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Investigating the Effect of Integration Approaches of Student Response System on Academic Achievement, Engagement and Cognitive Loads in Live Online Classes

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Abstract

Student response systems (SRSs) increase the engagement of students by supporting them to participate in the course and thus contribute to their academic achievement. However, in most of the experimental studies in which the effects of SRSs were investigated, details on how to integrate SRSs into the course were not provided. This study aimed to investigate the effect of using SRSs in different parts of live online classes on students' academic achievement, engagement, cognitive loads, and views about the SRSs. This study was conducted in a mixed-method research design and 80 undergraduate students who took the Research Methods course constituted the study group. Two experimental groups were randomly assigned. In the first experimental group, SRS was used at the end of the course as an assessment of the current week. In the second experimental group, SRS was used at the beginning of the course as an assessment of the previous week. The experiment lasted seven weeks. The academic achievement test, live online classes engagement scale, and cognitive load scale were used as data collection tools. The study findings show that the first experimental group has significantly higher academic achievement than the second experimental group. On the other hand, the integration approaches of the SRS did not affect significantly the engagement and cognitive load of the experimental groups. Qualitative findings indicate that the integration approaches of SRS have different contributions. The views of the two experimental groups regarding the advantages of the integration approaches of SRS are different.

Introduction

Technological advances continue to shape and change educational environments (Kim, 2019). Particularly, digital technologies make significant contributions to attracting students' attention in traditional learning environments (Lee et al., 2019; Ye et al., 2020). Today, there are many digital tools developed to support educational environments (Uzunboylu et al., 2020). Recently, student response systems (SRSs) are one of these digital tools that have been increasingly used in educational environments (Hunsu et al., 2016). SRSs can be defined as the whole system in which students respond to the questions asked by the teacher through various devices and the answers given by students are analyzed and the results are presented (Kay & LeSage, 2009). The first examples

of SRSs emerged as a hand-held remote control device to which students can send responses and appropriate software and hardware that process the signals sent from this device (Terrion & Aceti, 2012). In this technology, all students were required to purchase this hand-held remote control device or it should be given to students by educators for use in the classroom (Ault & Horn, 2018). However, this situation created an extra load both in terms of logistics and cost (Fies & Marshall, 2006; Knapp & Desrochers, 2009). The SRSs mentioned here are called “clickers” and their use in classroom settings began in the 1970s (Hooker et al., 2016; Jones et al., 2012; Wang, 2015). However, new solutions have started to emerge with the developing technology and the difficulties caused by the use of "clickers" have been reduced or eliminated by web-based software and mobile devices (Hunsu et al., 2016; Wang, 2018). Thus, the use of SRSs has become more common.

SRSs are referred to by many different names in the literature (Fies & Marshall, 2006; Kay & LeSage, 2009). Kay and LeSage (2009) reported that more than 26 different labels are used for SRSs in the literature. The fact that many new labels have emerged since this study (digital student response system, game-based response system, web-based response system) reveals the conceptual confusion here. However, despite this conceptual confusion, it is seen that the functions of all of them are almost the same. In this study, the term SRSs (student response systems), which is one of the most frequently used terms, has been preferred. SRSs have many advantages. In the traditional classroom, either volunteers or students selected by the teacher answer the questions asked by the teacher (Moorhouse & Kohnke, 2020). This causes only some students to attend the course or embarrasses students when chosen by the teacher if they do not know the subject. Since SRSs allow learners to participate in classroom activities anonymously, they minimize the problem of shyness and anxiety about whether the answer is correct (Castillo-Manzano et al., 2016; Duret & Avril, 2015; Meguid & Collins, 2017). One of the places where SRSs are quite advantageous is in the large classes (Tornwall et al., 2020). As students' answers are quickly analyzed and presented in the classroom, it enables both students and teachers to have information about the missing or misunderstood subjects (Ha, 2020; Kim, 2019; Lee et al., 2019). Thus, each student can be given feedback even in large classes (Jones et al., 2012). Therefore, SRSs provide convenience for classroom-wide interaction. Teachers' assessment of students through interactive technologies such as SRSs increases their motivation (Lee et al., 2019). In this context, SRSs facilitate and strengthen the interaction between teachers and students (Hunsu et al., 2016) as interaction is the key in learning process according to many learning and teaching theories and strategies (Van Daele et al., 2017).

The other important contributions of SRSs to the classroom are entertainment, motivation, engagement, and satisfaction. The contributions to these emotional variables directly or indirectly affect the academic achievement of students positively. According to the meta-analysis study by Hunsu et al. (2016), the effect of SRSs on non-cognitive outcomes is higher effect size than cognitive outcomes. This result reveals that SRSs have more of an impact on emotional outputs rather than cognitive outputs. Review studies in the literature confirm the positive contributions of the integration of SRSs into the classroom (Castillo-Manzano et al., 2016; Hunsu et al., 2016; Valenti et al., 2020). Reducing anxiety is another important advantage of SRSs. Providing students with an idea about what kind of questions may come in the exam contributes to the reduction of their exam anxiety (Balta et al., 2018), and interacting with the teacher or their peers during the course contributes to the reduction of in-class anxiety (Aşıksoy & Sorakin, 2018; Turan & Meral, 2018).

Integrating the SRSs into the classroom may result in some negative effects on the teachers and students. SRSs may create administrative problems such as classroom and time management for teachers (Ingalls, 2020). Students may get out of control and make noise as the use of SRSs changes the traditional flow of courses (Mays et al., 2020). On the other hand, it officially permits students to play with smartphones during courses (Barchilon Ben-Av & Ben-Av, 2016). In addition, it is difficult to prepare questions that can develop students' critical thinking skills that will enable them to learn in-depth rather than superficially (Rana et al., 2016). SRSs may also create some negative influences on students individually. It may cause students to passively accept the majority opinion instead of thinking critically (Chien et al., 2016). Therefore, it is not suitable for all courses. It may distract students' attention. In-class interaction may prevent students from focusing on the course. The time limit for questions may put pressure on students to respond quickly and accurately, which may cause anxiety and stress (Wang et al., 2018). Frequent use may reduce effects and cause students to get bored (Lee et al., 2019). This situation may also cause students to answer and finish early without paying attention. In addition, technical problems such as difficulty in use, internet connection problems, and small screen size are other difficulties of SRSs (Kocak, 2022).

Engagement, Cognitive Load and SRSs

Engagement has recently attracted the attention of researchers as an important variable in ensuring that learning process reaches the desired goal (Fatawi et al., 2020). Engagement is to make an effort to actively involve a learning task (Chunfeng Liu et al., 2019). Previous studies have indicated that engagement has sub-dimensions (Gunuc & Kuzu, 2015; Matthews et al., 2017; Zhoc et al., 2019). Since the study was conducted in live online classes, instructional, technological, social, withdrawal, behavioural, and emotional engagement which are the sub-dimensions of engagement in live online classes (Kocak & Goksu, 2023) were investigated. Instructional engagement can be defined as the effect of the teaching style used and the classroom atmosphere created by the teacher on the students (Chunfeng Liu et al., 2019). Integration of various educational technologies with appropriate pedagogical methods for the course will support the technological engagement of students (Bagriacik Yılmaz & Banyard, 2020). Fostering student-student and student-teacher interaction in the classroom and participating in classroom activities will increase social engagement (Zhoc et al., 2019). This interaction created in the classroom reduces the behavior of students to drop out of live online classes. Withdrawal can be defined as students dropping out of school when they are not satisfied with courses (Appleton et al., 2006; Barak et al., 2016). Behavioral engagement can be defined as participating in educational activities (Gunuc & Kuzu, 2015). Emotional engagement refers to the sense of involvement and belonging (Zhoc et al., 2019).

Existing literature indicates that SRSs contribute to increased student engagement (Orhan Göksun & Gürsoy, 2019; Sun et al., 2014). Particularly, the effects of gamification elements on engagement have been demonstrated by many experimental studies (Wang, 2015, Turan & Meral, 2018). However, no research has been found in the literature showing the effects of the integration approach of SRSs on engagement in live online classes. Therefore, this study will make a significant contribution to the literature.

Cognitive load is one of the other important variables whose effect is examined in educational technology studies.

The measurement of cognitive load allows us to learn the cognitive efficiency of instructional conditions (Paas et al., 2003). Cognitive load is defined as the mental effort students spend while performing an instructional task (Yu et al., 2014). According to cognitive load theory, the capacity of working memory is limited. Therefore, the instructional process should be designed effectively considering this limitation. Cognitive load theory is a multidimensional construct that includes intrinsic, extraneous, and germane cognitive load dimensions (Paas et al., 2003). The intrinsic cognitive load is not a load intended to be altered in the instructional process and cannot be easily changed. This type of cognitive load refers to learner characteristics (Sweller, 2010). The extraneous cognitive load, which is also referred to as an ineffective load, is expressed as a type of cognitive load that makes learning difficult and causes students to spend extra effort outside of the learning goal (Paas et al., 2003). Therefore, reducing the extraneous cognitive load is one of the primary purposes of instructional design (Sweller, 2010). The germane cognitive load, also called effective load, is not independent of intrinsic and extraneous cognitive load. The germane cognitive load is related to learning and teaching process and it refers to the load that occurs during the processing and construction of information in working memory. According to the cognitive load theory, working memory overload negatively affects student learning (Sweller, 2010; Paas et al., 2003; Yu et al., 2014).

Complex and difficult subjects can cause an increase in students' cognitive load (Licorish et al., 2018). SRSs can contribute to the reduction of students' cognitive load by presenting these complex topics as gamified (Ismail & Mohammad, 2017). Su (2016) and Turan et al. (2016) found that entertainment elements integrated into learning process contribute to the reduction of students' cognitive load. A limited number of articles in the literature have investigated the effect of SRSs on students' cognitive load. Yu et al., (2014) have found that the use of SRSs assists to reduce students' cognitive load in their experimental research. However, live online classes that include technological tools that students are not accustomed to from the traditional learning environment may increase students' cognitive load (Monteiro, 2014). Therefore, further research is needed to clearly demonstrate the effect of SRSs on cognitive load in live online classes. Besides, no study has been found in the existing literature to reveal the effects of different integration approaches of SRSs on the cognitive load.

Literature Review

There are many studies on SRSs in the literature. Some of these studies are survey research in which students' and teachers' views are obtained about SRSs (e.g., Mayhew et al., 2020; Van Daele et al., 2017). In some of these studies, SRSs are not the main component of the research and there are other tools or learning and teaching strategies integrated into classroom settings (e.g., Fotaris et al., 2016). The other studies are experimental research to investigate the effects of SRSs (e.g., Muir et al., 2020; Owen & Licorish, 2020). It is seen that many different variables such as academic achievement, motivation, engagement, anxiety and perception are discussed in the studies in which the effects of SRSs are examined experimentally (Kocak, 2022).

Some pedagogical variables such as engagement, anxiety, motivation, participation and attitude have been frequently studied in the literature. Several recent studies have shown that SRSs significantly contribute to engagement (e.g., Ha, 2020; Johnson, 2017; Turan & Meral, 2018). Moreover, the variables of class participation

(e.g., Barchilon Ben-Av & Ben-Av, 2016), anxiety (e.g., Aşıksoy & Sorakin, 2018), motivation (e.g., Chenchen Liu et al., 2019), and attitude (Galal et al., 2015) have been frequently investigated. It is seen that SRSs' negative impacts have been also examined in the literature. There are some findings in the studies that SRSs disrupt the classroom atmosphere, prevent students from focusing, take a lot of time (Ha, 2020), make the inclusion of smartphones in the classroom official (Barchilon Ben-Av & Ben-Av, 2016), cause students to be distracted (Ma et al., 2020), and provide superficial information (Kim, 2019).

The majority of these experimental studies have examined the effect of SRSs on academic achievement (Jones et al., 2012). However, there are conflicting results in the literature regarding the effect of SRSs on academic achievement. In some studies, a comparison has been made between the experimental group that received SRS-supported education and the control group that received a traditional education, and it has been concluded that the academic achievement of the group using SRS was significantly higher than the control group (Asmali, 2018; Cárdenas-Moncada et al., 2020; Johnson, 2017). Lin (2020) and Turan and Meral (2018) have compared game-based SRSs and non-game-based SRSs and have found that game-based student response systems significantly increased students' academic achievement. On the other hand, many studies have reported that SRSs do not make a significant difference compared to the traditional method on academic achievement (Cantero-Chinchilla et al., 2020; Jordan et al., 2021; Lee et al., 2019; Reynolds & Taylor, 2020). Also, there are studies in which the performance of the control group with traditional teaching is higher than the experimental group with SRS (Chenchen Liu et al., 2019). This inconsistency in the literature may be due to the integration approaches of SRSs in the course. Since these studies mostly focus on SRSs, insufficient attention has been paid to instructional strategies and the way SRSs are integrated (Jones et al., 2012). In this case, it indicates that more studies are needed to reveal the effects of the integration approaches of SRSs.

One of the key advantages of SRSs is that they can be used to give feedback quickly and easily. This allows instructors to check students' understanding even in large classrooms (Wang & Tahir, 2020). Feedback has a vital role in learning process (Corral et al., 2021) and is one of the most effective reinforcement tools used to confirm the information acquired by students as a result of learning process and to correct mistakes or misconceptions (Lemley et al., 2007; Masadeh & Elfeky, 2017). Feedback also helps students reduce the difference between their current and expected learning levels (Hattie & Timperley, 2007). The contributions of feedback to learning process have been demonstrated by many experimental studies (Balta & Tzafilkou, 2019). However, there are many conflicting results about the timing of feedback. Some research shows that immediate feedback helps students eliminate misunderstandings and reinforce learning. On the other hand, delayed feedback helps students' retention of correct responses (Butler et al., 2007). Feedback is a more crucial component in distance education settings than conventional face-to-face education (Chetwynd & Dobbyn, 2011; Halawa et al., 2017). In distance education, students may feel more isolated. Therefore, it may be more challenging to provide the educational needs of students with online learning environments (Halawa et al., 2017). In addition, the timing of feedback affects learning in live online classes as well as in traditional settings (Mullet et al., 2014). Although there are numerous studies in the literature investigating the effect of the timing of feedback in traditional environments (e.g., Corral et al., 2021; Mullet et al., 2014), there is no clear experimental study comparing the timing of feedback in SRSs in live online classes. Therefore, more research is needed on the effect of the timing of feedback in live

online classes. In the majority of the studies in which SRSs are included experimentally, the information that SRSs are used in the classroom is given, but the information at which stage of the course is used is mostly not clearly presented (e.g., Turan & Meral, 2018). Although some studies have provided recommendations for the use of SRSs, they are not based on experimental findings (e.g., Ault & Horn, 2018; Gousseau et al., 2016). On the other hand, there are many studies on the use of SRSs in face-to-face education, but no study has been found on its use in live online classes. Particularly, no study has been found investigating the effect of SRSs on cognitive load and engagement in live online classes. Finally, the qualitative part is another important aspect of this study as students' views on the advantages and disadvantages of integration approaches of SRSs have been analyzed comparatively. Thus, it can be said that the study will fill a crucial gap in the literature. In this regard, the study aims to investigate the effects of the SRS integration approach to live online classes on students' academic achievement, engagement, and cognitive load. For this purpose, the following research questions were addressed:

1) Are there any differences between the experimental groups in terms of the students' academic achievement, engagement, and cognitive load?
2) What are the students' views on the integration approach of SRS in the course?

Methodology

This study employed the convergent parallel mixed method design. In this design, researchers collect qualitative and quantitative data and analyze them separately, and then compare the results to see if the findings confirm or disconfirm each other (Creswell, 2013, p. 219). In the quantitative part of the study, an experimental method was preferred to determine the effect of using SRSs with a different method in the course. Experimental studies are important to reveal the cause-effect relationship (Mcmillan & Schumacher, 2013). Two experimental groups were assigned randomly. In the qualitative part of the study, qualitative data were collected from both experimental groups via a semi-structured interview.

Study Group

The study group of the research consisted of 80 second-year students registered to the Research Methods course in the Department of Library and Information Sciences, in Turkey. The study was conducted during the second semester of the 2020-2021 academic year. The students were divided randomly into two groups (40-40). A control group could not be formed as the number of students was limited. The participants of the study consisted of 50 female students (62.5%) and 30 male students (37.5%). However, since the study was volunteer-based, some students did not participate in the pre-test or the post-test. Also, the data of the students who did not attend any course during the 7 weeks were not included in the research. There were 36 participants in Experimental Group-I and 27 participants in Experimental Group-II. A power analysis was conducted to determine whether the current sample is large enough to detect the effects of the assumed size. According to the G*Power analysis result that the minimum sample size should be 56 to detect the differences ($d = .22$, $\beta = .90$, and $\alpha = .10$). So, it can be said that the current sample can be considered sufficient to detect the effects of the difference. The students in the experimental groups were taught the Research Methods course for one hour in a weekly live online class. Before starting the experimental research process, a pre-test was conducted to determine whether the groups were

equivalent in terms of academic achievement and it was determined that there was no significant difference between the two groups t(62)=.79, p>.05.

Table 1. Pre-test Comparison of the Experimental Groups

Groups	N	M	SD	t	p
Experimental Group–1	36	42.09	10.06	.79	.43
Experimental Group–2	27	39.67	13.65		

Student Response System

The Quizizz was used as an SRS in this study. Quizizz is a free and web-based tool. Questions prepared by the instructor before the lesson are asked to the students during the lesson, and the answers received from the students are analyzed and presented on the screen. Quizizz offers a funny learning experience as it contains gamification elements.

Measurement Tools

Academic Achievement Test

An academic achievement test was prepared according to the achievements of the first seven weeks of the Research Methods course. A statement table was developed to include all achievements for the 30-item pool. It is concerned to include at least one question for each achievement. This draft form was applied to 120 undergraduate students who took the Research Methods course the previous year. Item analysis was performed on the data of two groups which are upper and lower 27 percentile. Item difficulty index and discrimination power were calculated. The difficulty index of an item ranges from 0 to 1. The optimal value for the difficulty index should be between .30 and .80. The discrimination power ranges from -1 to +1. The value of discrimination power should be positive and higher than .30 (Ebel & Frisbie, 1991). As a result of the item analysis, 10 items were excluded because of the lower discrimination power. The discrimination power values of the items included in the test vary between .33 and .81, and the difficulty index values vary between .35 and .78. However, attention has been paid to having at least one question for each achievement. Each question has five options. Kuder-Richardson 20 (KR-20) reliability analysis was conducted to measure the reliability of the achievement test. The internal reliability coefficient of the achievement test was calculated as .78. It can be interpreted as a reliable tool. The achievement test was applied both as a pre-test and post-test.

Live Online Class Engagement Scale (LOCES)

LOCES is a five-point Likert-type measurement tool. The scale was used to measure the students' engagement levels in live online classes. The scale was developed by Kocak and Goksu (2023). The scale consists of 46 items and six factors: social, instructional, technologic, emotional, behavioral, and withdrawal. The total variance explained by LOCES was 64%. The model fit values of the scale were good ($\chi 2/df = 2.86$, RMSEA=.06, SRMR=.07, CFI=.90, IFI=.90). The internal consistency (α) for the factors vary between .75 and .96. High scores

of the subdimensions and total scale indicate a high-level engagement of students. LOCES was applied only as a post-test.

Cognitive Load Scale

Cognitive Load Scale was developed by Paas and Van Merrienboer (1993) and the scale was adapted into Turkish by Kiliç and Karadeniz (2004). The internal consistency coefficient of the scale was 0.82. The scale had nine points and ranged from 1 to 9. A score of 1-4 was interpreted as low-level cognitive load and 5-9 was interpreted as high-level cognitive load (Paas & Van Merrienboer, 1993). Cognitive Load Scale was applied only as a post-test.

Semi-Structured Interview

A semi-structured interview form was used as a data collection tool in the qualitative part of the study. These questions aim to determine the views of students on the use of SRS in the course. To ensure reliability, the interviews were conducted by the researcher immediately after the experimental process. Since the researcher was also the teacher of the course, a natural communication process was carried out between the participants and the researcher. The advantages and disadvantages of SRS in general and the advantages and disadvantages of the methods of integrating SRS into the course were examined. Six questions were included in the interview form according to the opinions of the two field experts. The interviews with the students were conducted over the phone. The following questions were asked to students:

1) Which devices did you use to answer questions asked with Quizizz?
2) Do you think there are advantages of using Quizizz in class? If yes, what are the advantages?
3) Do you think there are challenges of using Quizizz in class? If yes, what are the challenges?
4) Did you encounter any problems/challenges while using Quizizz during the live online classes? If yes, what are they?
5) At what stage (*beginning*/*end*) of the course do you think Quizizz should be used? Which do you think is more advantageous? What were the contributions of evaluating *the previous week*/*that week* with Quizizz at the *beginning*/*end* of the lesson?
6) Do you think there are disadvantages of using Quizizz at *the beginning*/*end* of the course? If yes, what are these disadvantages?

Settings

This study was conducted at a state university in Turkey. Ethical approval was obtained before starting the research process. The suitability of the research in terms of ethical principles was approved by the Social Sciences Ethics Committee. All activities were conducted on online platforms. Students who took the research methods course with the distance education method were randomly assigned to experimental groups. The same instructor (researcher) conducted the instructional activities during the seven-week course. The research process is presented in Figure 1.

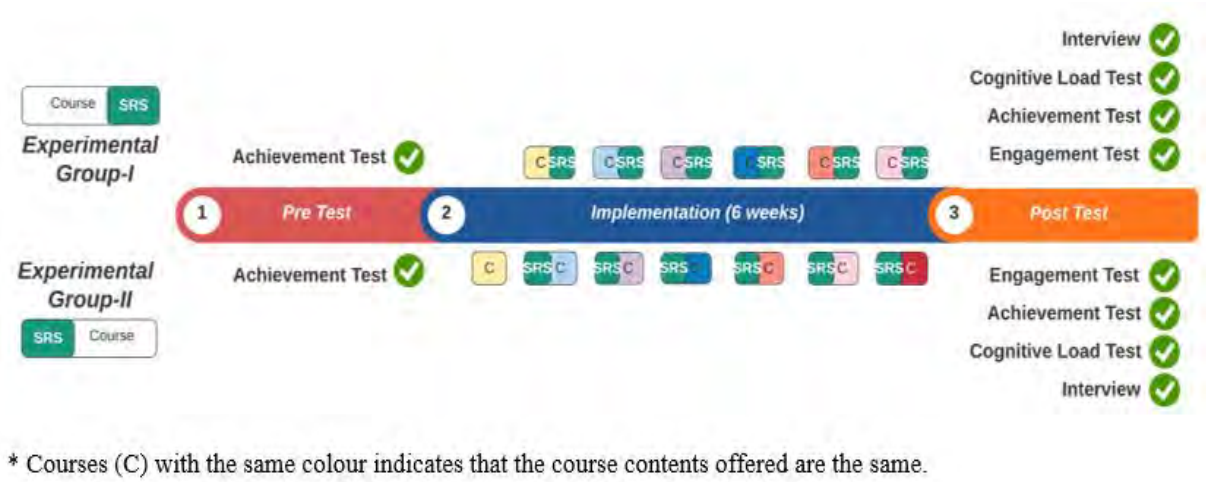


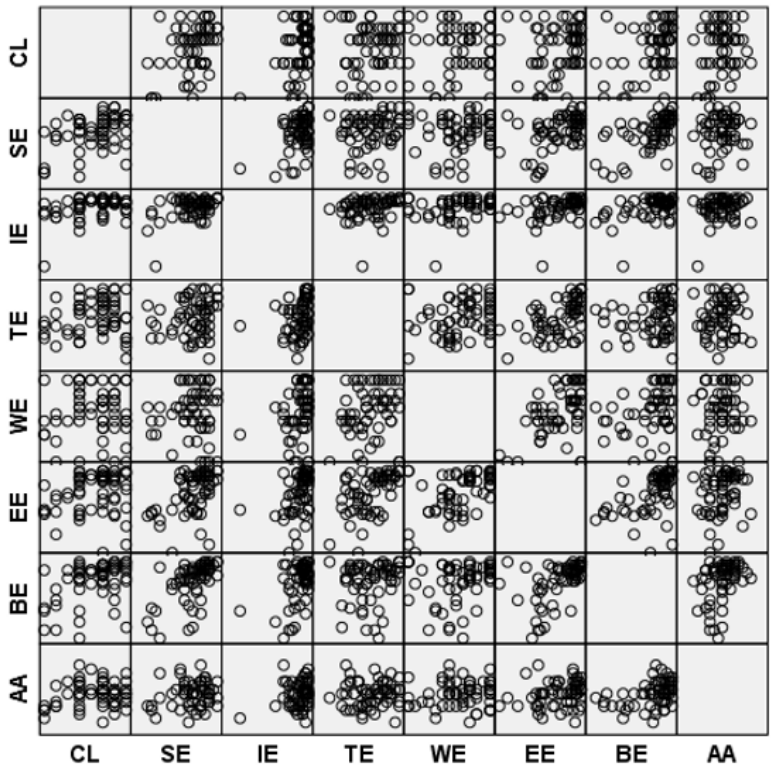
Figure 1. Research Process

First of all, the students were informed about the research process and then the academic achievement test was applied as a pre-test. After the pre-test, the instructional activities were conducted during the seven-week course. In the first experiment group, first instructional activities were conducted and then evaluation activities were conducted with Quizizz during the seven-week. In the second experimental group, the first evaluation activities were conducted with Quizizz and then the instructional activities were conducted. While evaluating the subject covered in that course in the group using SRS at the end of the lesson, SRS was not applied in the first week in the group using SRS at the beginning of the lesson and in the following weeks, questions about the topics covered the previous week. The questions asked through Quizizz are the same in both groups. After the above-mentioned seven-week instruction process, the achievement test, engagement scale, and cognitive load scale were applied as post-tests. After the implementation process was completed, the views of the students from both experimental groups were obtained through semi-structured interviews. Thus, the effect of using SRSs at two different stages of the course on students' academic achievement, cognitive load and engagement were investigated.

Data Analysis

In the quantitative part of the data analysis, the post-tests of the experimental groups were compared. To answer the first research question, the data obtained through the academic achievement post-test, engagement scale, and cognitive load scale were analyzed, respectively. One-way MANOVA test was implemented to determine whether there was a significant difference between students' post-test academic achievement, engagement, and cognitive load levels. Since it is known in the literature that there is a correlation between these variables, the MANOVA analysis technique was preferred. The assumptions of one-way MANOVA were checked. Firstly, Mahalanobis distance analysis was conducted and no outliers were found. Multivariate normality was analyzed and it was determined that this assumption was met (Field, 2009). The linearity of the variables was analyzed with a scatterplot graph (see Figure 2). It is observed that the assumption of linearity is met. Finally, the homogeneity of variance-covariance assumption was checked. Box's test results showed that the homogeneity of variance-covariance assumption was met (Box's M=54.26, F[36, 11469.54]=.17, p>.05). Besides, Levene's test of equality of error variances was not significant $F_{PostTestAchievement}[1,59]=.897$, $p>.05$; $F_{CognitiveLoad}[1,59]=.427$, $p>.05$;

$F_{SocialEngagement}[1,59]=.689$, $p>.05$; $F_{InstructionalEngagement}[1,59]=.263$, $p>.05$; $F_{TechnologicalEngagement}[1,59]=.558$, $p>0.05$; $F_{WithdrawalEngagement}[1,59]=0.256$, $p>0.05$; $F_{EmotionalEngagement}[1,59]=0.864$, $p>0.05$; $F_{BehavioralEngagement}[1,59]=.509$, $p>.05$;). Since the assumptions of MANOVA were met, MANOVA was used to answer first research question. Wilks's lambda statistic was chosen to report analysis results.



CL: Cognitive Load, SE: Social Engagement, IE: Instructional Engagement, TE: Technological Engagement, WE: Withdrawal Engagement, EE: Emotional Engagement, BE: Behavioural Engagement, AA: Academic Achievement

Figure 2. Scatterplot Graph between the Variables

To answer the second research question, the data obtained through semi-structured interview forms were analyzed with thematic analysis techniques. The thematic analysis consists of non-linear six phases (familiarization with the data, coding, searching for themes, reviewing themes, defining themes and naming, and writing-up) and is generally used to identify and analyze patterns in qualitative research (Clarke & Braun, 2013). Firstly, the audio recordings were transcribed by the researcher. The transcripts of the interviews were analyzed by the researcher and an expert. The expert helped the researcher to ensure reliability. Inter-rater reliability (Cohen-Kappa) was calculated and obtained as .90. This coefficient shows that there is an almost perfect agreement between the raters (Landis & Koch, 1977).

Findings

In this study, the data were collected and analyzed separately, therefore, the quantitative and qualitative findings are presented under separate headings. In the quantitative findings, the comparisons of the data collected by academic achievement test, live online class engagement scale and cognitive load scale were made. In the qualitative findings, the interviews with 12 students from the two experimental groups were presented as thematic

and descriptive.

The Effects of Integration Approach of SRS on Academic Achievement, Live Online Classes Engagement, and Cognitive Load

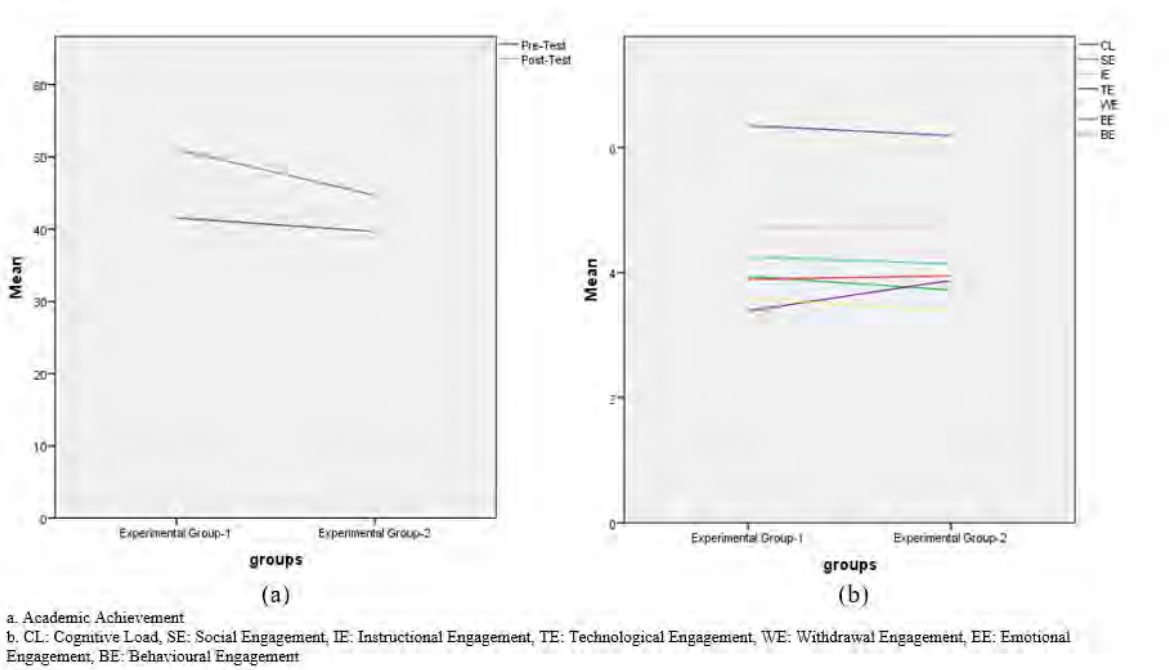
To answer the first research question, one-way MANOVA statistical analysis technique was used. Whether the academic achievement, cognitive load and engagement levels of the students differ according to the groups was analyzed with this technique. In the courses conducted with the direct instruction method, SRS was used at the end of the course in Experimental Group-I, and SRS was used at the beginning of the course in Experimental Group-II. The difference between the experimental groups in academic achievement, engagement and cognitive load was analyzed. The analysis result is given in Table 2.

Table 2. One-way MANOVA Results

	EG1		EG2					
Variables	$\bar{X}$	SD	$\bar{X}$	SD	F	df	p	η2
Academic Achievement	50.13	16.58	44.58	15.60	4.068	61	**.044**	.001
Cognitive Load	6.31	1.89	6.21	2.21	.040	61	.841	.064
Engagement								
Social	3.83	.84	3.74	.80	.451	61	.504	.008
Instructional	4.71	.33	4.70	.40	.143	61	.706	.002
Technologic	3.39	.81	3.88	.85	5.378	61	**.024**	.084
Withdrawal	3.49	1.17	3.40	1.24	.659	61	.420	.011
Emotional	3.92	.95	3.98	.99	.072	61	.789	.001
Behavioral	4.19	.81	4.22	.74	.409	61	.525	.007

MANOVA analysis result indicates that there is a significant difference between the two experimental groups (Wilks's lambda=.815, F[1, 61]=1.47, p<0.05). The univariate analysis result was checked. There is a significant difference between the academic achievement of the experimental groups. EG1 students ($\bar{X}$=50.13) who had SRS at the end of each weekly course were found more successful than EG2 ($\bar{X}$=44.58) students who had SRS at the beginning of weekly course F[1, 61]=4.06, p<0.05). There is no statistically significant difference between cognitive loads of the experimental groups ($\bar{X}_{EG1}$=6.31; $\bar{X}_{EG2}$=6.21). It is determined that both experimental groups do not have much cognitive load. Moreover, it is found that there is no statistically significant difference in the social, instructional, withdrawal, emotional, and behavioral engagement of the students. There is only a statistically significant difference in the technological engagement of the students. EG2 has higher technological engagement than EG1 (F[1, 61]=5.37, p<0.05).

When the analysis results are examined from a holistic perspective, Figure 3(a) demonstrates that the students' post-test scores in EG1 were statistically significant and higher than EG2. As seen in Figure 3(b), other variables do not change much, except for TE. The EG2 students ($\bar{X}$=3.88) have higher-level technological engagement than the EG1 students ($\bar{X}$=3.39).



a. Academic Achievement
b. CL: Cognitive Load, SE: Social Engagement, IE: Instructional Engagement, TE: Technological Engagement, WE: Withdrawal Engagement, EE: Emotional Engagement, BE: Behavioural Engagement

Figure 3. Distributions of Variable Scores by Experimental Groups

The Students' Views about the Integration Approach of SRS

In the qualitative part of the study, semi-structured interviews were performed to answer the second research question. Students' views about the use of SRS in the course were obtained. The interview was conducted with six students from each experimental group. The participants from the first experimental group were named as [EG1-X] and the participants from the second experimental group were named as [EG2-X].

Students' views about the use of SRS in live online classes and the integration approach of SRS in the courses were obtained. The students interviewed in both groups attended the classes with a smartphone or computer. Three students used only smartphones and five students used only computers. Four students stated that they followed the lessons sometimes by using a smartphone or sometimes a computer. All students answered "Yes" to the question "Do you think there are advantages to using Quizizz in class? If yes, what are the advantages?". The views of students about the advantages of SRS were classified under themes (see Figure 4).

Feedback theme is one of the most expressed characteristics of using SRS. EG1-B stated that using SRS is quite useful to measure the level of knowledge about the course. In the context of feedback, EG1-D stated as follows: "It gives information about whether the course has been understood or how much it has been understood." The theme of feedback was expressed by 9 students. The other themes mostly stated by the students are *entertainment*, *attention*, *competition, coming to the course prepared*, *preparing for the exam*, *motivation*, *learning*, *retention, engagement, learning the type of question* and *review.* Some students' statements about the advantages of SRS are as follows:

"It made our courses fun and time passed more quickly." [EG1-K] (Coded as Entertainment)

"I know there will be a quiz at the beginning of the course, so I come prepared." [EG2-H] (Coded as Come to Class Prepared)

"You listen to the course carefully because there is a quiz at the end." [EG1-S] (Coded as Attention)

"It allows us to revise the content of the previous week. It prepares us for the exam." [EG2-A] (Coded as Review and Preparing for the Exam)

"Since Quizizz was used, it strengthened my engagement in the course even more." [EG1-F] (Coded as Engagement)

Figure 4. Themes obtained for the Advantages of SRS

The majority of the students stated that SRS did not have any disadvantages. However, five students (42%) said that they had low motivation when they did not answer the questions correctly. EG2-P stated, "When I make mistakes, I think, I can't do it. Sometimes the thought may arise, why I cannot do it while others can do it." Moreover, one student stated a disadvantage as follows: "It can be exciting when answering. When there is excitement, it is difficult to focus on and read the questions." Another EG1-Y student expressed, "When I was distracted in the course, the quiz at the end of the lesson was not efficient." As another challenge, two students stated that using SRS at the beginning of the course and having bad results might be the reason for the decrease in their motivation during the course. EG2-D expressed this challenge as follows: "When I am not successful in the quiz, I cannot listen to the course effectively. When I make too many mistakes, my motivation decreases during the course."

There are some infrastructural challenges experienced in a live online class. For instance, EG1-K mentioned these challenges as follows: "There were some minor problems with my internet connection." Five students (41%) gave similar answers. In the answer to the question, "Did you encounter any problems/challenges while using Quizizz

during the live online classes? If yes, what are they?" two students (16%) stated another challenge. EG2-B stated: "It can be difficult to switch between the video conference and quiz tabs in the browser when I take the course on the smartphone." Other students stated that they did not experience any problems.

The views of the students about the integration approach of SRS are given as comparative. Each group was asked about the advantages of the integration approach implemented in their courses. The students in both experimental groups stated that they were advantageous in terms of review. While three of the students in EG1 stated that it was advantageous to use it at the end of the lesson in terms of "feedback", two of the students in EG2 stated that it was advantageous to use it at the beginning of the lesson in terms of "recall". Considering these findings, it can be said that the method of integration in the course reveals different advantages. The details of the comparison are presented in Figure 5.

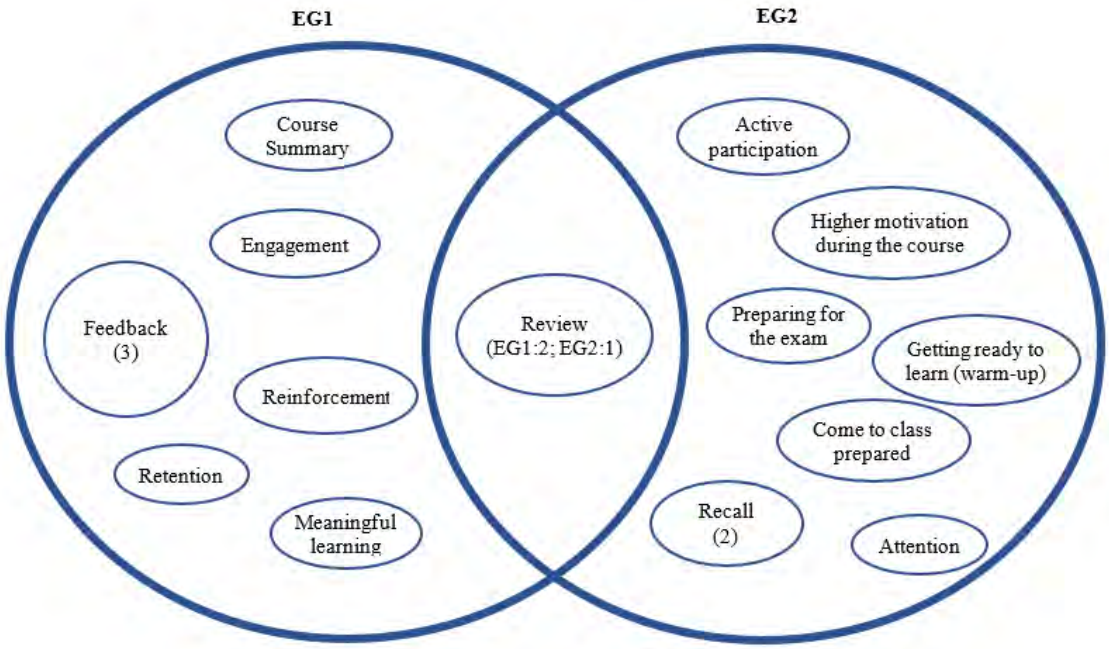


Figure 5. The Comparison of the Students' Views about the Advantages of Integration Approaches of SRS

Except for EG2-B and EG1-O, all participants of both groups expressed that their integration approach was more advantageous. EG2-B and EG1-O stated that both integration approaches had advantages. For instance, EG2-B stated as follows: "I think Quizizz can be used in both stages. Using Quizizz at the end of the lesson helps retention of knowledge. On the other hand, using it at the beginning of the lesson helps motivation." Some of the other views were as follows:

> *"We revise what we do not understand at the end of the lesson."* [EG1-O] (Coded as Review)
>
> *"Starting with the Quizizz makes us more motivated during the course."* [EG2-A] (Coded as Higher motivation during the course)
>
> *"It reinforces the course."* [EG1-K] (Coded as Reinforcement)
>
> *"I think that starting with the Quizizz at the beginning helps me warm up to the course better."* [EG2-S] (Coded as getting ready to learn (warm-up))

Students in EG1 stated that there was no disadvantage in using Quizizz at the end of the course. Conversely, two of the students in EG2 stated two disadvantages of using it at the beginning of the lesson. For instance, EG2-P stated one of the disadvantages of using SRS at the beginning of the course as follows: “When I fail the quiz, my motivation decreases and I find it difficult to focus on the course.” EG2-B likewise stated similar disadvantages: “When I make a mistake, I think I can't do it and I feel bad.” As seen from the findings; using SRS at the beginning of the course has two disadvantages. However, using SRS at the end of the course has no disadvantage.

Discussion

The current study aims to investigate the effects of the integration approaches of SRS on students’ academic achievement, live online class engagement, and cognitive load. Moreover, the views of the students about using SRS and the integration approaches were investigated. In this study, two experimental groups were randomly assigned. SRS was used at the end of the course in the first experimental group and in the other experimental group, it was used at the beginning of the lesson. SRS has been integrated into the direct instruction model in both groups.

The first experimental group, in which SRS was used at the end of the course, had higher academic achievement than the second experimental group, in which SRS was used at the beginning of the course. Although there are many studies in the literature in which SRSs are integrated into courses, it is seen that there is an inconsistency in the effect of SRSs on academic achievement. While SRSs contribute positively to academic achievement in some studies (Lin, 2020; Turan & Meral, 2018), it has been found that there is no effect in some studies (Cantero-Chinchilla et al., 2020; Lee et al., 2019). This contradiction in the literature may be due to insufficient focus on teaching strategies in technology integration studies (Jones et al., 2012). The significant difference in the academic achievement of the experimental groups in this study can be shown as evidence of this evaluation. The difference in the academic achievements of the experimental groups may be due to the different functions of immediate feedback and delayed feedback. Feedback has a crucial role in learning process. Therefore, it would be more appropriate to explain the difference through types of feedback. It is seen that different results have been obtained regarding the effect of both feedback methods on learning in the literature. While some studies indicate that immediate feedback has a better effect on learning and long-term retention, some studies indicate that delayed feedback has a greater effect (Mullet et al., 2014). On the other hand, studies in the literature show that delayed feedback is more effective than immediate feedback report that a good feedback process will need time to read and evaluate, so delayed feedback is better (Corral et al., 2021). However, due to the rapidity of SRSs in giving immediate feedback and overcoming this important difficulty, students who received immediate feedback may have been more successful than students who received delayed feedback. The fact that this research was conducted during the distance education process may also be the reason for the inconsistency of the results with the literature. Lemley et al. (2007) reported that students who received immediate feedback during the distance education process had better final exam scores. It can also be said that this result is consistent with the behaviourist paradigm. The reason for this comment is that feedback should be given immediately as a reinforcement or punishment (Mullet et al., 2014). When the views of the students in the experimental groups about the advantages of SRS are examined, it is seen that feedback comes to the fore. Moreover, when the views of the experimental groups on the

advantages of the integration approach of SRS are compared, it is determined that feedback is prominent in the views of the students in the first experimental group. It is seen that the recall theme becomes apparent in the views of the students in the second experimental group.

The result of the analysis indicates that there is no statistically significant difference between the students' engagement of the experimental groups. Engagement is one of the most important contributions of SRSs to students (Plump & LaRosa, 2017). In experimental studies, it has been proven that SRSs contribute to students' engagement levels (e.g., Muir et al., 2020; Orhan Göksün & Gürsoy, 2019). SRSs contribute to non-cognitive learning outcomes more than cognitive outcomes (Hunsu et al., 2016). In this study, as seen in Fig3(b), the engagement level of the two experimental groups is quite high. Therefore, it is clear that SRSs contribute highly to students' engagement. However, it has been determined that the integration approaches of SRS have no impact on the students' other engagements, except for the technological engagement. The engagement of the students in the second experimental group is significantly higher than that of the first experimental group. This can be related to the primacy effect. This effect may explain the finding that the technological engagement of the first experimental group in which technology was integrated at the beginning of the course was significantly higher than that of the second experimental group in which technology integrated at the end of the course. This effect refers to the tendency to remember an object or information at the early stage than at the middle or end (Tomić et al., 2017).

The result of the analysis indicates that there is no statistically significant difference between the cognitive load of the experimental groups. The fact that the cognitive load was not high in both groups and did not show a significant difference should be perceived as a positive result. To evaluate this result, we need to know what the cognitive load is. Cognitive load can be defined as mental effort when performing a limited task that has an impact on the cognitive system (Sweller et al., 1998). Intermediate level mental effort should be spent to make learning process more efficient (Paas & Van Merrienboer, 1993). High-level cognitive load refers to cognitive overload. Cognitive overload causes high levels of mental effort, resulting in difficulties in understanding, confusion and low performance (Kalyuga et al., 1998). Low-level mental effort leads to a medium level of performance. (Paas & Van Merrienboer, 1993). In a similar study, Roussel and Galan (2018) concluded that SRSs alleviate students' cognitive loads. Hwang & Fu (2019) also stated in their literature review study that the use of mobile devices during courses reduces cognitive load. In addition, a student's statement: "Quizizz helped me perceive the course as an easy course" in the interview after the implementation can be evaluated as an indicator that SRSs contribute to the reduction of cognitive load. This reveals that quantitative findings are supported by qualitative findings. No specific study has been found in the literature to directly examine the effect of SRSs on cognitive load.

The qualitative findings have shown that there are many advantages of Quizizz. It was determined that the advantages such as feedback, entertainment, attention, and competition were frequently expressed by the students. There are similar themes in the findings of previous studies (Orhan Göksün & Gürsoy, 2019; Owen & Licorish, 2020). When all the themes created as a result of the students' views about the advantages of SRSs are examined, it can be said that their contributions (e.g., entertainment, competition, motivation, and engagement) come to the fore. This result partially supports the conclusion reported by Hunsu et al. (2016) that SRSs have a greater effect

on non-cognitive outcomes. In addition, it is seen that the themes of preparing for the exam, coming to class prepared and learning the type of question have emerged from the students' views. The students stated that similar questions asked with Quizizz could be asked in the exam. Likewise, Schmidt et al. (2020) reported that questions in the SRS help with exam preparations. In addition, it was determined that having a quiz in the course caused the students to come to the course prepared. This can be interpreted as an indication of the increase in students' engagement even outside the class.

Another important qualitative finding is the comparison of the advantages of the SRS integration approaches. When the views of the students about the section of the course in which SRSs are integrated are compared, different advantages stand out. For instance; while the use of SRS at the beginning of the lesson contributed to recall, attention, active participation and motivation during the course, the use of SRS at the end of the course contributed to feedback, review, reinforcement and course summary. This finding can be shown as evidence that the integration approach provides different contributions to the course. However, some students stated as a disadvantage that using Quizizz at the beginning of the lesson might cause a decrease in motivation if the number of wrong answers was high. Nevertheless, it should be noted that if the number of correct answers is high, their participation, engagement and attention may increase. On the other hand, no disadvantages were stated for the use of Quizizz at the end of the course. Therefore, considering the previous quantitative and qualitative findings, it can be said that the contribution of using SRS at the end of the course is higher. Finally, in students' view, there is no serious difficulty in using SRS in a live online class. This shows that SRSs can be used easily in live online classes.

Conclusions and Recommendations

In this study, SRS was integrated into live online classes in higher education and the effects of the integration approaches of SRS on students' academic achievement, live online class engagement, cognitive load, and views were investigated. As a result, using SRS at the end of the course increased academic achievement more than using SRS at the beginning of the course. Moreover, integrating SRSs at the beginning or end of the lesson did not change the engagement, and cognitive load of the students. It was found that the engagement of the students was high and their cognitive loads were at the intermediate level in both integration approaches. In addition, according to the views of the students, it has been determined that SRSs' integration approaches provide different contributions. This result shows that SRSs can be integrated into courses with different methods in line with the desired output. This study has the potential to show how to integrate SRS into courses as this is quite crucial for instructors who are practitioners in the field.

The results of this study are limited to the Research Methods course. The absence of a control group in this study could be expressed as a limitation. Since there was no control group, the integration approaches could not be compared with the traditional method. In future studies, comparisons with traditional methods can be made. On the other hand, SRSs were used in live online classes during the distance education process, the findings are, therefore, limited to the distance education process. The effect of integration approaches in the traditional (face-to-face) classroom environment can be examined in future studies. As another limitation, this experimental study

lasted seven weeks. A longer experimental research design may be planned in future studies. In this study, the effect of SRS integration approaches was examined. Researchers may focus on what effects SRS will have when integrated into a complex or simple course. The following suggestions can be made based on the study findings:

1) The use of SRSs at the end of the class may contribute more to students' academic achievement.
2) The students' cognitive load was at the intermediate level in both integration approaches. Therefore, both integration approaches may contribute to keeping the cognitive load at an ideal level.
3) The majority of the students have positive views on the use of SRSs in the course. For this reason, teachers may integrate SRSs into courses, no matter which integration approaches they use.
4) It has been determined that the use of SRSs in different parts of the course provides different advantages. In this context, teachers may choose the integration approach that is appropriate for the purpose they want to achieve.

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