

The Impact of Online Quizzes on Pre-Service Teachers' Self-Directed Learning Skills and Spreadsheet Proficiency

Çevrimiçi Kısa Sınavların Öğretmen Adaylarının Öz-Yönetimli Öğrenme Becerilerine ve Elektronik Tablo Yeterliliklerine Etkisi

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ABSTRACT: We aimed to investigate the impact of online quizzes, both in terms of their utilization and active engagement during the teaching of spreadsheets subject on pre-service teachers' self-directed learning skills and spreadsheet proficiency in our study. The study included 96 participants in the experimental group and 77 in the control group. Throughout the course focusing on spreadsheets subject, participants in the experimental group were tasked with completing five online quizzes. Engagement levels were determined by the number of completed quizzes. Pre-test and post-test data on the self-directed learning scale and spreadsheet achievement test were collected from all participants. The data was analyzed using two-way repeated measures analysis of covariance mixed design. We found that the use of online quizzes and active engagement with online quizzes had no effect on participants' self-directed learning skills. Results also revealed a statistically significant difference between the control and experimental groups' pre-test and post-test scores on the spreadsheet achievement test, favoring the experimental group. Furthermore, participants with high engagement levels in online quizzes demonstrated significant improvements in spreadsheet achievement test scores.

Keywords: Engagement, online quiz, pre-service teacher, self-directed learning skill, spreadsheet proficiency.

ÖZ: Çalışmamızda, elektronik tablolar konusunun öğretimi esnasında çevrimiçi testlerin hem kullanımları hem de aktif katılım açısından öğretmen adaylarının öz yönetimli öğrenme becerilerine ve elektronik tablo yeterliliklerine etkisini araştırmayı amaçladık. Çalışmaya deney grubunda 96, kontrol grubunda 77 katılımcı katılmıştır. Elektronik tablolar konusunun işlendiği ders esnasında, deney grubundaki katılımcılardan beş çevrimiçi kısa sınavı tamamlamaları istenmiştir. Katılım düzeyleri, tamamlanan kısa sınavların sayısı ile belirlenmiştir. Öz-yönetimli öğrenme ölçeği ve elektronik tablo başarı testi ile ilgili ön test ve son test verileri tüm katılımcılardan toplanmıştır. veriler karma tasarımlı iki yönlü tekrarlı ölçümler varyans analizi kullanılarak analiz edilmiştir. Araştırma sonucunda çevrimiçi testlerin kullanımının ve çevrimiçi testlere aktif katılımın, katılımcıların öz yönetimli öğrenme becerilerine bir etkinin olmadığını belirledik. Sonuçlar kontrol grubu ile deney grubunun elektronik tablo başarı testindeki ön test ve son test puanları arasında deney grubunun lehine istatistiksel olarak anlamlı bir fark olduğunu da ortaya koymuştur. Ayrıca, çevrimiçi testlere yüksek düzeyde katılım gösteren katılımcıların elektronik tablo başarı testi puanlarında anlamlı artış görülmüştür.

Anahtar kelimeler: Katılım, çevrimiçi test, hizmet öncesi öğretmen, öz-yönetimli öğrenme becerisi, elektronik tablo yeterliliği.

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The integration of technology and pedagogy has fundamentally reshaped modern education. As the demand for digital literacy and proficiency continues to grow, educators face the critical task of preparing future teachers to navigate this digital landscape effectively (Erwin & Mohammed, 2022). At the core of this effort lies the mastery of spreadsheets, a vital tool with extensive applications across both educational and professional domains.

Proficiency in spreadsheets is no longer just a technical skill; it has become an essential professional prerequisite for pre-service teachers (Formby et al., 2017). Spreadsheets empower educators to move beyond basic data management and engage in sophisticated tasks such as student data analysis, visualization, and curriculum development (Udugama et al., 2023). In education faculties, Information Technologies (IT) courses serve as the primary platform for developing these foundational skills. However, conventional instructional methods in these courses often struggle to meet the evolving expectations of today's tech-savvy learners (Çiğdem & Öncü, 2023).

In this research, we investigated the integration of online quizzes into spreadsheet instruction as a means of supporting student engagement and structured practice in an online learning environment. Online quizzes were used to provide opportunities for repeated interaction with spreadsheet related tasks, allowing learners to engage with procedures such as formula use, data organization, and basic data manipulation. This approach aligns with recent directions in instructional technologies research that emphasize active practice and learner engagement. In line with this view, prior studies emphasize that practice oriented digital activities and task completion frequency can support engagement and skill development in computer-based learning contexts, particularly for procedural and application-focused domains (Henrie et al., 2015; Kahu & Nelson, 2018).

Our study was guided by a central inquiry: What is the impact of strategically integrated online quizzes on pre-service teachers' self-directed learning skills and spreadsheet proficiency? By framing our investigation within this context, we aimed to determine whether active engagement with online quizzes during the teaching of spreadsheets subject fosters the development of self-directed learning skills among participants and encourages deeper involvement with the subject matter. Thus, this study addresses whether online quizzes serve as catalysts for enhancing both self-directed learning skills and spreadsheet proficiency among pre-service teachers.

Theoretical Background

Online Quizzes as Pedagogical Tools

Online quizzes have gained prominence as effective pedagogical tools in the digital age (Leite et al., 2022). These quizzes, typically delivered through Learning Management Systems (LMS) or dedicated digital platforms, offer educators a versatile means to assess, engage, and enhance the learning experiences of their students (Gurkan & Cigdem, 2022). In the context of spreadsheet instruction within IT courses, online quizzes emerge as a dynamic resource to bolster pedagogical outcomes and prepare pre-service teachers for the demands of the modern educational landscape.

A primary role of online quizzes is to provide ongoing assessment and feedback, aligning with the core principles of formative assessment (Fernando, 2020). Educators

can design quizzes that target specific learning objectives, allowing them to gauge students' progress in real-time. Moreover, immediate feedback, a hallmark of online quizzes, offers learners direct insights into their performance, aiding in self-regulation and fostering a more robust understanding of the subject matter (Morris et al., 2021). Furthermore, online quizzes can be tailored to cater to diverse learning needs and styles (Ross et al., 2018). They support various question formats, ranging from multiple-choice to interactive spreadsheet simulations. This adaptability ensures that learners with varying initial proficiencies can engage with the material at their own pace and receive personalized feedback, thereby nurturing self-directed learning tendencies (Liu et al., 2022).

The interactive nature of online quizzes, featuring elements such as immediate scoring and time-management features, can significantly boost student's engagement. Such elements motivate students to participate actively in their learning process (Zainuddin et al., 2020). For pre-service teachers, for whom spreadsheet proficiency is a foundational competency, this heightened engagement can translate into increased readiness to utilize digital tools in their future classrooms. Online quizzes also offer educators valuable insights into student performance through data analytics (Liu et al., 2023). By identifying specific areas where students excel or require additional support, educators can implement data-driven interventions. These may include providing supplementary materials or targeted practice opportunities, which enhance the overall learning experience (Swiecki et al., 2022).

Incorporating online quizzes into spreadsheet instruction represents a strategic approach to empowering pre-service teachers with the skills and confidence needed for modern education. These tools not only offer effective assessment and feedback but also promote adaptability, engagement, and motivation among learners. As the digital landscape evolves, leveraging online quizzes as pedagogical instruments remains essential for preparing educators to meet the challenges of contemporary teaching environments.

Self-Directed Learning and Online Quizzes

Self-directed learning is widely recognized as a fundamental component of effective instruction (Zimmerman & Schunk, 2001). It encompasses learners' ability to autonomously set goals, monitor their progress, and adapt their strategies to achieve desired outcomes (Zimmerman, 1989). Within the context of pre-service teacher education, fostering self-directed learning through the integration of online quizzes is of paramount importance. Online quizzes can provide a structured platform for establishing specific learning objectives. Learners may utilize these tools to assess their knowledge and skills, pinpointing both areas of proficiency and those requiring further development. This process aligns with the initial phases of self-directed learning, where individuals set clear objectives and continually evaluate their progress (Zimmerman, 2002). For instance, if a pre-service teacher identifies a deficiency in spreadsheet formula knowledge via a quiz, they can proactively revise study materials or seek additional resources. This adaptive approach lies at the core of self-directed learning, as individuals actively adjust their strategies to optimize learning outcomes (Gleason et al., 2011; Winne & Hadwin, 2008).

Effective time management is another hallmark of self-directed learners. Online quizzes, which often include time constraints, prompt pre-service teachers to allocate their study time efficiently. This practice not only enhances quiz performance but also cultivates essential time management skills, a pivotal aspect of the self-directed learning process (Cleary & Zimmerman, 2001). Furthermore, online quizzes can significantly influence learners' motivation and self-efficacy beliefs (Pintrich, 2003). Favorable outcomes, such as achieving high scores, can bolster learners' confidence in their abilities, thereby motivating them to engage more deeply with the subject matter. This motivational aspect is intricately linked with self-directed learning, as motivated learners are more likely to persist in their efforts to attain their learning objectives (Zimmerman, 2000).

Ultimately, the integration of online quizzes into pre-service teacher education extends beyond mere assessment; it serves as a robust mechanism for nurturing self-directedness. By facilitating goal setting, adaptive strategies, efficient time management, and intrinsic motivation, online quizzes act as catalysts for empowering future educators with the skills necessary to navigate the dynamic landscape of modern education (Zimmerman, 2002).

Engagement with Online Quizzes

Student engagement is a pivotal factor in the effectiveness of any instructional intervention (Fredricks et al., 2004). Engaged learners are more likely to be motivated, active participants in their own learning process. Within the context of pre-service teacher education and the integration of online quizzes, understanding and promoting engagement is crucial (Hutain & Michinov, 2022). Online quizzes encourage active participation by prompting learners to interact with the subject matter, think critically, and make decisions in response to quiz questions (Yang et al., 2021). This active involvement fosters engagement and can lead to a deeper understanding of the subject matter.

Timely feedback keeps learners engaged by providing a clear path for self-improvement. Online quizzes often allow multiple attempts, providing learners with opportunities for mastery (Gurkan & Cigdem, 2022). The ability to retake quizzes until a satisfactory score is achieved can motivate learners to persist and engage with the material until they have reached the desired level of proficiency. Depending on learners' performance, subsequent quiz content can be adjusted to target specific areas of weakness. This personalized approach sustains engagement by ensuring that students receive relevant and appropriately challenging content.

Online quizzes are not merely assessment tools; they are effective instruments for promoting learner engagement (Rajabalee & Santally, 2021; Salas-Morera et al., 2012). By encouraging active participation, providing immediate feedback, allowing multiple attempts, and incorporating interactive elements, online quizzes significantly enhance the learning experiences of pre-service teachers.

The Importance of the Study

Spreadsheet proficiency has increasingly been recognized as a critical professional skill across disciplines, including pre-service teacher education and other applied computing fields (Formby et al., 2017). Despite this growing importance, empirical research examining how spreadsheet specific procedural skills are developed through digital instructional practices remains limited. In particular, while online quizzes studied in relation to learning outcomes, motivation, and engagement in higher education (Henrie et al., 2015; Kahu & Nelson, 2018; Ross et al., 2018; Zainuddin et al., 2020), this research focused on self-directed learning skills and spreadsheet proficiency. Moreover, existing meta-analyses on quizzing and testing effects primarily synthesized findings related to declarative knowledge and general learning gains, offering limited insight into applied contexts such as spreadsheet instruction that require iterative practice, tool manipulation, and procedural fluency (Morris et al., 2021; Yang et al., 2021).

In addition, research on self-directed learning emphasized the role of learner agency, engagement, and structured learning experiences in supporting learners' ability to plan, monitor, and evaluate their own learning processes (Zimmerman, 2000, 2002; Zimmerman & Schunk, 2001). Although recent studies began to explore the relationships among digital learning environments, engagement, and self-directed learning skills (Liu et al., 2022; Rajabalee & Santally, 2021), there was a lack of empirical evidence examining these constructs specifically within spreadsheet instruction and pre-service teacher education contexts. Furthermore, few studies simultaneously considered learners' varying levels of active engagement with online quizzes when investigating both self-directed learning skills and spreadsheet proficiency. Addressing these gaps, the present study sought to make a focused contribution to the literature by examining self-directed learning skills and spreadsheet proficiency together, while explicitly accounting for differences in engagement with online quizzes in an authentic course setting.

The Aim of the Study

The study aimed to investigate the impact of online quizzes, both in terms of their utilization and active engagement, during the teaching of spreadsheets subject on pre-service teachers' self-directed learning skills and spreadsheet proficiency. To achieve this aim, we formulated the following research questions:

1. What was the effect of utilizing online quizzes during the teaching of spreadsheets subject on pre-service teachers' self-directed learning skills and spreadsheet proficiency, when compared between the experimental and control groups?
2. How did active engagement with online quizzes during the teaching of spreadsheets subject influence pre-service teachers' self-directed learning skills and spreadsheet proficiency in the experimental group?

Method

Research Design

We conducted the study in a non-equivalent groups pre-/post-test quasi-experimental design. In experimental studies, researchers examine the effect of at least

one manipulated independent variable on one or more dependent variables (Creswell, 2014; Fraenkel et al., 2012; Gribbons & Herman, 1996). The study's independent variables were the teaching methods not utilizing online quizzes and utilizing online quizzes, and engagement levels. Self-directed learning skill and spreadsheet proficiency were dependent variables.

Participants

The study was conducted as part of a compulsory IT course in the education faculty of a state university in Türkiye. We used the convenience sampling method for determining the participants. The convenience sampling is utilized as a non-probability method that enables the inclusion of participants based on their immediate accessibility, thereby facilitating efficient data collection while conserving time, financial resources, and researcher effort (Fraenkel et al., 2012). The participant group consisted of 173 first-year pre-service teachers, 132 of whom were female and 41 of whom were male, enrolled in four classes of the compulsory IT course. We assigned participants from two classes to the experimental group and participants from the other two classes to the control group. Since the number of pre-service teachers in each class was not equal, the number of participants in the experimental and control groups was not equal. We presented the distribution of study participants by gender, control group, and experimental group in Table 1.

Table 1

The Distribution of Study Participants by Gender, Control Group, and Experimental Group

Group	Gender		Total
	Female	Male	
Control	58	19	77
Experimental	74	22	96
Total	132	41	173

Throughout the study, participants in the experimental group were tasked with completing five online quizzes using the learning management system on a weekly basis. We provided them with the flexibility to attempt these quizzes repeatedly, recording the number of quizzes completed. Table 2 provides details on the gender distribution of participants, the number of online quizzes completed by them and their respective engagement levels.

Table 2

Distribution of Participants by Gender, Engagement Levels and Number of Completed Online Quizzes

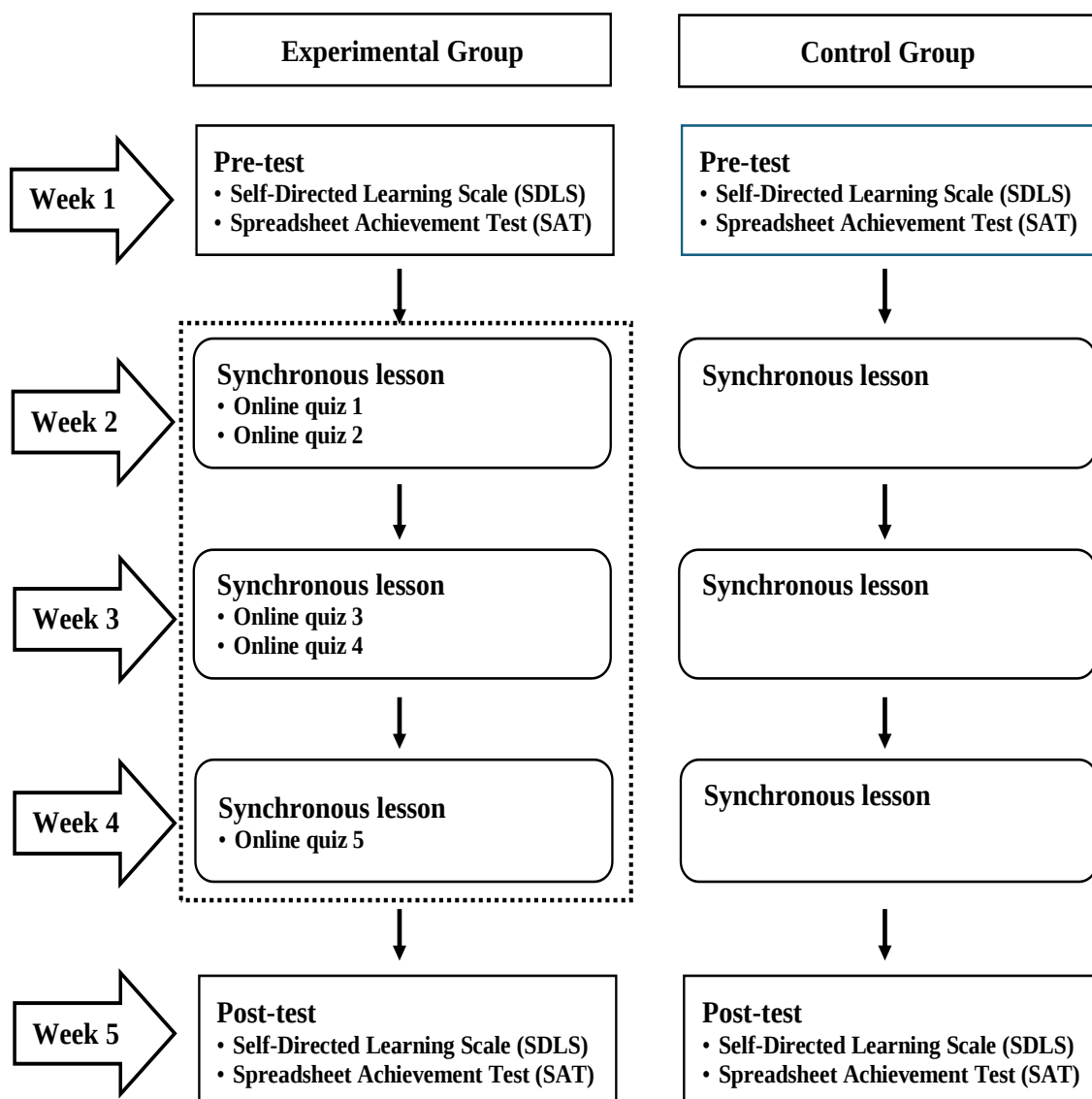
Engagement level		No Low				Moderate		High	Total
Number of completed quizzes		0	1	2	3	4	5		
Number of completions		-	once	once	once	once	once	more than once	
Gender	Female	13	4	4	7	2	13	31	74
	Male	10	1	0	1	1	1	8	22
Total		23	5	4	8	3	14	39	96

We assessed participants' engagement levels based on the number of online quizzes they completed, which reflects behavioral engagement in online learning environments. Previous research conceptualized behavioral engagement as observable engagement behaviors, such as completing learning tasks and activities (Fredricks et al., 2004; Henrie et al., 2015). Our categorization included: "No Engagement" for those who did not complete any quizzes; "Low Engagement" for those who completed one, two, or three quiz; "Moderate Engagement" for those who completed five or four quizzes; and "High Engagement" for those who completed all five quizzes more than once. The categorization used in this study was reviewed by two experts in the field of instructional technologies to confirm its appropriateness.

Context and Experimental Procedure

Our experimental procedure was conducted over a three-week period during the 14-week fall semester in the control and experimental groups. We structured the 14-week online IT course into three primary modules: Computer Systems, Office Software, and Web 2.0 Tools in Education. These modules were delivered synchronously, with three hours of instruction per week. The Office Software module encompassed subjects in word processing, spreadsheets, and presentation software. To facilitate remote learning, we utilized Microsoft (MS) Teams as our learning management system, which allowed us to record video sessions of our online classes. Before starting our online synchronous lessons, we administered the Self-Directed Learning Scale (SDLS) (Demircioğlu et al., 2018) and the Spreadsheet Achievement Test (SAT) as pre-tests to the participants in the control and experimental groups. Following the completion of synchronous lessons and online quizzes, we conducted post-tests using the SDLS and SAT. The experimental procedure is visually outlined in Figure 1.

Figure 1

Experimental Procedure

In the initial synchronous lesson of the first week, we provided an overview of spreadsheets and introduced the user interface and menus of MS Excel, widely utilized spreadsheet software in Türkiye. Moreover, we imparted keyboard shortcuts and demonstrated chart creation within MS Excel in both group. Following the first week's synchronous session, we distributed links of two online quizzes, each comprising 10 multiple-choice items pertaining to the topics covered in our instruction, to the experimental group's participants. We did not share any quizzes with the control group's participants.

In the control and experimental groups' the synchronous lesson of the second week, we delved into the topic of creating formulas for calculations within MS Excel. We provided insights into the key factors to consider when constructing formulas, including the formulation of basic mathematical operations in both group. After finishing the second week's synchronous session, we provided participants with access to two online quizzes, each featuring 10 multiple-choice items covering the topics we had covered. We did not share any quizzes with the control group's participants.

During the control and experimental groups' synchronous lesson of the third week, we instructed participants on creating formulas in MS Excel, particularly focusing on the "IF" command for logical comparisons and the technique of cell referencing. Following this lesson, we provided the experimental group's participants with a link to an online quiz comprising 10 multiple-choice items related to the topics we covered. We did not share any quizzes with the control group's participants. Figure 2 presents the English translation of a sample question from the online quizzes.

Figure 2

A Sample Question from the Online Quizzes

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Which of the following is the formula that prints "Fail" if Ali's final grade is less than 50, and "Pass" if it is greater than 50, in the table on the Microsoft Excel page in the figure? 

(1 Point)

	A	B	C	D	E
1	Name	Midterm	Final Exam	Final Grade	Result
2	Ali	100	90	94	Pass
3	Veli	45	50	48	Fail
4	Ayla	85	70	76	Pass

☐ a) =IF(D2<50;"Fail";"Pass")
☐ b) =IF(D2<50;"Fail";"Pass")
☐ c) =IF(D2>50;Pass;Fail)
☐ d) =IF(D2>50;Pass;Fail)
☐ e) =IF(D2=>50;"Fail";"Pass")

We emphasized to the experimental group's participants that they had the freedom to attempt the online quizzes multiple times, without any additional points awarded for completion. To monitor engagement, we maintained a record of the number of quizzes each participant completed. After completing a quiz, participants were directed to online video explanations, hosted on the YouTube platform, which became accessible upon submitting their answers. We facilitated this through MS Forms, enabling participants to revisit each quiz at their convenience. Upon completing a quiz, participants received automated feedback indicating correct and incorrect answers, with relevant video resources provided as feedback for incorrect responses.

One of the authors of this study instructed both the experimental and control groups to ensure procedural consistency. We informed the participants before the study that participation in the study would not affect the course passing status. We provided

the control group with links to the online quizzes after all the data had been collected to ensure instructional equality between the two groups. The same instructional materials, learning objectives, and weekly content structure were used for both groups, and all lessons were delivered according to a standardized instructional plan to minimize potential instructor expectancy or instructional bias. In addition, objective and structured assessment criteria were employed, and all pre-test and post-test instruments were scored using predefined scoring rules.

Data Collection Tools, Validity and Reliability

We gathered data using the SDLS and the SAT. SDLS, initially developed by Lounsbury et al. (2009), was adapted into Turkish by Demircioğlu et al. (2018). We designed SAT for this study.

SDLS is a unidimensional scale employed to assess the self-directed learning skills of pre-service teachers. It comprises 10 items rated on a five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). Scores on SDLS can range from a minimum of 10 points to a maximum of 50 points, with not negatively expressed items. Previous research by Lounsbury et al. (2009) reported Cronbach's Alpha reliability coefficients of 0.87 and 0.84 in different samples, while Demircioğlu et al. (2018) found the reliability coefficient of 0.85 for the Turkish adaptation. In our study based on our data, we calculated the Cronbach's Alpha reliability coefficient as 0.873 for the pre-test and 0.878 for the post-test.

We prepared an item pool of 30 items and designed an expert opinion form in order to develop the SAT. We gave it to two academicians who teach the IT course to get their expert opinion on whether the items were appropriate for the content of the subject of spreadsheets. We obtained the SAT with 28 items after removing two items based on the experts' evaluations and designed a draft test with these 28 items. We administered the draft test to 291 pre-service teachers who had completed the spreadsheets topic in IT course and studied in the education faculty at a state university in Türkiye as part of a pilot study. We coded and analyzed the data from the draft test with the IBM SPSS Statistics 27. Given that the test's items had a score of 1 or 0, we used the double point-serial correlation to determine which items should be excluded from the test (Alpar, 2016). We also performed the item-total correlations analysis, a comparison of the upper and lower 27% of the total test score distribution, the Kuder Richardson 20 [KR-20] test and Guttman split-half coefficient to determine which items should be included in the test and which should be removed.

Following all the analyses, we decided to include 20 items in the test in the final version of SAT. We found that average item difficulty of the test was 0.664; the item discrimination index of the test was 0.581; the item-total correlation coefficients were ranged from 0.300 to 0.718; comparison between the lower 27% and upper 27% of total test score distribution were statistically significant ($p < .01$) for all items; the KR-20 coefficient was 0.900 and Guttman split-half coefficient was 0.874. A participant can get the lowest score of 0 and the highest score of 20 from the SAT.

We found the KR-20 coefficient as 0.633 for the pre-test and 0.726 for the post-test with the use of this study's data. The KR-20 coefficient increased from 0.633 in the pre-test to 0.726 in the post-test, indicating an improvement following instruction. We interpreted that the relatively low pre-test reliability could be because of participants'

heterogeneous and limited prior knowledge of spreadsheet concepts, which resulted in restricted score variability. Although the post-test reliability was higher, it remained lower than the coefficient obtained during the test development phase ($KR-20=0.900$), which was conducted with a larger sample ($n=291$). We considered this difference to be attributable to the smaller sample size in the present study ($n=173$) and reduced score variance in the post-test, as many participants demonstrated similar levels of achievement after learning the content. Given that internal consistency coefficients are sensitive to sample characteristics and score variability, such differences across measurement occasions and samples are expected (Alpar, 2016; Fraenkel et al., 2012).

Data Analysis

We used IBM SPSS Statistics 27 for the data analysis. To calculate SDLS scores, we aggregated the points corresponding to participants' responses and divided the total by the scale's ten items. The resulting SDLS scores were assessed on a scaling system: 1.00-1.80 indicating "strongly disagree", 1.81-2.60 for "disagree", 2.61-3.40 representing "neutral/undecided", 3.41-4.20 signifying "agree", and 4.21-5.00 denoting "strongly agree". For Spreadsheet Achievement Test (SAT) scores, we assigned 1 point for correct responses and 0 points for incorrect answers, summing these to calculate the total score. In determining whether to employ parametric or non-parametric tests for analyzing participants' SDLS and SAT scores, we examined the skewness and kurtosis values. Table 3 presents the values for skewness and kurtosis.

Table 3

Skewness and Kurtosis Values of SDLS and SAT Scores

Group	Scale /Test	Variables		Pre-test		Post-test	
				Skewness	Kurtosis	Skewness	Kurtosis
Control	SDLS	-	-	-0.782	1.261	-0.694	1.433
	SAT	-	-	0.103	0.450	-0.323	1.477
Experimental	SDLS	-	-	0.077	0.224	-0.008	0.276
		Engagement level	No	-0.269	-0.497	0.520	0.227
			Low	-0.702	-0.148	-0.016	-0.103
			Moderate	0.124	-0.399	0.578	-0.120
			High	0.529	1.289	-1.062	1.268
	SAT	-	-	0.354	0.331	-0.955	0.512
		Engagement level	No	-0.133	-0.395	-0.636	-0.285
			Low	0.090	0.316	-0.144	-0.567
			Moderate	0.083	-0.887	-0.693	-0.309
			High	0.494	0.574	-0.313	-0.891

Note. SDLS: Self-Directed Learning Scale, SAT: Spreadsheet Achievement Test

The skewness and kurtosis values in Table 3, falling within the range of -1.5 to +1.5, indicated a normal distribution. This conclusion was further supported by visual

assessments using box-line, histogram, detrended and Q-Q graphs, in accordance with the guidelines provided by Tabachnick et al. (2013). Given the normal distribution of the data, we performed two-way repeated measures analysis of covariance (ANCOVA) mixed design to answer the research questions (Denis, 2019, 2021) because the control and experimental groups' pre-test mean scores were not equal. According to Denis (2021, pp. 226), the term "mixed design" implies the inclusion of both within- and between-subjects factors. We applied the Huynh-Feldt correction when Mauchly's test of sphericity was significant ($p < .05$), indicating a violation of the sphericity assumption for the within-subjects factor (Field, 2016).

Ethical Procedures

We applied to Balıkesir University for ethics committee approval and the ethics committee approved that there was no violation of research ethics with the ethics committee permission document dated 08.08.2025 and numbered E-19928322-108.01-552943. Participants were informed about the research aim, and informed consent was obtained from participants. Anonymity of the participants was provided in the reporting. In the study, no images were used by revealing the identity of the participants.

Results

Utilizing Online Quizzes on Self-Directed Learning Skills and Spreadsheet Proficiency

We computed the descriptive statistics of SDLS and SAT scores from the control and experimental groups in order to answer the study's first question (see Table 4).

Table 4

The Descriptive Statistics of SDLS and SAT Scores

Group	Scale /Test	Pre-test			Post-test		
		<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>
Control	SDLS	77	3.684	0.669	77	3.760	0.635
	SAT	77	11.286	2.910	77	13.701	2.540
Experimental	SDLS	96	3.721	0.415	96	3.769	0.390
	SAT	96	8.802	2.842	96	17.521	2.087

Note. SDLS: Self-Directed Learning Scale, SAT: Spreadsheet Achievement Test, N: number of participants, M: mean, SD: standard deviation,

Upon reviewing the descriptive statistics presented in Table 4, notable disparities emerged between the pre-test and post-test scores of both the control and experimental groups. We conducted a two-way repeated measures ANCOVA mixed design, utilizing pre-test scores as covariates. The results of this analysis on SDLS and SAT scores are outlined in Table 5.

Table 5

The Results of Two-Way Repeated Measures ANCOVA on SDLS and SAT Scores

Scale /Test	Source	Sum of Squares	Mean Square	F	η^2
SDLS	Pre-test on SDLS	28.801	28.801	614.818**	.783
	Group (control-experimental)	0.001	0.001	0.021	.000
	Measurement time (pre-/post-test)	6.275	6.275	66.977**	.283
	Pre-test*Measurement time	5.994	5.994	63.977**	.273
	Group*Measurement time	0.002	0.002	0.021	.000
SAT	Pre-test on SAT	418.806	418.806	319.000**	.652
	Group (control-experimental)	147.063	147.063	112.016**	.397
	Measurement time (pre-/post-test)	1398.913	1398.913	532.768**	.758
	Pre-test*Measurement time	584.677	584.677	222.671**	.567
	Group*Measurement time	294.126	294.126	112.016**	.397

Note. **p<.001

When utilizing pre-test scores as covariates, we found no statistically significant difference between the control and experimental groups' mean scores [$F(1, 170)=0.021$, $p>.05$, $\eta^2=.000$], but we found a statistically significant difference between mean scores obtained before and after the experimental procedure [$F(1,170)=66.977$, $p<.001$, $\eta^2=.283$] on SDLS. The pre-test*measurement time test demonstrated a statistically significant difference in mean scores [$F(1,170)=63.977$, $p<.001$, $\eta^2=.273$] and the group*measurement time test indicated no statistically significant difference in mean scores [$F(1,170)=0.021$, $p>.05$, $\eta^2=.000$] on SDLS. The findings on the control and experimental groups' mean scores suggest that utilizing online quizzes had no statistically significant effect on participants' self-directed learning skills when pre-test scores were controlled ($\eta^2=.000$) (see Figure 3).

Figure 3

Estimated Marginal Means on SDLS utilizing pre-test scores as covariates

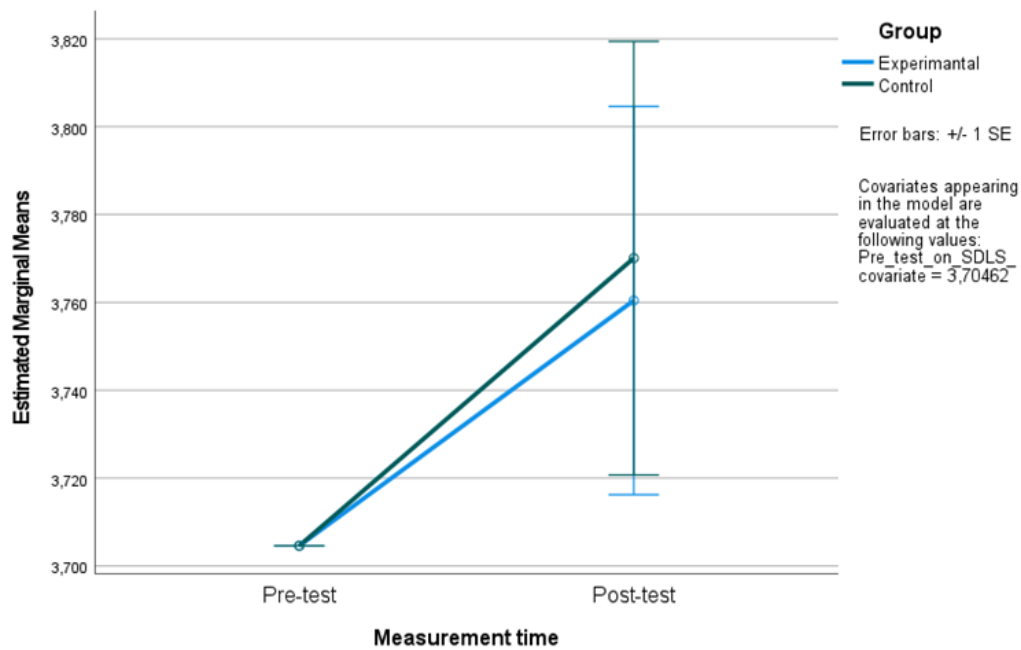


Figure 3 demonstrated the estimated marginal means of post-test scores on SDLS when controlling for pre-test scores. Although no statistically significant difference was found between the groups, the control group demonstrated a slightly higher adjusted post-test mean scores.

When utilizing pre-test scores as covariates, we found a statistically significant difference in both between control and experimental groups' mean scores [$F(1,170)=112.016$, $p<.001$, $\eta^2=.397$] and mean scores obtained before and after the experimental procedure [$F(1,170)=532.768$, $p<.001$, $\eta^2=.758$] the on SAT (see Table 5). Also, the pre-test*measurement time test indicated a statistically significant difference in mean scores [$F(1,170)=222.671$, $p<.001$, $\eta^2=.567$] and the group*measurement time test demonstrated a statistically significant difference in mean scores [$F(1,170)=112.016$, $p<.001$, $\eta^2=.397$] on SAT. Converting the eta-square value ($\eta^2=.397$) from the group*measurement time test into a Cohen's d value ($d=1.623$) using the methodology proposed by Lenhard and Lenhard (2017) further supported this conclusion, indicating a large effect size (Cohen, 1988). Accordingly the results suggests that participation in online quiz supported instruction was significantly associated with higher levels of participants' spreadsheet proficiency when pre-test scores were considered (see Figure 4).

Figure 4

Estimated Marginal Means on SAT utilizing pre-test scores as covariates

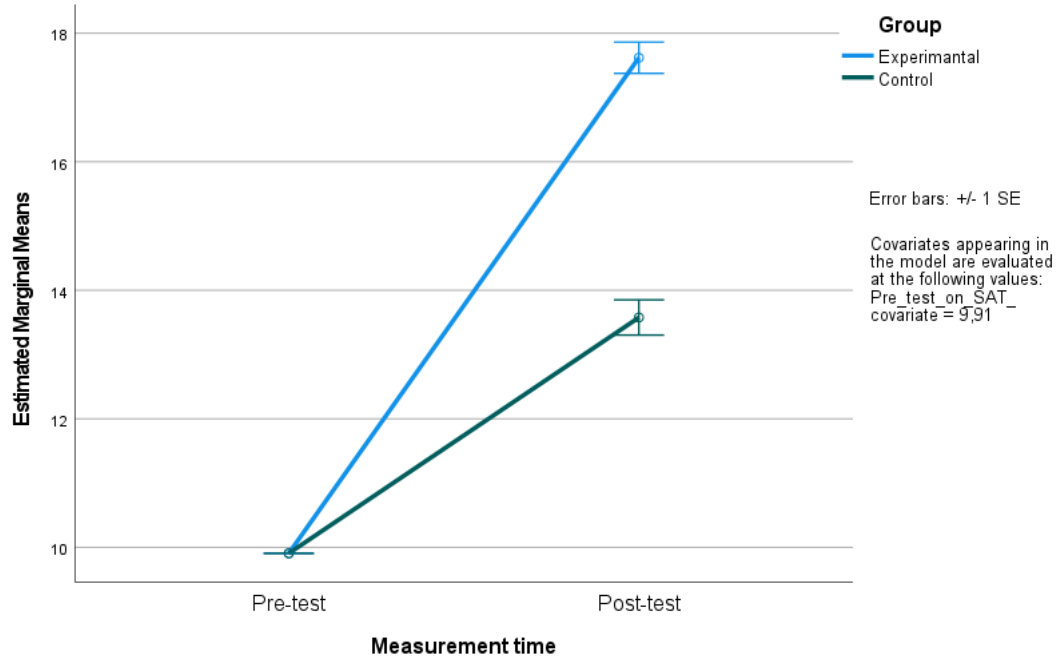


Figure 4 illustrated the estimated marginal means of post-test scores on SAT when controlling for pre-test scores. The adjusted means indicated that the experimental group achieved higher post-test scores on SAT than the control group. This finding was consistent with the ANCOVA results, which revealed a statistically significant difference in favor of the experimental group.

Active Engagement with Online Quizzes on Self-Directed Learning Skills and Spreadsheet Proficiency

We calculated the descriptive statistics of the experimental group's SDLS and SAT scores based on engagement level to investigate the study's second question (see Table 6).

Table 6

The Descriptive Statistics of SDLS and SAT Scores According To Engagement Level

Scale /Test	Group	Pre-test			Post-test		
		N	M	SD	N	M	SD
SDLS	No Engagement	23	3.735	0.442	23	3.761	0.492
	Low Engagement	17	3.718	0.315	17	3.724	0.456
	Moderate Engagement	17	3.665	0.513	17	3.653	0.285
	High Engagement	39	3.738	0.405	39	3.844	0.325
SAT	No Engagement	23	8.435	2.591	23	15.826	2.167
	Low Engagement	17	9.471	3.375	17	16.882	1.691
	Moderate Engagement	17	7.941	2.249	17	17.353	2.317
	High Engagement	39	9.103	2.945	39	18.872	0.951

Note. SDLS: Self-Directed Learning Scale, SAT: Spreadsheet Achievement Test, N: number of participants, M: mean, SD: standard deviation

After examining the descriptive statistics outlined in Table 6, disparities in the pre-test and post-test scores across the engagement level groups were evident. We conducted a two-way repeated measures ANCOVA mixed design using pre-test scores as covariates. Table 7 presents the results of this analysis on SDLS and SAT scores according to engagement level.

Table 7

The Results of Two-Way Repeated Measures ANCOVA on SDLS and SAT Scores According To Engagement Level

Scale /Test	Source	Sum of Squares	Mean Square	F	η^2
SDLS	Pre-test on SDLS	7.586	7.586	233.815**	.720
	Group (engagement levels)	0.093	0.031	0.959	.031
	Measurement time (pre-/post-test)	3.352	3.352	51.665**	.362
	Pre-test*Measurement time	3.310	3.310	51.018**	.359
	Group*Measurement time	0.187	0.062	0.959	.031
SAT	Pre-test on SAT	173.563	173.563	235.237	.721
	Group (engagement levels)	36.347	12.116	16.421**	.351
	Measurement time (pre-/post-test)	1335.646	1335.646	905.126**	.909
	Pre-test*Measurement time	394.035	394.035	267.025**	.746
	Group*Measurement time	72.693	24.231	16.421**	.351

Note. **p<.001

Upon incorporating pre-test scores as covariates, we found no statistically significant difference among the engagement levels groups' mean scores [$F(3,92)=0.959$, $p>.05$, $\eta^2=.031$], but we found a statistically significant difference between mean scores obtained before and after the experimental procedure [$F(1,94)=51.018$, $p<.001$, $\eta^2=.359$] on SDLS. The pre-test*measurement time test indicated a statistically significant difference in mean scores [$F(1,94)=51.018$, $p<.001$, $\eta^2=.359$] and the group*measurement time test indicated no statistically significant difference in mean scores [$F(1,94)=0.959$, $p>.05$, $\eta^2=.031$] on SDLS. The findings on the engagement levels groups' mean scores might suggest that active engagement with online quizzes has no statistically significant effect on participants' self-directed learning skills when pre-test scores were controlled ($\eta^2=0.031$) (see Figure 5).

Figure 5

Estimated Marginal Means of Engagement Groups on SDLS Utilizing Pre-Test Scores As Covariates

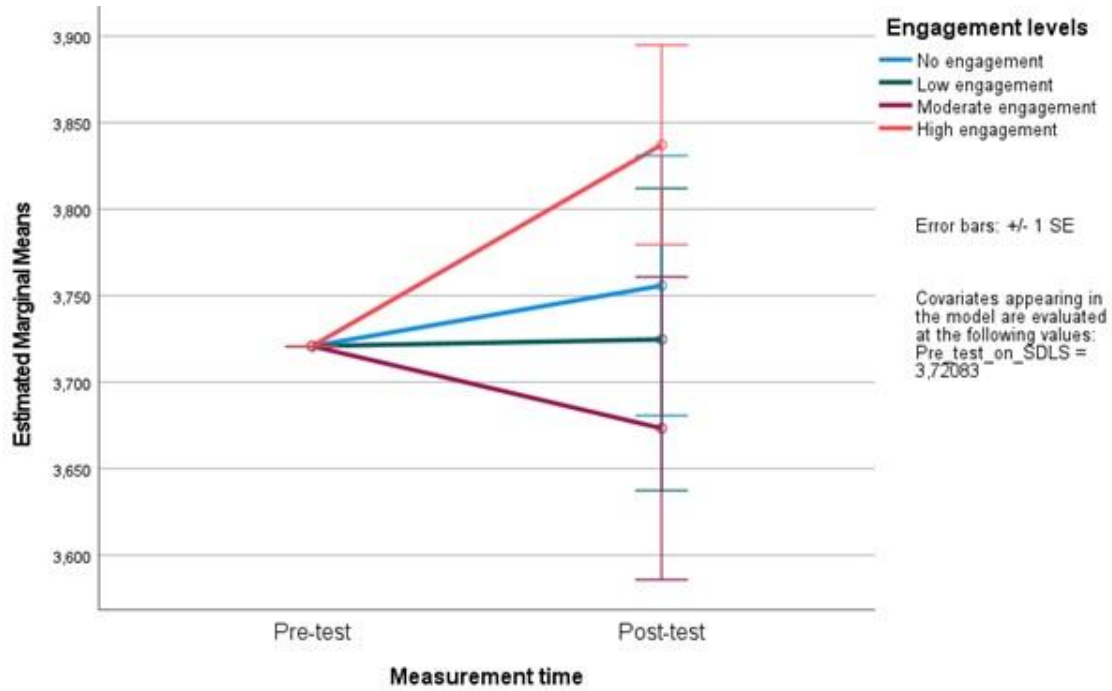


Figure 5 demonstrated the estimated marginal means of post-test scores on SDLS when controlling for pre-test scores. This finding was consistent with the ANCOVA results, which revealed no statistically significant difference among the engagement levels groups' mean scores.

When pre-test scores were used as covariates, we observed a statistically significant difference among the engagement level groups' mean scores [$F(3,92)=16.421$, $p<.001$, $\eta^2=.351$] and between mean scores obtained before and after the experimental procedure [$F(1,94)=905.126$, $p<.001$, $\eta^2=.909$] on SAT (see Table 7). The pre-test*measurement time test indicated a statistically significant difference in mean scores [$F(1,94)=267.025$, $p<.001$, $\eta^2=.746$] and the group*measurement time test indicated a statistically significant difference in mean scores [$F(1,94)=16.421$, $p<.001$, $\eta^2=.351$] on SAT. When we examined the pairwise comparisons table, we observed that the high engagement group's mean scores were significantly higher than all other groups' mean scores, and that the moderate engagement group's mean scores were significantly higher than the no engagement group's mean scores on SAT. These results suggest that active engagement with online quizzes was significantly associated with differences in participants' spreadsheet proficiency when controlling for pre-test scores. Additionally, transforming the eta-square value ($\eta^2=0.351$) into a Cohen's d value ($d=1.471$) using the methodology proposed by Lenhard and Lenhard (2017) indicates a large effect size (Cohen, 1988), supporting the observed group differences in participants' spreadsheet proficiency when pre-test scores were considered (see Figure 6).

Figure 6

Estimated Marginal Means of Engagement Groups on SAT Utilizing Pre-Test Scores As Covariates

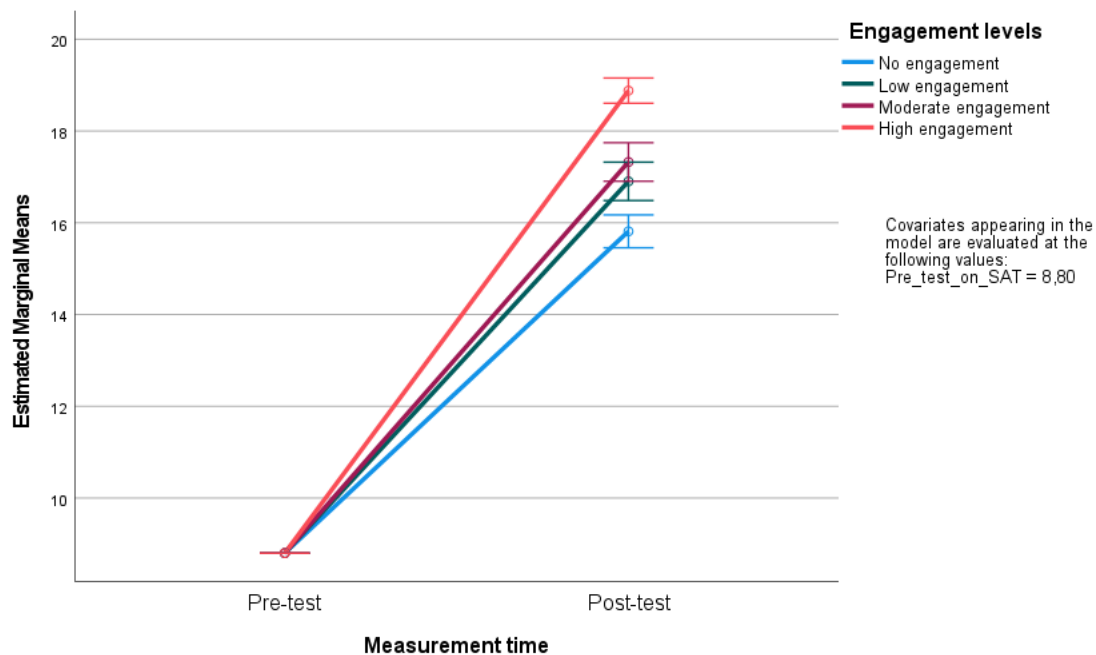


Figure 6 illustrated the estimated marginal means of post-test scores on SAT when controlling for pre-test scores. The adjusted means indicated that the higher engagement groups achieved higher post-test scores on SAT than the lower engagement group. This finding was consistent with the ANCOVA results, which revealed a statistically significant difference in favor of the higher engagement groups.

Discussion

The findings of this study provide valuable insights into the effectiveness of utilizing online quizzes and active engagement with online quizzes during the teaching of spreadsheets subject in self-directed learning skills and spreadsheet proficiency among first-year pre-service teachers. Our analysis revealed significant outcomes.

Effectiveness of Utilizing Online Quizzes on Self-Directed Learning Skills and Spreadsheet Proficiency

Initially, our study aimed to determine whether utilizing online quizzes during spreadsheet instruction influenced pre-service teachers' self-directed learning skills and spreadsheet proficiency. When controlling for pre-test scores, participants utilizing online quizzes exhibited a significant improvement in self-directed learning skills from pre-test scores to post-test scores but there was no significant difference between the control and experimental groups' self-directed learning skills. This outcome suggests that online quizzes might not play a contributing role in fostering self-directed learning skills among pre-service teachers. It is essential to acknowledge that self-directed learning is a multifaceted construct encompassing skills such as goal setting, resource identification, metacognition, and adaptability, and development of self-directed learning skills is recognized as a gradual and ongoing process that may not manifest as immediate changes within the relatively short period of our study (Zimmerman, 2002). This result aligns with existing literature suggesting that the cultivation of self-directed

learning tendencies often requires sustained effort and extended practice (Annandale & Reyneke, 2021; Tekkol & Demirel, 2018). Consequently, the impact of digital interventions on these complex skills may be intricate and highly context-dependent (Van der Kleij et al., 2015).

Regarding spreadsheet proficiency, a significant difference was observed between the control and experimental groups' mean scores on SAT, as well as between pre- and post-tests. When pre-test scores were controlled, it was found that utilizing online quizzes indicated a higher effect on participants' spreadsheet proficiency. This outcome underscores the effectiveness of online quizzes in positively influencing subject-specific performance. While the experimental group started with lower baseline scores, the significant progress observed aligns with previous research demonstrating the capacity of online quizzes to enhance academic achievement across various disciplines (Gurkan & Cigdem, 2022). The assessment offered by online quizzes ensures that students monitor their progress and have the opportunity to address gaps in their knowledge (Black & Wiliam, 1998). In this context, utilizing online quizzes serves as a vital preparatory step toward achieving higher academic performance in technical domains like spreadsheet proficiency.

Impact of Active Engagement with Online Quizzes on Self-Directed Learning Skills and Spreadsheet Proficiency

Secondly, our investigation into the impact of active engagement with online quizzes during spreadsheet instruction on self-directed learning skills and spreadsheet proficiency in experimental group yielded intriguing results. No significant differences were observed among the different engagement level groups and a significant difference was found between the pre- and post-test mean scores when controlling for pre-test scores on SDLS. This suggests that while active engagement with online quizzes likely contributes to the development of pre-service teachers' self-directed learning skills, the extent of this impact may be uniform across active users. As Zimmerman (2002) notes, self-directed learning is a complex construct involving goal setting, resource identification, and metacognition. Therefore, the effects of digital interventions like active quiz engagement on self-directed learning skills may be intricate and highly context-specific.

Regarding spreadsheet proficiency, significant differences were observed between pre- and post-test mean scores among engagement level groups on the SAT. This indicates that active engagement with online quizzes exerts a considerable influence on participants' spreadsheet proficiency. Furthermore, the effect size remained substantial, underscoring the efficacy of online quizzes in enhancing spreadsheet proficiency when pre-test scores were considered as covariates. These outcomes underscore the interconnectedness of engagement and academic achievement within our research context. Our data suggest that as students engage more actively with quiz content, they are more likely to exhibit enhanced academic achievement, possibly due to the repetitive practice and immediate feedback inherent in the system. The association between engagement and learning outcomes aligns with the broader educational literature, which emphasizes the pivotal role of learner engagement in influencing academic success (Fredricks et al., 2004). Engaging with online quizzes prompts students to think critically, apply procedural knowledge, and reflect on their

performance, all of which are essential components of self-directed learning (Urtel et al., 2006; Winne & Hadwin, 2008). The ability to attempt quizzes multiple times may have fostered a “mastery orientation” encouraging students to persist until proficiency is achieved. Therefore, educators should consider not only the structural design of quizzes but also pedagogical strategies that motivate sustained and active participation.

Implications and Future Directions

The results of this study have several implications for educators and researchers in the field of instructional technologies. Firstly, the integration of online quizzes into IT courses holds significant promise for promoting self-directed learning skills and enhancing subject-specific proficiency, particularly in technical domains like spreadsheet management. Educators should consider incorporating interactive online quiz activities into their teaching methodologies to facilitate more engaging and effective learning experiences for pre-service teachers. This approach moves beyond traditional passive instruction by providing a structured framework for immediate self-correction and iterative learning.

Moreover, future research endeavors could delve deeper into the specific design elements of online quizzes that contribute most effectively to skill acquisition. Investigating factors such as question types (e.g., procedural vs. conceptual), feedback mechanisms (e.g., explanatory video links), and quiz frequency may provide valuable insights into optimizing quiz-based learning interventions. Additionally, longitudinal studies could offer a more comprehensive understanding of the long-term effects of utilizing online quizzes on pre-service teachers' learning outcomes and their eventual transfer of these skills to their own professional teaching practices.

In conclusion, this study contributes to the growing body of literature on the instructional benefits of online quizzes by specifically addressing their application in the underserved area of spreadsheet instruction. By elucidating their role in promoting self-directed learning skills and subject-specific proficiency, our findings underscore the potential of online quizzes as versatile tools for enhancing student learning experiences in the digital age. As educators continue to explore innovative pedagogical approaches, online quizzes stand out as a promising avenue for fostering learners' engagement, autonomy, and academic success in increasingly complex technological environments.

Limitations

One of the primary limitations of this study is its focus on a specific group of participants, first-year pre-service teachers enrolled in an IT course at a single state university. As such, the results may not be directly applicable to other student populations, different academic disciplines, or diverse cultural contexts. Future research should aim to replicate this study with more diverse groups to assess the generalizability of the results across various demographics.

Furthermore, we employed a non-equivalent groups pre-/post-test quasi-experimental design. This approach meant that participants were not randomly assigned to groups, and the pre-test scores and group sizes were not equal. Specifically, the disparity in baseline spreadsheet achievement scores between the control and experimental groups may have influenced the magnitude of the observed gains. While we utilized ANCOVA to statistically control for these initial differences, this non-

randomized structure may still limit the internal validity of the study. Future research should strive to use more robust experimental designs involving random assignment and balanced groups to further increase the validity of the findings.

Additionally, the study's reliance on a specific intervention in the experimental group without an equivalent alternative activity for the control group introduces the possibility that the observed improvements were partially due to the extra effort or attention received by the experimental participants. Future studies could address this by comparing online quizzes with other active learning methods to isolate the specific effects of the quizzes.

Lastly, the study relied on self-report measures and standardized achievement tests to assess self-directed learning skills and spreadsheet proficiency. While these instruments are common in educational research, they are subject to response bias and may not fully capture the qualitative complexity of students' learning processes. Incorporating multi-methodological approaches, such as classroom observations or semi-structured interviews, in future research would provide a more comprehensive understanding of participants' learning experiences.

Conclusion

In conclusion, our study provides a comprehensive examination of the effects of utilizing online quizzes during spreadsheet instruction on the pre-service teachers' self-directed learning skills and technical proficiency. The findings highlight the potential of online quizzes can positively contribute to student learning outcomes within IT courses. Despite the identified methodological limitations, the research revealed significant insights regarding the impact of digital quizzes on both self-directed learning and spreadsheet achievement. While significant differences were not observed in self-directed learning skills when analyzed specifically by engagement levels, participants who interacted more actively with the online quizzes demonstrated a marked improvement in spreadsheet proficiency. These results suggest that online quizzes are particularly effective in enhancing subject-specific performance in technical domains where repetitive practice and immediate feedback are essential.

Furthermore, the application of ANCOVA, utilizing pre-test scores as covariates, revealed notable effects of online quizzes on both measured constructs. This finding underscores the critical importance of accounting for prior knowledge and baseline abilities when evaluating the effectiveness of instructional interventions in pre-service teacher education. Ultimately, this study emphasizes the transformative potential of strategically integrating online quizzes into instructional practices. By fostering active engagement and providing a structured framework for self-regulation, such tools can significantly enhance learning outcomes and better prepare pre-service teachers for professional success in an increasingly digitalized educational landscape.

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Statement of Responsibility

HÇ: Conceptualization, Formal analysis, Methodology, Validation, Visualization, Writing – Original draft, Writing - Review & Editing. **GÖ:**

Conceptualization, Formal analysis, Methodology, Validation, Visualization, Writing – Original draft, Writing - Review & Editing.

Conflicts of Interest

The authors declare that they have no conflict of interest.

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