depicted how well the test measured the concept (use of online reading strategies) that we intended to measure. Therefore, the study concludes that the discriminant validity of both instruments was also good for assessing the students' use of online reading strategies in their L1 and L2.

TABLE 1 Summary of statistics based on persons and items for both versions ( $N = 1,214$ ).

| Statistics                            | Hungarian version |       | English version |       |
|---------------------------------------|-------------------|-------|-----------------|-------|
|                                       | Persons           | Items | Persons         | Items |
| Number                                | 1,214             | 38    | 1,214           | 38    |
| Mean                                  | 0.15              | 0.00  | 0.09            | 0.00  |
| Standard deviation                    | 0.77              | 0.35  | 0.77            | 0.38  |
| Standard error of item mean           | 0.03              | 0.06  | 0.02            | 0.06  |
| Mean outfit (MNSQ)                    | 1.05              | 1.05  | 1.02            | 1.04  |
| Mean outfit (ZSTD)                    | −0.3              | −0.2  | −0.2            | −0.1  |
| Separation                            | 3.74              | 9.84  | 3.74            | 10.07 |
| Reliability (Cronbach's alpha)        | 0.93              | 0.95  | 0.92            | 0.94  |
| Chi-squared ( $\chi^2$ )              | 84,955.13         |       | 122,762.57      |       |
| Df                                    | 30,929            |       | 44,249          |       |
| Item raw score-to-measure correlation | −0.10             |       | −0.10           |       |

MNSQ, outfit mean square; ZSTD, z-standardized score.

TABLE 2 Convergent validity measures of the L1 and L2 versions of the OSORS questionnaires ( $N = 1,214$ ).

| Instruments       | Factors                     | No. of items | Cronbach's Alpha (>0.60)* | Average variance extracted (>0.50)* | Composite reliability (>0.70)* |
|-------------------|-----------------------------|--------------|---------------------------|-------------------------------------|--------------------------------|
| Hungarian version | Global                      | 18           | 0.89                      | 0.53                                | 0.89                           |
|                   | Problem-solving             | 11           | 0.90                      | 0.52                                | 0.83                           |
|                   | Support                     | 9            | 0.85                      | 0.52                                | 0.82                           |
|                   | Total (Overall reliability) | 38           | 0.95                      | 0.53                                | 0.87                           |
| English version   | Global                      | 18           | 0.88                      | 0.58                                | 0.90                           |
|                   | Problem-solving             | 11           | 0.89                      | 0.53                                | 0.82                           |
|                   | Support                     | 9            | 0.83                      | 0.54                                | 0.89                           |
|                   | Total (Overall reliability) | 38           | 0.94                      | 0.55                                | 0.94                           |

TABLE 3 Discriminant validity measures of the L1 and L2 versions of the OSORS questionnaires ( $N = 1,214$ ).

| Instruments versions | Component correlation matrix |               |               |               |
|----------------------|------------------------------|---------------|---------------|---------------|
| Hungarian version    | Components                   | 1             | 2             | 3             |
|                      | 1. Global                    | <b>0.728*</b> |               |               |
|                      | 2. Problem-solving           | 0.628         | <b>0.721*</b> |               |
|                      | 3. Support                   | 0.403         | 0.345         | <b>0.721*</b> |
| English version      | Components                   | 1             | 2             | 3             |
|                      | 1. Global                    | <b>0.761*</b> |               |               |
|                      | 2. Problem-solving           | 0.389         | <b>0.728*</b> |               |
|                      | 3. Support                   | 0.442         | 0.543         | <b>0.734*</b> |

\*Square root of AVE values.

## Validation of reading comprehension tests in L1 and L2

To determine the reliability and normality measures of the reading comprehension tests (cloze types and reading tasks with a short continuous text) in the L1 and L2, we investigated internal consistency reliability (Cronbach's alpha) and normality measures.

The internal reliability values of the L1 and L2 tests were 0.83 and 0.85, respectively. Measures for testing normality were used for both versions. Kline (2016) recommends a guideline to identify severe non-normality, stating that skewness (Sk) values exceeding 3 and kurtosis (K) values surpassing 10 indicate a significant violation of the normality assumption. The findings indicate that



TABLE 4 Item difficulty and discrimination of reading comprehension tests in L1 and L2 (N = 1,214).

| Reading comprehension test in L1 |                     |                         | Reading comprehension test in L2 |                     |                         |
|----------------------------------|---------------------|-------------------------|----------------------------------|---------------------|-------------------------|
| Items                            | Difficulty (Logits) | Discrimination (PTMEAS) | Items                            | Difficulty (Logits) | Discrimination (PTMEAS) |
| Item1                            | 1.48                | 0.3                     | Item1                            | −2.00               | 0.31                    |
| Item2                            | −1.98               | 0.33                    | Item2                            | −1.11               | 0.41                    |
| Item3                            | 1.42                | 0.31                    | Item3                            | −1.67               | 0.38                    |
| Item4                            | 0.01                | 0.32                    | Item4                            | −0.88               | 0.5                     |
| Item5                            | 0.88                | 0.32                    | Item5                            | −1.18               | 0.46                    |
| Item6                            | 1.03                | 0.34                    | Item6                            | −0.12               | 0.43                    |
| Item7                            | 0.15                | 0.46                    | Item7                            | −1.07               | 0.32                    |
| Item8                            | 1.12                | 0.34                    | Item8                            | 0.04                | 0.31                    |
| Item9                            | 0.12                | 0.3                     | Item9                            | −0.19               | 0.3                     |
| Item10                           | 0.45                | 0.34                    | Item10                           | −0.14               | 0.44                    |
| Item11                           | 0.08                | 0.35                    | Item11                           | −0.53               | 0.31                    |
| Item12                           | 0.37                | 0.41                    | Item12                           | 0.14                | 0.43                    |
| Item13                           | 0.83                | 0.4                     | Item13                           | −0.38               | 0.46                    |
| Item14                           | 0                   | 0.4                     | Item14                           | −1.20               | 0.37                    |
| Item15                           | −0.57               | 0.32                    | Item15                           | 1.09                | 0.52                    |
| Item16                           | 0                   | 0.34                    | Item16                           | 0.01                | 0.56                    |
| Item17                           | 0.42                | 0.47                    | Item17                           | −0.52               | 0.51                    |
| Item18                           | 0.17                | 0.32                    | Item18                           | 1.12                | 0.63                    |
| Item19                           | 0.75                | 0.45                    | Item19                           | −0.41               | 0.59                    |
| Item20                           | 1.41                | 0.29                    | Item20                           | 0.15                | 0.6                     |
| Item21                           | 0.42                | 0.35                    | Item21                           | 0.59                | 0.6                     |
| Item22                           | −0.09               | 0.52                    | Item22                           | 0.76                | 0.56                    |
| Item23                           | −0.03               | 0.38                    | Item23                           | −0.07               | 0.59                    |
| Item24                           | −0.70               | 0.39                    | Item24                           | 1.07                | 0.69                    |
| Item25                           | 0.77                | 0.3                     | Item25                           | 0.16                | 0.32                    |
| Item26                           | −0.22               | 0.44                    | Item26                           | −0.03               | 0.54                    |
| Item27                           | −1.16               | 0.34                    | Item27                           | 1.17                | 0.6                     |
| Item28                           | −2.00               | 0.37                    | Item28                           | 1.03                | 0.59                    |
| Item29                           | −0.79               | 0.3                     | Item29                           | 0.98                | 0.6                     |
| Item30                           | −1.07               | 0.31                    | Item30                           | −0.17               | 0.58                    |
| Item31                           | −1.23               | 0.38                    | Item31                           | 0.02                | 0.6                     |
| Item32                           | −1.43               | 0.38                    | Item32                           | −0.42               | 0.6                     |
| Item33                           | −0.24               | 0.32                    | Item33                           | 0.92                | 0.56                    |
| Item34                           | −1.73               | 0.36                    | Item34                           | 0.35                | 0.62                    |
| Item35                           | −0.38               | 0.33                    | Item35                           | 0.48                | 0.57                    |
| Item36                           | 2                   | 0.3                     | Item36                           | 0.21                | 0.56                    |
| Item37                           | 1.07                | 0.5                     | Item37                           | 1.51                | 0.61                    |
| Item38                           | −0.44               | 0.48                    | Item38                           | 1.1                 | 0.72                    |

(Continued)

TABLE 4 (Continued)

| Reading comprehension test in L1 |                     |                         | Reading comprehension test in L2 |                     |                         |
|----------------------------------|---------------------|-------------------------|----------------------------------|---------------------|-------------------------|
| Items                            | Difficulty (Logits) | Discrimination (PTMEAS) | Items                            | Difficulty (Logits) | Discrimination (PTMEAS) |
| Item39                           | 1.11                | 0.43                    | Item39                           | −0.65               | 0.48                    |
| Item40                           | 1.56                | 0.37                    | Item40                           | 0.49                | 0.67                    |
| Item41                           | −1.20               | 0.34                    | Item41                           | −0.22               | 0.54                    |
| Item42                           | −0.97               | 0.37                    | Item42                           | −0.02               | 0.6                     |
| Item43                           | −1.48               | 0.33                    | Item43                           | 0.4                 | 0.57                    |
| Item44                           | 0.02                | 0.43                    | Item44                           | 0.63                | 0.58                    |
|                                  |                     |                         | Item45                           | −0.20               | 0.36                    |
|                                  |                     |                         | Item46                           | −0.74               | 0.46                    |
|                                  |                     |                         | Item47                           | −0.16               | 0.41                    |

both the L1 ( $Sk = -0.28$ ,  $K = 0.35$ ) and L2 ( $Sk = -0.21$ ,  $K = 0.46$ ) versions exhibited normal distribution in assessing students' reading comprehension achievement. Moreover, the difficulty and discrimination indices of the tests were examined using logit measures and point-measure correlations (PTMEAS) derived from Rasch analysis of two-parameter logistic models. In evaluating the reading comprehension tests administered in both L1 and L2, the item difficulty logit measures fell within the acceptable range of  $\pm 2.00$ . Additionally, the discrimination values exceeded the threshold of  $+3.00$ , indicating acceptable to strong item discrimination (Table 4). These findings confirm the overall quality and validity of the reading comprehension tests in both L1 and L2. For visual clarity, the item characteristic curves for both test versions are presented in Figures 1, 2. These characteristic curves were described using the ratios of the expected scores to ability measures. For the L1 and L2 versions, the ratios of the test characteristic curves exhibited nearly linear relationships between expected scores and ability measures. In other words, the students' ability grew with the increase in their test scores in their L1 and L2.

### Homogeneity measures of reading comprehension tests across genders

The study analyzed differential item functioning (DIF) as an inquiry into whether or not bias existed across genders for the L1 and L2 versions. DIF mainly presented the each-item measure of the learners' responses on the use of online reading strategies (Adams et al., 2020; Boone et al., 2014). Figures 3, 4 indicated that all items from both versions were between 0.20 and  $-0.20$  logits, thus highlighting that no biased measure existed across genders for both versions (three recommended levels; minor, slight to moderate [ $DIF \geq 0.43$  logits], and moderate to large [ $DIF \geq 0.64$ ] logits) (Zwick et al., 1999).

The item separations (representing various levels of item difficulty) for both versions were nearly the same (3.74 for persons, and 9.84 and 10.07 for items of the Hungarian and English versions), which is greater than 3, as recommended by Ahmad

and Siew (2021). Accordingly, both versions exhibit the same levels of item difficulty for students (Fisher, 2007; Taber, 2018). Based on these findings, the research has underlined that both versions of the instruments were homogeneous in addressing the research questions.

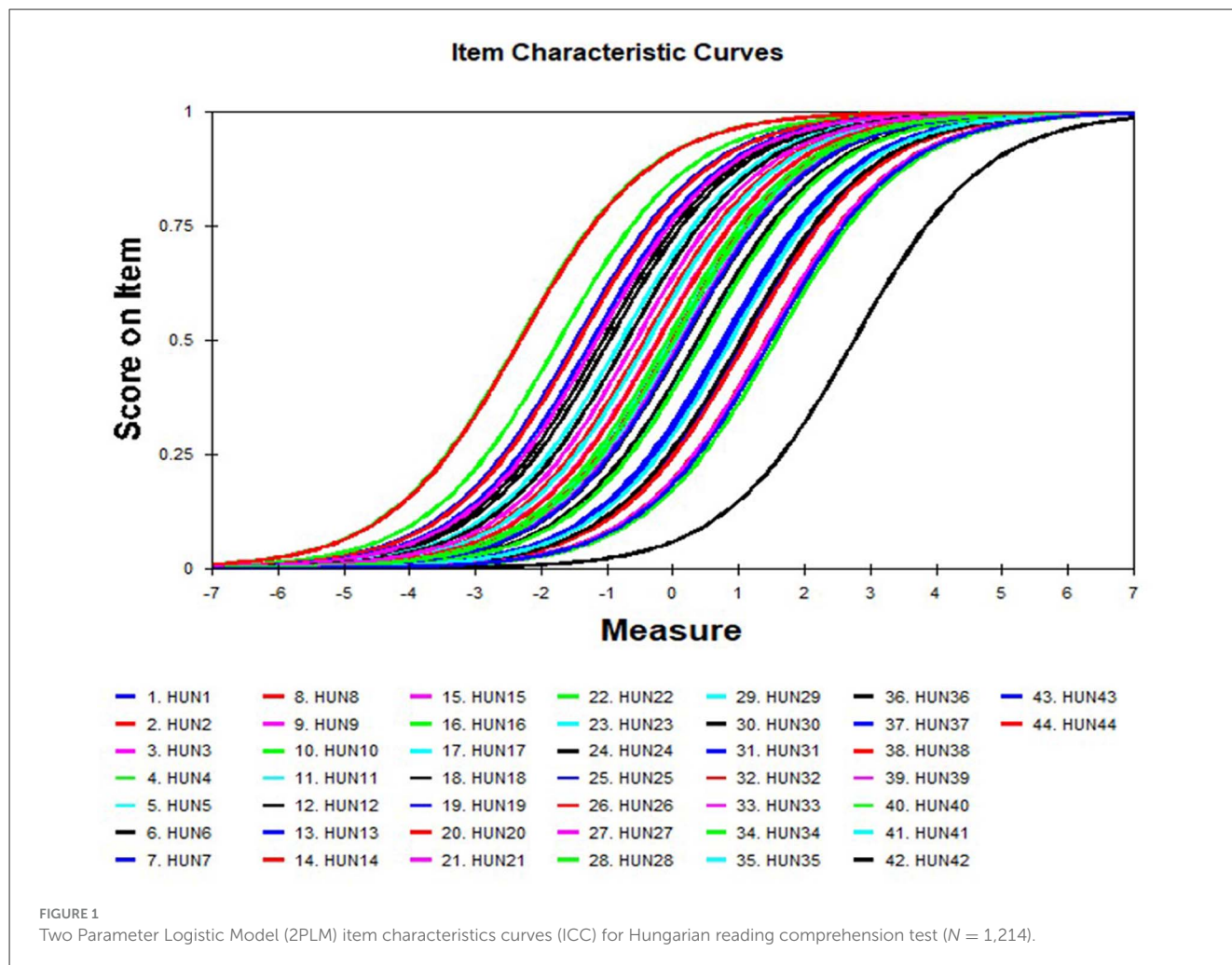
### Validation of the assessments of attitudes toward L1 and L2

The study further evaluated the appropriateness of assessing students' attitudes toward L1 and L2 using a four-point Likert scale. The weighted mean-square fit statistic (MNSQ) was calculated for the items measuring attitudes toward both L1 and L2. The results indicated weighted MNSQ values of 0.48 for the L1 assessment and 0.61 for the L2 assessment, both falling within the acceptable range of 0.5–1.5 (Habók et al., 2024). Additionally, Figure 5 presents the test characteristic curves for L1 and L2, both demonstrating acceptable person-item alignment with logit values approximating 0.00. These findings indicate that the attitude assessments exhibit good model fit, contain no redundant information, and are suitable for measuring students' attitudes toward L1 and L2.

*Addressing RQ1: What are the most frequently employed online reading strategies in the L1 and L2 among lower secondary students?*

RQ1 seeks to ascertain online reading strategy use, such as identifying which online reading strategy is most frequently or rarely used, for reading comprehension. We used Rasch analysis for both versions. The findings obtained from the Hungarian version (left panel in Figure 6) illustrated that the students most frequently used global reading strategies (e.g., G11, G12, and G16) to comprehend reading passages whereas problem-solving (e.g., P6 and P7) and support (e.g., S9) reading strategies are rarely used in the reading process in the L1.

However, the results derived from the English version (right panel in Figure 6) showed that the participants most frequently employed support reading strategies (e.g., S3, S4, and S9) while global (e.g., G12 and G2) and problem-solving (e.g., P4) strategies were rarely used. This finding is entirely different from the use of strategies in the L1. The reason may be that the students prefer



to use other support reading materials, such as dictionaries and translated materials, to comprehend the reading passages.

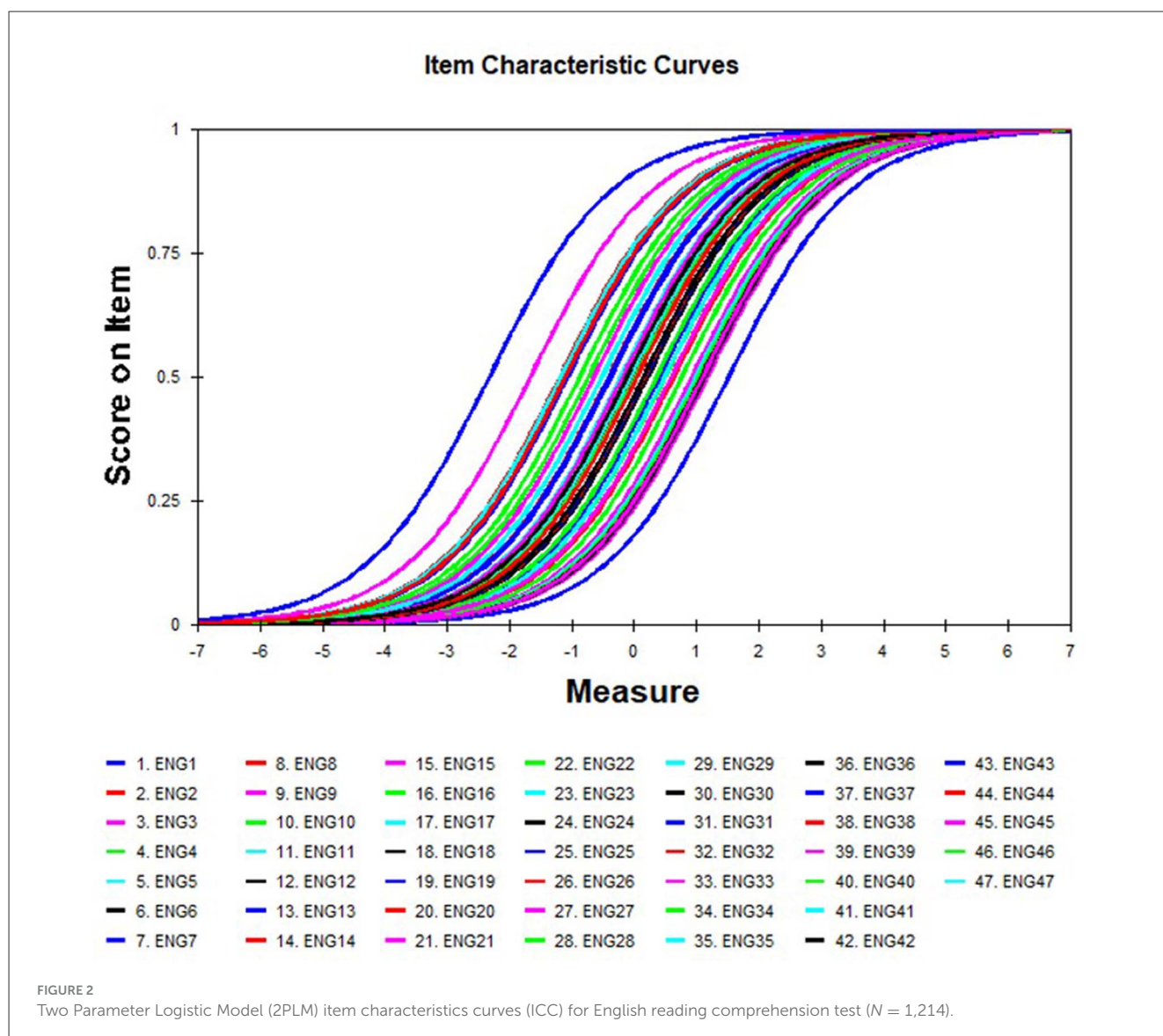
*Addressing RQ2: What are the significant connections between students' use of online reading strategies in the L1 and L2?*

We used R programming for correlational analyses between the two versions and their sub-variables (HGlo = Global reading strategies in Hungarian, HProb = Problem-solving strategies in Hungarian, HSup = Support reading strategies in Hungarian; and EGlo = Global reading strategies in English, EProb = Problem-solving strategies in English, ESup = Support reading strategies in English). The study found no significant correlation between the two versions (Hungarian: HGlo, Hprob, and HSup; English: EGlo, EProb, and ESup; Figure 7). However, we found significant and strong positive correlations between the sub-variables in the L1, such as those for global/problem-solving ( $r = 0.86$ ; between HGlo and HProb), global/support ( $r = 0.85$ ; between HGlo and HSup), and support/problem-solving ( $r = 0.83$ ; between HSup and HProb). Furthermore, we found significant correlations between a few variables in the English version, such as global/problem-solving ( $r = 0.87$ ; between EGlo and Eprob), global/support ( $r = 0.81$ ; between HGlo and HSup), and problem-solving and support ( $r = 0.82$ ; between HProb and HSup).

*Addressing RQ3: What are the relationships between students' attitudes toward the L1 and L2, and between these attitudes and online reading strategies for online reading?*

RQ3 addresses the causal relationships between attitudes toward language and online reading strategies. The study used a multivariate multiple regression for analysis, in which attitude toward language is a continuous predictor (covariate) and online reading strategies are the dependent variables. After testing for homogeneity measures, we then used the General Linear Model (GLM) procedure. In the L1, the findings demonstrated that students' attitudes toward Hungarian exerted significant and positive medium effect sizes on their global reading strategies ( $\eta = 0.33$ ), problem-solving strategies ( $\eta = 0.34$ ), and support reading strategies ( $\eta = 0.36$ ).

For L2, the study found that students' attitudes toward English also led to significant and positive medium effect sizes on their global reading strategies ( $\eta = 0.310$ ) and problem-solving strategies ( $\eta = 0.31$ ), except for small effects on support reading strategies ( $\eta = 0.17$ ; Table 5). The reason may be that the learners were likely to use support reading strategies (most frequently used; Figure 6) under



any condition; thus, the impact of their language attitudes on the use of support reading strategies was found to be of low significance.

The study used R programming to investigate the relationships between attitudes toward the L1 and L2. We found no significant correlation ( $r = -0.069$ ,  $*p = 0.017$ ) in the relationship between attitudes toward the L1 and L2 (Figure 8). In other words, high or low levels of attitudes toward the L2 were unrelated to attitudes toward the L1.

*Addressing Q4: What impact does students' online reading strategy use have on their reading comprehension outcomes in the L1 and L2?*

The study confirmed the structural model via MPlus8 to analyze the effects of the use of online reading strategies on students' L1 and L2 reading comprehension. Based on the literature reviewed above, we grouped online reading strategies into three types, global, problem-solving, and supportive, which were set as the independent variables. Alternatively, reading comprehension achievement was considered the dependent variable. Using the two

versions of the questionnaires, the study confirmed RQ2 using two structural models. First, we identified the two models with non-significant probability values (Kline, 2016). Afterward, we confirmed their fit indexes in accordance with recommendations, such as the absolute fit indexes (CFI and TLI), comparative fit index (via RMSEA), and parsimonious fit index (through the division of  $\chi^2$  by  $df$ ). Table 6 presents the fit indexes for both versions.

In the L1, global ( $\beta = 0.38$ ,  $p < 0.05$ ) and support reading strategies ( $\beta = 0.45$ ,  $p < 0.05$ ) contributed noteworthy and positive effects on students' reading comprehension achievement in contrast to problem-solving strategies ( $\beta = -0.79$ ,  $p < 0.05$ ; Figure 9).

In contrast to the Hungarian version of the model noted above, we correlated certain variables, such as  $g_2$  and  $g_3$ , as well as  $p_8$  and  $p_{10}$ , in the English version for a better fit. We also omitted impacts, which were non-significant (problem-solving strategies on reading achievement). Figure 10 indicates that global ( $\beta = 0.78$ ,  $p < 0.01$ ) and support reading strategies ( $\beta = 0.97$ ,  $p < 0.01$ ) exerted significant and positive effects on



### Differential Item Functioning across Gender for L1 Reading Comprehension Test

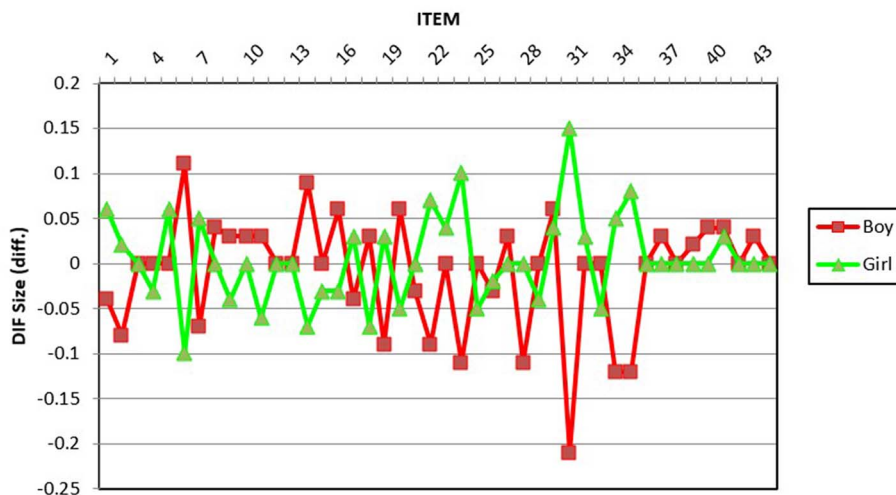


FIGURE 3  
Differential item measures of the reading comprehension test in L1 ( $N = 1,214$ ).

### Differential Item Functioning across Gender for L2 Reading Comprehension Test

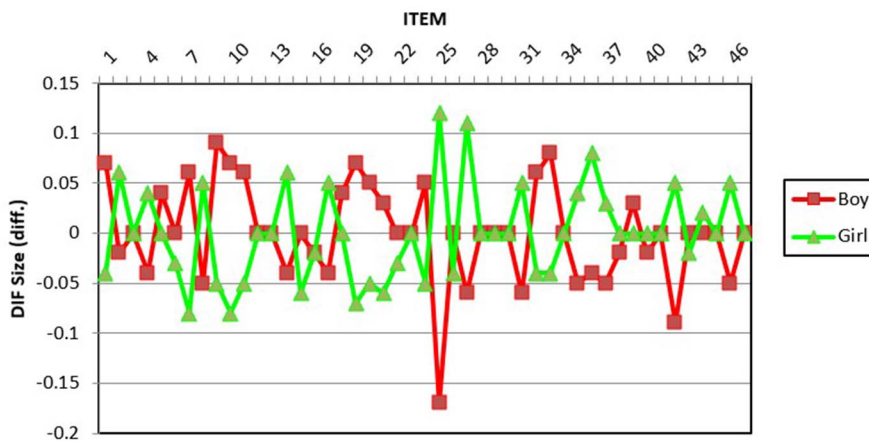


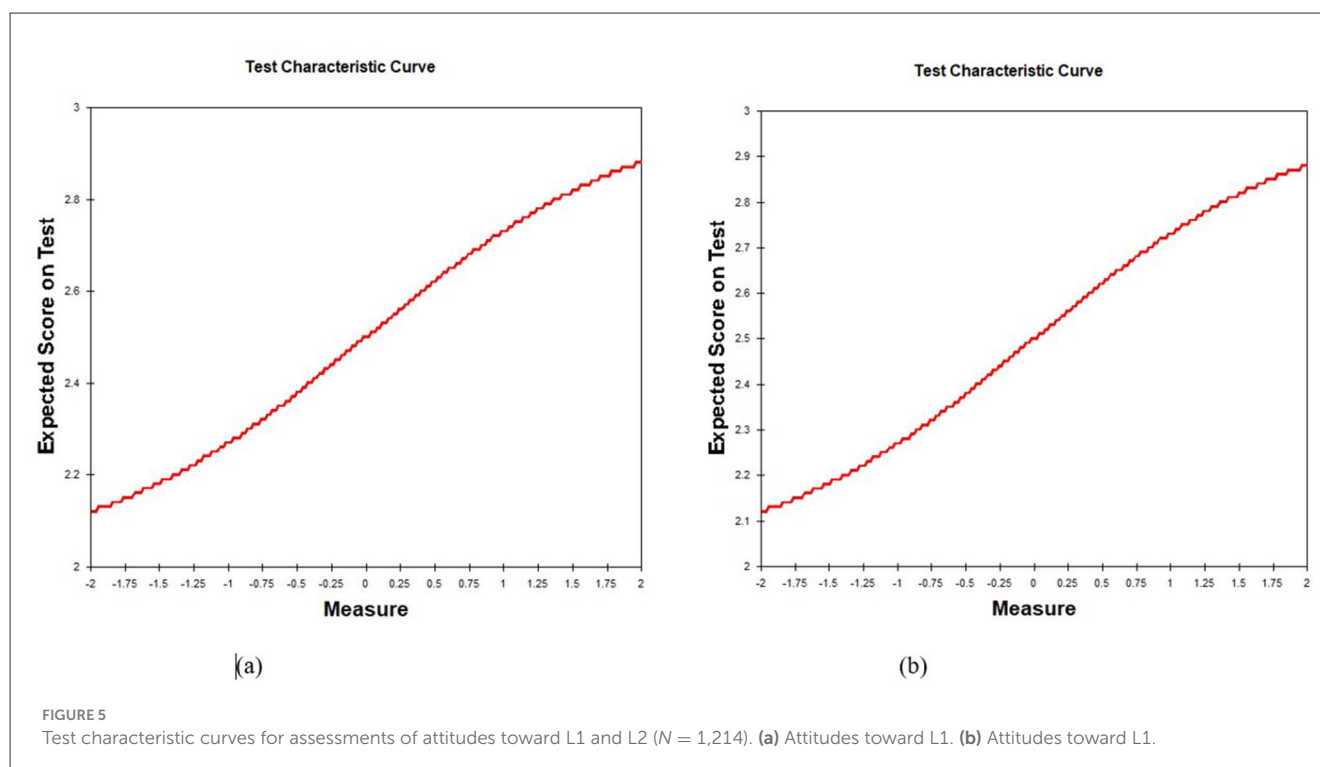
FIGURE 4  
Differential item measures of the reading comprehension test in L2 ( $N = 1,214$ ).

reading comprehension achievement in English. However, the study observed no significant effect of problem-solving strategies on reading comprehension achievement.

## Discussion

This study investigated how Hungarian middle school students use different online reading strategies in their L1 compared to their

L2. The primary finding is that students employ distinct reading strategies depending on whether they are reading in their L1 or L2. Specifically, students primarily use global and support reading strategies in their L1, while they rely more on support reading strategies and problem-solving strategies in the L2. In this study, moreover, the four main research questions were addressed to fill the research gaps observed in the literature on the use of Hungarian students' online reading strategies.

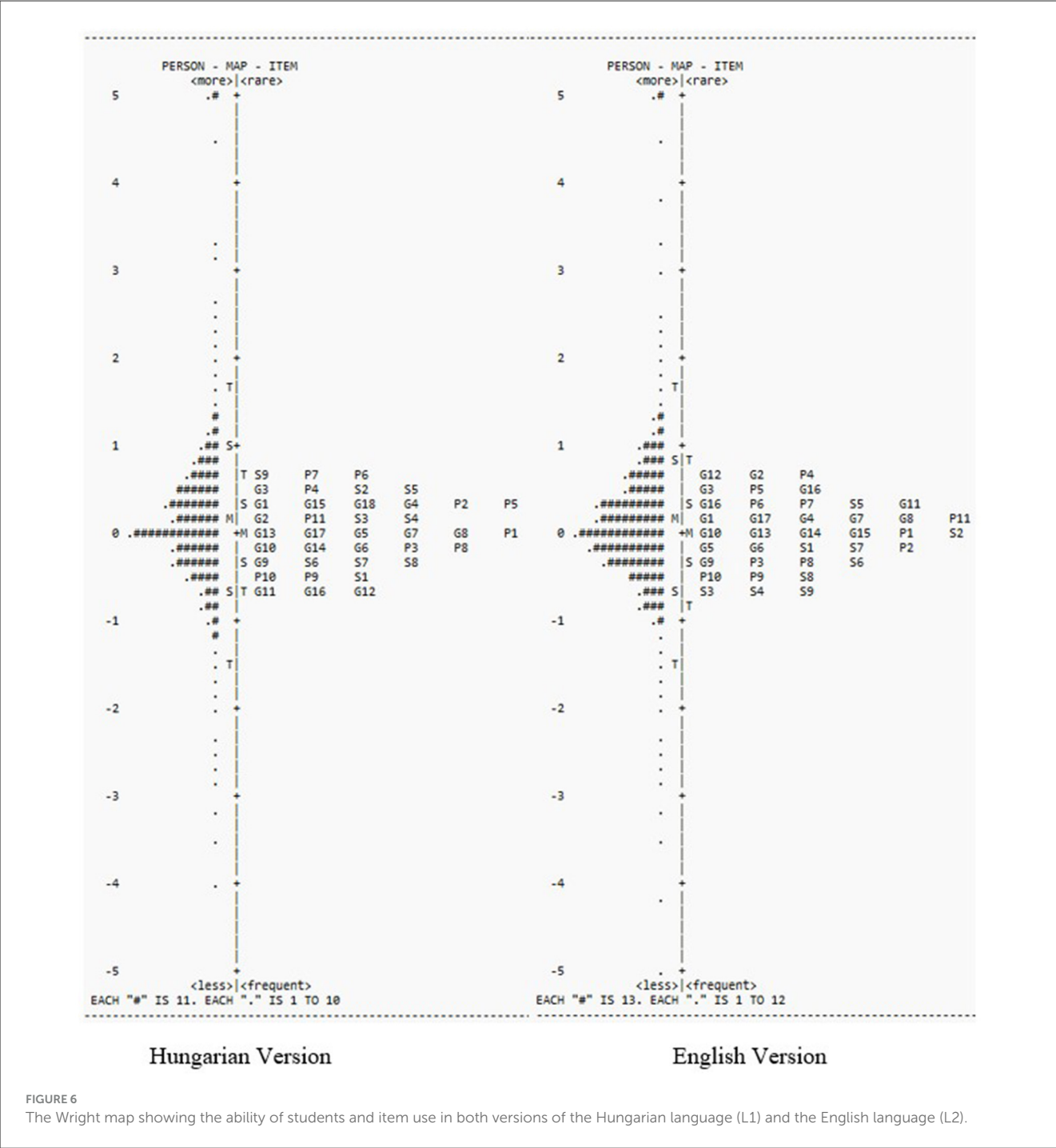


In relation to RQ1, a WINSTEPS Rasch Analysis demonstrated that in both the L1 and L2, the students predominantly employed global and support reading strategies. For global reading strategies, the students first established the reading objectives followed by pre-reading of texts, deciding on the focus of reading, and predicting future events by solving the different problems that emerge from reading the passages. It was easy for the students to perform these tasks in Hungarian. In other words, they understood the reading text and easily negotiated around potential reading problems without any language barrier. Therefore, we assumed that this reason underlies their most frequent use of global reading strategies in their L1. This finding was also consistent with some studies (e.g., Amer et al., 2010; Habók et al., 2024) that found that only highly skilled readers most frequently use global reading strategies. Alternatively, the students displayed a few language barriers in their L2; thus, they could not directly solve potential problems that emerge from the reading passages. Therefore, they were dependent on other support reading strategies, such as using dictionaries, underlining meaningful texts, and circling important words or phrases. The result for RQ1 in the L2 is in line with that of Al-Seghayer (2014) and differs from those of other studies (e.g., Azmuddin et al., 2017; Freihat, 2022; Do and Phan, 2021), which most frequently used problem-solving strategies. This difference may be the reason for the different levels of students' learning ability. In general, previous studies (Azmuddin et al., 2017; Freihat, 2022; Do and Phan, 2021) have focused on undergraduates, whereas the current study focuses on middle school students.

The converse of the online reading strategies the students most commonly employed is their least frequent use of online reading strategies. In their L1, the Hungarian students used problem-solving strategies the least and supported reading strategies more

often. In their L2, they rarely employed global reading strategies, with problem-solving strategies used more often. Comparing the most rarely used strategies in the L1 and L2, the study resulted in that problem-solving strategies were the strategies least employed by Hungarian students. This finding demonstrated that the students had a lower preference for problem-solving strategies such as setting goals, recalling the background schema of related knowledge, and predicting the text. This result is in line with those of Habók et al. (2024) that highly skilled readers prefer global reading strategies, whereas less skilled readers typically use support reading strategies. In the present study, it was noted that students exhibited infrequent use of problem-solving strategies in comparison to their use of global and support reading strategies.

For RQ2, the study found no significant relationship between the students' use of online reading strategies in their L1 and L2. Although this finding suggests that the language difference between the L1 and L2 might have contributed to the lack of significant relationships, it is important to provide more context and evidence. Previous studies, such as Nikolov and Csapó (2010), noted a moderate correlation between the L1 and L2, but the study overlooked the use of online reading strategies. Similarly, Tary (2022) also examined university students' use of online reading strategies but found no significant correlation between the L1 and L2. This suggests that factors other than mere language proficiency might influence the use of online reading strategies across different languages. In our study, we observed positive significant correlations among the sub-variables (global, problem-solving, and support strategies) of both versions. If the students managed to efficiently use one type of reading strategy, then they may improve their use of other reading strategies. However, these correlations did not extend across languages, indicating



that the transfer of strategy use between the L1 and L2 might be limited.

To address RQ3, the study found no significant relationship between students' attitudes toward their L1 and L2. In other words, the Hungarian students' attitude toward their L1 was unrelated to their high or low levels of attitudes toward their L2. However, their attitudes exhibited positive moderate relationships with the use of online reading strategies. These findings were in line with that of Laeli et al. (2022), who illustrated the importance of students' enjoyment and positive attitudes in using online reading strategies.

Lastly, we sought the answer to RQ4. For the L1 and L2, global and support reading strategies showed a noteworthy positive effect on students' reading comprehension achievement. The reason underlying this result may be that students who intend to use problem-solving strategies need to achieve a high level of language proficiency and background knowledge. This allows them to establish reading objectives, solve problems arising from the reading passages, and predict text information when necessary. Therefore, the students displayed certain difficulties in using problem-solving strategies, which led to the scarce use of these

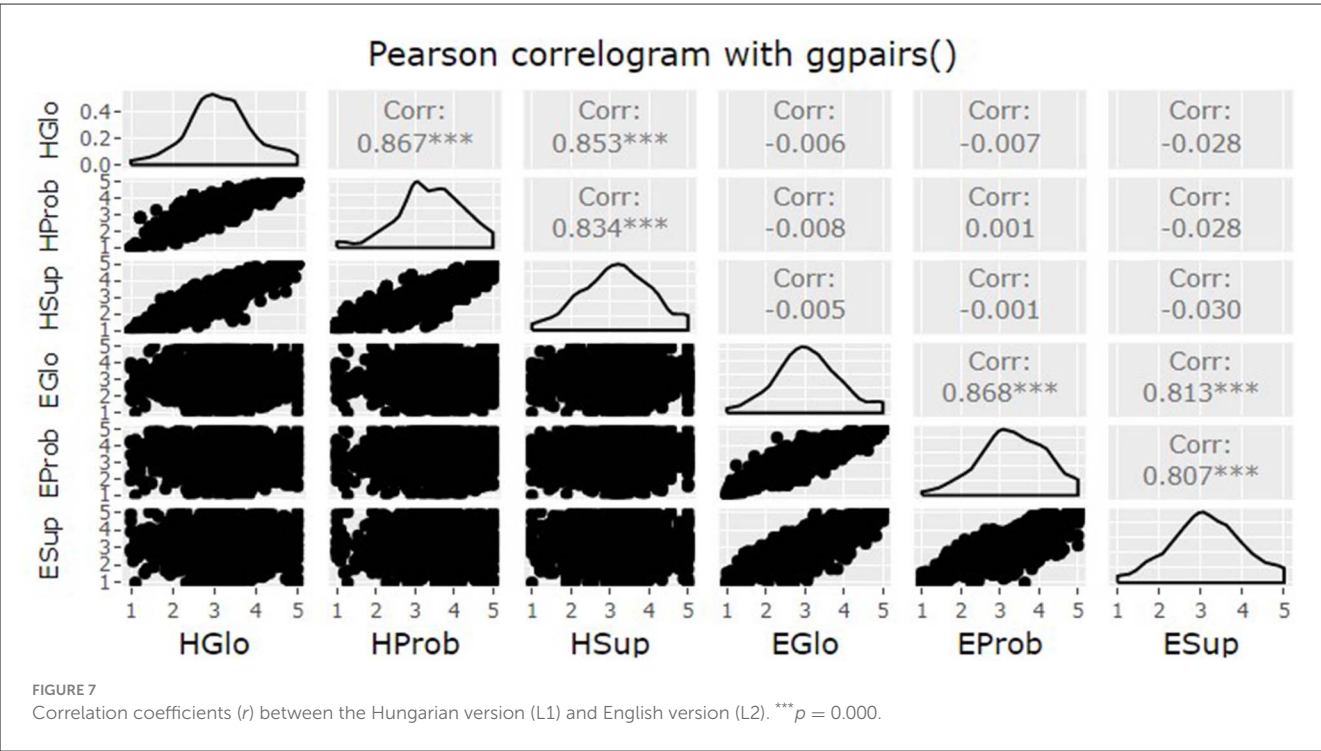


TABLE 5 Relationships between attitudes toward language and the use of online reading strategies.

| Covariates                  | Dependent variables | <i>F</i> | <i>p</i> *** | $\eta^2$ | $\eta$ |
|-----------------------------|---------------------|----------|--------------|----------|--------|
| Hungarian language attitude | Global              | 24.86    | 0.000        | 0.11     | 0.33   |
|                             | Problem-solving     | 27.73    | 0.000        | 0.12     | 0.34   |
|                             | Support             | 30.79    | 0.000        | 0.13     | 0.36   |
| English language attitude   | Global              | 24.86    | 0.000        | 0.11     | 0.33   |
|                             | Global              | 40.61    | 0.000        | 0.10     | 0.31   |
|                             | Problem-solving     | 39.57    | 0.000        | 0.10     | 0.31   |
|                             | Support             | 13.05    | 0.000        | 0.03     | 0.17   |

etas,  $\eta^2 = 0.1$  (medium), 0.15 (large), 0.01 (small) (Józsa et al., 2022). \*\*\* $p = 0.000$ .

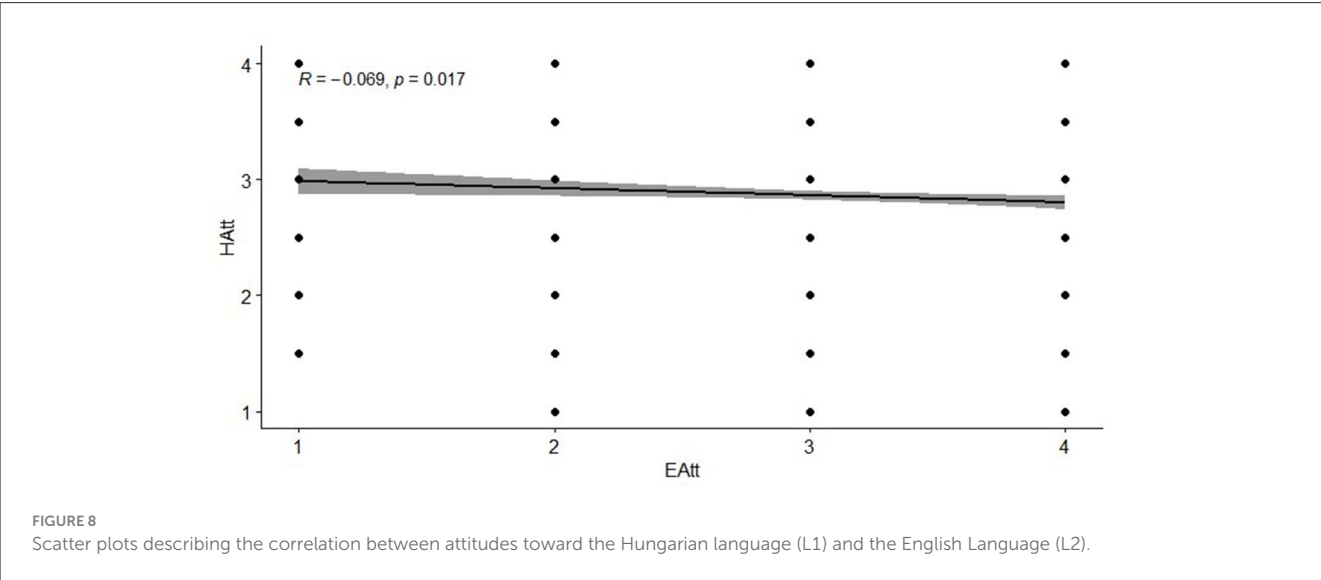
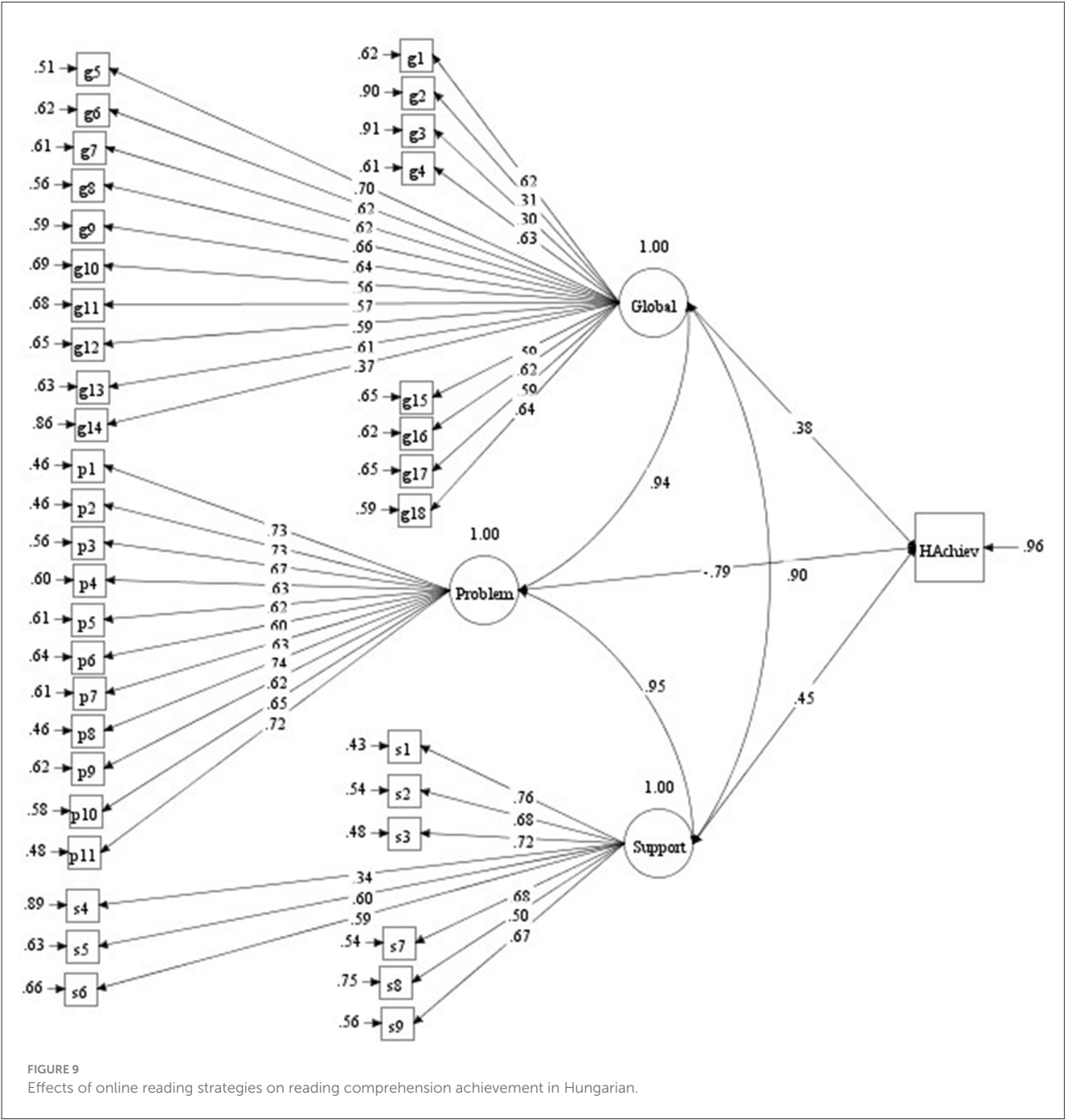


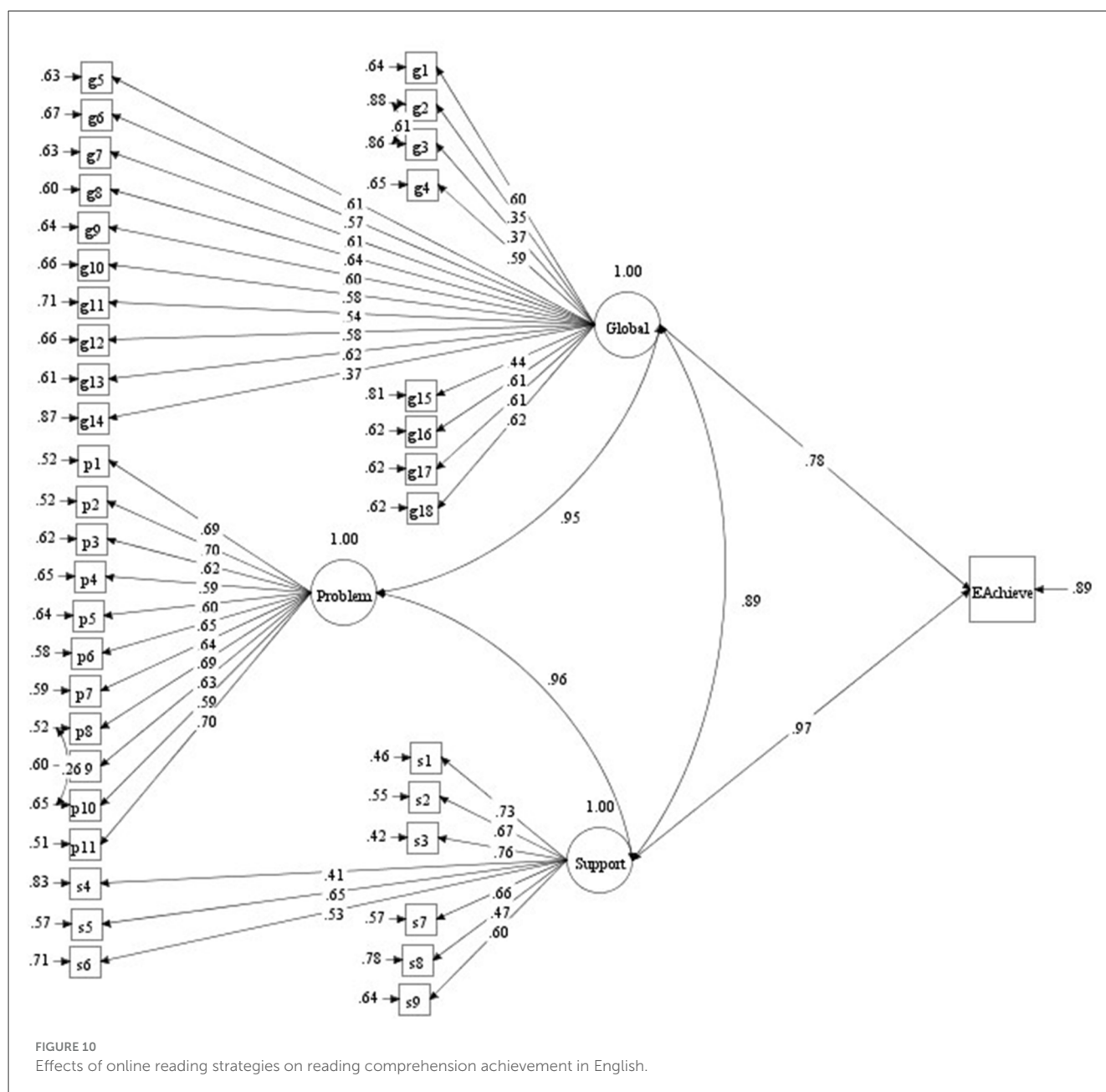


TABLE 6 Model fit indices (N = 1,214).

| Category         | Goodness-of-fit index | Hungarian version (values) | English version (values) | Recommended values        |
|------------------|-----------------------|----------------------------|--------------------------|---------------------------|
| Absolute fit     | CFI                   | 0.92                       | 0.90                     | ≥0.90 (Hsieh, 2019)       |
|                  | TLI                   | 0.90                       | 0.90                     | ≥0.90 (Hsieh, 2019)       |
| Incremental fit  | RMSEA                 | 0.06                       | 0.07                     | <0.08 (Hair et al., 2010) |
|                  | SRMR                  | 0.05                       | 0.06                     |                           |
| Parsimonious fit | $\chi^2/df$           | 2,279.35/797               | 2,117.05/798             | <3 (Józsa et al., 2019)   |



strategies. However, [Yaghi \(2021\)](#) and [Yan et al. \(2022\)](#) found that students' online reading strategies exerted significant effects on their reading comprehension achievement. The opposite is true for [Cheng \(2016\)](#), who stated that no significant relationship could be detected between students' use of online reading strategies and their reading proficiency in their L2. Notably, however, [Cheng](#)



(2016) emphasized the development of reading proficiency among university students.

## Limitations

There are certain limitations to this study. First, the sample is composed of students in Grades 5 and 8 and thus does not cover all grades in middle school. Therefore, further studies should be conducted at all middle school levels, and, if possible, at the high school, undergraduate, and graduate levels. Moreover, the questionnaire only focused on three types of online reading strategies. Future studies could thus explore other types.

## Conclusion

In summary, this study demonstrates that Hungarian students mainly preferred to use global reading strategies in their Hungarian language use, whereas they most frequently employed support reading strategies in their English as a foreign language use. No significant relationship has been demonstrated between the students' use of reading strategies in their L1 and L2; positive significant relationships have been found between the three reading strategies. Furthermore, students' attitudes toward their L1 and L2 exerted positive relationships with their use of online reading strategies. Specifically, learners' online reading strategies (except for problem-solving strategies) showed significant positive effects on reading comprehension achievement. In the current digital age,

ICT continues to exert its influence on daily life. Therefore, the current study is helpful to varying degrees for language learners and teachers in deciding what and how to teach. As this study is a comparison of the students' use of online reading strategies in their L1 and L2, the findings could benefit L1 and L2 teachers in selecting the appropriate reading strategies and supporting the development of digital reading comprehension among students. Moreover, the study not only addresses the gaps in the current literature regarding the use of online reading strategies among Hungarian middle school students in their L1 and L2, but it also provides insights that could be generalized to other language instruction contexts. Based on an analysis of the preferences, relationships, and effects of these strategies, our findings may inform educators and researchers in various linguistic and educational settings, enhancing their understanding of how online reading strategies can impact reading comprehension and attitudinal development across different languages and cultures.

## Data availability statement

The datasets presented in this article are not readily available because in accordance with the Ethics Statement, the data will be treated confidentially and will not be disclosed to third parties. Requests to access the datasets should be directed to Anita Habók, [habok@edpsy.u-szeged.hu](mailto:habok@edpsy.u-szeged.hu).

## Ethics statement

The studies involving humans were approved by Review Board at the Doctoral School of Education (University of Szeged). The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin.

## Author contributions

AH: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. TO: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. AM:

Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing.

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## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

## Generative AI statement

The author(s) declare that no Gen AI was used in the creation of this manuscript.

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