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Students Engagement in Science during Covid-19 Pandemic: Role of Self-Efficacy Beliefs and Achievement Goals

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ABSTRACT This study investigated the relationships among achievement goals, self-efficacy beliefs, and engagement in science during COVID-19. Distance education was launched due to COVID-19, and there is a need to examine these relations in the online science learning context. Participants were 448 students between 5th and 8th graders receiving distance education for eight months. Path analysis indicated mastery-approach goals and particular self-efficacy aspects positively predicted student engagement. Science communication and conceptual understanding have become prominent among self-efficacy aspects, while higher-order cognitive skills were unrelated to student engagement. Also, negative linkages were identified between performance-approach goals, emotional engagement, cognitive engagement, and performance-avoidance goals. The variance explained in the engagement components ranged from 47% to 60%. Some of the participants' engagement and motivation in science were negatively affected by distance education. Suggestions were made to foster students' engagement and motivation in distance science education.

Keywords Engagement, Achievement Goals, Self-Efficacy, Distance Science Education, COVID-19 Pandemic

1. INTRODUCTION

Formal education programs have been delayed in several countries of the latest COVID-19, affecting approximately 1.6 billion students worldwide (UNESCO, 2020a; UNESCO, 2020b). In many countries, distance education was launched, and classes started to be held online. Recent studies have begun to reveal the impacts of the pandemic on education, like low student engagement during remote learning (Ewing & Cooper, 2021), and maladaptive patterns are expected in students' motivation and academic engagement due to converting academic programs to online platforms (Parker et al., 2021). Due to low motivation and challenges in accessing services by low-income students, all students didn't have an equal opportunity to learn in distance education during the transition. By comparing the era of school environment education to distance education, there was a large proportion of absent students (Santibañez & Guarino, 2020). Indeed, students' motivation is a prominent antecedent of students' engagement (e.g., Jang, Kim & Reeve, 2012; Reeve & Lee, 2014). Highly motivated students engage in learning-related practices and are willing to learn (Brown, 2009; Mustafa, Elias, Noah & Roslan, 2010). The current study conceptualizes students' motivation as achievement goals and self-efficacy beliefs. It aims to investigate the roles of these motivational constructs on middle school students' engagement in science during the COVID-19 pandemic.

Student engagement is the individual's active, constructive, and purposeful interaction with the learning process (Martin & Bolliger, 2018; Skinner, Zimmer-Gembeck & Connell, 1998). Self-efficacy is one-factor affecting student engagement (Bangga, 2021; Linnenbrink & Pintrich, 2003). Self-efficacy is related to individuals' beliefs in their abilities to succeed in academic studies (Al-Abyadh & Abdel Azeem, 2022; Bandura, 1986). Recent research points out the importance of examining students' multi-faceted self-efficacy in science learning (Lin, 2021). Besides self-efficacy, achievement goals are related to students' engagement. Achievement goal theory is based on the goals that cause the individual to perform the behavior (Shim & Ryan, 2005). These goals are correlated to different degrees with learning strategies, motivation,

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and emotions (Huang, 2012; Wigfield & Cambria, 2010; Wirthwein, Sparfeldt, Pinquart, Wegerer & Steinmayr, 2013).

Many studies have investigated the connections between engagement, achievement goals, and self-efficacy beliefs of students in face-to-face learning environments (e.g., Al-Baddareen, Ghaith & Akour, 2015; Diaconu-Gherasim, Măirean & Brumariu, 2019; Diseth, Danielsen & Samdal, 2012; Uçar & Sungur, 2017; Jiang, Song, Lee & Bong, 2014; Kıran, Sungur & Yerdelen, 2019; Wirthwein, Sparfeldt, Pinquart, Wegerer & Steinmayr, 2013). However, there is a need to examine the relationships between the listed variables in the distance education process with the COVID-19 pandemic. Understanding the underlying relations may help specify precautions to promote students' engagement and motivation in science during the pandemic and distance education.

During the pandemic, science lesson was significantly affected. A study examining science teachers' opinions during the distance education period Another study revealed that secondary school teachers expected a decrease in students' performance in STEM subjects due to lack of contact hours with students and deprivation of e-learning activities for interacting with teachers (Sintema, 2020). This study will examine the relationships between engagement, self-efficacy, and achievement goals of students in science lessons who have been experiencing distance learning for eight months in Turkey. Thus, this study primarily examines how achievement goals and self-efficacy beliefs relate to science engagement. Along these lines, we proposed that self-efficacy beliefs would be linked to concentration directly and indirectly through its effect on achievement goals. The secondary aim of this study is to investigate students' thoughts on the impact of distance education on their engagement and motivation in a science lesson.

1.1 The Relationship between Self-Efficacy Beliefs and Achievement Goals

Being capable and knowledgeable is not enough for individuals to be successful in their work. Individuals' self-efficacy beliefs indicate their persistence in achieving success and willingness to start and concentrate on the goal (Bandura, 1982; Shi, 2021). For instance, the student's evaluation of their abilities in learning the fundamental concepts taught in the class indicates self-efficacy (Salili & Lai, 2003). Past experiences, performances, and psychological states are all factors that influence self-efficacy beliefs. (Li, Xu & Zhao, 2022; Schunk, 1984). Self-efficacy is emphasized in motivation theories as a fundamental condition (Deci & Ryan, 2012). In this respect, individuals can meet their competency needs after meeting the self-efficacy condition, which is crucial. This situation demonstrates that students' self-efficacy, which drives their behavior, is linked to their achievement goals and competencies (Elliot & Hulleman, 2017). Students' perceptions of their self-efficacy beliefs also play an essential role in academic life because students' views of their competencies are linked to how they define competence. How students perceive themselves can lead them to success or failure (Elliot, 2006).

Although the self-efficacy of students in science learning was generally assumed as unidimensional, recent research assesses it as multidimensional, including dimensions of conceptual understanding, science communication, everyday applications, practical work, and higher-order cognitive skills (e.g., Lin, 2021; Wang, Liang & Tsai, 2018). Conceptual understanding is students' confidence in their abilities to know definitions of basic science concepts and explain charts/graphs about science. Higher-order cognitive skills assess efficacy beliefs for employing more complex skills like designing scientific experiments to verify their hypotheses. Practical work relates to students' efficacy beliefs for using laboratory equipment and performing laboratory activities. In contrast, everyday applications measure students' judgments about their abilities to utilize scientific methods to solve daily problems. Lastly, science communication measures students' feeling comfortable declaring their opinions about science issues and discussing them with others in the class (Wang, Liang & Tsai, 2018). This multi-faceted structure of self-efficacy is considered to capture its various aspects in this study. However, the practical work dimension was not used because, during distance education, students could not use laboratory equipment and do laboratory experiments. Therefore, besides practical work, this study addressed the rest of the efficacy aspects.

Another well-researched motivation theory related to students' learning outcomes is the achievement goal theory (Ames, 1992; Chazan, Pelletier & Daniels, 2022; Dweck, 1986). According to the theory, the individual's goal orientation consists of four fundamental dimensions. These are the mastery approach, performance approach, mastery-avoidance, and performance-avoidance goals. Individuals with mastery-approach goals aim to improve their knowledge and skills when fulfilling a task. These people are always trying to learn new things, collaborating with other students, and self-evaluating how much they have learned and how far they have progressed (Elliot & McGregor, 2001; Pintrich, 2000a; Thorkildsen & Nicholls, 1998). While the individual with a mastery goal has only themself as an opponent, the individual with a performance goal uses others as a reference, tries to demonstrate their abilities to others, compares their achievements with peers, and attaches importance to others' opinions. Thus, performance goal orientation is affected by environmental reactions (Ames & Archer, 1987; Murdock, Hale & Weber, 2001). A person with mastery-avoidance goals avoids being misled by learning and failing to master goals. In contrast, a person with performance-avoidance goals avoids being unsuccessful compared to others (Elliot & McGregor, 2001).

According to Schunk & Pajares (2009), self-efficacious students adopt approach goals and put more effort into achieving the values they have embraced. On the other hand, students with low self-efficacy beliefs pursue avoidance goals and try less for their objectives. In a meta-analysis study, Huang (2016) investigated the relationships between achievement goals and self-efficacy in 125 studies. The study showed that self-efficacy was weakly correlated to mastery-avoidance and performance-avoidance goals, while the links between mastery-approach goals and self-efficacy were moderate to strong. In a recent meta-analysis (Strunk, Lester, Lane, Hoover & Betties, 2021), mastery avoidance was tested using meta-analytic confirmatory factor analyses. It was shown that models fit the data better without mastery avoidance, and the authors recommended that researchers not include mastery avoidance.

Additionally, in their qualitative study, Lee & Bong (2016) examined the explanations of middle school students regarding their achievement goals with the student's statements. And found that mastery-avoidance goals were rare among students. Based on these results, in the current study, we discluded mastery-avoidance goals and focused on mastery-approach, performance-approach, and performance-avoidance goals.

1.2 Student Engagement and its Relation with Achievement Goals and Self-Efficacy

Student engagement has generally been addressed in three dimensions emotional, cognitive, and behavioral (Fredricks, Blumenfeld & Paris, 2004). Students' fear, anxiety, happiness, and enjoyment are examples of emotional engagement; students' strategy development and reasoning are examples of cognitive engagement; lastly, students' involvement in tasks and demonstrating appropriate behaviors during the lesson are examples of behavioral engagement (Fredricks, Blumenfeld & Paris, 2004). Then, agentic engagement was added to the literature by Reeve & Tseng (2011). Agentic engagement is the student's active contribution to the class, such as telling the teacher their favors and disfavors in the classroom and making suggestions about it.

Empirical studies generally revealed positive relationships between approach goals and student engagement (e.g., Kıran, Sungur & Yerdelen, 2019). To illustrate, a study conducted with 7th-grade students showed that performance-approach goals positively predicted emotional, agentic, and behavioral engagement but did not predict cognitive engagement. On the other hand, master-approach goals positively predicted all dimensions of engagement in science (Kıran, Sungur & Yerdelen, 2019). In another study with 6th and 7th-grade students, mastery-approach goals positively predicted cognitive, behavioral, and emotional engagement, while performance-approach plans positively predicted emotional, mental, and agentic engagement in science. Finally, another study with 7th-grade students found that mastery-approach goals positively predicted all types of engagement (i.e., cognitive, emotional, behavioral, and agentic). In contrast, performance-approach plans predicted none of the engagement types in science (Hıdıroğlu & Sungur, 2015).

Studies on the relationship between engagement types and self-efficacy have found either a positive or no relationship (e.g., Ferrell, 2012; Lin, 2021; Sökmen, 2021). For instance, Kıran, Sungur & Yerdelen (2019) and Sökmen (2021) found that self-efficacy positively predicted all dimensions of engagement. On the other hand, the self-efficacy estimated cognitive and emotional engagement but was not effective in predicting behavioral and agentic engagement. Ferrell (2012) found that students' self-efficacy beliefs were positively related to cognitive engagement but did not link to affective and behavioral engagement. Another study that conceptualized multidimensional aspects of self-efficacy revealed that particular aspects of self-efficacy were significant predictors of particular engagement dimensions, such as everyday applications being a positive predictor of cognitive and emotional engagement but not significantly predicting behavioral, social, and agentic engagement (Lin, 2021).

1.3 Purpose of the Study

Students' achievement goals, self-efficacy beliefs, and engagement are important throughout their academic life (Salili & Lai, 2003; Schunk & Pajares, 2009). Students' achievement goals contain the motives that drive their behavior and are linked to their self-efficacy beliefs (Deci & Ryan, 2012; Elliot & Hulleman, 2017). In this regard, it is critical to understand students' motivational sources to guide them. The first aim of this study is to explore the relationships among self-efficacy beliefs, achievement goals, and engagement of middle school students

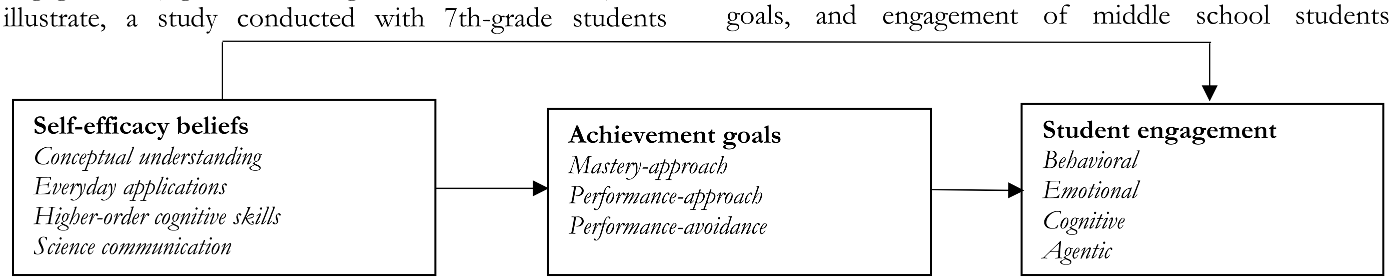

Figure 1 The relationship between study variables

transitioning to distance education due to the COVID-19 pandemic. Figure 1 depicts the relationship between study variables, following the theories and previous research findings. We hypothesized that self-efficacy beliefs predict achievement goals and engagement directly and indirectly through their effect on achievement goals. The second aim of this study is to investigate students' thoughts on the impact of distance education on their motivation and engagement in science.

2. METHOD

2.1 Research Design

That is a quantitative study that seeks to investigate (1) the predictive effect of self-efficacy beliefs and achievement goals on engagement in distance science education and (2) students' thoughts about the effects of distance education on students' engagement and motivation in science during the COVID-19 pandemic. The data were collected through an online questionnaire in November and December 2020. Data were collected in two sessions at three-day intervals to prevent errors due to students' responses to too many scale items.

2.2 Context of the Study

There is 12-year mandatory education in Turkey. Each of the education periods, given at three levels, primary, middle, and high school, lasts four years. The science lesson is a must-course taught four hours a week, from the 3rd grade to the end of 8th grade. The science curriculum adopted the inquiry-based approach, creating objectives and activities in this direction (Ministry of National Education [MoNE], 2018). Students who have finished middle school take the High School Entrance Test, and based on their scores, they can enroll in an appropriate high school.

With the first COVID-19 case on March 13, 2020, in Turkey, primary, middle, and high schools went on a holiday for a week. The MoNE established the necessary infrastructure to provide a TV channel and students to obtain education from such a platform to begin distance learning as part of this process. Afterward, teachers continued to distance education students through Zoom, Skype, and Google Meetings. However, At the beginning of the 2020-2021 academic year, the MoNE began delivering distance learning classes through the Education Information Network (EIN), including several educational videos, queries, and books. Then, the process achieved unity in practice (August 31, 2020). MoNE developed programs consisting of online classes for teachers and students through EIN. The class hours were the same as in the standard term; only the class duration was reduced from 40 minutes to 30 minutes. The MoNE determined the rules for the lessons and notified the schools with an official letter. One of these rules is that students' cameras should not be turned on during live classes to protect personal data. Teachers decided whether to turn on their cameras themselves. In the classes where the data were collected for this study, the science teachers had their cameras on while the students attended the classes with their cameras turned off, and Zoom was used for the online classes. The science teachers mostly used PowerPoint presentations to explain the science topic, showed videos related to the science concepts being taught, and asked questions to the students during the classes. Students answered questions from the teachers by writing their responses in the message area or orally through their microphones. Additionally, the teachers gave students homework mostly consisting of multiple-choice tests about the science topic.

2.3 Sample

The sample comprises 448 middle school students enrolled in two schools selected by convenience sampling method and located in a province in Turkey's east. These students have been receiving distance education for eight months. Students attended the live online classes on average 68.04% (SD= 23.63) of the time. Of the participants, 259 (57.8%) are female, and 189 (42.2%) are male. Regarding grade level, 27.2% were in the 5th, 26.1% were in the 6th, 27.9% were in the 7th, and 18.8% were in the 8th. 80.6% of the participants had a study room at home. 67.2% had no problem with internet access, while 31.3% sometimes had internet access, and 1.6% had no. The education level of the parents is as follows: 38.8% of their mothers and 13.2% of their fathers graduated from primary school, 17.2% of the mothers and 11.4% of the fathers graduated from middle school, 23.9% of the mothers and 40.2% of the fathers graduated from high school, and 18.1% of the mothers and 34.8% of the fathers graduated from college.

2.4 Data Collection

Demographic Information and Attendance in Live Online Classes

The demographic information section asks about the gender, grade levels of the students, possession of a study home at home, internet access, and parents' education level. The student attendance rates in online classes were taken from the EIN's records, where students log in to the online classes affiliated with the MoNE.

Science Learning Self-Efficacy Questionnaire

Items of the science learning self-efficacy questionnaire (Wang, Liang & Tsai, 2018) are responded to on a 5-point Likert-type scale (1= strongly disagree, 5= strongly agree). During distance education, since students did not use the laboratory, items of practical work dimension of the questionnaire were not used in the present study while the rest of the four dimensions were used: (1) The four items in the scale represent the conceptual understanding dimension (e.g., "I feel confident when I interpret graphs/charts related to science"), (2) The higher-order cognitive skills dimension is represented by six items (e.g., "When I come across a science problem, I will actively think it over first and devise a strategy to solve it"), (3) four items about the everyday application dimension (e.g., "I can use scientific methods to solve problems in everyday life") and lastly, (4) four items for science communication dimension (e.g., "In science classes, I can clearly express my opinions"). The scale was translated and adapted into Turkish for middle school students by Sezgintürk & Sungur (2020), who provided validity and reliability evidence for the Turkish version of the scale (the results of the confirmatory factor analysis [CFA] and reliability analysis are stated as follows: fit indices SRMR= .05; CFI= .97; NNFI= .96 and the Cronbach alpha coefficient of the sub-dimensions ranges between .70 and .84). In the present study, CFA was performed and fit indices revealed good model fit (SRMR= .04, CFI= .99, GFI= .91, NFI= .98) and the Cronbach alpha coefficients for the sub-scales ranged between .80 and .89.

Achievement Goals Questionnaire

The achievement goals questionnaire was developed by Elliot & McGregor (2001) and was adopted into Turkish for middle school students by Şenler and Sungur (2007). The 5-point Likert-type scale (1= never, 5= always) has 15 items and four sub-dimensions. This study used mastery-approach, performance-approach, and performance-avoidance sub-scales, while the mastery-avoidance sub-scale was not utilized. The mastery approach is measured with three items (e.g., "It is important for me to understand the content of this course as thoroughly as possible"). There are also three items in the performance-approach sub-scale (e.g., "It is important for me to do better than other students"). On the other hand, performance-avoidance includes six items (e.g., "My goal in this class is to avoid performing poorly."). CFA performed in the Turkish adaptation study proved the scale's validity (GFI= .92, CFI= .92, NFI= .90, SRMR= .07), and Cronbach's alpha coefficients ranged between .64 and .81 for the subscales (Şenler & Sungur, 2007). In the current study, CFA was conducted, and fit indices showed good model fit (SRMR= .05, CFI= .97, GFI= .96, NFI= .97). Additionally, Cronbach's alpha values ranged between .64 and .87.

Student Engagement Scale

A 22-item scale to determine student engagement was used (Reeve & Tseng, 2011). The ranking includes four sub-dimensions. Of these, behavioral engagement (e.g., "I work hard when we start something new in science class") and agentic engagement (e.g., "During science class, I express my preferences and opinions") consist of five items; the affective engagement dimension had four items (e.g., "When we work on something in science class, I feel interested") and cognitive engagement had eight items (e.g., "When doing schoolwork, I try to relate what I'm learning to what I already know"). The scale was adapted to Turkish for middle school students by Uçar & Sungur (2018). CFA results showed that the model fitted the data well (SRMR = .04, RMSEA= .05, CFI= .99). Besides, the researchers found that Cronbach's alpha coefficients for the sub-dimensions ranged between .82 and .88. In the present study, CFA was conducted and fit indices revealed acceptable model fit (SRMR= .05, CFI= .97, GFI= .85, NFI= .95). Cronbach alpha coefficients of sub-dimensions ranged between .65 and .86.

Thoughts about the Effects of Distance Education on Students' Engagement and Motivation in Science Class

Students were asked how their engagement in the science lesson was affected by not being in the same physical environment with the teacher and classmates, from looking at a screen, and from changes made by the students in the online classes. They were also asked how did the science lesson with distance education affects their motivation. These questions were responded to as (1) negatively affects, (2) it affects neither negatively nor positively, (3) positively affects, and (4) I can't attend classes at all. Additionally, participants responded to a Yes/No question about whether they could easily express themselves in the science lesson.

Data Analysis

As explained above, we performed CFA to check the construct validity of the scales used in this study. Although previous studies provided evidence for the construct validity of the scales, we needed to validate the scales given the distance education context of this study. The mean and standard deviation for the study variables were explored to gain insight into the variables. Path analysis was conducted to test the proposed relationships in our model (Figure 1). Lastly, percentages were used to examine participants' thoughts about the effects of distance education. The descriptive statistics were conducted using IBM SPSS 23, while CFA and path analysis were performed using LISREL 8.8 program (Jöreskog & Sörbom, 2007).

3. RESULT AND DISCUSSION

3.1 Descriptive Statistics

Descriptive statistics for the self-efficacy beliefs, achievement goals, and engagement aspects are presented in Table 1. Mean values for self-efficacy aspects were close,

Table 1 Descriptive statistics for the variables

Variables	M	SD	Cronbach's Alpha
Conceptual understanding	3.49	.94	.80
Everyday applications	3.35	.92	.80

Table 1 Descriptive statistics for the variables (*Continued*)

Variables	M	SD	Cronbach's Alpha
Higher-order cognitive skills	3.25	.97	.89
Science communication	3.56	1.04	.84
Mastery-approach goals	4.23	.97	.87
Performance-approach goals	3.83	1.12	.82
Performance-avoidance goals	3.09	.85	.64
Agentic engagement	3.84	.72	.76
Behavioral engagement	3.77	.77	.77
Emotional engagement	3.65	.68	.65
Cognitive engagement	3.66	.75	.86

Table 2 Direct, indirect, and total effects on achievement goals

	Mastery-approach goals			Performance-approach goals			Performance-avoidance goals		
	Direct	Indirect	Total	Direct	Indirect	Total	Direct	Indirect	Total
Conceptual understanding	.30	-	.30	.17	-	.17	.04	-	.04
Everyday applications	.10	-	.10	.06	-	.06	.17	-	.17
Higher-order cognitive skills	-.04	-	-.04	.03	-	.03	.12	-	.12
Science communication	.25	-	.25	.14	-	.14	-.12	-	-.12

Table 3 Direct, indirect, and total effects on student engagement

	Agentic engagement			Behavioral engagement			Emotional engagement			Cognitive engagement		
	Direct	Indirect	Total	Direct	Indirect	Total	Direct	Indirect	Total	Direct	Indirect	Total
Conceptual understanding	.31	.06	.36	.16	.02	.19	.10	.04	.14	.18	.04	.22
Everyday applications	.10	.02	.12	.24	.01	.24	.10	.01	.11	.16	.00	.16
Higher-order cognitive skills	.03	-.01	.02	-.13	.00	-.13	.08	-.01	.07	.02	-.02	.00
Science communication	.18	.05	.23	.43	.02	.45	.36	.04	.40	.39	.05	.44
Mastery-approach goals	.20	-	.20	.05	-	.05	.18	-	.18	.14	-	.14
Performance-approach goals	-.03	-	-.03	.05	-	.05	-.09	-	-.09	.01	-	.01
Performance-avoidance goals	.02	-	.02	.00	-	.00	-.01	-	-.01	-.08	-	-.08

ranging from 3.25 (SD= .97) to 3.56 (SD= 1.04). Students pursued higher levels of mastery-approach goals (M= 4.23, SD=.97) than performance-approach (M= 3.83, SD= 1.12) and performance-avoidance goals (M= 3.09, SD= .85). Mean values for engagement aspects (ranging from 3.65 to 3.84) showed that students engaged in the online science class.

3.2 Relationships among Students' Engagement, Self-efficacy Beliefs, and Achievement Goals

We proposed that self-efficacy beliefs predict achievement goals and engagement directly and indirectly through their effect on achievement goals (Figure 1). Path analysis was conducted to assess the hypothesized relationships. For good model fit, fit indices of CFI, GFI, and NFI values greater than .90 and S-RMR values lower than .08 are recommended (Kelloway, 1998; Kline, 2004). In this study, fit indices showed that the proposed model fits the data well (CFI= .97, GFI= .92, NFI= .97, S-RMR= .07). However, the Chi-Square test was significant (χ^2 = 217.99, df= 3), which may be due to the large size of the sample (Tabachnick & Fidell, 1996).

The standardized path coefficients for direct, indirect, and total effects are given in Tables 2 and 3, and significant paths are shown as graphs in Figure 2. In the model, paths from self-efficacy aspects and achievement goals to engagement variables were determined. These motivational variables accounted for 49% of the variance in agentic engagement. Parameter estimates showed that conceptual understanding (β = .31), science communication (β = .18), and mastery-approach goals (β = .20) were significantly and positively associated with agentic engagement. The most considerable total effect on agentic engagement was from the conceptual understanding (.36). The indirect effect of the conceptual knowledge on agentic engagement was .06,

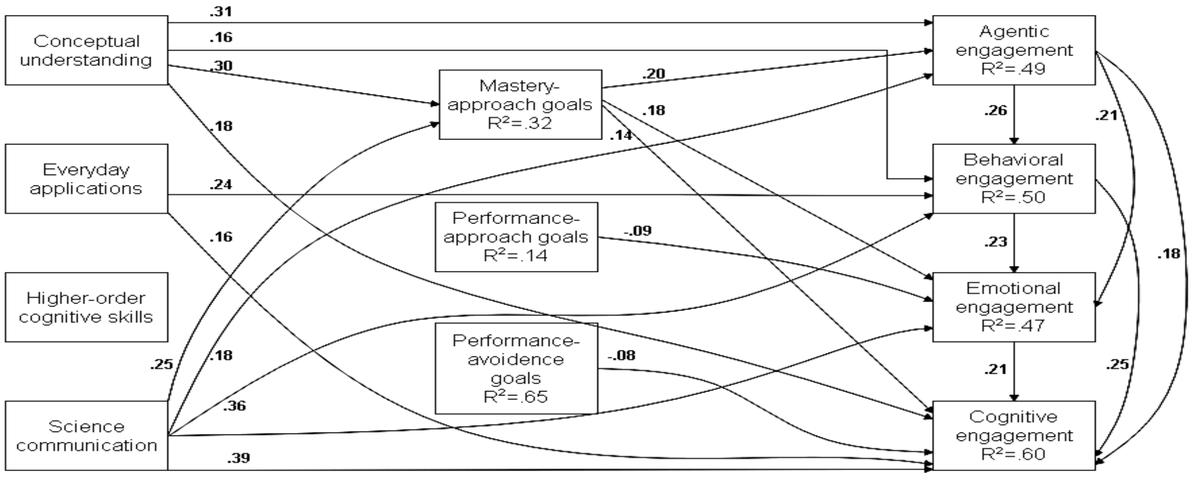

Figure 2 Path model with significant paths only

which could be attributed to the direct impact of this variable on the achievement goals. Indirect effects of everyday application, higher-order cognitive skills, and science communication on agentic engagement were .02, -.01, and .05, respectively.

Half of the variance (50%) in behavioral engagement was explained by self-efficacy aspects and achievement goals. In addition, conceptual understanding (β = .16), everyday applications (β = .24), and science communication (β = .43) were found to be positive and significant predictors of behavioral engagement.

Moreover, self-efficacy aspects and achievement goals explained 47% of the variance in emotional engagement. Parameter estimates showed that science communication (β = .36) and mastery-approach goal (β = .18) were significant and positive, while performance-approach goal (β = -.09) was negatively and significantly associated with emotional engagement.

Self-efficacy aspects and achievement goals accounted for 60% of the variance in cognitive engagement. Parameter estimates showed that conceptual understanding (β = .18), everyday applications (β = .16), science communications (β = .39), and mastery-approach goals (β = .14) were significantly and positively linked to cognitive engagement. In contrast, performance-avoidance goals (β = -.08) were negatively related to cognitive engagement.

When the total effects on behavioral, emotional, and cognitive engagement were examined, the strongest full effects were from the science communication. Science communication has a real impact of .45 on behavioral engagement, .40 on emotional engagement, and .44 on cognitive engagement. The indirect effect of science communication was .02 on behavioral engagement, .04 on emotional engagement, and .05 on cognitive engagement. It is seen that most of the total results were due to direct effects rather than indirect effects. Lastly, regarding the relationships between achievement goals and self-efficacy beliefs, it was found that self-efficacy aspects account for 32% of the variance in mastery-approach goals. Parameter estimates showed that conceptual understanding (β = .30) and science communication (β = .25) were significantly and positively associated with mastery-approach goals. However, only 14% of the variance in the performance-approach plans and 5% in performance-avoidance dreams were accounted for by the self-efficacy aspects, and none of the self-efficacy aspects were significantly related to performance goals.

In brief, analysis results indicated that among self-efficacy variables, conceptual understanding and science communication positively predicted mastery-approach goals and most of the engagement variables. Besides, everyday applications positively predicted behavioral and cognitive engagement. On the other hand, higher-order cognitive skills were not related to any of the engagement aspects and achievement goals. The analysis also showed that while mastery-approach goals were positively associated with most engagement aspects, this was not the case for performance goals. Negative linkages were identified between emotional engagement, performance-approach goals, cognitive engagement, and performance avoidance goals.

3.3 Thoughts about the effects of Distance Education

Participants' thoughts about the effects of distance education on their engagement and motivation in live online science classes were examined using descriptive statistics (Table 3). Some of the student's engagement in the science classes was negatively affected by not being physically in the same environment as their science teacher (41.5%) and with other students (29.9%). Looking at a fixed screen for a long time in science class negatively influenced 35.7% of the student's engagement. More than half of the participants (54.9%) were disrupted by the changes made by their classmates on the online platform, such as turning on and off the camera and writing in the chat. Furthermore, doing the science lesson with distance

Table 4 Participants' thoughts about the effects of distance education on their engagement and motivation in the live online science class

	Negatively affects	It affects neither negatively nor positively	Positively affects	I can't attend classes at all
How does the fact that you are not physically in the same environment as your science teacher affect your engagement in the science lesson?	41.5%	45.3%	11.2%	2%
How does not being in the same physical environment as other students affect your engagement in the science lesson?	29.9%	54.2%	13.6%	2.2%
How does looking at a fixed screen for a long time in science class affect your engagement in the science lesson?	35.7%	47.1%	14.7%	2.5%
How do your friends' changes in the sound, chat, and camera (like turning on and off the camera or writing in the chat) affect your engagement in the science lesson?	54.9%	37.3%	6.0%	1.8%
How does doing the science lesson with distance education affect your motivation in the lesson?	42.6%	43.3%	11.8%	2.2%

education affected 42.6% of the student's motivation in the lesson negatively. Lastly, 73.0% of the participants responded yes to the question, "Can you easily express yourself in the science lesson, such as saying that you do not understand the subject, asking questions, and answering?" while 27.0% responded no. Table 4 shows participants' thoughts about the effects of distance education on their engagement and motivation in the live online science class

4. CONCLUSION

This study explored the relationships among engagement, achievement goals, and self-efficacy beliefs of middle school students who shifted to distance education because of the COVID-19 pandemic. When the predictive effects of self-efficacy aspects on engagement are examined, science communication and conceptual understanding emerge. Science communication predicted all engagement components; conceptual understanding predicted agentic, behavioral, and cognitive engagement; and everyday application positively predicted behavioral and mental engagement. However, higher-order cognitive skills are not related to any engagement component. Higher-order cognitive skills, which refer to students' critical evaluations of their problems, establishing hypotheses, and making systematic observations and research, seem neglected in distance science education. During distance education, to prevent the students' lack of subject knowledge, teachers preferring the activities more in the levels of expertise and comprehension may have caused it. PowerPoint presentations were tools to teach, questions related to the objectives were solved, and the scientific investigations were neglected, which might have affected the result for this dimension. In previous studies, self-efficacy was generally addressed as a unidimensional construct. Their findings revealed that self-efficacy positively predicts all engagement aspects (Kıran, Sungur & Yerdelen, 2019; Sökmen, 2021) or part of them (Ferrell, 2012). One study (Lin, 2021) examined multi-facet self-efficacy (i.e., practical work, conceptual understanding, everyday applications, higher-order cognitive skills, and science communication) to engage. Two or three of the self-efficacy components positively predicted mental, behavioral, emotional, social, and agentic engagement components.

Moreover, this study showed that students with high mastery-approach goals were more genetically, emotionally, and cognitively engaged. In contrast, students with performance-approach goals had low levels of emotional engagement, and students with performance-avoidance goals had low levels of cognitive engagement. The variance explained in engagement aspects by achievement goals and self-efficacy varied between 47% and 60%. Previous studies generally showed that performance-approach and mastery-approach goals were positively related to engagement dimensions (Kıran, Sungur & Yerdelen, 2019). However, some studies did not show a connection between performance-approach goals and performance-avoidance-goals with the dimensions of engagement (e.g., Hıdıroğlu & Sungur, 2015) or found that performance-approach goals were positively related to particular engagement aspect (e.g., Shi, 2021). For instance, Shi (2021) found that performance-approach purposes were positively associated with agentic engagement while unrelated to behavioral, emotional, and cognitive engagement. However, the current study's finding of a negative relationship between emotional engagement and the performance-approach goal was unexpected. We thought that the distance education process might affect this result. MoNE has repeatedly warned school administrators and teachers not to open students' cameras in live online classes during distance education. These precautions aim to protect students but may also affect performance-approach goal-oriented students and their emotional engagement. The students in an online setting with an off-camera could have less chance to express their emotions and feel unable to demonstrate their abilities to their peers and teacher. Although performance-approach goal-oriented students are interested in demonstrating their expertise and skills to others, gaining their appreciation, and ranking among accomplished students (Pintrich, 2000b), live classes cannot provide many opportunities for them. Therefore, these results conducted in distance education can be different from the other studies of face-to-face education. Although students with performance-approach goals contrast themselves to others when assessing their accomplishments, since they focus on their development and use themselves as a reference point (Pintrich, 2000b), distance education may influence mastery-approach goal-oriented individuals less negatively. This speculation of whether students with performance-approach and mastery-approach goals are differentially affected by distance education needs to be investigated in future studies.

When the predictive effects of self-efficacy components on achievement goals are examined, we see that conceptual understanding and science communication was positively linked to mastery-approach goals. Previous studies also indicated strong and positive relationships between mastery-approach goals and self-efficacy (e.g., Deci & Ryan, 2012; Linnenbrink, 2005; Ryan, Patrick & Shim, 2005). However, this study determined that self-efficacy did not predict performance-avoidance and performance-approach goals. Contrary to these results, previous studies indicated a positive relationship between self-efficacy and performance-approach goals (e.g., Elliot & Church, 1997; Salili, Chiu & Lai, 2001). However, similarly to our results, no relationship was determined between performance-approach goals and self-efficacy in some other studies (e.g., Huang, 2016).

Some participants reported that their engagement in the science classes was negatively affected by not being physically in the same environment as their science teacher and peers in online science classes. That might be due to students' unfamiliarity with distance education because they were used to face-to-face learning before the pandemic. This incline that we should prepare students for unexpected events like the pandemic so that they can be less affected by such transitions in the education system. Consulting hybrid education, which incorporates both face-to-face and distance education, might be helpful, even when the pandemic is over. Furthermore, some of the participants reported that doing the science lesson with distance education negatively affected their motivation in the lesson. These findings suggest that not all students were equally affected by distance education regarding their engagement and motivation in science. Some had difficulty expressing themselves in the lesson by saying they did not understand the subject, asking questions, and answering. They were disrupted by their peers' online behaviors, such as turning on and off the camera and writing in the chat. At this point, enhancing teachers' teaching abilities in distance education might be helpful to prevent students' disruptive behaviors in online settings and give students opportunities for participation in the lesson.

Due to their positive predictive effect on students' engagement, supporting students' mastery-approach goals and self-efficacy beliefs seems essential in science. For instance, allowing students to make suggestions about how the lesson should be structured and asking more questions may help prevent them from being distracted during live science classes. Students can be assigned tasks and homework aligned with their interests and skills, suitable for their levels, and achievable (Ames, 1992; Dweck, 1986; Elliot & Dweck, 1988). Assigning diverse tasks new for students and setting short-term goals is also recommended. Furthermore, when assessing a student's success in the process, teachers should not compare students; instead, their personal development should be evaluated using the student in question as a reference. Appreciating the students' efforts, telling them that making errors is a part of the learning process, involving students in the decision-making process, and supporting students' autonomy in the learning environments such as by providing opportunities for students to take the initiative and work independently are highly recommended in this regard (Ames, 1992).

This study has some limitations, though. First, the relationships between engagement, self-efficacy, and achievement goals were investigated without any attempt to impact their and students' thoughts about the effect of distance education on their engagement and motivation in science were described. Having a correlational and descriptive research design, establishing a cause-effect relationship based on the results is inappropriate (Fraenkel, Wallen & Hyun, 2012). Future research can investigate the effects of factors in distance science education, such as involving students in decision-making, on students' motivation and engagement. Moreover, in addition to the closed-ended survey questions tapping students' thoughts about distance education, open-ended questions can be used, which may provide in-depth information about students' ideas. Lastly, convenience sampling limits the generalizability of the findings (Fraenkel, Wallen & Hyun, 2012).

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