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INTEGRATING QR CODES INTO FOREIGN LANGUAGE EDUCATION: EFFECTS ON LEARNERS' FLOW EXPERIENCE AND CLASSROOM ENGAGEMENT[1] [2]

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ABSTRACT

The increasing use of technological tools in education has made the adoption of innovative methods in learning processes inevitable. This shift has transformed digitalization in education from a mere option into a fundamental element that enhances learning efficiency. In recent years, Quick Response (QR) codes have increasingly been used in education, as in many other areas of daily life. The present study aims to comprehensively examine the integration of QR codes into German as a foreign language reading texts and students' experiences during the reading process. In this study, students were able to learn unfamiliar words encountered in German as a foreign language reading text quickly and practically through integrated QR codes. Students' participation in the lesson and their flow experiences during the German language learning process were analyzed. The findings indicate that integrating QR codes into course materials makes learning German as a foreign language more accessible and enjoyable. It was observed that students demonstrated performance comparable to traditional learning in terms of class participation and flow experiences during the German language learning process. Qualitative findings revealed that students perceived QR codes as practical and enjoyable; however, the use of mobile devices sometimes caused distraction and limited peer and teacher interaction. Overall, QR codes were found to enhance accessibility and enjoyment in learning German as a foreign language. The study suggests that QR codes can serve as an innovative tool when combined with diverse instructional methods, while also outlining limitations and directions for future research.

Keywords: QR Codes, German as a foreign language, mobile language learning, flow experience, student engagement

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INTRODUCTION

A strong vocabulary base is essential for learners to attain proficiency in a second language (Nation, 2001). Reading is one of the methods employed to enhance the vocabulary size of L2 learners (Hou et al., 2022). Numerous early studies have demonstrated the advantages of reading activities on developing students' vocabulary knowledge (Barcroft, 2004; Elley & Mangubhai, 1983; Grabe & Stoller, 1997).

Despite these positive developments, technological advancements have enabled the redefinition of methods and contexts used in education. The continuous global progress of technology has made using technological tools in education a necessity, reshaping learning processes and aiming to achieve specific educational goals (Alnahdi, 2014). Mobile-Assisted Language Learning (MALL) supports L2 learners with continuous access to information and fosters interaction within diverse language learning contexts (Ahn & Lee, 2016). In particular, the use of mobile media, as part of this process, has expanded learning opportunities and opened new pathways in education, facilitating the achievement of desired outcomes (Stockwell, 2007). In this context, mobile technology is utilized not only as a communication tool but also as instruments that offer users various functionalities, allowing them to create personal learning spaces and access educational materials (Cheng et al., 2010). Through mobile devices, existing mobile applications are frequently used by students inside and beyond the classroom setting to enhance their language proficiency (Zou et al., 2018; Aslan, 2016).

Thanks to mobile devices, Quick Response (QR) codes—now an integral part of our daily lives—have emerged as significant tools across various fields (Abdul Rabu et al., 2019). As a paper-based bridge text, a QR code connects online and offline media (Bagheri-Nesami et al., 2025). This connection allows students to access a variety of multimedia materials, which can provide additional instructions beyond those available in paper-based learning resources (Tang & Wang, 2012). Integrating QR codes with mobile technologies can promote dynamic and accessible language learning environments, offering students a more immersive and motivating educational experience (Büyükkol et al., 2024; Çelik, 2012; Abdul Rabu et al., 2019).

Integrating QR codes into L2 learning can positively contribute to students' experiences throughout the learning process (Cruse & Brereton, 2018). As suggested by the Dual Coding Theory (Clark & Paivio, 1991), the combined use of written text and visuals in mobile dictionaries can encourage students to engage actively in learning (Tang & Wang, 2012). In this context, QR Code-supported L2 reading processes are believed to enrich students' learning experiences by making vocabulary acquisition more conscious and interactive. In this study, QR codes integrated into reading texts enabled students to learn the meanings of unfamiliar words directly through the codes rather than using traditional dictionaries. The effects of this method on students' levels of class participation and their flow experiences were analyzed.

Although various studies have investigated the use of QR codes, their functions, and contributions to learning processes have not yet been examined in detail across different contexts. In addition, no prior studies have specifically addressed the use of QR codes in L2 German instruction.

QR-Codes in Language Education

Created by a Japanese firm more than two decades ago, QR codes have become widely used with the rise of internet-enabled mobile technologies (Law & So, 2010). QR codes are mainly designed to facilitate the rapid and seamless transfer of information to digital platforms (Acartürk, 2012). QR codes store different forms of data (such as text, URLs, phone numbers, etc.) in a format that can be easily scanned and read optically. This allows users to access information quickly through devices that read the QR code, such as smartphones, tablets, and barcode scanners (Acartürk, 2012). Mobile phones, like computers, have become a fundamental tool in education for students, enabling communication, information search, and following educational programs (Misnawati et al., 2023). A notable feature of mobile phones is their ability to access information quickly and easily through QR codes; these codes can be scanned using the phone's camera to access the content (Crompton et al., 2012).

Due to their small size and ability to provide quick access to information, QR codes are used in almost every field (Abdul Rabu et al., 2019). Recently, numerous studies have shown that QR codes are also employed in education. In this context, QR codes have become the subject of experimental research within the mobile learning process (Çelik, 2023; Kuru-Gönen & Zeybek, 2022).

In the early years, researchers such as Saprudin et al. (2014), Lai et al. (2013), Robertson and Green (2012), and Law & So (2010) began to present various examples of the application of QR codes in classroom settings. In subsequent years, more detailed research continued. For instance, it has been noted that the use of QR codes not only enhances students' L2 proficiency (AlNajdi, 2022) but also positively influences students' motivation (Büyükkol et al., 2024; Çelik, 2012; Abdul Rabu et al., 2019), fosters positive attitudes towards the L2 learning process (Çelik, 2012; Abdul Rabu et al., 2019), and increases their participation in lessons (Büyükkol et al., 2024; Abdul Rabu et al., 2019; Tang & Wang, 2012). Furthermore, positive developments have been observed in L2 pronunciation training (Chee et al., 2021). Additionally, the integration of QR codes has been found to facilitate out-of-class learning (Büyükkol et al., 2024; Pérez-Sanagustín et al., 2016; Crompton et al., 2012) and make in-class activities more appealing, enabling students to complete tasks that were previously either impossible or impractical (Cruse & Brereton, 2018). Based on all these findings, integrating QR codes into educational curricula allows students to access online or offline digital content, thereby fostering a student-centered approach that promotes active engagement and mastery of learning content (Tang & Wang, 2012).

QR codes have been utilized in L2 to support the development of multiple language skills. Aziza (2020) aimed to investigate how QR codes are used in listening comprehension and to explore students' responses during this process. The study found that QR codes effectively taught listening skills and increased students' interest in learning. Based on observation and survey data, it was concluded that QR codes are suitable for listening instruction and encourage more active student participation in lessons. Izza et al. (2024) demonstrated that students using QR code-enhanced textbooks significantly improved L2 listening comprehension and oral

communication skills. Yunus et al. (2020) found that QR codes supported L2 vocabulary acquisition and improved students' autonomous learning skills, boosting their self-confidence. Compared to traditional memorization methods, QR codes facilitated the recall of target words and were considered more effective by students. Kuru-Gönen and Zeybek (2022) designed reading texts enriched with QR codes to support understanding culture-specific terms during L2 extensive reading and highlighted that QR codes contributed to a better grasp of the texts by providing access to additional resources. Söğüt and Atasever Belli (2022) reported that students saw embedding QR codes into writing and speaking practice as a timesaving, effective, and enjoyable tool that enhanced motivation and strengthened interaction. They also concluded that this application made learning environments more participatory and collaborative. Studies addressing L2 students' perceptions of QR code usage have provided positive findings, indicating that this technology contributes to language development.

Flow, Engagement, and MALL

Mobile-Assisted Language Learning (MALL) encompasses L2 processes using portable devices (Rahimi & Miri, 2014). Mobile devices possess a unique ability to access all types of information at any time of the day, whether at home, school, on public transport, or outdoors (Şad et al., 2020). Due to these capabilities, mobile learning can significantly enhance students' motivation and interest when appropriate learning strategies and support are provided (Hwang & Wu, 2014). According to the Dual Coding Theory (Paivio, 1991), multimedia learning materials delivered through mobile devices can increase students' motivation and positively contribute to learning. Csikszentmihalyi (2014) highlights the importance of the flow concept in motivating learners.

Flow, first introduced by Csikszentmihalyi (1997), is a mental state where a person becomes fully engaged in an activity, unaware of time passing or external interruptions. Within educational settings, flow theory offers a theoretical basis for enhancing student engagement in learning activities (Shahian et al., 2017) and presents chances for ideal learning and performance (Csikszentmihalyi, 1975). There are four key emotions experienced during the state of flow: intense physical or mental involvement in the activity, full concentration on the task with reduced interaction with external factors, absence of anxiety or concern regarding the completion of the activity, and a perception of time passing quickly, indicating a change in the concept of time (Csikszentmihalyi, 1975). According to Whalen's (1997) Flow Model, unlike boredom, "low challenge and low skill", relaxation, "high skill but low challenge", and anxiety, "low skill and high challenge", the flow experience arises from the combination of high skill and high challenge. According to this model, flow occurs at the intersection of arousal and control, where high challenge and skill converge.

Previous studies emphasize that the flow experience significantly increases learning motivation and participation (Almetev, 2018). According to the research by Smith et al. (2023), a positive association is observed between deep, effortless concentration (DEC) student engagement and academic results, indicating that those more prone to flow will likely show greater involvement and comprehension in class.

Astin (1984) initially conceptualized participation as the degree of physical and mental energy a student devotes to academic involvement. While student participation generally encompasses behaviors such as school attendance and involvement in activities, classroom participation focuses on interactions occurring within the specific context of a course (Cents-Boonstra et al., 2020). In line with the objectives of this study, three different types of participation have been proposed by various researchers in the literature (e.g., Nguyen et al., 2018; Cooper, 2014; Fredricks et al., 2004; Yonezawa et al., 2009): Behavioral participation emerges through observable actions such as students arriving on time to class, focusing on assigned tasks, and putting effort into completing assignments. Emotional participation is demonstrated by students' enthusiasm for the course, willingness to engage, and the exhibition of a positive learning attitude. Cognitive participation is related to students' awareness of the importance of educational processes and specific topics, setting personal learning goals, utilizing self-regulation skills, and developing intrinsic motivation for academic success.

Based on the qualitative results of a study by Kuru-Gönen and Zeybek (2022), QR code-supported reading experiences were identified as one of the elements that motivate students. The study showed that students perceived the experience as engaging, stimulating, and enjoyable, which heightened their motivation to participate in the course and reading activities. This finding aligns with the results of several studies, which suggest that motivating teaching behaviors enhance student participation (Van den Berghe et al., 2013, 2016; Jang, et al., 2010).

The Present Study and Research Questions

The purpose of this study is to explore students' experiences in reading through L2 reading texts integrated with QR codes. The study's findings aim to identify deficiencies in current practices and provide insights into areas that require improvement. To achieve this goal, the following objectives have been established:

1. How do QR codes affect students' levels of class participation?
2. How does QR code-supported reading affect students' L2 flow experience?
3. What is the students' feedback on QR code-supported reading materials?

METHOD

Research Design

This study was conducted using a mixed methods research design. In the quantitative phase, a quasi-experimental design involving the manipulation of the independent variable was employed, and to enhance the reliability and validity of the study, an equivalent control group design closely approximating a true experimental setup was adopted (Baker, 2017). In the qualitative phase, students' views on QR code–supported reading experiences were collected through semi-structured interviews, and the data were analyzed following Braun and Clarke's (2006) six-step thematic analysis approach.

Participants

The research was conducted with 52 students enrolled in the German Language Teaching program at a public university in Turkey. These students, enrolled in the German Reading Skills course, were assigned to experimental and control groups by considering characteristics such as age, academic achievement, and gender. In the control group, instruction followed traditional methods, relying solely on printed reading materials without supplementary resources. Conversely, the experimental group accessed unfamiliar vocabulary through QR codes. The implementation phase lasted 10 weeks. Before the study, it was confirmed that all participants had smartphones and internet access. Furthermore, students installed a QR code reader application to interact with the QR code-enhanced texts. In the second stage of the study, face-to-face interviews were held with 10 volunteers from the experimental group, and their responses were recorded and transcribed for analysis.

Experimental Procedure

The study was designed within the scope of a German reading skills course and conducted using a quasi-experimental design involving experimental and control groups over a ten-week implementation period. In the experimental group, reading texts were selected in line with course objectives and supported with QR codes developed for unfamiliar vocabulary items encountered in the texts. Prior to each lesson, the texts were carefully reviewed, and words that were appropriate to the students' proficiency level yet potentially challenging in terms of comprehension were identified. These vocabulary items were selected based on expert consultation. The QR code contents included not only Turkish equivalents of the target words, but also context-appropriate visuals and example uses in the target language. This design aimed to support learners in constructing meaning within the textual context rather than focusing solely on isolated word meanings.

During reading activities, students in the experimental group read the texts individually and then accessed unfamiliar words by scanning the QR codes. The activities were carried out under teacher guidance, and the instructional process was planned identically for both groups to control for teacher effects. In contrast, the control group studied the same textbook and reading materials without QR code support, using traditional instructional methods. In this group, students primarily relied on dictionaries or assistance from the instructor to learn the meanings of unfamiliar words.

Throughout the implementation, learning objectives were kept consistent across both groups, with the only variation being the type of instructional materials used. To enhance the reliability of the study, expert opinions were consulted prior to weekly activities, and the implementation process was systematically monitored by the researcher.

Data Collection Instruments

Flow Short Form Scale (FSS)

The Flow Short Scale (FSS), originally created by Rheinberg et al. (2003) and later adapted into Turkish by İşigüzel & Çam (2014), was employed in this study. This Turkish adaptation consists of 13 items distributed across two distinct sub-dimensions. Participants rated items on a 7-point Likert scale, where 1 indicates strong disagreement and 7 indicates strong agreement, with intermediate values reflecting varying levels of agreement. The first sub-dimension, "flow experience," includes 10 items, while the second sub-dimension, "anxiety," is represented by 3 items.

During the Turkish validation conducted by İşigüzel & Çam (2014), the Kaiser-Meyer-Olkin (KMO) adequacy coefficient — used to assess sample adequacy — was calculated as 0.88. Exploratory factor analysis showed that the first factor, comprising 10 items, explained 34.27% of the total variance, and the second factor, consisting of 3 items, accounted for an additional 9.79%. Together, these two factors, both exceeding an eigenvalue of 1.00, explained 44.06% of the overall variance. The Cronbach's alpha reliability coefficients were reported as 0.88 for the flow experience dimension, 0.67 for the anxiety dimension, and 0.78 for the entire scale.

Classroom Engagement Scale

The Class Engagement Scale was developed by Eryılmaz (2014). Comprising 15 items, this scale evaluates various aspects of students' participation in class, categorized into three sub-dimensions: "Behavioral Participation," "Emotional Participation," and "Cognitive Participation." The scale is a 5-point Likert-type scale. The responses are scored using the following statements: (1 = Not Appropriate at All, 2 = Not Appropriate, 3 = Slightly Appropriate, 4 = Appropriate, and 5 = Completely Appropriate). The internal consistency of the overall scale, measured by Cronbach's Alpha, was calculated as 0.92. For the sub-dimensions, the coefficients were 0.84 for emotional participation, 0.86 for behavioral participation, and 0.84 for cognitive involvement.

Data Analysis

The research adopted a mixed-methods approach, incorporating both qualitative and quantitative components, which were analyzed independently. For the quantitative analysis in this study, data were processed using the SPSS statistical software, and independent as well as dependet and independent -sample t-tests were conducted to assess differences between the experimental and control groups. To assess the normality of data distribution, skewness and kurtosis values were examined, thereby informing the decision on whether parametric tests were suitable. In instances where data did not conform to normal distribution, nonparametric alternatives— specifically the Mann-Whitney U was applied. Descriptive metrics such as means, standard deviations, and minimum-maximum ranges were used to compare baseline group characteristics. To assess changes over time

within groups, t-tests were conducted, while comparisons between groups were analyzed using independent sample t-tests.

In the qualitative phase of the study, semi-structured interviews were conducted to capture students' experiences related to using QR technology. The interview data were analyzed using Braun and Clarke's (2006) six-step thematic analysis approach. First, the interview transcripts were read repeatedly to ensure familiarity with the dataset. Subsequently, meaningful units were transformed into codes, and potential themes were generated based on these codes. The themes were then reviewed in terms of their consistency with the data and, in the final stage, were defined and reported. This process enabled a holistic evaluation of students' experiences with QR code–supported reading activities.

To ensure intercoder reliability, the coding conducted independently by two researchers was compared, and the agreement rate was calculated using the formula proposed by Miles and Huberman (1994). The level of agreement was found to be 93%, which is considered above the acceptable reliability threshold for qualitative research.

Regarding the validity and reliability of the study, the criteria suggested by Lincoln and Guba (1985) were taken into consideration. In this context, prolonged engagement with the participants was established, the data collection process was conducted in detail, and methodological triangulation was achieved with multiple data collection tools. The inclusion of a second researcher in the coding process enabled researcher triangulation. In addition, the findings were submitted for expert review to ensure content validation.

When reporting the findings, direct quotations with high representational value were included. In accordance with ethical principles, real names were not used, and students were coded as "S1, S2, S3, …". This approach both protected participant confidentiality and allowed the relationship between interpretations and the data to be clearly traced.

FINDINGS

Quantitative Analysis

Table 1. Descriptive Statistics of the Scales Used in the Study

Scale	Min.	Max.	$\bar{X}$	s	Skewness	Kurtosis
FFS Pre-Test	38,00	81,00	59,8462	9,88440	,096	-,393
FFS Post-Test	22,00	81,00	59,1538	11,37487	-,834	1,267
Classroom Engagement Scale Pre-Test	30,00	72,00	53,0000	9,42046	,020	-,143
Classroom Engagement Scale Post-Test	28,00	73,00	54,1923	10,27282	-,232	,212

Table 1 presents the descriptive data for the FSS and Classroom Engagement scales applied in the study, including measures such as mean, standard deviation, minimum-maximum values, skewness, and kurtosis. If skewness and kurtosis values fall between -2 and +2, the assumption of normality is met. Accordingly, parametric tests were used for the scales and sub-dimensions that met the normality assumption, while non-parametric tests were employed for those that did not.

The mean score obtained from the FSS pre-test was calculated as 59.84, while the mean score from the post-test was 59.15. The pre-test mean score for the Classroom Engagement Scale was 53.00, and the post-test mean score was 54.19. It was observed that the assumption of normality was met for all pre-test and post-test scores of the scales. Therefore, the analyses were carried out using parametric tests.

Table 2. Pre-Test Comparison of Scores from the Flow Short Form Scale (Independent Samples T-Test)

	Group	N	$\bar{X}$	s	t	sd	p
Flow	Experimental	28	58,4643	8,73682	-1,091	50	,281
	Control	24	61,4583	11,04528			

The independent samples t-test analysis of the pre-test scores on the Flow Short Form Scale revealed no statistically significant difference between the experimental and control groups ($p > .05$). This finding suggests that both groups had comparable starting points before the intervention.

Table 3. Pre-Test and Post-Test Comparison of FSS Scores in the Control Group (Dependent Samples T-Test)

	Test	N	$\bar{X}$	s	t	sd	p
Control Group	Pre	24	61,4583	11,04528	-1,517	23	,143
	Post	24	56,8333	13,08390			

The t-test results analyzing the change in scores from the pre-test to the post-test for the control group indicated a decrease of 4.62 points, from a mean of 61.45 to 56.83. Nevertheless, this reduction was not statistically significant ($p > .05$).

Table 4. Pre-Test and Post-Test Comparison of FSS Scores in the Experimental Group (Dependent Samples T-Test)

	Test	N	$\bar{X}$	s	t	sd	p
Experiment Group	Pre	28	58,4643	8,734682	1,602	27	,121
	Post	28	61,1429	9,47009			

According to the t-test results examining the change observed between the experimental group's pre-test and post-test scores an increase of 2.68 points was observed from the pre-test (M = 58.46) to the post-test (M = 61.14). However, this difference was not statistically significant ($p > .05$).

While the mean score in the pre-test was M = 58.46 (SD = 8.73), this value increased to M = 61.14 (SD = 9.47) in the post-test. The results of the paired-samples t-test indicated that this increase was not statistically significant (t(27) = 1.60, p > .05). The effect size analysis showed that this change corresponded to a small effect size (Cohen's d ≈ 0.30).

Table 5. Post-Test Comparison of FSS Scores (Independent Samples T-Test)

	Group	N	$\bar{X}$	s	t	sd	p
Flow	Experiment	28	61,1429	9,47009	1,374	50	,176
	Control	24	56,8333	13,08390			

According to the independent samples t-test results examining the post-test differences in participants' scores on the Flow Short Form Scale, no meaningful statistical differences were found between the experimental and control groups (p > .05).

Table 6. Pre-Test Comparison of Classroom Engagement Scale Scores (Independent Samples T-Test)

	Group	N	$\bar{X}$	s	t	sd	p
Classroom Engagement	Experiment	28	54,0357	10,02767	,854	50	,397
	Control	24	51,7917	8,71271			

According to the independent samples t-test results examining the pre-test differences in participants' scores on the Classroom Engagement Scale, no statistically significant differences were found between the control and experimental groups (p > .05). The absence of significant differences in the pre-test indicates that both groups started the study under similar conditions.

Table 7. Pre-Test and Post-Test Comparison of Classroom Engagement Scale Scores in the Control Group (Dependent Samples T-Test)

	Test	N	$\bar{X}$	s	t	sd	p
Control Group	Pre	24	51,7917	8,71271	,142	23	,888
	Post	24	52,0833	11,10001			

According to the t-test results examining the disparity between the pre-test and post-test scores of participants in the control group, an increase of 0.29 points was observed from the pre-test (M = 51.79) to the post-test (M = 52.08). However, this difference was not statistically significant (p > .05).

Table 8. Pre-Test and Post-Test Comparison of Classroom Engagement Scale Scores in the Experimental Group (Dependent Samples T-Test)

	Test	N	$\bar{X}$	s	t	sd	p
Experiment Group	Pre	28	54,0357	10,02767	1,527	27	,138
	Post	28	56,0000	9,32936			

According to the t-test results examining the disparity between the pre-test and post-test scores of participants in the experimental group, an increase of 1.96 points was observed from the pre-test (M = 54.03) to the post-test an examination of the Classroom Engagement Scale scores of students in the experimental group revealed an increase of 1.96 points from the pre-test to the post-test. While the mean pre-test score was M = 54.04 (SD = 10.03), this value increased to M = 56.00 (SD = 9.33) in the post-test. The results of the paired-samples t-test indicated that this increase was not statistically significant (t (27) = 1.53, p > .05). The effect size value suggested that the observed increase corresponded to a small effect size (Cohen's d ≈ 0.29).

Table 9. Post-Test Comparison of Classroom Engagement Scale Scores (Independent Samples T-Test)

	Group	N	$\bar{X}$	s	t	sd	p
Classroom Engagement	Experiment	28	56,0000	9,32936	1,383	50	,173
	Control	24	52,0833	11,10001			

According to the outcomes of the independent samples t-test examining the post-test differences in participants' scores on the Classroom Engagement Scale, no statistically significant differences were found between the control and experimental groups (p > .05).

When the results of the Mann–Whitney U tests are considered as a whole, variables such as enjoyment, anxiety, boredom, preparation for the lesson, and dictionary use did not yield statistically significant differences in students' flow experiences or levels of classroom engagement (p > .05). Although some variations in mean scores were observed across groups—for instance, lower averages among students who reported experiencing anxiety or boredom, or higher pre-test flow scores among those who did not use a dictionary—these differences did not reach statistical significance and largely diminished following the instructional intervention. These findings suggest that certain affective and behavioral individual characteristics, when examined in isolation, are not sufficient to account for differences in flow experience or classroom engagement.

In contrast, self-reported classroom participation emerged as the only variable demonstrating a statistically significant effect. Students who indicated that they actively participated in the lessons obtained significantly higher scores on the Classroom Engagement Scale in both the pre-test and post-test compared to those who reported low or no participation (p < .05). While no significant difference was identified in flow scores with respect to participation status, this result indicates that active involvement in classroom activities strengthens students' interest in the lesson and their engagement in the learning process. At the same time, it suggests that the flow experience cannot be explained solely or directly by observable participation behavior.

Qualitative Analysis: Semi-structured Interviews

In the qualitative phase of the study, face-to-face semi-structured interviews were conducted with 10 students from the experimental group. The data obtained from these interviews were analyzed by following Braun and Clarke's (2006) six-phase thematic analysis framework, and the coding process was carried out using NVivo 14

software. Based on similarities among the codes, two main categories were identified: (1) Features Supporting the Learning Process and (2) Features Limiting the Learning Process.

Within the category Features Supporting the Learning Process, two themes emerged: Cognitive Efficiency and Positive Emotions. The second category, Features Limiting the Learning Process, also comprised two themes, namely Attentional Distraction and Interactional Constraints.

Features Supporting the Learning Process

As a result of the thematic analysis, two themes were identified under the category "Features Supporting the Learning Process": (1) Cognitive Efficiency and (2) Positive Emotions. These themes are presented in detail below together with their associated codes and representative student quotations.

Cognitive Efficiency

Under the theme Cognitive Efficiency, the identified codes and the student statements representing these codes are presented as illustrative examples. The codes associated with this theme are Rapid Access, Accurate Understanding, and Visual Support.

Table 10. Cognitive Efficiency

Theme	Codes	Examples of Student Statements
Cognitive Efficiency	Rapid Access	"I can learn immediately; there is no loss of time." (S2) "As soon as I look at the word, I can understand the sentence." (S6) "I understand the text more quickly." (S10)
	Accurate Understanding	"I can directly see the meaning used in the text through the QR code." (S1) "It gets confusing in a dictionary, but the QR code provides the correct meaning." (S7) "I can clearly see which meaning is intended." (S10)
	Visual Support	"When I see an image, it stays in my mind." (S6) "Visuals are very helpful." (S10) "I understand better with photos." (S3)

Students stated that QR codes provided a faster, more practical, and more efficient learning experience compared to using a dictionary. The following student statements clearly illustrate this point:

> "With QR codes, we can directly access the information as soon as we scan the code, which makes it more practical. I think it is faster and more practical. When using a dictionary, you have to write the word, search for it, and so on, but with QR codes we can learn it immediately. It helped us a lot in understanding the overall meaning of the text more easily." (S2)

"It saves time… I think checking a dictionary is much slower. Scanning the QR code with the camera and looking at it is better." (S4)

"When there was a word, we didn't know in a sentence, we were able to understand that sentence immediately because we could quickly find its meaning through the QR code." (S6)

Students reported that QR codes prevented confusion by presenting the correct meaning of words within their textual context:

"Normally, when I look up a word in a dictionary, many meanings come up, but with QR codes I can directly see the meaning used in the text, so I think it works better. This helped me the most in understanding the text." (S1)

"A word can have 15 different meanings. When I check a dictionary, about ten meanings appear. But because you provided only the example that fits that specific context in the QR code, it made sense to me." (S3)

"When I look up a word in a dictionary, there are too many meanings, and sometimes it's hard for it to settle in my mind while reading the text. That's why having the meaning used in the text was better, in my opinion." (S5)

"By the end of the text, everything had completely settled in our minds." (S6)

In addition, students stated that the visuals included in the QR codes facilitated comprehension:

"At first, I struggled because I was used to checking a dictionary, but later, when I started scanning the QR codes, I could see the word, its image, and an example sentence. Over time, I got very used to this. It helped me understand more easily. Normally, many meanings come up in a dictionary, but with QR codes I can directly see the meaning used in the text, which works better for me. This helped me the most in understanding the text." (S1)

"Yes, because you provided both example sentences and visual support—and since I am someone with stronger visual intelligence—it made it easier for me to remember." (S2)

"It is helpful visually. For example, there is a word called "Abreibung", and there is also a photo of it. You say, 'Oh, this is what it refers to.' And because my visual intelligence is strong, it was very helpful for me." (S3)

Positive Emotions

Under the theme Positive Emotions, the identified codes and the student statements representing these codes are presented as illustrative examples. The codes associated with this theme are Interest, Curiosity, and Enjoyment.

Table 11. Positive Emotions

Theme	Codes	Examples of Student Statements
Positive Emotions	Interest	"The lesson became more engaging." (S1) "I come to class more willingly." (S8) "I felt that I learned more in this lesson." (S2)

	Curiosity,	"I want to see what's inside the QR code." (S1) "I'm curious about its content." (S5) "It's a style we've never seen before… it really sparks curiosity." (S6)
	Enjoyment	"It was very enjoyable." (S3) "I didn't get bored; I had fun." (S2) "Doing it with a phone is enjoyable." (S8)

A large proportion of the students stated that QR codes increased their interest in the course and created a more engaging learning environment compared to traditional text-based reading activities. Students S2 and S8 associated this experience with increased motivation to participate in the lesson, as illustrated in the following statements:

"Because of the energy you bring to the class and the interaction we have through QR codes, I feel that I can participate more comfortably. My motivation in the lesson increased."

"I felt that I learned more in this course because it felt productive. When I went home, I didn't feel like the lesson had been a waste of time." (S2)

"I feel more motivated because I can understand the text." (S8)

For some students, this increased interest was not only related to the use of technology itself but also to the nature of the content provided. Student S7 noted that even the visual appearance of the QR codes attracted attention:

"The QR codes looked visually appealing. They also included images, which helped me understand the content better." (S7)

Student S8 emphasized that QR codes had transformed their reading habits:

"Reading used to be boring, but now I read poems and try to understand them." (S8)

Even among students who initially approached QR codes with skepticism, a strong sense of curiosity emerged after using them. Student S5 reflected this shift as follows:

"At first, I was very prejudiced… I thought, 'We already have dictionaries, why do we need this?' But when I realized how practical it was, I became much more curious about what kind of content was in the QR codes." (S5)

Student S7 highlighted that QR codes made the reading experience more enjoyable:

"Looking up words in a dictionary was monotonous, but with QR codes it felt different. It became more enjoyable." (S7)

Similarly, the statement of S8 indicates that QR codes had a noticeable impact on motivation and emotional engagement with the course:

"I came to class very willing to participate." (S8)

Finally, S10 emphasized that activities conducted without QR codes were considerably less engaging:

"Activities with QR codes are more enjoyable and faster. Today's activity without QR codes took much longer and felt boring." (S10)

Features Limiting the Learning Process

As a result of the thematic analysis, two themes were identified under the category "Features Limiting the Learning Process": (1) Attentional Disruption and (2) Interactional Constraints.

Attentional Disruption

Under the theme of Attentional Disruption, the codes identified and the sample student statements representing these codes are presented below. Within this theme, three codes were determined: Smartphone notification, Tendency toward social media use, and technical issues.

Table 12. Attentional Distraction

Theme	Codes	Examples of Student Statements
Attentional Distraction	Smartphone notification	"When a notification appears, my eyes automatically shift to it." (S1) "When a message comes in, it distracts my attention." (S5) "When notifications pop up, my mind drifts elsewhere." (S7) "My battery runs low, a notification appears… and my focus is lost." (S9) "Notifications caused attentional distraction." (S10)
	Tendency Toward Social Media Use	"My phone constantly pulls me toward social media." (S1) "If you go to YouTube, your attention easily drifts away." (S9) "I sometimes think, 'Let me check this first, then I'll move on to the QR code.'" (S7)
	Technical Issues	"The phone drains the battery very quickly." (S3) "Even though I had an internet connection, my phone sometimes failed to get a signal in the classroom." (S5, S7) "There were times when the battery was not sufficient." (S10)

The most frequently expressed concern among students was that notifications received on mobile devices interrupted the reading process. Even when phones were set to silent mode, notifications were reported to distract students' attention. One participant described this situation as follows:

> "I read the text while holding my phone, but when a notification appears at the top of the screen, my eyes shift to it. I open it, and at that moment I may end up looking at something else. This might

be the only drawback. Even when the phone is on silent mode, it constantly draws my attention by making me wonder whether there is something on social media." (S1)

Similarly, P5 stated that notifications made it difficult to maintain focus, expressing this as follows:

"I already have a lot of trouble concentrating… and we are using our phones, so a message comes in, someone sends something… that really didn't help with focusing. That's the only problem because attention can get distracted very easily." (S5)

It was observed that, for some students, notifications were able to completely disrupt the flow experience. For instance, S9 stated:

"The battery runs out, a notification comes in, sometimes I look at YouTube, sometimes Instagram… my mind can drift." (S9)

The experience of S10 also confirms the impact of notifications on attention:

"The phone battery wasn't enough… and the incoming notifications caused distraction." (S10)

These statements indicate that, due to the nature of mobile device use, external stimuli are inherently involved in the reading process and may negatively affect the sustainability of attention from time to time.

Some students reported that even in the absence of notifications, the mere accessibility of the phone increased the tendency to turn to social media or other applications. S1's statement clearly illustrates this tendency:

"The phone always draws my attention by making me wonder if there is something on social media." (S1)

Similarly, S7 stated that they switched between applications during the lesson:

"I think, 'let me check this, let me check that… then I'll move on to the QR code.'" (S7)

Some students indicated that attentional disruption was directly caused by technical problems. Rapid battery drain, insufficient internet connectivity, or device-related performance delays led to interruptions in attention.

S4 stated that frequent use of QR codes increased battery consumption as follows:

"At first, using a QR code for every word took a bit longer, and my battery ran out very quickly." (S4)

Similarly, S5 expressed technical limitations in the following words:

"It drains my phone's battery a lot… and not everywhere at school has an internet connection, which is another problem." (S5)

S7's statements indicate that internet connectivity directly affected the lesson process:

"When my internet doesn't work, it becomes a problem. There can also be battery issues." (S7)

Finally, S8's statement shows that technical problems can unexpectedly interrupt students' attention:

"Phone battery is an important issue, and sometimes the internet doesn't work." (S8)

Interactional Constraints

Under the theme of Interactional Constraints, the identified codes and the student statements representing these codes are presented below. This theme consists of three codes: Reduced Peer Communication, Reduced Teacher–Student Interaction, and Decreased Classroom Participation.

Table 13. Interactional Constraints

Theme	Codes	Examples of Student Statements
Interactional Constraints	Reduced Peer Communication	"I get bored when I work individually; it's better when I'm with friends." (S1) "I didn't need to talk to anyone." (S9)
	Reduced Teacher–Student Interaction	"I didn't really ask the teacher many questions." (S9 – classroom participation did not change) "I didn't feel the need to ask the teacher questions." (S10)
	Decreased Active Participation	"My in-class participation stayed the same; there was no difference." (S9) "I solved it on my own." (S9)

Some students stated that QR codes reduced the need for peer interaction, as they enabled quick and independent access to word meanings. S1 emphasized that working in groups was more motivating and noted that the process was less fluent when working alone:

"When I do it on my own, I can't really explain it properly because I get bored… when we work together instead of individually, the flow is much better." (S1)

Similarly, S9 indicated that QR codes facilitated individual problem-solving, which eliminated the need for discussion with peers:

"QR codes are just fun. I didn't really experience flow because of notifications, and I solved everything on my own. I guess I didn't need to talk to or discuss anything with anyone." (S9)

Some students also reported reduced interaction with the teacher, as QR codes allowed them to resolve comprehension-related problems without seeking instructional support. P9 stated that they asked fewer questions during the lesson:

"I didn't really ask the teacher many questions… my classroom participation stayed the same." (S9)

Similarly, S10 explained that direct access to information through QR codes reduced the need to ask questions, as follows:

"I didn't realize how quickly time passed, so it was effective in that sense, but I didn't feel the need to ask my friends anything, or the teacher either." (S10)

These statements suggest that QR codes may partially reduce the teacher's guiding role in the classroom.

Some students reported that their classroom participation remained unchanged or decreased, as QR codes made it easier to solve tasks individually. S9 stated:

"My classroom participation stayed the same. There was no difference. I solved the questions more easily on my own." (S9)

The statement of S7 indicates that technical factors and notifications could interrupt classroom participation:

"Yes, there were times when I got into the flow… but checking the phone affected the flow." (S7)

Finally, S10's statement points to a decrease in both peer and teacher interaction, as well as classroom participation:

"I didn't realize how quickly time passed… but I didn't feel the need to ask my friends anything, or the teacher either." (S10)

DISCUSSION and CONCLUSION

This study examined the effects of QR code–supported reading experiences on L2 flow experiences and classroom engagement levels of pre-service German language teachers at the university level. The findings indicate that the use of QR codes supports the learning process from both cognitive and affective perspectives; however, this support does not translate into a direct or strong impact on more complex learning outcomes such as flow and classroom engagement.

Similar patterns have been reported in mobile-assisted language learning research, where vocabulary-focused mobile interventions did not yield sustained or strong effects (Zhang, Song, & Burston, 2011; Alemi et al., 2012; Derakhshan & Kaivanpanah, 2011). Nevertheless, the literature also reports that digital tools such as QR codes can enhance learners' positive emotions toward the learning process (Kuru-Gönen & Zeybek, 2022). Similarly, although the quantitative findings of the present study did not reveal statistically significant differences, the qualitative data suggest that the QR code–supported activities enriched the learning experience and fostered positive emotional responses among students.

With regard to the first research question—"What is the effect of QR codes on students' classroom engagement in the L2 reading process?"—the findings demonstrate that the QR code–supported reading experience did not lead to a substantial increase in classroom engagement. Although post-test scores showed a slight increase compared to pre-test scores, this difference was not statistically significant according to the t-test results ($p >$

.05). This finding suggests that the use of QR codes alone may not be sufficient to enhance classroom engagement and that engagement represents a multidimensional construct influenced by multiple factors.

The quantitative findings become more interpretable when considered alongside the qualitative results. Student perspectives revealed that while QR codes enabled rapid access to word meanings, they also reduced peer interaction and communication with the instructor and introduced potential distractions associated with mobile device use. These findings help explain why the limited increase observed in the quantitative data did not reach statistical significance in terms of classroom engagement and indicate that QR code use may not foster the expected level of engagement when not supported by in-class interaction.

Grothaus (2023) investigated classroom engagement among Thai and German university students in online learning contexts and highlighted the role of peer relationships, student–instructor interaction, and technology. Thai students reported decreased engagement due to prolonged screen time, self-monitoring while keeping cameras on, and digital distractions. Similarly, Bunting et al. (2021) argued that while portable mobile devices may increase social interaction, they can simultaneously constrain behavioral engagement, as intensive social interactions may shift students' focus from learning activities to maintaining interpersonal relationships. In line with the findings of the present study, these factors may limit the contribution of mobile learning tools to reading skills. Furthermore, other research has emphasized language proficiency as a key variable influencing the quality of engagement in mobile learning. Studies conducted with Chinese university students indicate that as language proficiency increases, students spend less time and participate less frequently in out-of-class mobile-assisted English learning, whereas learners with lower proficiency levels tend to engage more intensively in mobile learning activities (Huang et al., 2024; Huang, 2025).

The qualitative findings further suggest that while QR code use strengthens individual learning, it may also reduce in-class interaction. Some students reported that direct access to information via QR codes limited opportunities for communication with peers and instructors and reduced the intensity of classroom discussions. However, Yuan et al. (2025) emphasize that social interaction and collaborative problem-solving processes are among the key factors that deepen cognitive engagement.

Previous studies have shown that integrating QR codes into language teaching makes learning environments more engaging, innovative, and interactive, thereby supporting learning (Bakla, 2018; Kuru-Gönen & Zeybek, 2022). Notably, many of these studies are based on qualitative research designs, with findings primarily derived from observations and interviews. Consistent with this literature, the qualitative findings of the present study indicate that QR code use facilitated faster and more holistic comprehension of texts. Students reported that they could access word meanings and visually supported explanations within seconds, which increased reading fluency and saved time compared to dictionary use. Some students also emphasized that supporting vocabulary with both visual and auditory elements enhanced retention. The simultaneous use of textual and visual elements

aligns with Dual Coding Theory (Paivio, 1991) and appears to strengthen learners' positive emotions toward the learning process.

Huang (2025) reported that feedback and engaging tasks in AI-supported learning environments can enhance positive emotions, whereas technical limitations, delayed feedback, or inaccurate evaluations may lead to anxiety and frustration. In the present study, students' references to distractions and technical problems suggest that QR code–supported practices may also pose risks that limit affective engagement (Huang, 2025).

Contrary to the findings of this study, Söğüt & Atasever Belli (2024) reported that QR codes were perceived as tools that increase motivation, save time, and support interaction in L2 writing and speaking skills. Similarly, Huah and Jarrett (2014) found that integrating QR codes and mobile devices increased student participation in L2 listening and speaking activities. Chen (2022) demonstrated that even limited integration of mobile tools such as Kahoot! and Padlet positively influenced students' perceptions of lessons and their engagement. Tan and Chee (2021) showed that QR codes enhanced students' motivation, autonomy, and collaboration in pronunciation instruction. However, the findings of the present study indicate that QR code use does not yield similar outcomes in all contexts. According to the qualitative data, students frequently received notifications during mobile device use or were easily distracted by internet access, even in the absence of notifications. These distractions led to disengagement from activities and a gradual decline in classroom participation. Accordingly, both qualitative and quantitative findings suggest that the effect of digital tools such as QR codes on sustaining classroom engagement is limited.

In summary, the results indicate that QR code–supported reading activities did not produce a marked or statistically significant increase in students' classroom engagement. Although a slight increase was observed in the experimental group's post-test scores, this increase did not reach statistical significance. The qualitative findings demonstrate that while QR codes facilitated rapid and individualized access to vocabulary and generated positive emotions, reduced peer and instructor interaction and mobile-related distractions constrained the strengthening of classroom engagement. These results suggest that the engagement-enhancing potential of QR codes remains limited when not supported by classroom interaction, attention management, and instructional guidance.

Regarding the second research question—"How does QR code–supported reading affect students' L2 flow experiences?"—the findings indicate that the QR code–supported reading experience did not lead to a substantial difference in students' L2 flow experiences. Although an increase was observed from the pre-test ($M = 54.03$) to the post-test ($M = 56.00$), this difference was not statistically significant ($p > .05$). This suggests that while QR code use may be associated with a slight upward trend, it does not exert a strong or direct effect on flow experiences.

The quantitative findings gain further meaning when interpreted in conjunction with the qualitative results. Semi-structured interviews revealed that QR codes facilitated learning cognitively by enabling rapid access,

contextualized meaning presentation, and visual support, thereby fostering positive emotions such as interest, curiosity, and enjoyment. Despite these cognitive and affective benefits, most students reported that they did not experience deep concentration or sustained flow during the reading process.

The literature emphasizes that flow experience is associated not only with positive emotions but also with intense concentration, a sense of control, and cognitive challenge (Csikszentmihalyi, 1990; MacIntyre & Mercer, 2014; Moneta, 2013). Flow is shaped by intrinsic motivation and involves complete absorption in the task at hand (Csikszentmihalyi, 1988). In the present study, however, QR code–supported reading activities enabled students to complete tasks more quickly and effortlessly, which may have reduced the level of cognitive challenge required. As a result, tasks perceived as "too easy" may have limited students' entry into a flow state that requires intense focus and deep cognitive engagement. In this respect, while digital support provides external facilitation, excessive guidance or ready-made structures may constrain learners' independent cognitive processing and weaken the exploratory and effortful dimensions of learning (Cañas et al., 2012; Chiou et al., 2017; Tseng, 2020). Although QR codes were expected to support flow by reducing lexical barriers and enabling uninterrupted reading, the facilitative function appears to have diminished cognitive challenge rather than deepened engagement.

The theme of distraction emerging from the qualitative findings further supports this interpretation. Students reported that notifications, tendencies to shift toward social media applications, and technical problems frequently disrupted their attention. Some explicitly stated that they were unable to experience flow for these reasons (e.g., "I didn't really experience flow because of notifications" [S9]; "checking the phone affected the flow" [S7]). Such external stimuli undermine uninterrupted concentration, a core component of flow experience, and prevent full immersion in the reading process. These reports help explain why no statistically significant increase in flow was observed quantitatively. Since flow is characterized by experiential components such as intense focus, a sense of control, and altered time perception, disruptions in attentional continuity make the emergence of flow less likely (Abuhamdeh, 2020; Csikszentmihalyi, 2008; Nakamura & Csikszentmihalyi, 2020). Moreover, flow-like experiences have been shown to be associated with technical issues, highlighting the critical role of attention management in digital learning environments (Thatcher et al., 2008; Yang et al., 2014).

When compared with studies reporting that mobile learning applications enhance flow experiences (Almetev, 2018; Park et al., 2010; Wang et al., 2022; Zhao & Khan, 2022), the present findings suggest that the effectiveness of QR code–supported reading activities is highly sensitive to context and implementation. Factors such as task difficulty, attention management, and opportunities for interaction appear to play a decisive role in the emergence of flow. Additionally, the literature indicates that individuals' predispositions toward flow vary considerably (Csikszentmihalyi et al., 1997; Ullén et al., 2012; Tse et al., 2025).

Furthermore, the qualitative findings indicate that QR codes may constrain the interactional dimension of learning. Students reported that rapid and individualized access to word meanings reduced the need to discuss

with peers or ask questions of the instructor. However, social interaction and collaborative problem-solving are widely recognized as key contributors to deep engagement in learning. This interactional limitation may have weakened the social context necessary to support both classroom engagement and flow experience.

In conclusion, although QR code–supported reading activities facilitated cognitive processing and generated positive emotions, they did not fully provide the conditions required for the emergence of flow, such as deep concentration, sufficient challenge, and uninterrupted attention. The consistency between the quantitative and qualitative findings indicates that the results can be meaningfully interpreted within the framework of flow theory.

SUGGESTIONS

Future research should investigate the long-term effects of QR code–supported learning through longitudinal studies to determine whether its influence on engagement, and flow experience is sustained over time. In addition, the instructional design of QR code applications should be examined more closely, particularly the combined effects of visual, auditory, and gamified elements on learning outcomes. Beyond affective outcomes, future studies may also explore the cognitive dimension of QR code use, including its potential role in supporting higher-order thinking and self-regulated learning. Furthermore, QR codes should be examined across different language skills such as speaking, listening, and writing, as well as with different learner groups and proficiency levels. Finally, future studies may investigate contextual factors such as mobile distractions and the role of teacher guidance in shaping the effectiveness of QR code–supported activities.

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