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Technology-Enhanced Joyful Learning in English as a Foreign Language Reading Comprehension: A Rasch Model Survey

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ABSTRACT

Purpose of the study: This study aims to examine english as a foreign language learners' perceptions of technology-enhanced joyful learning in reading comprehension, focusing on how digital tools support comprehension, enjoyment, engagement, and learner autonomy in technology-mediated english reading activities.

Methodology: This study used a quantitative cross-sectional survey involving 1,510 english as a foreign language learners. Data were collected through the technology-enhanced joyful learning in english as a foreign language reading comprehension: a rasch model survey questionnaire. the instrument contained 15 likert-scale items covering technology-supported english as a foreign language reading comprehension, Joyful Learning through Technology, and learner engagement and autonomy in technology-enhanced reading constructs. data were analyzed using descriptive statistics and rasch model analysis.

Main Findings: The results showed that learners generally perceived technology-enhanced joyful learning positively. Edmodo was the most preferred platform, followed by Kahoot, Google Classroom, Quizlet, Duolingo, and Read&Write. Rasch analysis indicated acceptable item fit and item reliability. Technology was most strongly endorsed for supporting learner autonomy, self-paced reading, and main-idea identification, while comprehension accuracy and reading interest were relatively harder to endorse.

Novelty/Originality of this study: This study contributes a rasch-validated measurement framework that integrates technology-supported english as a foreign language reading comprehension, joyful learning through technology, and learner engagement/autonomy. It advances existing english as a foreign language reading research by showing that different technologies provide different affordances for comprehension support, joyful engagement, task motivation, and autonomous learning.

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1. INTRODUCTION

Digital technology has increasingly reshaped the landscape of English as a Foreign Language (EFL) learning by transforming how learners access texts, interact with language input, receive feedback, and regulate their own learning processes [1]-[4]. In reading comprehension, technology is no longer understood merely as an instructional medium, but as a learning ecosystem that enables learners to engage with english texts through digital

platforms, mobile applications, online classrooms, gamified activities, multimodal resources, and artificial intelligence-supported tools [5]-[7]. This transformation is particularly important in EFL contexts, where learners often face limited exposure to english outside the classroom and require flexible, repeated, and meaningful interaction with reading materials. Technology-enhanced learning can provide such support by allowing learners to access varied texts, revisit materials, use vocabulary assistance, participate in interactive tasks, and monitor their own progress in ways that are difficult to achieve through conventional print-based instruction alone [8]-[11].

In EFL reading comprehension, technology plays several pedagogical roles. First, it functions as an access facilitator, enabling learners to obtain English reading materials more easily through learning management systems, digital libraries, mobile applications, and online reading platforms [12]-[15]. Second, it serves as a comprehension scaffold, helping learners understand difficult vocabulary, sentence structures, and textual meanings through digital dictionaries, annotation tools, translation support, hyperlinks, and automated feedback. Third, technology becomes an engagement enhancer by incorporating multimedia, interactive quizzes, gamification, and collaborative online activities into reading tasks [16]-[20]. These affordances suggest that technology can support not only the technical process of reading but also learners' motivation, confidence, and sustained engagement with English texts. Zhong [21], for example, found that online collaborative flipped classroom instruction improved English reading skills and self-regulated learning among EFL learners, indicating that technology-supported environments can strengthen both comprehension and learner regulation.

The technological dimension of EFL reading is also closely related to the emergence of more interactive and learner-centered reading experiences [22]. Unlike traditional reading instruction, which often positions learners as passive recipients of texts and teacher explanations, technology-enhanced reading allows learners to interact with texts more dynamically [23], [24]. Learners can pause, repeat, highlight, search meanings, receive instant feedback, complete digital exercises, and collaborate with peers through online platforms. Such features are pedagogically significant because reading comprehension requires more than decoding words; it requires active meaning-making, inferencing, monitoring, and reflection. Studies on educational technology in EFL learning indicate that digital tools can contribute to learners' affective and motivational experiences, including self-efficacy and enjoyment in English learning. Zhang [25], discussed the role of educational technology in supporting EFL learners' self-efficacy and enjoyment, reinforcing the view that digital learning environments may influence both cognitive and emotional dimensions of language learning.

Within this technological shift, joyful learning becomes an important construct. Joyful learning in EFL reading refers to a learning experience in which learners feel interested, emotionally comfortable, motivated, and engaged while reading English texts. Technology can support joyful learning by making reading activities more interactive, personalized, visually appealing, and less monotonous. Gamified platforms, for example, may transform reading tasks into more enjoyable learning experiences through points, challenges, immediate feedback, competition, collaboration, and progress tracking [26], [27]. Cheng et al. [28] found that gamification contributed positively to EFL reading proficiency and foreign language learning enjoyment among undergraduate learners, with gamified settings improving focus, teamwork, communication, and personal enjoyment. This evidence suggests that technology can make reading comprehension not only more effective but also more emotionally engaging.

Recent developments in artificial intelligence have further expanded the technological possibilities of EFL reading instruction. AI-supported reading tools can assist learners by providing explanations, summarizing texts, generating comprehension questions, giving vocabulary support, and offering adaptive feedback based on learners' needs. Although the use of AI in EFL reading remains an emerging field, recent studies have begun to examine ChatGPT-based reading assistants and AI-chatbot support as tools for enhancing reading comprehension and learning engagement [29], [30]. Werdiningsih et al. [31], for instance, investigated a ChatGPT-based reading assistant in EFL reading instruction and reported its relevance for reading comprehension and learner engagement. These developments indicate that the future of EFL reading may increasingly involve intelligent, responsive, and personalized technologies that support learners' comprehension processes.

However, despite the growing interest in technology-enhanced EFL learning, several research gaps remain. Much existing research has focused on whether digital tools improve reading achievement, while less attention has been given to how learners perceive technology as a source of enjoyable, engaging, and autonomous reading experience. In addition, studies on technology-enhanced reading often examine comprehension, motivation, engagement, or autonomy separately, even though these dimensions are closely connected in digital learning environments. A learner who enjoys technology-supported reading may become more motivated to read; a learner who can control digital reading activities may become more autonomous; and a learner who receives technological support may better understand texts and sustain reading effort. Therefore, a more integrated survey is needed to capture how learners experience technology-enhanced joyful learning in EFL reading comprehension.

The specific research gap addressed in this study lies in the limited empirical integration of three interrelated dimensions in EFL reading research: technology-supported reading comprehension, joyful learning through technology, and learner engagement/autonomy. Previous studies have provided valuable evidence on digital tools, gamification, online learning platforms, and AI-supported language learning; however, these studies

have not sufficiently explained how these dimensions operate together as a unified learner-response construct in technology-mediated EFL reading. Moreover, technology is frequently treated as a general instructional medium rather than as a differentiated digital ecosystem in which various tools may offer different affordances for comprehension support, joyful engagement, task motivation, and autonomous learning. This creates a conceptual gap in understanding how learners experience technology-enhanced joyful learning not merely as an achievement-oriented intervention, but as a multidimensional reading experience involving cognitive, affective, and regulatory processes.

Another methodological issue concerns the measurement of learners' responses to technology-enhanced reading. Many survey studies in applied linguistics rely on raw Likert-scale scores without fully examining item quality, response category functioning, person ability, and construct validity. This limitation is important because survey data should not only describe learners' agreement levels but also show whether the instrument validly measures the intended constructs. Aridan et al. [32] emphasized that Rasch models are useful for analyzing Likert-scale surveys in applied linguistics because they help validate score interpretation, evaluate item functioning, and improve the quality of measurement. Therefore, the Rasch Model is appropriate for examining learners' responses to technology-enhanced joyful learning in EFL reading comprehension.

The novelty of this study is its development and validation of an integrated Rasch-based measurement framework that combines Technology-Supported EFL Reading Comprehension (TRC), Joyful Learning through Technology (JLT), and Learner Engagement and Autonomy in Technology-Enhanced Reading (LAT). Unlike previous research that tends to examine technology use, reading comprehension, enjoyment, or autonomy as separate variables, this study positions them as interconnected dimensions of technology-enhanced joyful reading. The urgency of the study is also evident in the rapid expansion of digital platforms, gamified applications, mobile-assisted learning tools, and AI-supported reading technologies in EFL contexts. Without valid measurement and clearer understanding of learners' perceptions, educators may adopt digital tools based on popularity rather than pedagogical function. Thus, this study is urgently needed to provide empirical evidence on how technology can be selected, designed, and integrated to support reading comprehension, enjoyment, engagement, and learner autonomy in a more purposeful way.

Based on these considerations, the present study investigates Technology-Enhanced Joyful Learning in EFL Reading Comprehension through a Rasch Model survey. This study positions technology as the central learning support that facilitates reading comprehension, joyful learning, engagement, and learner autonomy. The instrument is organized into three constructs: Technology-Supported EFL Reading Comprehension (TRC), Joyful Learning through Technology (JLT), and Learner Engagement and Autonomy in Technology (LAT). By applying Rasch analysis, this study aims to examine how EFL learners respond to technology-supported reading experiences and how the questionnaire items function psychometrically. The study is expected to contribute theoretically by integrating technology, joyful learning, and EFL reading comprehension into a unified measurement framework; methodologically by using Rasch analysis to validate learner-response data; and practically by offering insights for designing digital reading activities that are effective, enjoyable, engaging, and learner-centered.

2. RESEARCH METHOD

This study employed a quantitative cross-sectional survey design to examine learners' perceptions of technology-enhanced joyful learning in the context of EFL reading comprehension. The survey approach was considered appropriate because the study aimed to capture learners' responses toward the use of technology as a support system for reading comprehension, enjoyment, engagement, and autonomous learning [33], [34]. To strengthen the measurement quality of the questionnaire, the study applied the Rasch Model, particularly because Rasch analysis is widely used to examine Likert-scale survey data by evaluating item functioning, person measures, response category performance, and score interpretation validity in applied linguistics research [32], [35], [36]. The study focused on three latent constructs: TRC, JLT, and LAT. These constructs were developed to represent the technological, affective, and learner-regulation dimensions of EFL reading. Rather than measuring reading achievement directly, the study investigated how learners perceived technology as a medium that supports comprehension, creates enjoyable learning experiences, and promotes engagement and autonomy in reading activities.

2.1. Instruments

The research instrument was a structured questionnaire titled Technology-Enhanced Joyful Learning in EFL Reading Comprehension: A Rasch Model Survey. The questionnaire consisted of two major parts. The first part collected demographic information, including gender, age, current level of study, frequency of technology use for English learning, and the preferred technology for improving English reading comprehension. The second part measured learners' responses to technology-enhanced joyful learning in EFL reading comprehension.

The main scale consisted of 15 Likert-type items distributed across three constructs. Each construct contained five items. The first construct, TRC, measured how technology supports access to reading materials,

vocabulary understanding, main-idea identification, text summarization, and overall comprehension accuracy. The second construct, JLT, measured the extent to which technology makes EFL reading more enjoyable, engaging, interesting, less stressful, and emotionally motivating. The third construct, LAT, measured learners' focus, motivation, self-paced learning, control over the learning process, and independent learning in technology-supported reading activities.

Table 1. Measurement Constructs and Item Distribution

Construct	Code	Number of Items	Focus of Measurement
Technology-Supported EFL Reading Comprehension	TRC	5	Technology support for vocabulary, main ideas, summarization, and comprehension accuracy
Joyful Learning through Technology	JLT	5	Enjoyment, interest, engagement, enthusiasm, and reduced stress in EFL reading
Learner Engagement and Autonomy in Technology-Enhanced Reading	LAT	5	Focus, motivation, self-paced learning, learner control, and independent reading

The questionnaire used a five-point agreement scale ranging from 1 = Strongly Disagree to 5 = Strongly Agree. However, preliminary data screening showed that the actual response pattern in the uploaded dataset was concentrated in categories 3, 4, and 5, with no observed responses in categories 1 and 2. Therefore, the rating scale functioning needed to be examined carefully during Rasch analysis. In Rasch-based survey validation, response category diagnostics are important because rating categories should function in an ordered and meaningful way for valid score interpretation.

2.2. Participants

The study analyzed 1,510 valid responses from EFL learners. Participants were predominantly male (66.23%) and mainly undergraduate students (62.25%), with age distributed relatively evenly across the categories of 21–24, 25–28, and above 28 years. Technology use for English learning varied among respondents, while Edmodo emerged as the most preferred platform for improving reading comprehension (21.85%), followed by Kahoot, Google Classroom, Quizlet, Duolingo, and Read&Write.

Table 2. Respondents' Demographic and Technology Preference Profile

Demographic Variable	Category	Frequency	Percentage
Gender	Male	1,000	66.23%
	Female	510	33.77%
Age	21–24 years old	510	33.77%
	25–28 years old	500	33.11%
	Above 28 years old	500	33.11%
Level of study	Undergraduate student	940	62.25%
	Master's student	520	34.44%
	Doctoral student	50	3.31%
Preferred technology	Edmodo	330	21.85%
	Kahoot	280	18.54%
	Google Classroom	270	17.88%
	Quizlet	250	16.56%
	Duolingo	230	15.23%
	Read&Write	150	9.93%

2.3. Data Analysis and Rasch Measurement Model

Data analysis was conducted in two stages. First, descriptive statistics were used to summarize respondents' demographic characteristics, technology usage frequency, and preferred digital learning tools for EFL reading comprehension. Descriptive analysis also provided an overview of responses across the three constructs: Technology-Enhanced Reading Comprehension (TRC), Joyful Learning through Technology (JLT), and Learning Achievement through Technology (LAT).

Second, Rasch analysis was performed using Winsteps software (Version XX) to evaluate the psychometric quality of the instrument. Because all items employed a common five-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree), the Rasch Rating Scale Model (RSM) was applied. The RSM was considered appropriate because it assumes a consistent rating structure across all items and enables the assessment of item functioning, respondent measures, and category performance.

Several Rasch indicators were examined, including item fit statistics (infit and outfit MNSQ), person and item reliability, separation indices, and Wright map analysis. Item fit statistics were used to determine the extent

to which individual items conformed to model expectations, while reliability and separation indices evaluated the consistency and discriminatory power of the instrument. Wright maps were used to compare respondent abilities and item difficulty on a common logit scale. In addition, rating scale diagnostics were conducted to assess the functioning and ordering of response categories.

3. RESULTS AND DISCUSSION

3.1. Technology Use Profile of EFL Learners

The first analysis examined learners' preferred technologies for improving English reading comprehension. This analysis was important because the study positioned technology not merely as a general instructional medium, but as a digital learning support system that may shape learners' reading comprehension, enjoyment, engagement, and autonomy.

Table 5. Preferred Technology for Improving EFL Reading Comprehension

Preferred Technology	Frequency	Percentage
Edmodo	330	21.85%
Kahoot	280	18.54%
Google Classroom	270	17.88%
Quizlet	250	16.56%
Duolingo	230	15.23%
Read&Write	150	9.93%
Total	1,510	100.00%

Table 5 shows that Edmodo was the most preferred technology, selected by 330 respondents (21.85%), followed by Kahoot (18.54%), Google Classroom (17.88%), Quizlet (16.56%), Duolingo (15.23%), and Read&Write (9.93%). This distribution indicates that EFL learners did not depend on a single form of educational technology. Instead, they preferred different digital tools with different pedagogical affordances. Edmodo and Google Classroom may represent classroom management and digital interaction platforms; Kahoot and Quizlet may reflect gamified and practice-oriented learning; Duolingo may represent mobile language learning; and Read&Write may function as a more direct reading-support or assistive tool. Therefore, technology in this study should be interpreted as a diverse digital ecosystem rather than a single homogeneous medium.

Table 6. Frequency of Technology Use for English Learning

Frequency of Technology Use	Frequency	Percentage
Never	370	24.50%
Rarely	240	15.89%
Sometimes	280	18.54%
Often	390	25.83%
Very often	230	15.23%
Total	1,510	100.00%

Table 6 indicates that 390 respondents (25.83%) often used technology for English learning, while 230 respondents (15.23%) used it very often. However, 370 respondents (24.50%) reported that they never used technology for English learning. This pattern suggests that learners' exposure to educational technology was uneven. Although digital tools are increasingly visible in EFL learning, not all learners have the same level of familiarity or experience with technology-supported reading. This finding is important because technology-enhanced joyful learning may depend not only on the availability of digital tools but also on learners' digital habits, access, and prior learning experiences.

3.2. Construct-Level Responses Across Preferred Technologies

The next analysis compared learners' responses across three constructs: TRC, JLT, and LAT. This analysis aimed to identify whether different preferred technologies were associated with different patterns of learner perception.

Table 7. Construct Mean Scores Based on Preferred Technology

Preferred Technology	n	TRC Mean	JLT Mean	LAT Mean	Overall Mean
Duolingo	230	4.548	4.400	4.504	4.484
Quizlet	250	4.424	4.472	4.448	4.448

Kahoot	280	4.486	4.407	4.457	4.450
Google Classroom	270	4.474	4.496	4.526	4.499
Read&Write	150	4.507	4.333	4.427	4.422
Edmodo	330	4.364	4.485	4.485	4.444

Table 7 shows that Google Classroom obtained the highest overall mean score (M = 4.499), particularly in the LAT construct (M = 4.526). This suggests that learners who preferred Google Classroom perceived technology as highly supportive of engagement, learner control, and autonomous reading. This result is understandable because Google Classroom functions as a learning management platform that enables learners to access reading materials, revisit tasks, submit assignments, and manage their learning activities in a structured digital space.

Duolingo obtained the highest score in TRC (M = 4.548), indicating that learners who preferred Duolingo tended to perceive technology as useful for supporting vocabulary development, reading practice, and comprehension support. Meanwhile, Google Classroom and Edmodo showed relatively high scores in JLT, suggesting that classroom-based digital platforms may contribute to enjoyable and socially connected reading experiences. Interestingly, Read&Write showed a relatively high TRC score but the lowest JLT score. This indicates that Read&Write may be perceived more as a functional reading assistance tool than as a joyful or emotionally engaging platform. Overall, the results suggest that different technologies support different aspects of EFL reading: some are stronger for comprehension support, while others are stronger for engagement, classroom interaction, autonomy, or enjoyment.

3.3. Rasch-Based Instrument Quality

Rasch analysis was conducted to examine the measurement quality of the instrument. The analysis included 1,510 respondents and 15 items. Because the questionnaire used Likert-scale responses, Rasch analysis was appropriate for examining item functioning, person measures, category structure, and score interpretation. Rasch models are useful for validating Likert-scale survey data in applied linguistics because they help transform ordinal responses into calibrated measures and support more rigorous interpretation of questionnaire data.

Table 8. Summary Statistics Based on Rasch Parameter

Rasch Parameter	Person	Item
N	1,510	15
Total observations	22,650	22,650
Mean measure	1.20 logits	0.00 logits
Standard deviation of measure	0.44	0.12
Mean standard error	0.45	0.04
Mean infit MNSQ	1.00	1.00
SD infit MNSQ	0.26	0.08
Mean outfit MNSQ	1.00	1.00
SD outfit MNSQ	0.26	0.08
Separation index	0.00	2.50
Reliability	0.00	0.86

Table 8 shows that the item fit statistics were acceptable. The mean infit and outfit MNSQ values for items were both 1.00, indicating that the items generally functioned according to Rasch model expectations. The item reliability value of 0.86 and item separation index of 2.50 indicate that the instrument had a reasonably stable item hierarchy. This means that the 15 items were able to represent different levels of endorsement within the construct of technology-enhanced joyful learning in EFL reading comprehension.

However, the person reliability and person separation values were low. This result does not necessarily indicate that the instrument was invalid; rather, it suggests that respondents' answers were highly clustered in the positive response categories. In other words, most learners showed similarly favorable perceptions toward technology-enhanced joyful learning, making it difficult for the instrument to distinguish respondents into clearly different levels.

Table 9. Statistics of Rating Scale Analysis

Response Category	Category Label	Observed Count	Observed Percentage	Average Measure	Outfit MNSQ	Andrich Threshold
1	Strongly Disagree	0	0.00%	Not estimated	Not estimated	Not estimated
2	Disagree	0	0.00%	Not estimated	Not estimated	Not estimated

3	Neutral	1,240	5.47%	0.99	5.52	Not estimated
4	Agree	9,760	43.09%	1.12	0.66	-1.03
5	Strongly Agree	11,650	51.43%	1.30	0.81	1.03

Table 9 shows that only categories 3, 4, and 5 were used by the respondents. Categories 1 and 2 were not selected at all. This indicates a strong positive response tendency toward technology-enhanced joyful learning in EFL reading comprehension. The average measures increased monotonically from category 3 to category 5, indicating that higher response categories represented higher levels of the measured construct. However, the outfit MNSQ for category 3 was 5.52, which indicates that the neutral category functioned inconsistently. In rating scale analysis, outfit mean-square values above 2.00 suggest excessive unexpected randomness, while ordered thresholds and advancing average measures are important indicators of category functioning.

Therefore, although the item structure was acceptable, the rating scale requires methodological caution. The original five-point scale may need to be reviewed in future administrations because the lower categories were unused. For the present study, this pattern indicates that learners generally had positive perceptions of technology-enhanced joyful learning, but the response distribution was not sufficiently spread across all categories.

3.4. Item Difficulty Analysis Based on Logit Value

Item difficulty was examined using the Logit Value of Item (LVI). In survey-based Rasch interpretation, a higher positive logit value indicates that an item is more difficult to endorse, whereas a lower negative logit value indicates that an item is easier to endorse. The classification was based on the item logit mean and standard deviation. Items above +0.119 logits were categorized as very difficult to endorse, items between 0.000 and +0.119 as difficult to endorse, items between -0.119 and 0.000 as easy to endorse, and items below -0.119 as very easy to endorse.

Table 10. Category of item Difficulty Based on Logit Value (LVI)

Item Code	Construct	Item Statement	Mean Score	LVI	Item Difficulty Category
TRC5	TRC	Technology helps me understand English texts more accurately.	4.384	0.219	Very difficult to endorse
JLT3	JLT	Technology increases my interest in reading English materials.	4.404	0.163	Very difficult to endorse
JLT1	JLT	Learning English reading through technology makes the learning process more enjoyable.	4.424	0.106	Difficult to endorse
JLT5	JLT	I feel more enthusiastic when reading activities are supported by technology.	4.437	0.068	Difficult to endorse
LAT1	LAT	Technology helps me stay focused while reading English texts.	4.437	0.068	Difficult to endorse
LAT4	LAT	Technology gives me more control over my English reading learning process.	4.450	0.029	Difficult to endorse
TRC1	TRC	Technology helps me access English reading materials more easily.	4.450	0.029	Difficult to endorse
JLT4	JLT	Technology makes reading English texts feel less stressful.	4.457	0.010	Difficult to endorse
LAT2	LAT	Technology motivates me to complete English reading tasks.	4.464	-0.010	Easy to endorse
TRC4	TRC	Technology improves my ability to summarize English texts.	4.464	-0.010	Easy to endorse
TRC2	TRC	Technology helps me understand difficult vocabulary in English texts.	4.483	-0.069	Easy to endorse
JLT2	JLT	Technology makes English reading activities more engaging.	4.490	-0.089	Easy to endorse
TRC3	TRC	Technology supports me in identifying the main ideas of English texts.	4.510	-0.151	Very easy to endorse
LAT3	LAT	Technology allows me to learn English reading at my own pace.	4.517	-0.172	Very easy to endorse
LAT5	LAT	Technology encourages me to become more independent in learning English reading.	4.523	-0.193	Very easy to endorse

Table 10 shows that the most difficult item to endorse was TRC5 with an LVI of 0.219 logits. This means that learners were relatively more cautious in agreeing that technology helps them understand English texts more

accurately. This finding is important because it suggests that technology is not automatically perceived as a direct solution for deeper comprehension accuracy. Technology may help learners access materials, understand vocabulary, and identify main ideas, but accurate comprehension still depends on how the technology is used pedagogically.

The second most difficult item was JLT3, which states that technology increases learners' interest in reading English materials. This indicates that although learners generally perceived technology positively, its ability to stimulate sustained reading interest was not equally strong across respondents. In other words, technology must be designed or implemented in an engaging way to generate joyful reading experiences.

The easiest items to endorse were LAT5, LAT3, and TRC3. These findings suggest that learners most strongly perceived technology as supporting independent learning, self-paced reading, and main-idea identification. Thus, the clearest contribution of technology in this study was not only comprehension support, but also learner autonomy. Technology appears to give learners more control over when, where, and how they engage with English reading materials.

3.5. Person Logit Distribution of Learners' Perceptions

Person logit analysis was conducted to examine the distribution of learners' perceptions toward technology-enhanced joyful learning in EFL reading comprehension. The mean person measure was 1.20 logits, indicating that respondents generally had a positive tendency to endorse the items.

Table 11. Logit Value of Person Analysis

Person Category	Logit Interval	Frequency	Percentage	Interpretation
Low	< 0.647	160	10.60%	Learners showed relatively lower endorsement of technology-enhanced joyful learning in EFL reading.
Moderate	0.647 to 1.087	750	49.67%	Learners showed moderate positive perception of technology-supported reading and joyful learning.
High	> 1.087 to 1.528	450	29.80%	Learners showed strong endorsement of technology-enhanced joyful learning in EFL reading.
Very High	> 1.528	150	9.93%	Learners showed very strong endorsement of technology-supported joyful and autonomous EFL reading.
Total	—	1,510	100.00%	—

Table 11 shows that most respondents were located in the moderate category, consisting of 750 learners (49.67%). This was followed by the high category with 450 learners (29.80%) and the very high category with 150 learners (9.93%). Only 160 learners (10.60%) were located in the low category. These findings indicate that most learners perceived technology-enhanced joyful learning positively.

However, the presence of a low-perception group suggests that technology-supported reading does not benefit all learners equally. Some learners may have limited access to technology, low familiarity with digital reading tools, or a preference for conventional reading methods. Therefore, the implementation of technology-enhanced joyful learning should consider learners' technological readiness, digital habits, and preferred platforms.

3.6. Technology-Based DIF: Digital Affordances in EFL Reading Comprehension

The most important DIF finding appeared in the preferred technology variable. This analysis is central to the study because it shows that learners' responses varied depending on the technology they preferred. Therefore, technology should not be treated as a single general variable. Different tools may support different dimensions of EFL reading comprehension, joyful learning, engagement, and autonomy.

Table 12. DIF Analysis Based on Preferred Technology

Item	Construct	Most Difficult Group to Endorse	Easiest Group to Endorse	DIF Contrast	Interpretation
LAT2	LAT	Read&Write	Quizlet	1.475	Large DIF
JLT3	JLT	Read&Write	Edmodo	1.428	Large DIF
JLT2	JLT	Duolingo	Quizlet	1.252	Large DIF
TRC3	TRC	Google Classroom	Read&Write	1.174	Large DIF
TRC5	TRC	Edmodo	Kahoot	0.882	Moderate DIF
LAT1	LAT	Quizlet	Read&Write	0.785	Moderate DIF
LAT3	LAT	Read&Write	Kahoot	0.754	Moderate DIF
TRC2	TRC	Edmodo	Duolingo	0.692	Moderate DIF
LAT5	LAT	Quizlet	Google Classroom	0.650	Moderate DIF

Item	Construct	Most Difficult Group to Endorse	Easiest Group to Endorse	DIF Contrast	Interpretation
JLT4	JLT	Duolingo	Quizlet	0.628	Moderate DIF
LAT4	LAT	Quizlet	Edmodo	0.582	Moderate DIF
JLT1	JLT	Google Classroom	Edmodo	0.577	Moderate DIF

Table 12 shows that preferred technology produced the strongest DIF pattern. The largest DIF appeared in LAT2, which measures whether technology motivates learners to complete English reading tasks. This item was more difficult to endorse among learners who preferred Read&Write and easier to endorse among learners who preferred Quizlet. This indicates that Quizlet may be perceived as more motivating for completing reading-related activities, possibly because it provides repetitive practice, flashcard-based learning, and quiz-like interaction.

The second largest DIF appeared in JLT3, which measures whether technology increases learners' interest in reading English materials. This item was most difficult to endorse among Read&Write users and easiest to endorse among Edmodo users. This suggests that Read&Write may function more as a technical reading-support tool, while Edmodo may provide a more socially connected or classroom-based learning experience that increases learners' interest in reading. The JLT2 item also showed large DIF. This item was more difficult to endorse among Duolingo users and easier to endorse among Quizlet users. This indicates that not all digital or gamified tools produce the same joyful learning experience. Although Duolingo is widely associated with mobile language learning, respondents in this dataset appeared to associate Quizlet more strongly with engaging reading activities.

Another important DIF finding appeared in TRC3, which measures technology's role in helping learners identify the main ideas of English texts. This item was more difficult to endorse among Google Classroom users and easier to endorse among Read&Write users. This finding is pedagogically meaningful because Read&Write may provide more direct support for reading assistance, whereas Google Classroom functions more as a learning management platform. Therefore, Google Classroom may support organization and autonomy, while Read&Write may support specific comprehension processes. Overall, the technology-based DIF results show that different technologies support different dimensions of EFL reading. Quizlet appears to be strongly associated with motivation and engagement; Google Classroom supports autonomy and learning organization; Duolingo supports technology-based reading practice and vocabulary exposure; Kahoot supports interactive engagement; Edmodo supports socially connected joyful learning; and Read&Write supports direct reading assistance. These findings strengthen the central argument of the study: technology-enhanced joyful learning in EFL reading comprehension depends not only on the presence of technology, but also on the specific affordances of the technology used by learners.

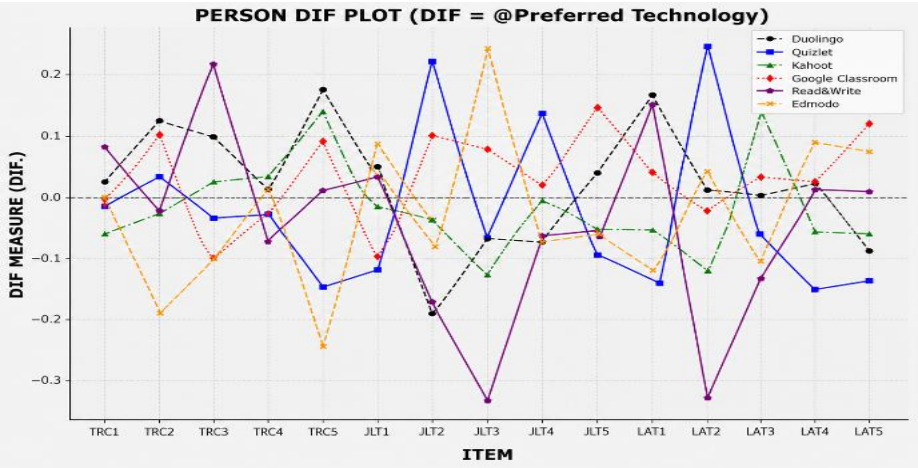

Figure 1. Graph of person DIF based on preferred technology

Figure 1 shows that learners' perceptions of technology-enhanced joyful learning in EFL reading comprehension varied across the six preferred technology groups: Duolingo, Quizlet, Kahoot, Google Classroom, Read&Write, and Edmodo. The DIF patterns indicate that each technology was associated with different learning affordances. In the TRC construct, Duolingo tended to show stronger positive responses for vocabulary and comprehension-related items, while Read&Write showed a clear positive tendency on identifying main ideas, suggesting its role as a direct reading-support tool. In contrast, Edmodo and Google Classroom showed lower values on some comprehension items, indicating that these platforms may function more as learning management or communication tools rather than direct comprehension scaffolds.

For the JLT and LAT constructs, the graph shows that Quizlet was strongly associated with engagement and motivation, especially in encouraging learners to complete reading tasks, while Edmodo appeared to support

reading interest and joyful learning through a more socially connected learning environment. Google Classroom showed stronger tendencies in learner autonomy, self-paced learning, and learning organization, whereas Read&Write appeared more useful for functional reading assistance than for emotional engagement or task motivation. Overall, the DIF plot confirms that technology should not be treated as a single general variable in EFL reading. Different digital tools support different dimensions: Duolingo and Read&Write are more closely related to comprehension support, Quizlet and Kahoot to interactive engagement, Edmodo to joyful and social learning, and Google Classroom to autonomy and learning management.

The findings of this study confirm that technology-enhanced joyful learning is a relevant construct for understanding how EFL learners experience reading comprehension in digitally mediated environments. The generally positive learner responses indicate that technology is perceived as supportive not only for accessing reading materials, but also for facilitating comprehension, engagement, enjoyment, and learner autonomy. This finding is consistent with previous studies showing that technology-supported EFL learning can strengthen learners' self-efficacy, online interaction, self-assessment, motivation, and positive affective engagement [37]-[39]. Similarly, the positive role of technology in EFL reading aligns with Wang's study, which found that an online collaborative flipped classroom improved English reading skills and self-regulated learning among EFL learners [40]-[42]. However, the present study extends these findings by showing that learners' responses to technology are not uniform; instead, they are shaped by the specific digital tools they prefer and the pedagogical affordances those tools provide.

The technology profile of respondents shows that Edmodo was the most preferred platform, followed by Kahoot, Google Classroom, Quizlet, Duolingo, and Read&Write. This pattern suggests that EFL learners engage with a varied digital ecosystem rather than a single dominant platform. The construct-level results further indicate that different technologies are associated with different dimensions of learning. Google Classroom obtained the highest overall mean score and was particularly strong in the LAT construct, suggesting that it supports learner autonomy, learning organization, and self-paced access to reading tasks [43]-[45]. This finding is consistent with studies on online learning platforms that emphasize the role of digital environments in promoting autonomous learning and continuity of learning activities [46]-[48]. Meanwhile, Duolingo obtained the highest TRC score, indicating that learners perceived it as helpful for vocabulary exposure, structured language practice, and comprehension support. This supports previous findings that mobile-assisted language learning platforms such as Duolingo can encourage self-directed reading practice and strengthen learners' engagement with English texts [49]-[51].

The results also show that joyful learning through technology is not produced automatically by the mere presence of digital tools. Although learners generally endorsed JLT items positively, the item "Technology increases my interest in reading English materials" was relatively more difficult to endorse. This finding suggests that technology must be intentionally designed and pedagogically integrated to generate sustained interest in reading. In line with Cheng et al. [26], gamification can improve EFL reading proficiency and foreign language learning enjoyment when it provides meaningful engagement, feedback, challenge, and learner participation. The present study supports this claim, especially through the DIF results showing that Quizlet was more strongly associated with task motivation and engagement. Digital flashcard-based learning has also been reported to enhance vocabulary learning, engagement, and persistence among EFL learners [52]-[54]. Thus, the affective value of technology in EFL reading depends not only on digital access but also on interaction design, task structure, feedback, and the extent to which the tool makes reading practice active and rewarding.

The Rasch analysis provides further evidence that the instrument functioned adequately at the item level. The mean infit and outfit MNSQ values were acceptable, and the item reliability value indicated a reasonably stable item hierarchy. This supports the usefulness of Rasch analysis for validating Likert-scale survey data, particularly because Rasch models can examine item functioning, response category performance, and score interpretation more rigorously than raw Likert means alone [55]-[59]. This finding is in line with Wang [37], who emphasized that Rasch models are valuable for applied linguistics survey research because they help validate whether questionnaire scores can be meaningfully interpreted. Nevertheless, the low person reliability and separation values indicate that respondents were clustered in positive response categories. This suggests a ceiling effect, where most learners tended to agree or strongly agree with the items. While this confirms generally favorable attitudes toward technology-enhanced joyful learning, it also indicates that the instrument may need more discriminating items in future research to better capture variation among learners with different levels of digital experience.

The item difficulty results reveal an important pedagogical distinction. Items related to learner autonomy, self-paced reading, and main-idea identification were easier to endorse, whereas items related to accurate text comprehension and increased reading interest were more difficult to endorse. This means that learners perceived technology most clearly as a tool for independence and access, but less automatically as a tool for deeper comprehension and sustained reading interest. This finding is theoretically meaningful because it suggests that technology provides learning affordances, but these affordances require instructional mediation. In other words, digital tools can help learners access, revisit, and manage reading tasks, but comprehension accuracy still depends

on reading strategy instruction, task design, feedback quality, and learners' ability to use digital support critically. This supports the view that technology-enhanced reading should not replace pedagogical scaffolding; rather, it should be integrated with purposeful reading instruction.

The DIF analysis based on preferred technology provides the most distinctive finding of this study. The results show that different technologies function differently across TRC, JLT, and LAT. Quizlet was more strongly associated with engagement and task motivation, Edmodo with reading interest and socially connected joyful learning, Google Classroom with autonomy and learning management, Duolingo with vocabulary and comprehension support, Read&Write with direct reading assistance, and Kahoot with interactive engagement. This pattern confirms that technology in EFL reading should not be treated as a homogeneous variable. For example, Read&Write showed stronger association with main-idea identification, which is consistent with its function as a literacy-support tool that offers reading, comprehension, vocabulary, text-to-speech, and study support features. However, it was less associated with joyful engagement, suggesting that functional support and emotional engagement are not always produced by the same tool. Thus, the pedagogical value of technology depends on whether the selected tool matches the intended learning objective.

The novelty of this study lies in its integration of three dimensions that are often examined separately in EFL research: technology-supported reading comprehension, joyful learning through technology, and learner engagement/autonomy. Unlike studies that evaluate technology mainly in terms of achievement outcomes, this study provides a Rasch-validated learner-response framework that shows how learners perceive different technologies as supporting different reading experiences. The use of DIF analysis further advances the field by revealing that learner perceptions differ according to preferred technology, not merely according to general technology use. This contributes to a more nuanced understanding of digital affordances in EFL reading comprehension.

The practical implication is that EFL instructors should select technology based on pedagogical function rather than popularity. Tools such as Duolingo and Read&Write may be more appropriate for vocabulary support, reading assistance, and comprehension scaffolding; Quizlet and Kahoot may be more useful for interactive practice, motivation, and gamified engagement; Edmodo may support social interaction and joyful classroom communication; while Google Classroom may strengthen learner autonomy, task organization, and continuity of reading activities. Therefore, technology-enhanced joyful learning requires deliberate instructional design that aligns digital tools with reading objectives, learner characteristics, and affective needs. Future studies should test these affordance-based interpretations through experimental, longitudinal, or mixed-method designs that examine not only learners' perceptions but also their actual reading performance, strategy use, and emotional engagement over time.

Despite these practical implications, several limitations should be acknowledged. The observed ceiling effect, positive response tendency, and extremely low person reliability indicate that the instrument had limited sensitivity to distinguish respondents across different levels of technology-enhanced joyful learning. As a result, subtle variations in learners' perceptions may not have been fully captured, thereby restricting the precision of respondent classification. Furthermore, the findings were derived from self-reported perceptions and should not be interpreted as direct evidence of improvements in actual reading performance or learning outcomes.

4. CONCLUSION

This study concludes that technology-enhanced joyful learning provides a meaningful framework for understanding EFL learners' reading experiences, particularly when technology is viewed not merely as a learning medium but as a differentiated digital ecosystem that supports comprehension, enjoyment, engagement, and autonomy. The Rasch Model analysis of 1,510 responses showed that the instrument adequately measured three interrelated constructs: TRC, JLT, and LAT. Learners generally expressed positive perceptions toward technology-supported reading, with the strongest endorsement appearing in items related to independent learning, self-paced reading, and main-idea identification. However, items related to accurate text comprehension and increased reading interest were relatively more difficult to endorse, indicating that technology alone does not automatically guarantee deeper comprehension or sustained reading motivation. These findings suggest that technology must be pedagogically designed, selected, and integrated according to learners' reading needs rather than used as a generic instructional tool. The most important contribution of this study lies in showing that different technologies support different dimensions of EFL reading comprehension. Edmodo was the most preferred platform, while the DIF analysis revealed that Quizlet was more strongly associated with engagement and task motivation, Google Classroom with learner autonomy and learning organization, Duolingo with vocabulary and comprehension support, Read&Write with direct reading assistance, Kahoot with interactive engagement, and Edmodo with socially connected joyful learning. Thus, technology-enhanced joyful learning should be understood as an affordance-based approach in which each digital tool serves a specific pedagogical function. Practically, EFL instructors should align digital platforms with instructional objectives: using comprehension-support tools for vocabulary and main-idea development, gamified platforms for engagement, and learning management systems

for autonomy and continuity of learning. Future research should refine the rating scale, involve more balanced participant groups, and examine how specific technologies affect actual reading performance through longitudinal, experimental, or mixed-method designs.

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AUTHOR CONTRIBUTIONS

L.E. contributed to the conceptualization of the study, instrument development, data collection, data curation, formal analysis, visualization, and writing of the original draft. A.B.S. contributed to research supervision, methodological guidance, validation of the research design, and critical review of the manuscript. S. contributed to the validation of the instrument, interpretation of findings, and review and editing of the manuscript. B.K. contributed to methodological refinement, Rasch analysis interpretation, supervision, and critical revision of the manuscript. F. contributed to literature review, data checking, manuscript editing, and project administration. All authors read and approved the final version of the manuscript.

INFORMED CONSENT STATEMENT

Informed consent was obtained from all subjects involved in the study. Before completing the survey, participants received detailed information regarding the purpose of the research, data collection procedures, confidentiality measures, and their rights as research participants. Participation was entirely voluntary, and respondents could discontinue their participation at any stage without penalty. By completing the questionnaire, participants provided their informed consent to participate in the study. All collected data were anonymized and handled in accordance with established ethical research principles.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

USE OF ARTIFICIAL INTELLIGENCE (AI)-ASSISTED TECHNOLOGY

The authors used ChatGPT Plus during the manuscript preparation process solely for improving sentence structure, word choice, language clarity, and readability. The authors did not use the tool to generate research content, analyze data, interpret results, or prepare references. All AI-assisted outputs were reviewed, revised, and verified by the authors, who take full responsibility for the final content of the manuscript.

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