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Investigating Engagement and Achievement in an Online Teacher Education Course during the Compulsory Distance Education Period*

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ABSTRACT

The primary purpose of this study is to investigate ways of improving preservice teachers' engagement in a teacher education course designed for online delivery and offered during the COVID-19 pandemic. While online teaching is a prominent research area, descriptions of online learning environments based on sound frameworks are typically missing in the literature. Addressing this gap, we investigated the role of online instruction, whose design was guided by the National Survey of Student Engagement (NSSE) framework, and supporting different types of interaction on students' engagement and course achievement. We designed two versions of the same course differing only in terms of the level of learner-learner and learner-content interaction support provided. The participants were 38 preservice teachers from a range of departments, who were in two different sections of the course, randomly assigned to one of the versions. Data were collected using a modified version of the NSSE survey at the beginning and at the end of the course. The analysis showed that online course design based on the NSSE framework was effective for improving students' engagement in a project-based teacher education course even in the COVID-19 pandemic period. Meanwhile, the participants did not differ in terms of their engagement scores in time regarding the course version they attended. And, there was no difference regarding students' achievement scores as measured by their final course grades. The findings highlighted the need to design online courses based on sound theory and provided insight into prioritizing different types of interactions in project-based online courses.

Keywords: Online course design, engagement, NSSE, interaction modes, teacher education, preservice teachers

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1. INTRODUCTION

While the evaluation of online learning environments by focusing on student learning outcomes is valuable, there is a need to go beyond these and "consider the quality of the learning experience as a whole" (Robinson & Hullinger, 2008, p. 1). One of the most well-known initiatives that aim to promote student learning and improve the quality of undergraduate education is the National Survey of Student Engagement (NSSE) (Kuh, 2001). First launched in 2000, the NSSE project revolves around a survey of college students to identify educational practices strongly associated with high levels of learning and personal development. The survey was last updated in 2013 and reflects the "seven principles of good practice in undergraduate education" that is based on a synthesis of a long line of research regarding collegiate quality in higher education (NSSE, 2013). In the US and Canada, it has been used by several higher education institutions and serves as a tool for institutional analysis and comparison (NSSE, 2017).

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Even though the NSSE was created for a holistic assessment of on-campus higher education, its principles can be used to design and assess effective instruction (either blended or fully online) for a single course (Robinson & Hullinger, 2008). Instead of test scores, NSSE focuses on the notion of "student engagement" that is considered a more legitimate indicator of institutional quality. Engagement is an essential factor in student success based on a long tradition of prior research and theory (NSSE, 2013). Student engagement is "an umbrella term [...] that includes the extent to which students participate in educationally effective activities as well as their perceptions of facets of the institutional environment that support their learning and development" (NSSE, 2013, p.1). Student engagement focuses on activities and experiences that result in desired college outcomes. The NSSE framework consists of ten engagement indicators grouped within four themes (see Table 1). Engagement indicators are more operationalized forms of the themes.

Table 1.
NSSE Themes and Engagement Indicators (https://nsse.indiana.edu)

Theme	Engagement Indicators
Academic Challenge	Higher-Order Learning
	Reflective and Integrative Learning
	Learning Strategies
	Quantitative Reasoning
Learning with Peers	Collaborative Learning
	Discussions with Diverse Others
Experiences with Faculty	Student-Faculty Interaction
	Effective Teaching Practices
Campus Environment	Quality of Interactions
	Supportive Environments

Theme 1. Academic Challenge

The academic challenge theme focuses on experiences related to academic activities and opportunities that challenge students to develop their skills and knowledge. The theme consists of four engagement indicators: higher-order learning, reflective and integrative learning, learning strategies, and quantitative reasoning.

Theme 2. Learning with Peers

Learning with peers is related to the different ways students interact with each other. This could take the form of discussing course materials with peers and conversing with those from diverse backgrounds. Two engagement indicators make up the theme of learning with peers: collaborative learning and discussions with diverse others.

Theme 3. Experiences with Faculty

This theme is concerned with students' contact with the faculty members in and outside of instructional settings and effective teaching. Thus, two engagement indicators contribute to this theme: student-faculty interaction and effective teaching practices.

Theme 4. Campus Environment

The relationships between students, staff, and faculty members affect students' engagement in learning and development (Kuh, 2003). Students are more satisfied with the supportive environments in which they build positive relationships (NSSE, 2013). Quality of interactions and supportive environment are the two engagement indicators that represent the campus environment theme.

1.1 The Three Modes of Interaction

While NSSE focuses on the overall quality of higher education, one can also conceptualize effective instruction for a single course and the modes of interaction it has to scaffold. In the context of distance education, Moore (1989) suggested that educators need to distinguish between three types of interaction when designing instruction from a distance. These are learner-content (LC), learner-instructor (LI), and learner-learner (LL) interaction.

LC is the type of interaction between the learner and the content of a specific subject we expect learners to understand. Most traditional forms of distance education supported learners' interaction with the content through printed text materials, TV programs, or computer software. The second type of interaction is the one between the learner and the instructor (LI). This interaction should occur to stimulate and maintain the student's interest in the subject and improve the student's understanding of the subject matter. (Moore, 1997). For that, students need to be in dialogue with their instructors (Moore, 1991), which refers to two-way synchronous or asynchronous communication between the learner and the instructor (Moore & Kearsley, 1996). Even if learners can positively interact with the content, they need support from a subject-matter expert because they may not know how to apply the content they learn. Through the interaction with the instructor, learners can eliminate their

misunderstandings and benefit from instructor feedback for their learning. The final form of interaction, LL, occurs when one learner interacts with other learners, one-to-one or as a group, with or without an instructor's guidance. Moore (1989) offered some strategies to design a distance learning environment that supports this interaction type. Group presentations, peer discussions, and small group studies are some successful ways to enhance LL interaction.

Moore (1989) suggested educators "organize programs to ensure maximum effectiveness of each type of interaction, and ensure they provide the type of interaction most suitable for various teaching tasks of different subject areas, and learners at different stages of development" (p. 5). On the other hand, Anderson (2003) theorized that having only one of the three forms of interaction at a high level (LL, LI, or LC) and offer the other two at minimal levels could still support deep and meaningful formal learning. Several researchers investigated the role of supporting different types of interactions on student engagement and learning. In their study in a corporate setting, Padilla Rodriguez and Armellini (2015) showed no significant difference between learners' exam results in three versions of an online course, each of which predominantly supported one type of interaction. In their meta-analysis study, Bernard et al. (2009) reported that the combination of LL and LC or LI and LC interactions produced significant effects on student learning, while the combination LL and LI were found not to be significant. Jaggars and Xu (2016), on the other hand, identified that a sufficient level of LI interaction engaged students more and increased their academic performance. In Ke's study, when all interaction types were included in a course design in a balanced way, it promoted more reflective and self-regulated online discussions (Ke, 2013).

1.2. Statement of the Problem

The findings of the empirical studies suggest that there may not be one best solution regarding the type of interaction support for enhancing the online learning experience. Different courses and content may require different types of interaction formulations. Therefore, when designing effective online learning environments, it is essential to understand how supporting different types of interactions influences student learning and engagement within the context of a particular course.

1.3. Purpose of the Study

In this study, we aimed to examine the role of online instruction, whose design is based on the NSSE framework, and supporting different types of interaction on students' engagement and course achievement. We designed two versions (V1 and V2) of a project-based educational technology course for preservice teachers based on the engagement indicators (NSSE, 2017). These course versions differed only in terms of the level of LL and LC interaction support provided.

1.4. Research Questions

The following research questions guided the study:

Research Question 1 (RQ1): Is there a significant difference between students' NSSE engagement scores before and after taking the online course?
RQ2: Is there a significant difference between students who took V1 and students who took V2 of the course regarding their engagement scores?
RQ3: Does any interaction occur between being in one of the two versions of the online course (V1 & V2) and the time of pre- and post-tests?
RQ4: Is there a significant difference between students who took V1 and students who took V2 of the course in terms of their achievement scores at the end of the treatment?

2. METHOD

Ethical approvals for this study were obtained from the Institutional Review Board. This study employed a quasi-experimental pre-test-post-test design. The independent variable of the study is the different modes of online interaction realized in two versions of a project-based teacher education course, which is designed based on the NSSE framework. There were two conditions (groups): V1 and V2 of the course differing only at the type of LC and LL interaction support. Students who were enrolled in two sections of the course were randomly assigned to one of the course versions; thus, available groups were used. Students in both sections were given a modified version of the NSSE survey at the beginning and the end of the course. Students' final course grades were also evaluated and compared (V1 & V2 sections) at the end of the course.

2.1. Context and Participants

The online course was initially designed by the research team (authors) for a blended format, having both face-to-face and online modules. However, due to the outbreak of the global COVID-19 pandemic, face-to-face education was suspended in March 2020 in higher education, and universities have taken a sharp turn towards online digital formats since then. Thus, the authors, who are teacher educators and experts in technology-based learning environments, redesigned the course as a fully online course with asynchronous and live synchronous components. They offered the two versions of the online course to preservice

teachers at a state university in Istanbul in the Fall 2020 semester, within the COVID-19 compulsory online distance education period.

The participants were 38 preservice teachers from a range of departments (see Table 2 for participant demographics). Students who were enrolled in two different sections of the course were randomly assigned to one of the versions of the online course. The LC section had 20 students, while the LL section had 18 participants.

Table 2.
Participants

Department	**LC Group**	**LL Group**
Guidance and Psychological Counseling	9	8
Mathematics Education	4	1
Foreign Language Education	6	5
Science Education	0	2
Teaching Chemistry	1	0
Teaching Physics	0	2
Group Total	20	18
TOTAL	38	

This course is a required educational technology course for most of the teaching programs in the junior year at the faculty of education. Therefore, students were from a variety of departments, and assumed to be homogenous in terms of their initial technological skills before starting the course.

2.1. Data Collection

The design of the project-based teacher education course is based on the NSSE engagement indicators (NSSE, 2017). The following NSSE engagement indicators guided the online course design: higher-order learning, reflective and integrative learning, learning strategies, and effective teaching practices (see Table 3). The online course was designed to involve synchronous (in the format of live meetings) and asynchronous components. Regarding the course content, students worked on different project assignments to develop their understanding of concepts related to technology integration and 21st-century skills.

Table 3.
The Design of the Online Course based on the NSSE Engagement Indicators

Engagement Indicators (https://nsse.indiana.edu)	**Specific Items (https://nsse.indiana.edu)**	**Implementation in the Course**
Higher-order learning	Applying facts, theories, or methods to practical problems or new situations	Course assignments
	Analyzing an idea, experience, or line of reasoning in depth by examining its parts	Readings, reflection tasks, & class discussions
	Evaluating a point of view, decision, or information source	Course assignments, feedback, & class discussions
	Forming a new idea or understanding from various pieces of information	Final design task based on previous assignments
Reflective and integrative learning	Combined ideas from different courses when completing assignments	Major-based course assignments
	Learned something that changed the way you understand an issue or concept	Course assignments & reflections
Learning strategies	Identified key information from reading assignments	Readings & other tasks before class
	Reviewed your notes after class	Reflection tasks
	Summarized what you learned in class or from course materials	Reflection tasks & class activities
Effective Teaching Practices	The instructor provided a clear explanation of course goals and requirements	Syllabus & course structure
	The instructor taught course sessions in an organized way	Course structure, course schedule
	The instructor used examples or illustrations to explain difficult points	Live meetings, videos, & blog posts
	The instructor provided feedback on draft or work in progress	Live feedback sessions
	The instructor provided prompt and detailed feedback on tests or completed assignments	Written feedback

To support higher-order learning, students were provided with opportunities to analyze resources regarding the effective use of technology to support 21st-century skills (i.e., critical thinking, creativity, collaboration, and communication), developed projects to support these skills in their future classrooms, and reflected on how their understanding of technology integration evolved after each learning activity in both versions of the course. Students were expected to integrate their pedagogical, technological, and content knowledge into a design task in their final project. In this project, students had an opportunity to form a new understanding from various pieces of information by designing a learning experience that integrated content knowledge from their departmental courses, pedagogical knowledge from their methods courses, and technological knowledge that they gained from the activities being completed in the present online course.

To support reflective and integrative learning, students were asked to design course projects based on their majors to provide opportunities to combine ideas from different classes. After each main learning activity, reading responses and reflection tasks were designed according to the learning strategies engagement indicator. Students were expected to reflect on how their learning process changed their understanding of technology integration in education.

Effective teaching practices indicator played an essential role in choosing the learning technologies to run the course. The technologies used involved Moodle, Zoom, and Panopto, which allowed instructors to provide an organized course structure, share course materials, and give timely feedback on assignments. Live meetings were carefully planned based on the effective teaching practices engagement indicator to increase interaction with the instructor. Course instructors provided constant feedback on draft assignments during online feedback sessions.

To investigate the role of different types of interaction support on students' engagement, two versions of the course (see Table 4) were created, focusing on both asynchronous tasks and synchronous class activities. The first version (V1) is specifically designed to support LC interaction, while in the second version (V2), LL interaction is given more weight, keeping LI interaction the same in both versions. In V1, students mainly were assigned tasks to support their interaction with the content individually, such as to examine materials (text-based, videos, or blogs), and explore additional resources, while in V2, students mostly interacted with their peers before and after class (see Figure 1). The differences between the two course versions can be illustrated considering one of course topics, namely meaningful learning with technology (Figure 2). Before the live class meeting, students in both versions of the course read an article on the topic, were encouraged to think about the content through some guiding questions, and completed a quiz. However, students' responsibilities and roles differed in discussions during the live class meetings. In V1, the instructor conducted a whole-group discussion minimizing peer interaction. In V2, she created Zoom breakout rooms for small groups to increase peer interaction. After the live class meetings, students in V1 were expected to submit an additional resource on meaningful learning with technology and use it in their reflection assignment. The students in V2 were required to submit their group discussion summary to the Forum on Moodle and to write a short response to one of the other groups' summary posts in addition to writing reflections.

Table 4.
The Two Versions of the Online Course

Version 1 (shortly the LC group)	LC & LI interaction supported; LL interaction kept at the minimum
Version 2 (shortly the LL group)	LL & LI interaction supported; LC interaction kept at the minimum

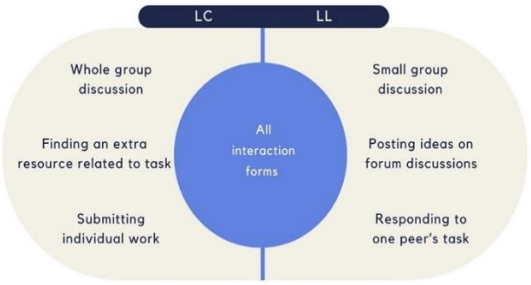

Figure 1. *Typical Tasks and Forms of Interaction Compared in the Two Versions of the Course*

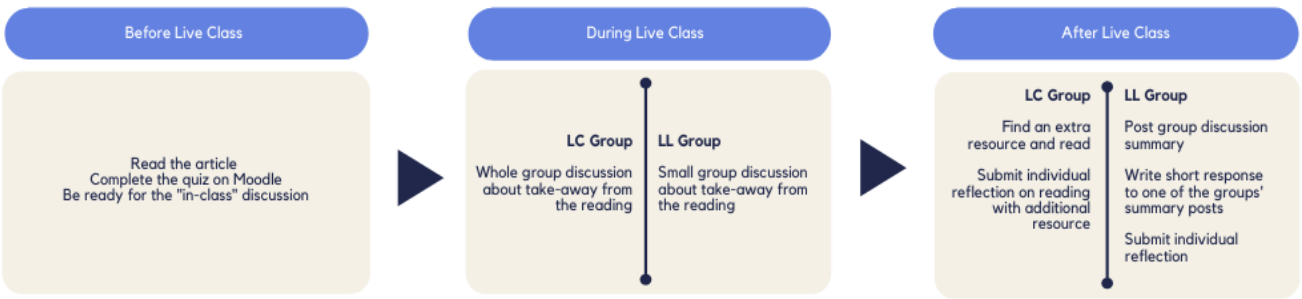

Figure 2. *Tasks and Forms of Interaction for the "Meaningful Learning with Technology" Topic in the Two Versions of the Course*

The two sections of the course were equivalent in terms of the covered content and types of assignments. The only difference was the type of support students received regarding LC and LL interaction in synchronous and asynchronous course tasks and activities.

2.1.1 The Survey

Students in both sections of the course were given a version[1] of the NSSE survey (NSSE, 2013) at the beginning and at the end of the course. The original NSSE survey aims to assess the whole educational college experience, not just one-course experience. Thus, the items related to only one-course experience were used, which involved 17 items. For example, the items regarding the campus environment (see below) were not used since they required students to consider factors not directly related to the present online course.

"Indicate the quality of your interactions with the following people at your institution:
Students
Academic advisors
Faculty
Student services staff (career services, student activities, housing, etc.)
Other administrative staff and offices (registrar, financial aid, etc.)"

No new items were added to the survey. For the instrument's reliability, Cronbach's alpha value was calculated based on the data of 54 preservice teachers, different from the study participants, who took the 17-item survey. The result indicated a Cronbach's alpha of .81.

For the pre-test, which was given at the beginning of the semester, the participants were told to respond to the survey questions considering their school experience until that point. At the post-test, they were told to consider only their experience in the present online course.

2.1. Data Analysis

The survey results were scored using the NSSE scoring instructions. The items were converted to a 60-point scale. For example, "never," "sometimes," "often," and "very often" received 0, 20, 40, 60 points, respectively. Then the points were summed. That way, for each administration, a single engagement score was calculated for each participant.

After checking parametric test assumptions, a 2x2 mixed ANOVA analysis was used to answer the first three research questions. The within-subjects factor involved time (pre-test and post-test), and the between-subjects factor involved the two groups of students in the two sections of the course (V1 &V2). Both time and group main (the two versions of the course) effects and the interaction effect were investigated. In order to analyze differences in students' course achievement, students' course assignments and final course projects were evaluated using detailed rubrics to determine a final score (see Appendix A). After checking parametric test assumptions, the Mann-Whitney U test was used to compare the means of groups (those in V1 & V2) in terms of final course achievement.

3. FINDINGS

RQ1: Is there a significant difference between students' NSSE engagement scores before and after taking the online course?

Before carrying out the 2x2 mixed ANOVA analysis, parametric test assumptions, including the level of measurement, independence of observations, normality of distribution, homogeneity of variance, were checked. The level of measurement assumption was satisfied since students' engagement was measured with NSSE survey scores. Furthermore, the independence of observation assumption was also fulfilled since one measurement did not impact the other one. In order to check the normality of the dependent variable, skewness and kurtosis values were calculated. The z-values of skewness and kurtosis values for pre-and post-test scores were in the acceptable range, between -1.96 and 1.96. In addition, the Shapiro-Wilk test results suggested that pre- and post-test engagement scores were normally distributed (Table 5). The Levene's test was not significant for both pre- and post-test scores (Table 6), thus the homogeneity of variances can be assumed.

[1] NSSE items were used with permission from The College Student Report, National Survey of Student Engagement, Copyright 2001-19 The Trustees of Indiana University.

Table 5.
Shapiro-Wilk Test

	Groups	Statistic	df	Sig.
Pre-test	LC	.939	20	.225
	LL	.948	18	.398
Post-test	LC	.953	20	.421
	LL	.945	18	.345

Table 6.
Levene's Test

		Levene Statistic	df1	df2	Sig.
Pre-test	Based on Mean	1.687	1	36	.202
Post-test	Based on Mean	3.213	1	36	.081

As seen in Table 7, the descriptive statistics results showed that students in both versions of the course increased their engagement scores after the intervention. The analysis revealed a statistically significant difference between participants' pre- and post-test scores, $F = 5.172$, $df = 1.00$, $p < .05$ (see Table 8) with a large effect size ($\eta^2 = .126$). In other words, participants' engagement scores significantly increased after attending the online courses.

Table 7.
Descriptive Statistics

	Group	Mean	Std. Deviation	N
Pre-test	LC	602.00	153.266	20
	LL	670.00	119.065	18
	Total	634.21	140.571	38
Post-test	LC	638.00	197.233	20
	LL	761.11	118.515	18
	Total	696.32	174.099	38

Table 8.
Tests of Within-Subjects Effects

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Time	Sphericity Assumed	76534.269	1	76534.269	5.172	.029	.126
	Greenhouse-Geisser	76534.269	1.000	76534.269	5.172	.029	.126
	Huynh-Feldt	76534.269	1.000	76534.269	5.172	.029	.126
	Lower-bound	76534.269	1.000	76534.269	5.172	.029	.126
Error (Time)	Sphericity Assumed	532728.889	36	14798.025			
	Greenhouse-Geisser	532728.889	36.000	14798.025			
	Huynh-Feldt	532728.889	36.000	14798.025			
	Lower-bound	532728.889	36.000	14798.025			

RQ2: Is there a significant difference between students who took V1 and students who took V2 of the course regarding their engagement scores?

There was a statistically significant group main effect, $F = 5.500$, $df = 1$, $p <. 05$ (Tables 9 & 10) with a large effect size ($\eta^2 = .133$). Thus, there was a significant difference between overall engagement scores of students who took V1 and students who took V2 of the course.

Table 9.
Estimated Marginal Means for Group

Group	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
LC	620.000	28.044	563.125	676.875
LL	715.556	29.561	655.604	775.507

Table 10.
Tests of Between-Subjects Statistics

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	33796584.795	1	33796584.795	1074.339	.000	.968
Group	173005.848	1	173005.848	5.500	.025	.133
Error	1132488.889	36	31458.025			

RQ3: Does any interaction occur between attending to one of the two versions of the online course (V1 & V2) and the time of tests?

To analyze whether students' pre and post-test scores changed regarding the course version attended, the interaction effect between the "group" and the "time of the test" was examined (Table 11). Even though there was a significant main effect of time $F = 5.172$, $df = 1.00$, $p < .05$ and group $F = 5.500$, $df = 1.00$, $p < .05$, there was no statistically significant interaction effect between time and group $F = .972$, $df = 1.00$, $p > .05$ as seen in Table 12. In other words, the improvement in the engagement scores can be considered homogenous for both groups of students who attended the two different versions of the course.

Table 11.
*Estimated Marginal Means for Group*Time*

Group	Time	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
LC	Pre	602.000	30.897	539.338	664.662
	Post	638.000	36.854	563.257	712.743
LL	Pre	670.000	32.568	603.949	736.051
	Post	761.111	38.847	682.325	839.897

Table 12.
Tests of Interaction Effects

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Time * Group	Sphericity Assumed	14386.901	1	14386.901	.972	.331	.026
	Greenhouse-Geisser	14386.901	1.000	14386.901	.972	.331	.026
	Huynh-Feldt	14386.901	1.000	14386.901	.972	.331	.026
	Lower-bound	14386.901	1.000	14386.901	.972	.331	.026
Error (Time)	Sphericity Assumed	532728.889	36	14798.025			
	Greenhouse-Geisser	532728.889	36.000	14798.025			
	Huynh-Feldt	532728.889	36.000	14798.025			
	Lower-bound	532728.889	36.000	14798.025			

RQ4: Is there a significant difference between students who took V1 of the course and students who took V2 of the course in terms of their course achievement scores at the end of the treatment?

Before carrying out the analysis to investigate participants' course achievement, parametric test assumptions were controlled. A Mann-Whitney U test was used instead of a t-test since the achievement scores are not assumed to be normally distributed based on the Shapiro-Wilk test results. The results of these analyses are shown in Table 13 and 14.

Table 13.
Shapiro-Wilk Test on Achievement Scores

	Groups	Statistic	df	Sig.
Achievement	LC	.805	20	.001
	LL	.749	18	.000

Table 14.
Mann-Whitney U Test

Group	N	Mean Rank	U value	Z value	p value
LC	20	18.60	198.000	-.526	.599
LL	18	20.50			

A Mann-Whitney U Test revealed no significant differences between the achievement scores of LL group (Md = 91.97, n =18) and LC group (Md = 90.47, n = 20), U =198.000, z = –.526, p = .599, r = .09. That is, the course achievement of students who were in the two different course versions (V1 & V2) did not significantly differ.

4. DISCUSSION AND CONCLUSIONS

This study primarily investigated ways of improving preservice teachers' engagement in a teacher education course designed for online delivery and offered during the compulsory distance education period caused by the COVID-19 pandemic. A 2x2 mixed ANOVA analysis allowed us to examine both the role of online course design based on the NSSE engagement indicators (time within-subjects factor) and the types of interaction on students' engagement (group between-subjects factor). We further examined the interaction effect between group (being in one of the two versions of the online course) and time (pre-and post-test) main effects. The findings showed that the online course design based on the NSSE engagement indicators was effective for improving students' engagement in a project-based teacher education course even within the compulsory distance education period during the COVID-19 pandemic. That is, we found a significant difference between students' post- and pre-test engagement scores regardless of the course version they attended. Meanwhile, we did not identify any interaction effect between attending to the different course versions and the time of engagement scores (pre- and post-tests). That is, the participants did not differ in terms of engagement scores in time regarding the course version they attended. Furthermore, there was no difference regarding students' achievement scores as measured by their final course grades.

The findings of the present study should be interpreted considering the pandemic circumstances. For instance, in recent studies, scholars identified lower emotional engagement of undergraduate students in online environments compared to face-to-face ones during the pandemic (Castro & George, 2021; Salta, Paschalidou, Tsetseri, & Koulougliotis, 2022; Sum, Ivy, & Wong, 2021; Walker & Koralesky, 2021). Most argued that lower engagement in online learning was due to lack of LI and LL interactions. Similarly, examining the effects of LI, LL, and LC interactions on preservice teachers' self-regulation in online learning, Kara, Kukul, and Çakır (2021) found that LL and LC interactions significantly affected perceived learning and satisfaction of learners. Moore (1989) argues that three types of interaction (LL, LC, and LI) provide essential guidance to improve student engagement in online learning. He further suggests instructors "organize programs to ensure maximum effectiveness of each type of interaction, and ensure they provide the type of interaction most suitable for various teaching tasks of different subject areas, and learners at different stages of development" (Moore, 1989, p. 5). Our findings showed that in the context of a project-based teacher education course, students' engagement increased regardless of the version of the online course they attended. Also, there was no statistically significant difference in students' course achievement in the two versions. That is, one can conclude that either supporting LI and LC or LI and LL interaction were equally effective. This finding can be explained by the fact that both versions of the course were carefully designed based on the NSSE engagement indicators.

Due to the context of the present online course, we were not able to investigate the role of LI interaction in this study. Manipulating the LI interaction in either section would cause a perception of inequality regarding instructor support, which is deemed essential, especially in the pandemic period (Hamdan et al., 2021; Sason & Kellerman, 2021). We instead chose to keep LI support constant and at a high level in both sections of the course. In the present study, LI interaction was provided before, during, or after live class sessions to improve engagement and facilitate student learning. In their meta-analysis, Bernard et al. (2009) found that supporting LI interaction proved less effective on student achievement than LC and LL interaction. Quadir, Yang, and Chen (2022) distinguished between two types of learning outcomes as subjective and objective. While subjective learning outcomes referred to "the learners' self-perceived learning performance and satisfaction with their learning experience" (p. 294), objective learning outcomes are defined in terms of the results of exam, quiz, or report-based assessments given to the students during the course. They found that all three types of interactions, LC, LI and LL, were influential on subjective learning outcomes, while only LL and LC interactions significantly influenced objective learning outcomes in a graduate level blog-based course. That is, LI interaction did not appear to have an effect on objective learning outcomes in their study. However, Jaggar and Xu (2016) suggested that when high-level LI interaction was offered in online courses, student achievement increased as students became more dedicated to the course and academically performed better. Therefore, future research could investigate the role of LI interaction on students' course achievement and engagement in similar project-based teacher education courses in contexts that allow manipulation of LI interaction.

Several researchers also highlighted the importance of choosing pedagogically-appropriate combinations of interaction types rather than the cost and time considerations as argued by Anderson (2003) (Bernard et al., 2009; Carroll, Lindsey, Chaparro, & Winslow, 2019; Meyer, 2014). Although interaction as a core premise for meaningful and engaging learning (Wang, Chen, & Anderson, 2014) has been investigated widely, interaction by itself does not ensure that learners engage in an online learning process (Padilla Rodriguez & Armellini, 2015). If the design of online activities is not pedagogically oriented, favoring one interaction type over others may harm educational practices and adversely affect learner engagement. In this sense, this study

also underlines the importance of meaningful incorporation of interaction types into learning tasks rather than merely focusing on the quantity of interaction types (Garrison & Cleveland-Innes, 2005).

The course design described in this paper may provide useful guidelines for teacher educators and instructional designers who would aim to design engaging online courses. This study also highlighted the need to develop online courses based on sound frameworks and provided insight into prioritizing different types of interactions in online course design in teacher education. As for further research, similar course designs could be implemented in disciplines other than teacher education given that different subject areas might require different combinations of support regarding the three types of interaction. In addition, a fully asynchronous course could be designed to better investigate the role of LI interaction on learners' engagement.

Research and Publication Ethics Statement

Bogazici University Institutional Review Board for Humanities and Social Sciences (SBINAREK) reviewed and approved the present study before data collection with the date and meeting number 15.11.2019 - 2019/8. All ethical procedures were followed during and after completing the study.

Contribution Rates of Authors to the Article

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Statement of Interest

The authors declare no conflict of interest.

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Appendix A: Final Project Rubric

Project Component	Description	Points
Introduction	• Tell about your background and the rationale behind your topic choice. • Give an overview of your topic/ material. • This page should include an introduction to the topic/material for parents or students: the purpose of activities, helpful hints, what kind of materials should be used, in what sections parental guidance may be needed, tips for extension activities (virtual field trips, additional books, etc.).	/10
Inquire – Question	• An engaging introduction to the unit – Essential Question (You may have more than one.) • Parents and students should know what the adventure is about based on this question. • Include learning objectives.	/25
Hook – Anticipatory Set	• Present some facts, website resources, additional questions, etc. – this is where you get students prepared for the question. • Include two+ appropriate online games or activities related to your questions – don't just provide a link, give instructions to students to do something with the material you present in this section o Examples: They may answer a few questions in the WebQuest o They can play the game and share their scores o They may ask their questions on a Padlet wall or Discord	/30
Explore - Guiding the Research	• After being introduced to the topic in the previous steps, students will begin to research their questions at this stage. • Provide a list of websites, videos, or tutorials (this can be your mini-tutorial) that are appropriate for your target group of learners. • Ensure you are not just listing resources but describing the content briefly and assigning a task to students when they explore the resource. Do not forget to assign a task to students after they explore each resource. You can ask them to create a poster, create a video/animation, or an interactive presentation using the information they gather from the resources.	/35
Show What You Know – Student Product	• This is the product – after they've completed all the previous steps, what can learners create as an artifact of their learning? This will be a creative endeavor. You should provide a rubric or guidelines to ensure quality.	/20