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Flipped learning readiness in teaching programming in middle schools: Modelling its relation to various variables

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Abstract

The aim of this study is to investigate the effect of students' flipped learning readiness (FLR) on engagement, programming self-efficacy, attitude towards programming, and interaction intensity in the information and technology classrooms where programming is taught with the flipped classroom (FC) model. The study group of this research, which is designed by the relational screening method, consists of 371 students studying in middle school. Structural equation model was used for the data analysis. The results of the study revealed that FLR and its indicators in the programming teaching conducted with the FC model are significant predictors of engagement, attitude, programming self-efficacy, and interaction intensity. FLR is most strongly related to programming self-efficacy, whereas it is most weakly related to interaction. The most striking result of this study is that the FC model is an effective option in terms of providing engagement, interaction, self-efficacy, and learner attitude, which are the key components for the success of the instruction. It is thought that this study assists to create an awareness on the impact of FLR on students, on subjects that frame in-class attitudes, and behaviours of students.

KEYWORDS

attitude towards programming, engagement, flipped learning readiness, middle school, programming self-efficacy, programming teaching

1 | INRODUCTION

In our age, interaction via computers has been increasing day by day (Manovich, 2013). Computers and acting as a "computer" have become necessities in order to understand and solve the problems confronted in a world that is surrounded by programs. Therefore, individuals should possess known programming languages and code literacy in order to participate in daily life activities (Rushkoff, 2010).

After all, recently, different approaches have emerged on how to integrate technology into education to increase success in education (Li et al., 2014), and FC model is one of the prominent approaches to technology integration into education (Li et al., 2014), which is a type of blended learning (Alsancak Sirakaya, 2015). However, it has been reported in the literature that various difficulties emerge in terms of programming teaching (Bosse & Gerosa, 2017; Gomes & Mendes, 2007; Hill, 2015). For instance, Chen (2014, pp. 2–3) compiled the difficulties that occur in programming teaching and stated that these difficulties are "monotony and abstractness (e.g. variables, constants), diversity in students' background and skills, the perception that programming content is difficult, lack of problem solving and rational thinking skills, inability to make a connection between theoretical and practical education, low motivation and attitude towards learning programming." Furthermore, when they confront problems and difficulties, students may lose their motivation and willingness for programming (Giannakos, Krogstie, & Chrisochoides, 2014; Jenkins, 2002; Tugun, Uzunboylu, & Ozdamli, 2017). If students are not motivated, they cannot learn (actively) and be successful (Ryan & Deci, 2000). Chen (2014) indicated that more learning opportunities should be created for students in terms of programming activities and FC model (Francl, 2014) in which teaching is performed through videos before lectures.

Of note, the level of effort to cope with the problems faced by the students in the FC model may decline over time depending on their level of engagement, interaction, attitude, and self-efficacy (Lape et al., 2014; Smit, Brabander, & Martens, 2014). Hence, in order to ensure the effectiveness of the FC model, it is necessary that students have a similar level of engagement in the online and in-class activities of the course and show a similar level of interaction in these environments (Bishop & Verleger, 2013). Similarly, self-efficacy and attitude towards the course can affect the frequency of the engagement in activities and the willingness in the FC model and thus could decrease the learning performance (Freeman et al., 2014; Karaca & Ocak, 2017; Stone, 2012). Consequently, success in FC model comes with understanding students' ability to realize the tasks, needs, and readiness for them (Mercado, 2008). As a matter of fact, readiness in FC is a concept that requires and encompasses the ability of an individual to benefit from the advantages of online learning (Lopes, 2007), being physically and mentally ready for learning (Borotis & Poulymenakou, 2004) and the ability to use technology (Demir, 2015). For this reason, it is important to examine FLR and its related variables in a course including teaching complex skills such as programming in FC so that the learning process and outputs can be enhanced. After all, the FC model would improve the learning process and outcomes in teaching activities such as programming in which it is important to create more learning opportunities for students in the classroom (Giannakos et al., 2014; Jenkins, 2002). To this end, in the current study, it has been aimed to understand better the role of these variables in the application of FC model and to investigate the effect of FLR on these variables.

2 | THEORETICAL FRAMEWORK

2.1 | FC model

The FC model is used to actualize active learning in a student-centred environment (Freeman et al., 2014; Stone, 2012). The FC model enables in-class active learning implementations by increasing learning time (Kamarainen et al., 2013). The FC model is a model where direct instruction is given out-of-class mostly through videos, and the class time can be used for deeper discussions on the subject, peer collaboration, and personalized instructor counselling (Francl, 2014). Activities making students put their knowledge into practice and gain higher order thinking skills by benefitting from the time they spend at school at upper level are used in an FC environment (Bergmann & Sams, 2012; Davies, Dean, & Ball, 2013; Smith, 2015; Yarbro, Arfstrom, McKnight, & McKnight, 2014). Also, this model differentiates teaching by serving individual differences and prepares grounds for teaching which is suitable for individual pace (Johnson, Adams-Becker, Estrada, & Freeman, 2015). Bishop and Verleger (2013) emphasize that in the FC model, primary in-class component is not the lesson; there must be nonclass video lessons, and that through these videos, the students should be able to access the learning content of the new topics they are going to learn. The purpose of the FC model is to prepare ground for the activities for students to practice their knowledge and gain them higher order thinking skills beyond directly educating them (Bergmann & Sams, 2012; Davies et al., 2013; Gaughan, 2014; Tucker, 2012).

The research literature demonstrates that the FC model has various contributions to teaching and learning processes (Giannakos, Krogstie, & Aalberg, 2016). In a traditional classroom, a new content is presented for one time and unclear points are explained again. On the other hand, the FC model enables students to review written/recorded learning materials in her/his own speed and as much as it is required, or to skip the content that student is already informed about (Blau & Shamir-Inbal, 2017). As students can reach learning content on their own, the learning content is flexible (Moffett, 2015). In addition to flexibility and individualization, FC model promotes the improvement of self-organization strategies related to home-learning processes (Gerstein, 2012). In the course of in-class learning, students participate in questioning and problem-solving activities, form their information, work with their peers, and reflect the learning process. Such kind of implementations present an opportunity for richer learning choices and researching the content more deeply during in-class learning (Moffett, 2015; Vaughan, 2014). The FC model ensures that there is more time allocated for active learning, implementation, asking questions, and teamwork (Freeman et al., 2014; Hwang, Lai, & Wang, 2015; Stone, 2012).

2.2 | FC model in programming teaching

It is thought that the FC model will improve the learning process and results in teaching activities such as programming that active learning is important (e.g., Giannakos et al., 2014; Jenkins, 2002). Specifically, active participation of students in lectures is important as programming includes abstract concepts, and the tools (messenger, blog, forum etc.) that are presented in the online dimension of the FC model support active participation and interaction (Tugun et al., 2017). Due to the fact that students' previous knowledge and skills are important for ICT usage in terms of programming teaching, students can organize their learning phases on their own.

Lepp and Tonisson (2015) emphasized that individualization is important in programming teaching and methods that can individualized teaching should be included. In the FC model, the student makes an individual effort for each learning objective. Students can watch or repeat the programming lecture content that is offered out-of-class by skipping or repeating it (Pawelczak, 2017).

In programming activities, the theory and implementation should be balanced, and in the literature, it is seen that this is generally disregarded (Durak, 2016). When the student comes to the classroom, it is identified that if she/he has learning misconceptions, then programming-based learning applications are actualized. In this way, more time is allowed for discussion and cooperative study on programming implementations. In FC, the teacher can increase the interaction with students, answer their questions, differentiate the level of implementation and amount, monitor individual progress, and make scaffolding (Durak, 2017). Likewise, the FC model presents a structure that requires active participation in order to provide motivation for learners in programming teaching (Tugun et al., 2017). The student takes the learning responsibility by means of the programming duties that are given in class or out-of-class, and this way, learning motivation increases (Pawelczak & Baumann, 2014).

Allison, Orton, and Powell (2002) noted that instructors face difficulties in terms of "how to deliver programming course." Kinnunen and Malmi (2008) emphasize that an effort is put from an educational perspective to overcome difficulties faced in programming teaching. In order to overcome these challenges and make programming more fun, easy-use visual program tools have been developed for the beginners and children such as Scratch (Hoegh & Moskal, 2009). Despite this situation, it was seen that the challenges related to programming teaching have been continuing (Tugun et al., 2017). According to Jenkins (2002), more learning opportunities should be created for students within the programming activities in order to overcome these challenges. Karaca and Ocak (2017) indicate that FC model is an effective way to overcome these difficulties.

It was found out in studies that employed the FC model that the FC model increases student motivation, learning performance, and motivation (Chen, 2014; Giannakos et al., 2014; Herala, Vanhala, Knutas, & Ikonen, 2015; Horton & Craig, 2015; Karaca & Ocak, 2017; Puarungroj, 2015; Zhong, 2017). In the study conducted by Pawelczak (2017), the traditional method of programming education was compared with the FC model; it was found out that FC model changes the negative perception towards programming course by expanding learning time, making learning more fun with online multiple environment, and increasing learning performance, and participation is high by means of discussions/feedback that occur in an online environment. Therefore, it is thought that the FC model is an appropriate method in programming teaching. In addition, it was emphasized in the research studies that FC model that learning status of students are correlated with out-of-class preparation, technology use, and communication competencies (Kim, Kim, Khera, & Getman, 2014; Shea & Bidjerano, 2012). Particularly, as out-of-class activities have a role in the FC model, it is important to consider the readiness of students (Blooma, Kurian, Chua, Goh, & Lien, 2013; Hwang et al., 2015; Lai & Hwang, 2016).

2.3 | FLR and its indicators

This study examined the readiness to learn as related to FC. Hao (2016b) conducted a study to determine readiness of students to flipped learning. In this study, five factors that explain readiness to flipped learning have emerged. These are "Learner Control and Self-Directed Learning, Technology Self-Efficacy, Motivation for Learning, In-class Communication Self-efficacy and Doing Previews" factors (p. 297).

2.3.1 | Learner control and self-directed learning

According to Knowles (1975), "learner control and self-directed learning" is described as the processes of individuals of understanding their needs, identifying learning objectives, identifying necessary sources, choosing appropriate learning strategies, and taking an initiative in evaluation of learning. According to Zimmerman (2000), self-management is the degree of learners to participate in learning processes actively from metacognitive, motivational and behavioural aspects. In the FC model, students take a more active role in the process, and they are responsible of watching lecture videos before the lecture and answer the questions, and share and discuss the points that are not clear to them with other students and teacher. In this model, the decisions of students, who have a full control on learning processes, on where and with which material they will actualize learning are taken by them. "Learner control and self-directed learning" is an important component in order to ensure learning efficiency in FC.

2.3.2 | Technology self-efficacy

Due to the fact that online courses provide learning on networks such as the Internet, individuals' use-of-technology skills and self-efficacy is effective on learning processes (Hung, Chou, Chen, & Own, 2010). Eastin and LaRose (2000) noted that technology self-efficacy does not only include main tasks as turning on/off the computer and uploading/downloading but also has a capacity to implement higher level skills such as solving problems by using technology. FC presents a wide variety of learning sources and appropriate technologies. Students are required to have technology self-efficacy in order to access the lecture resources, using online lecture tools appropriately, interaction with teacher and peers, participating in discussions, and solving problems.

2.3.3 | Motivation for learning

Motivation has an important impact on students' attitudes and learning behaviours (Deci & Ryan, 1985; Fairchild, Horst, Finney, & Barron, 2005; Ryan & Deci, 2000). Students' possession of motivational orientation towards learning has an important impact on their learning performances (Ryan & Deci, 2000). Saadé, He, and Kira (2007) indicated that motivation plays an important role in terms of success or failure of online learning. The dimension of "motivation towards learning" is the driving force in terms of students learning efforts for online content and their learning performances. Understanding the motivation levels of students towards learning and preferences is very important to plan, produce, and implement the education resources (Federico, 2000).

2.3.4 | In-class communication self-efficacy

Research findings demonstrate that timid students tend to participate in online environments in comparison with traditional environments (Palloff & Pratt, 1999). For this reason, it is important to create opportunities for the interaction and communication of students in the process of teaching in the FC model (Hao, 2016b). In addition, communication self-efficacy can be seen as a way of asking questions in the FC model, addressing the issue more deeply, and preventing weakening of the engagement of students with course. Hung et al. (2010) asserted that the structure of online communication self-efficacy is a dimension to overcome online communication limitations.

2.3.5 | Doing previews

The FC model requires students to make a preparation in a sufficient level before they come to the class (Peled, Blau, & Grinberg, 2015). Students who are used to the traditional methods may not display the willingness of taking the responsibility of their own learning and monitor their own progress (Bedi, 2018; Johnson et al., 2015; Talbert, 2015). Active participation in the learning activities actively will be difficult for students who are not prepared before the lecture. For this reason, in a successful FC model, it is important to examine out-of-class sources before the lecture. Additionally, in the FC model, learning preparation of the teacher reduces the perceived difficulty and increases the perceived value of that course (Stelzer, Gladding, Mestre, & Brookes, 2009).

2.4 | FLR and engagement

Participation is an important prerequisite for learning (Fredricks, Blumenfeld, & Paris, 2004). Cole and Chan (1994) described student participation as the "level of student engagement and active participation in learning activities." In the classrooms where active participation is actualized, student participation is considered as an important component of learning due to its various educational benefits (Berman, 2014; Rocca, 2010). According to Dixson (2010), student participation is one of the main components of effective online learning environments, and participation of students has positive relations with academic performance.

The FC model presents a wide range of learning sources and technologies. In class, students attend learning processes to access out-of-class resources, solve problems, or to participate in discussions that are led by the teacher. In FC, individualization of learning, provision of a variety of learning resources, and including various online and offline interaction elements can support engagement. In the context of FC, engagement is one of the indicators that is used to make an evaluation regarding learning performance in FC, and engagement in FC is a constant effort (in class, out-of-class) put by students to reach the learning objectives (Abeysekera & Dawson, 2015). When the literature is reviewed, it is seen that FC implementations increase student participation (Baepler, Walker, & Driessen, 2014; Roach, 2014; Saulnier, 2015; Xiong et al., 2015). For this reason, this study assumes that FLR and engagement are correlated.

In the FC model, technology self-efficacy and communication self-efficacy express students', who actualize independent and individualistic learning, self-confidence perceptions towards their performance (Kop & Fournier, 2011; Milligan, Littlejohn, & Margaryan, 2013; You & Song, 2013). This perception of self-confidence supports the use of FC environments in an effective way (Durak, 2017). It is expected that students' self-learning and learning motivations would play an important role in participation and ensuring the consistency of participation when long duration lectured and autonomy levels are considered (Breslow et al., 2013). Furthermore, in FC, it was seen that in-class participation is correlated with the situation of having a sufficient level of preparation before the lecture (Peled et al., 2015). Accordingly, in FC, it would be easier for students who do previews for the lecture content to participate in in-class learning. As such, the present study addressed the following hypotheses:

> **H1.** *FLR levels of the students in FC will positively affect their engagement.*

> **H1a.** *Learner control and self-directed learning of the students in FC will affect their engagement positively.*

> **H1b.** *Technology self-efficacy of the students in FC will affect their engagement positively.*

> **H1c.** *In-class communication self-efficacy of the students in FC will affect engagement positively.*

> **H1d.** *Students' motivation for learning in FC will affect their engagement positively.*

> **H1e.** *The fact that students do previews in FC will affect their engagement positively.*

2.5 | FLR and attitude towards programming

Attitude is defined as the tendency that is attributed to an object or a situation or that affects the thoughts, feelings, and behaviour related to that object or situation (Smith, 1968). Attitude affects the time that an individual is allocated for fulfilling a task, choice of strategy, beliefs as perceived control, the level of effort, resilience in overcoming problems, and finally, performance (Bandura, 1977).

In the process of programming learning, there is a need to examine the variables in order to ensure consistency of overcoming high levels of problems, being patient to reach the aim, and displaying willingness of trying new solutions. FC model has presented a more flexible learning environment in programming activities with its structure that is different than traditional learning (Pawelczak, 2017). This environment that supports personalized learning assists to overcome the challenges that occur in programming teaching and, as a result, to develop a positive attitude towards programming (Chen, 2014; Giannakos et al., 2014; Herala et al., 2015; Horton & Craig, 2015; Puarungroj, 2015; Zhong, 2017). For this reason, this study assumes that FLR and attitude towards programming are related.

According to Bandura (1982), individuals' self-efficacy beliefs are closely related with their behaviours as they play an important role in terms of formation of their attitudes. It can be said that students' technology and communication self-efficacy is related with their attitudes towards programming. In FC, students' attitudes towards programming reflect on their behaviours and motivations (Chen, 2014). In addition, students' attitudes are also important in terms of actualizing their autonomous

Furthermore, students' attitudes are effective in terms of actualizing self-directed learning activities in FC. Due to the fact that readiness of students to the lecture supports active participation in FC (Missildine, Fountain, Summers, & Gosselin, 2013), students' attitudes are expected to improve positively. As such, the present study addressed the following hypotheses:

> **H2.** *FLR levels of the students in FC will positively affect their attitudes towards programming.*

> **H2a.** *Learner control and self-directed learning of the students in FC will positively affect their attitude towards programming.*

> **H2b.** *Technology self-efficacy of the students in FC will positively affect their attitude towards programming.*

H2c. *In-class communication self-efficacy of the students in FC will positively affect their attitudes towards programming.*

H2d. *Students' motivation for learning in FC will positively affect their attitudes towards programming.*

H2e. *The fact that students do previews in FC will positively affect their attitudes towards programming.*

2.6 | FLR and programming self-efficacy

According to Bandura (1977), self-efficacy is related to students' performance and effort to fulfil a task in the direction of their perception of own capabilities. The high level of self-efficacy supports the success of individuals (Hwang, Wu, & Chen, 2012; Pintrich & De Groot, 1990) and having more competence to cope with difficult tasks (Altun & Mazman, 2012; Askar & Davenport, 2009; Bandura, 2001). At this point, it can be said that self- efficacy has an important place in programming teaching, which is considered to be difficult for beginner students in particular (Anastasiadou & Karakos, 2011; Hongwarittorrn & Krairit, 2010; Kukul, Gökçearslan, & Günbatar, 2017; Meluso, Zheng, Spires, & Lester, 2012).

While performing extracurricular activities in e-learning environments, behaviour of abandoning the learning environment is often observed when students encounter a problem (Yilmaz, 2017). At this point, it is seen important to examine learning programming self-efficacy in learning in FC.

Chen (2014) indicated that technology self-efficacy is fundamental in terms of increasing programming self-efficacy. As communication self-efficacy is an important component of learning, it is thought that it is associated with programming self-efficacy. Lepp and Tonisson (2015) emphasize the importance of learning motivation in terms of improving beliefs towards learning to programme in FC. Teachers are expected to pave the way for controlled and self-directed learning, to initiate the learning tasks such as doing previews, and to improve self-efficacy towards learning (Knowles, 1975). In addition, certain studies demonstrated that readiness for learning reduces the perceived difficulty of the lecture in FC and increases educational benefit and perceived value of the course (Narloch, Garbin, & Turnage, 2006; Stelzer et al., 2009). It could be possible to increase students' self-efficacy by uploading videos about the course content and lead students to be engaged with more challenging contents effectively in class times in FC. As such, the present study addressed the following hypotheses:

H3. *The FLR levels of the students in FC will affect their programming self-efficacy positively.*

H3a. *Learner control and self-directed learning of the students in FC will affect their programming self-efficacy positively.*

H3b. *Technology self-efficacy of the students in FC will affect their programming self-efficacy positively.*

H3c. *In-class communication self-efficacy of the students in FC will positively affect their programming self-efficacy.*

H3d. *Students' motivation for learning in FC will affect their programming self-efficacy positively.*

H3e. *The fact that students do previews in FC will affect their programming self-efficacy positively.*

2.7 | FLR and interaction

One of the most important elements in technology-supported learning environments is intercomponent interaction (Driscoll, 2002; Garrison, Anderson, & Archer, 2003). Interaction is one of the basic expectations and objectives of the education. Especially in the e-learning environment, the existence and the types of the interaction are considered important, and there are various discussions on the size of the interaction and how it should be (Arbaugh, 2000; Berge, 2002; Mclaren, 2010; Moore, 1989).

In FC, cooperative learning tasks such as online brainstorming, group-based practical assignments, peer review, feedback, and healing aid are carried out in nonclass learning time (Bergmann & Sams, 2012; Davies et al., 2013). At FC, it is assumed that students control their own speed, progress, and learning responsibilities in the learning process according to their own individual needs. In FC, course hours have been flexed for teachers to have learning purpose interactions with learners such as observation, guidance, feedback, and mentoring (Flumerfelt & Green, 2013; Fulton, 2012). Furthermore, in FC, students are also provided with an opportunity to access informative presentations and course content during nonclass hours and to engage actively (Missildine et al., 2013). In the FC model, it is relatively easy to distribute course materials in both online and face-to-face environments through different media forms and establish a good communication and interaction among students–teacher–peers (Davies et al., 2013).

In the FC model, instructors and learners need to be in constant interaction not only at school but with online learning materials afterschool (Thompson, 2013). Therefore, the studies in the literature demonstrated that the interaction among students–teacher–peers and interaction self-efficacy is increased in FC and students are actively involved in learning processes in line with their wishes (Herreid & Schiller, 2013). It can be said that students' technology self-efficacy will be increased in this way. It is thought that doing previews will reduce the perceived difficulty of a course and increase the interaction of students with their course resources, teachers, and peers. As such, the present study addressed the following hypotheses:

H4. *FLR levels of the students will positively affect their interaction level in FC.*

H4a. *Learner control and self-directed learning of the students in FC will positively affect their interaction level in FC.*

H4b. *Technology self-efficacy of the students in FC will positively affect their interaction level in FC.*

H4c. *In-class communication self-efficacy of the students in FC will positively affect their interaction level in FC.*

H4d. *Students' motivation for learning in FC will positively affect their interaction level in FC.*

H4e. *The fact that learners do previews in FC will affect their interaction level in FC positively.*

3 | METHOD

Relational screening model was used in this study because it aims to reveal the relationships between the FLR levels of middle school students and various variables. This model is generally used to identify the interaction between two or more variables and its amount. In screening models, the variables that a relationship will be searched between are symbolized independently. However, relational screening model is a research model that aims to determine the degree of change of two or more variables together and/or their existence. The relationships that are revealed in this model cannot be interpreted as a real cause and effect relationship; however, identifying the situation of a variable by providing certain hints provides beneficial results in terms of comprehending the situation of a variable (Karasar, 2005).

3.1 | Research model

The research model is based on the literature. In this model, variables and research hypotheses are shown in Figure 1.

When Figure 1 is examined, it can be seen that the subfactors that consist FLR are "learner control and self-directed learning, technology self-efficacy, communication self-efficacy, motivation for learning, and doing previews." In addition, in Figure 1, the variables that were addressed in this study and the hypotheses presented concerning the relationship between these variables. In addition, in the model that is based on the hypotheses given in Figure 1, it can be seen that the impact on students' FLR levels and student participation in FC, attitude towards programming, programming self-efficacy, and preferences of interaction in FC is examined.

3.2 | Study group and characteristics

The study group of the research consists of 371 students studying at 5th, 6th, 7th, and 8th grade in 12 different classrooms in two middle schools under the Ministry of Education in a town in Ankara Province, Turkey. The reason why these grades are selected is the study was carried out at the middle school level, and the middle school level in Turkey covers 5th, 6th, 7th, and 8th grades. Besides, Ministry of Education provides a normal distribution in terms of academic achievement when determining the grades and classes in Turkey. Nevertheless, in this study, it was also checked whether there were significant differences among the participants between the grade levels in terms of gender and academic achievement.

The study group was selected by convenience sampling method. The study was conducted based on participants' voluntariness. All participants attended 15-week programming teaching with the FC model within the scope of the Information Technology and Software course during the spring semester of 2017. Demographic information of the participants is presented in Table 1.

According to Table 1, 48.5% of the participants were female and 51.5% were male; 21.56% of the participants were in the 5th grade, 24.80% in the 6th grade, 26.15% in the 7th grade, and 27.49% in the 8th grade. The age average of the participants is 13.81; 76.11% of the participants live in urban areas and 23.89% of them live in rural areas. The students who live in rural parts reach their school via transported education every day. Many of the participants live in urban areas, and their parents are mostly high school graduate (respectively 38.5% and 46.1%). When the paternal and maternal education levels are considered, the rate of mothers with primary school education is 18.6% and fathers is 13.5%. From the perspective of education levels, it is seen that fathers' education levels are higher.

The class that participants general academic average is the highest is 8th grades (M = 3.75), and the lowest is 6th grades (M = 3.59). As these grades prepare for the Turkish high school entrance exam, it is expected that the academic average is higher. When the statistics regarding that students differ according to their gender and academic achievement are examined, the results of chi-square independence test show that four grade levels have a similar distribution in terms of gender variable. It can be said that the students in different classes

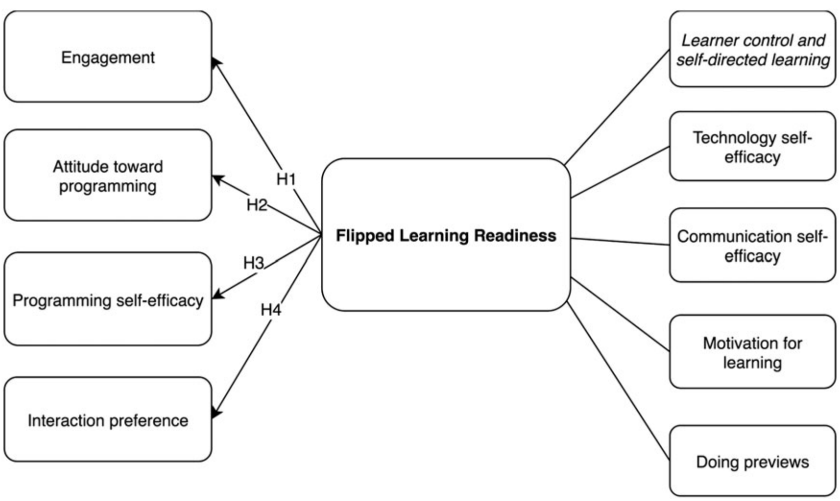

FIGURE 1 Hypothesis-based default research model

TABLE 1 Distributions related to demographic characteristics of the participants

Variables	Options	*f*	%
Gender	Female Male	180 191	48.5 51.5
Grade	5th Grade 6th Grade 7th Grade 8th Grade	80 92 97 102	21.56 24.80 26.15 27.49
Age	Min = 10, max = 16, mean = 13.81, *SD* = 1.754		
Living area	Rural Urban	89 282	23.89 76.11
Educational background of your mother	Primary school graduate Middle school graduate High school graduate Bachelor's, Master's, or PhD degree	69 110 142 50	18.6 29.4 38.5 13.5
Educational background of your father	Primary school graduate Middle school graduate High School Graduate Bachelor's, Master's or PhD Degree	50 69 171 81	13.5 18.6 46.1 21.8
Academic grade point average	5th grade mean = 3.65; 6th grade mean = 3.59; 7th grade mean = 3.71; 8th grade mean = 3.75; general mean = 3.68		
Changes by academic success of the participants in the grades	Levene Statistic = 0.261, p = 0.854; F (3.367) = 1.337, p = 0.261		
Changes by gender of the participants in the grades	Pearson chi-square: 7.078, p = 0.069		

have a similar distribution in terms of their general academic point averages.

3.3 | Data collection tools

"Personal Information Questionnaire Form" was developed by the researcher. While developing this form, two experts' opinion was taken. Data regarding participants' personal information, their attitudes towards teaching programming during Information Technology course, and the interaction preferences/levels of the students during programming teaching in FC were collected with this 20-item data collection tool. Items in the questionnaire differ according to the questions and are generally Likert.

"Flipped Learning Readiness Scale (FLRS)" was developed by Hao (2016b) and adapted to Turkish by Durak (2017). There are 26 items and five subdimensions in the scale. These five subdimensions are learner control and self-directed learning, technology self-efficacy, in-class communication self-efficacy, motivation for learning, and doing previews. The scale is scored between "*strongly disagree*" (1) and "*strongly agree*" (5). The Cronbach's α reliability coefficients of the original scale (total and subdimensions) were found to be 0.85, 0.79, 0.82, 0.70, 0.73, and 0.87, respectively.

"Engagement Scale" was developed by Sarıtepeci (2012) within the scope of master's thesis, and validity reliability studies were carried out. This scale, consisting of 34 items and three factors, is five-point Likert scale. Grading is as "*Never*" (1) and "*Always*" (5). In this scale consisting of three factors, "active and collaborative learning (ACL)" subdimension consists of 17 items, "student's forced level (SFL)" consists of seven items, and "the feedback level and students–teachers interaction (FLSTI)" subdimension consists of 10 items. In this study, the Cronbach's α reliability coefficient calculated for the scale is 0.92. The Cronbach's α reliability coefficient for subscales is 0.97, 0.93, and 0.84, respectively.

"Computer Programming Self-Efficacy Scale for Middle School Students" developed by Kukul et al. (2017). This scale consists of 31 items and one factor. This scale is five-point Likert scale, and there is no reverse item on the scale. According to the five-point Likert scale, scaling changes between "*strongly disagree*" (1) and "*strongly agree*" (5). In this study, the Cronbach's α reliability coefficient calculated for the scale is high (0.91).

3.4 | Application process and collection of data

Fifteen-week programming course was carried out in the FC model with the students in the 5th, 6th, 7th, and 8th years of middle school. Scratch program was chosen as a programming teaching tool because Scratch is the most commonly used and most functional tool in early programming teaching (Durak, 2016). In addition, the use of Scratch positively influences children's learning to program and engagement in teaching programming (Zuckerman, Blau, & Monroy-Hernández, 2009). Programming concepts, sample Scratch program application videos, are presented weekly to the participants in the Edmodo environment. Project work was carried out during teaching programming process, and peer groups were formed both in the Edmodo environment and in the classrooms. Internet access is provided for students who do not have Internet access out of classroom at school. The model of the implementation process is presented in Table 2.

In Table 2, the content, implementation calendar, and course resources were handled during the implementation. In the first face-to-face lecture, teacher explained the requirements of the course, how the course will be carried out, and their expectations about the course. The students were assisted to register on Edmodo system, and this environment was presented to students. It has been

TABLE 2 Programming teaching activities in flipped classroom (FC)

Weeks	Programming teaching activities	Learning activities in FC model: In-class learning activities	Learning activities in FC model: Out-of-class learning activities
Week 1	Programming-input stage Basic concepts of programming-Software, Programming Language, Programming Process Short presentation of Scratch - Simple sample application presentation	• Study Sheets • Programming Exercise Tasks • Problem-Based Learning Scenarios	• YouTube videos that programming is presented or explain why learning programming at early aged is important • Videos that notable individuals for computer science mention the importance of programming • PDF that explains the Scratch program and its installation • Other course components and course tasks were introduced by using a PDF that was consisted of screenshots and instructions. ○ Course website (edmodo.com) ○ Study Sheets/Programming Exercise Tasks ○ Discussion forums ○ Messenger ○ Collaborative documents (Edmodo Library, Google Drive, Onedrive)
Week 2	Programming-analysis stage Introducing Scratch Media Tools Character-Costum, Background	• Problem-Based Learning Scenarios • Study Sheets/Programming Exercise Tasks	• Videos that programming concepts are introduced • The website that was designed by the Ministry of Education and Scratch code blocks were presented. scratch.eba.gov.tr • student blogs • online class discussions on programming tasks
Week 3-4	Programming-design stage Algorithm and Flow Diagram Application	• Problem-Based Learning Scenarios • Study Sheets/Programming Exercise Tasks	• Algorithm examples/formation of daily task algorithm/pdf file that the example of it was presented • Study Sheets
Week 5-7	Programming-design stage Character-Costum, Background integrity, and code placement of these items Scratch sounds and sound recording with Scratch	• Problem-Based Learning Scenarios • Study Sheets/Programming Exercise Tasks	• Videos that programming concepts are introduced • Study Sheets/Programming Exercise Tasks
Week 8-10	Programming-coding stage Loop, repetition, sequence, iteration, condition, event handling, parallel execution variable, operator	• Problem-Based Learning Scenarios • Study Sheets/Programming Exercise Tasks	• Videos that programming concepts are introduced • Study Sheets/Programming Exercise Tasks
Week 11-14	Project Preparation Debug Studies	• Preparing games and applications with Scratch • Study Sheets/Programming Exercise Tasks	The debug activities that are included in Scratch mit were used. The students were asked to discuss the mistakes that they identify in example programs and how to solve these problems. The teacher led the discussions.
Week 15	Presentation of Projects Implementation of Data Collection Tools	At the end of the process, the products were presented to their friends and their reactions to the products of their peers were taken. Data collection tools were filled by students at the end of the implementation.	At the end of the process, the products were presented in an online environment.

Note. Study sheets (13): The documents which are translated into Turkish and expert opinion-taken versions of materials which were prepared by MIT and developed for secondary schools were used.

Programming Exercise Tasks (22): The documents which are translated into Turkish and expert opinion-taken versions of materials which were prepared by MIT were used.

Problem-Based Learning Scenarios (19): Developed by the researchers.

identified that all of the students who participate in the implementation have smartphones. All of the students downloaded Edmodo applications to their phones. In this way, they could be able to receive notifications on course activities, messages, and shares. In addition, students' participation in online environment was facilitated. Edmodo environment was preferred in this study due to the fact that is appropriate for middle school level and similar structure to Facebook that offers perception of ease of use (Dere, Avcı Yücel, & Yalçınalp, 2016).

The application was continued for 15 weeks in total. During the implementation process, students watched a related video on the subject of each week before the lecture. The course delivery and informative source videos consist of preparation videos on YouTube and videos that were prepared by the researcher. In these videos expert opinions, explanations of various programming concepts and examples are shown. The videos that are related to the subject of each week were shared with students before the lecture through the learning environment. The length of the videos varies between 2 and

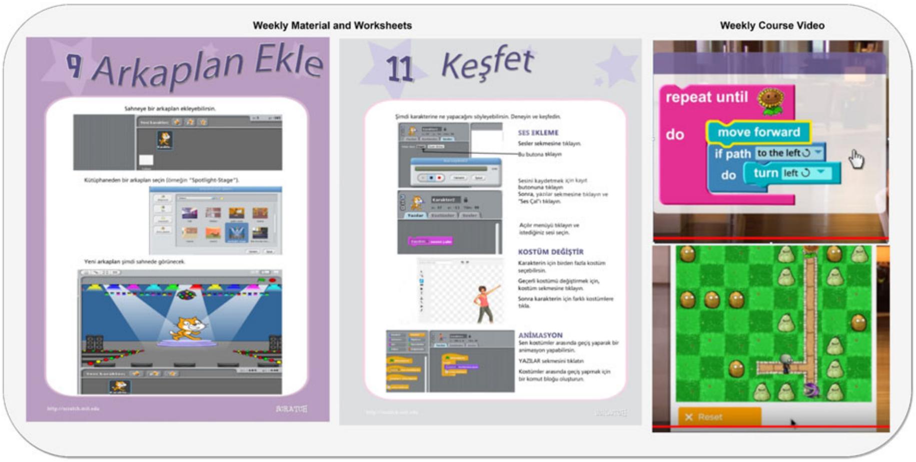

FIGURE 2 Examples of the material used in the application process-worksheets and video [Colour figure can be viewed at wileyonlinelibrary.com]

10 min. After the videos, programming tasks related to the subject were given in order to ensure that students watch the video.

While viewing the video, students could ask their questions related to the subjects that they had learned and videos they had watched to their teacher. In addition, in order to let students watch/review the course resources before the lecture, a reminding share was made on Edmodo by the teacher. Study sheets/programming exercise tasks were used to enable students to make more practice on the programming subjects/implementations that were summarized and implemented in the course. The screenshots of some examples of materials that were used in the course were presented in Figures 2 and 3. A part of the activities that were performed in the classroom was carried out individually and another part as a group activity. In addition, online group discussion and project work were implemented in this process.

In the last 5 weeks of the process, a project development study was conducted in order to enable students to implement what they have learned towards programming concepts. The project preparation process of the students is as follows: "subject/problem situation-analysis of a problem situation making suggestions for the solution of the problem-planning-research (content, selection of characters that will be used, and preparation)-programing process-mistake control of the projects-presentation) was followed. As a result of the process, projects were shared on an online environment. Furthermore, as a result of the process, students were required to fill the data collection tools.

Data collection tools in the study were applied the study group as printed. The application was voluntary. Besides, in order to get sincere answers, no personal information such as their name and school number was requested from the participants who agreed to do the application.

3.5 | Analysis of data

Structural equation modelling (SEM) was used in order to create a model to determine the existence of relationships between the FLR levels of middle school students and various variables and to explain and predict these relationships between these variables. Analysis of the data was carried out with LISREL 8.51 program. In order to demonstrate the level of conformity of the relationship patterns in the proposed model, the $\chi 2$ fit indexes were used.

Before the factor analysis, the condition of suitability of the data for factor analysis was examined by Kaiser–Meyer–Olkin (KMO) coefficient and Barlett Sphericity test. Buyukozturk (2009) indicates that the result of KMO that is higher than 0.60 is an indicator that shows that data are suitable for the factor analysis. The KMO coefficient value that was calculated was found as 0.71. Due to the fact that this value is bigger than 0.60 (0.71>0.60), it was determined that the data are suitable for factor analysis.

When Table 3 is examined, the goodness of fit values of the model in this study indicate that the model fits well. Also, the goodness of fit index of the model was found to be significant at 0.05 level. In Table 3, references that the fit index ranges were taken as "good fit and acceptable fit."

RMSFA value was found as 0.008. The RMSFA value of 0.008 demonstrates good fit. This value is among the good fit values. NFI, NNFI, and CFI were calculated as 0.95. These values indicate a good fit. Furthermore, the GFI value is 0.97. This value is also among the good fit values. In addition, when the scale scores are interpreted, scores below 2 are considered as a low range, between 2 and 3 are intermediate, 3 and above are high.

In the study, FLR (and its indicators, learner control and self-directed learning, technology self-efficacy, communication self-efficacy, motivation for learning, and doing previews), engagement (and its indicators: ACL, SFL, and FLSTI), and descriptive statistics related to attitude towards programming, programming self-efficacy and interaction levels were calculated on responses given to the items related to attitude and interaction level in FLRS, engagement scale, programming self-efficacy scale, and personal information form. In order to reveal the relationship model between these scales and the data collected with personal information form and the variables included in the research and to test the research hypotheses, the path coefficients were calculated and the SEM was used.

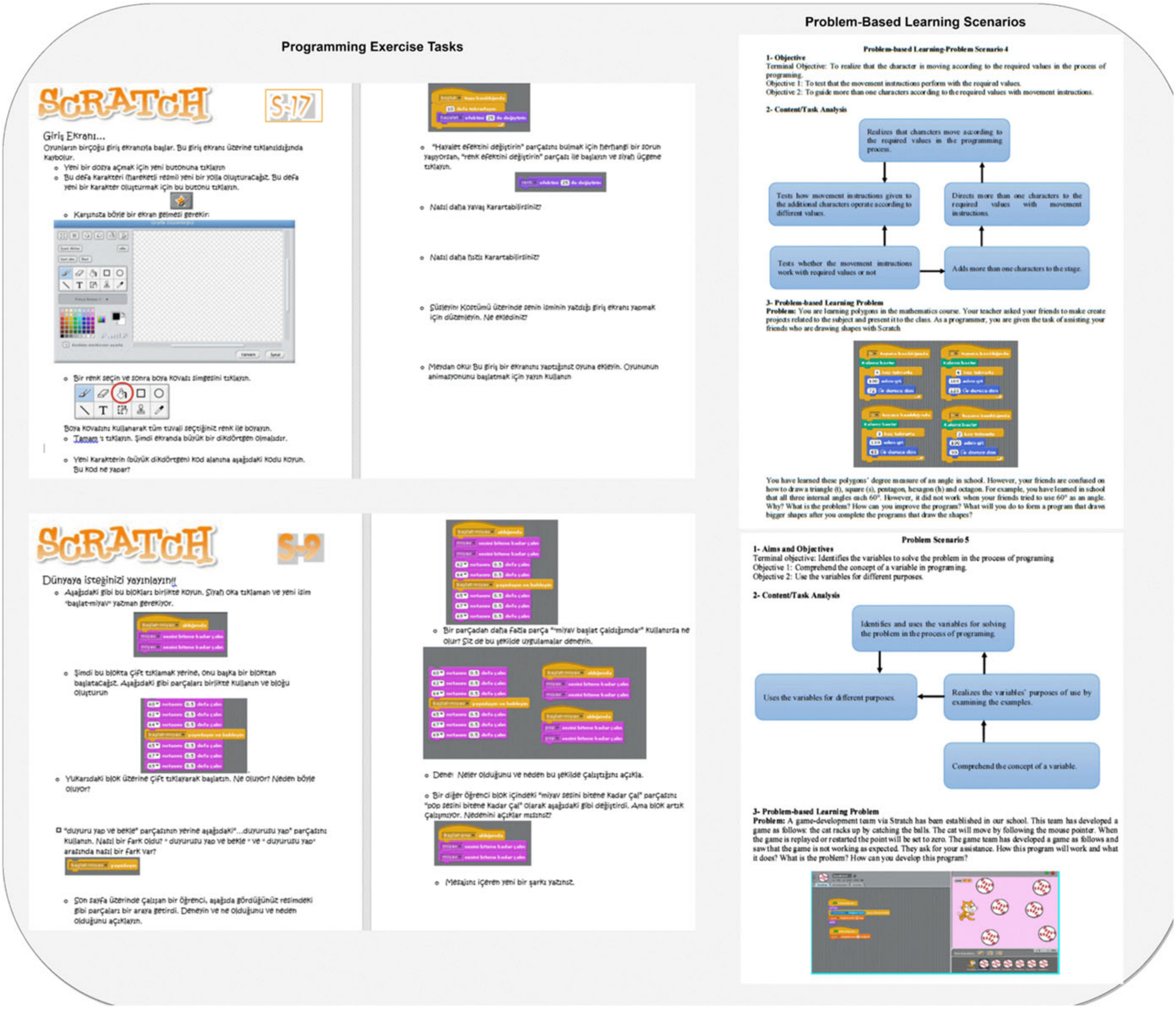

FIGURE 3 Examples of the material used in the application process-programming exercise tasks and problem-based learning scenarios [Colour figure can be viewed at wileyonlinelibrary.com]

TABLE 3 Values of goodness of fit index in structural equation model

Fit values	Good fit values	Acceptable fit values	Resource	Values reached
RMSEA	$0 < RMSEA < 0.05$	$0.05 < RMSEA < 0.10$	Schermelleh-Engel, Moosbrugger, and Müller (2003)	0.008
NFI	$0.95 \leq NFI \leq 1$	$0.90 \leq NFI \leq 0.95$	Thompson (2004)	0.95
NNFI	$0.97 \leq NNFI \leq 1$	$0.95 \leq NNFI \leq 0.97$	Tabachnick and Fidell (2007)	0.95
GFI	$0.95 \leq GFI \leq 1$	$0.90 \leq GFI \leq 0.95$	Tabachnick and Fidell (2007)	0.97
CFI	$0.95 \leq CFI \leq 1$	$0.90 \leq CFI \leq 0.95$	Schermelleh-Engel et al. (2003); Tabachnick and Fidell (2007)	0.95

4 | FINDINGS

The findings and interpretations of the study are given in this section.

Descriptive values related to FLR, engagement, attitude towards programming, programming self-efficacy, and interaction levels of students are presented in Table 4. The values in the "arithmetic mean/number of items (*k*)" were used in order to make an easier interpretation of the relative ordering of the factors and subfactors included in Table 3.

When Table 3 is examined, the average of the students' total scores in the FLRS scale is 78.26 (M/k = 3.01, SD = 0.66). Students indicated that the highest FLR level is the subdimension of "motivation for learning" (M = 9.48, SD = 0.76), and it is followed respectively by the subdimensions of learner control and self-directed learning

TABLE 4 Descriptive statistics of students' FLR, engagement, attitude towards programming, programming self-efficacy, and interaction levels

Scales	Number of items (*k*)	Min. score	Max. score	Mean	Mean/*k*	*SD*
FLR	26	41.60	117	78.26	3.01	0.66
FLR-1	8	8.00	40.00	24.88	3.11	0.99
FLR-2	9	9.00	45.00	27.81	3.09	0.95
FLR-3	4	5.00	18.00	11.96	2.99	0.81
FLR-4	3	6.00	15.00	9.48	3.16	0.76
FLR-5	2	2.66	8.00	5.42	2.71	0.63
Engagement	34	34.00	170.00	113.9	3.35	0.73
ACL	17	17.00	85.00	56.71	3.34	0.81
SFL	7	7.00	35.00	25.12	3.59	0.87
FLSTI	10	10.00	50.00	32.04	3.20	01.17
Attitude towards programming	1	1.00	5.00	3.87	3.87	0.96
Programming self-efficacy	31	31.00	155.00	100.13	3.23	0.82
Interaction	3	6.00	15.00	10.56	3.52	0.71
learner-learner	1	2.00	5.00	3.45	3.45	0.87
instructor-learner	1	2.00	5.00	3.46	3.46	0.93
learner–content	1	2.00	5.00	3.65	3.65	0.91

Note. FLR: Flipped learning readiness; FLR-1: learner control and self-directed learning, FLR-2: technology self-efficacy, FLR-3: communication self-efficacy, FLR-4: motivation for learning; FLR-5: doing previews. ACL: Active and collaborative learning, FLSTI: the feedback level and students–teachers interaction, SFL: student's forced level.

(M = 24.88, SD = 0.99), technology self-efficacy (M = 27.81, SD = 0.95), and communication self-efficacy (M = 11.96, SD = 0.81). The lowest FLR level that was indicated by the students is the subdimension of "doing previews" (M = 5.42, SD = 0.63). According to these findings, the FLR levels of students are at a high level. Accordingly, it can be said that students feel ready for the education given by the FC model. It was seen that students' motivation towards learning is high in FC. On the other hand, it is seen that the level of students' readiness of doing previews for the lecture is lower than other dimensions.

When the averages in the engagement scale were 113.90 (M/k = 3.35, SD = 0.73). When the subdimensions of the engagement scale were examined, it was seen that the highest engagement score was taken by the subdimension of SFL (M = 25.12, SD = 0.87), and it was followed respectively by the dimensions of ACL (M = 56.71, SD = 0.81) and FLSTI (M = 32.04, SD = 1.17). It is seen that student participation is high in the FC model. Furthermore, the subdimension of SFL, which is related to the level of effort and struggling against difficulties aspect of student participation, has the highest engagement score. Therefore, it can be said that students put the required effort to fulfil the tasks in the FC model.

The averages in the self-efficacy scale are 100.13 (M/k = 3.23, SD = 0.82). It can be said that students programming self-efficacy is high in the FC model. It is thought that the tasks are given in and out of class in FC model and the feedbacks given towards the status of fluffing these tasks by the teacher of the course constantly are effective in terms of reaching a high level of student programming self-efficacy.

Student's score average of attitude towards programming, which was received through personal information form is 3.87 (M/k = 3.87, SD = 0.96). The attitude scores of students have the highest average in comparison with all other variables in the FC model. From this point of view, it can be said that the programming teaching implementations that are actualized by the FC model have a positive impact on developing positive attitudes.

The average regarding students' interaction levels in FC is 10.56 (M/k = 3.52). When their interaction preference scores are examined, learner–content interaction dimension (M = 3.65, SD = 0.91) of the interaction is ranked first. The instructor–learner interaction dimension of the students (M = 3.46, SD = 0.93) is ranked second, and learner–learner interaction dimension (M = 3.45, SD = 0.87) is ranked last.

The coefficients of the SEM are presented in Figure 4.

When the SEM given in Figure 4 is examined, the model fit indexes are chi-square significant (367.24, p = 0.000). When the variables related to FLR were examined, it was seen that the variable that is the most important and has the highest correlation coefficient (γ = 0.31) was "programming self-efficacy" followed by "attitude toward programming" (γ = 0.30), "engagement" (γ = 0.29), and "interaction level" (γ = 0.12).

When the structural model is examined, it is seen that FLR is most related to programming self-efficacy. Based on this, it can be said that students' level of learning readiness in FC will affect positively their programming self-efficacy most and their interaction intensities least.

When the coefficients of FLR subdimensions are examined, it is seen that the dimensions of technology self-efficacy (γ = 0.95) and communication self-efficacy (γ = 0.89) come to the forefront. The dimension with the lowest connection coefficient is the dimension of "doing previews" (γ = 0.54).

As shown in Table 5, correlation values between FLR scores and other variables are as follows: FLR–engagement (r = 0.304, p < 0.01), FLR–attitude towards programming (r = 0.293, p < 0.01), FLR–programming self-efficacy (r = 0.301, p < 0.01), and FLR–interaction (r = 0.103, p > 0.05). If correlation coefficients are between 0.07 and 1.00 as an absolute value, it is defined as a high level of relationship; if they are between 0.70 and 0.30, moderate level of relationship; and if they are between 0.30 and 0.00, it is defined as a low level of relationship (Buyukozturk, 2009). Based on these findings, there is a moderate level of positive relationship between FLR and engagement

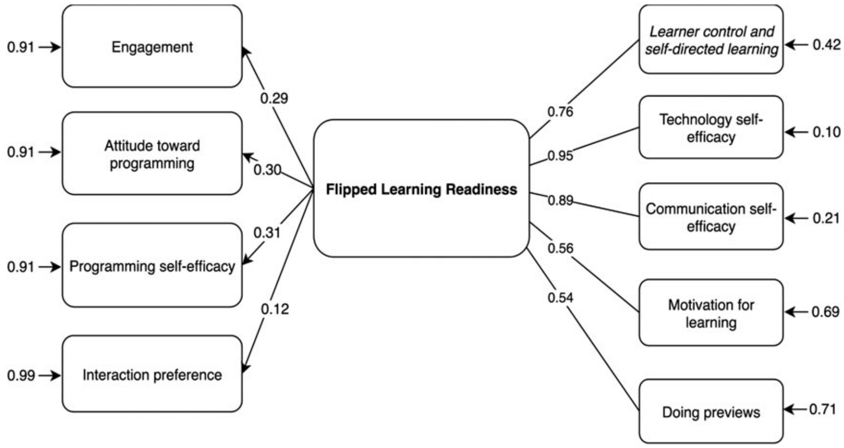

FIGURE 4 Structural equation model coefficients

TABLE 5 Correlations matrix

	1	2	3	4	5	6	7	8	9	10
1. FLR	1									
2. FLR-1	0.720**	1								
3.FLR-2	0.727**	0.734**	1							
4.FLR-3	0.791**	0.672**	0.746**	1						
5. FLR-4	0.670**	0.365**	0.539**	0.463**	1					
6. FLR-5	0.636**	0.340**	0.488**	0.520**	0.344**	1				
7. Engagement	0.304**	0.190**	0.250**	0.221**	0.277**	0.309**	1			
8. Attitude towards programming	0.293**	0.171**	0.260**	0.217**	0.260**	0.293**	0.661**	1		
9. Programming self-efficacy	0.301**	0.219**	0.261**	0.247**	0.209**	0.278**	0.431**	0.659**	1	
10. Interaction	0.103	0.136*	0.119*	0.94	0.021	0.002	0.028	0.81	0.42	1

Note. FLR: Flipped learning readiness; FLR-1: learner control and self-directed learning, FLR-2: technology self-efficacy, FLR-3: communication self-efficacy, FLR-4: motivation for learning; FLR-5: doing previews.

Bold, variables; not bold, sub-factors.

**Correlation is significant at the 0.01 level (two-tailed).

*Correlation is significant at the 0.05 level (two-tailed).

and programming self-efficacy, and low level of positive relationship between FLR and attitude towards programming. There is no statistically significant relationship between FLR and interaction level.

In addition, the correlation between FLR and all subdimensions is positive, and middle and high level. The correlation between FLR and motivation for learning and doing previews is positive and middle level; the correlation between FLR and other subdimensions is positive and high level. The subdimension that demonstrates the lowest correlation with FRL is "doing previews" (r = 0.636, p < 0.01). According to the given findings, it is possible to say that in the programming teaching conducted in FC classrooms, among the FLR and its indicators, learner control, self-directed learning, and technology self-efficacy are important on interaction intensity.

Based on these findings, it can be said that increasing the students' learning readiness in FC will increase students' engagement to the course, programming self-efficacy, and attitude towards programming in a positive way.

As it can be seen in Table 6, twenty-four hypotheses were tested in total. The impact of FLR and subdimensions of "engagement" was found significant (β = 0.29, p < 0.05). The hypotheses between the FLR and subdimensions and "engagement" were accepted (H1, H1a, H1b, H1c, H1d, and H1e). The direct impact of FLR and subdimensions of "attitude toward programming" was found significant (β = 0.30, p < 0.05). The relevant hypotheses were accepted (H2, H2a, H2b, H2c, H2d, and H2e). The direct impact of FLR and subdimensions of "programming self-efficacy" was found significant (β = 0.31, p < 0.05). The relevant hypotheses were accepted (H3, H3a, H3b, H3c, H3d, and H3e). The direct impact of FLR and subdimensions of "interaction" was found significant (β = 0.12, p < 0.05). Among the relevant hypotheses, H4, H4a, and H4b were accepted and H4c, H4d, and H4e were declined.

5 | DISCUSSION

Findings of this study, examining the FLR levels in FC and the variables that it predicts, reveal that FLR and its indicators are important predictors of engagement, attitude towards programming, programming self-efficacy, and interaction. The research model shows that the increase in FLR levels of students will also increase the students' engagement to the course, programming self-efficacy, and attitude towards programming in FC teaching module.

TABLE 6 Hypothesis acceptance/rejection table

Way/relation				Stand. coefficients	*t* value	Acceptance/rejection
H1	FLR	→	Engagement	0.29	5.60	Acceptance
H1a	*FLR-1*	→	Engagement	0.19	.3.39	Acceptance
H1b	*FLR-2*	→	Engagement	0.25	4.54	Acceptance
H1c	*FLR-3*	→	Engagement	0.22	3.98	Acceptance
H1d	*FLR-4*	→	Engagement	0.28	5.06	Acceptance
H1e	*FLR-5*	→	Engagement	0.31	5.70	Acceptance
H2	FLR	→	Attitude towards programming	0.30	5.39	Acceptance
H2a	*FLR-1*	→	Attitude towards programming	0.17	3.05	Acceptance
H2b	*FLR-2*	→	Attitude towards programming	0.26	4.73	Acceptance
H2c	*FLR-3*	→	Attitude towards programming	0.22	3.91	Acceptance
H2d	*FLR-4*	→	Attitude towards programming	0.26	4.73	Acceptance
H2e	*FLR-5*	→	Attitude towards programming	0.29	5.38	Acceptance
H3	FLR	→	Programming self-efficacy	0.31	5.54	Acceptance
H3a	*FLR-1*	→	Programming self-efficacy	0.22	3.95	Acceptance
H3b	*FLR-2*	→	Programming self-efficacy	0.26	4.74	Acceptance
H3c	*FLR-3*	→	Programming self-efficacy	0.25	4.48	Acceptance
H3d	*FLR-4*	→	Programming self-efficacy	0.21	3.76	Acceptance
H3e	*FLR-5*	→	Programming self-efficacy	0.28	5.09	Acceptance
H4	FLR	→	Interaction	0.12	2.06	Acceptance
H4a	*FLR-1*	→	Interaction	0.14	2.42	Acceptance
H4b	*FLR-2*	→	Interaction	0.12	2.10	Acceptance
H4c	*FLR-3*	→	Interaction	0.09	1.66	Rejection
H4d	*FLR-4*	→	Interaction	0.02	.37	Rejection
H4e	*FLR-5*	→	Interaction	0.01	.03	Rejection

Note. FLR-1: Learner control and self-directed learning, FLR-2: technology self-efficacy, FLR-3: communication self-efficacy, FLR-4: motivation for learning; FLR-5: doing previews.

5.1 | FLR levels of middle school students and indicators of FLR

The grades that middle schools students received in FLR and its indicators were examined. According to the findings, the middle school students have the highest readiness in "motivation for learning" dimension. It can be said that this is followed respectively by learner control and self-directed learning, technology self-efficacy, and communication self-efficacy subdimensions. The lowest FLR level that is indicated by students is the subdimension of "doing previews." According to these findings, students' FLR levels are at high levels.

In the motivation dimension of FLR, the students who received the course that was organized in the FC model demonstrated that they are open for new learning applications, learn from their mistakes, and are willing to share their opinions with others. When the literature is reviewed, it can be said that motivation is an important variable in the FC model. The results obtained from the studies that examined motivation in FC model (Arshad & Imran, 2013; Chao, Chen, & Chuang, 2015; Davies et al., 2013; Hao, 2016a, 2016b; Hung et al., 2010; Strayer, 2012; Yilmaz, 2017) and results of this study are consistent. It is thought that the main properties of the FC model and the active learning activities that were realized in the classroom have had an impact on this situation. Indeed, according to Day and Foley (2006), active learning is one of the most important ways of increasing motivation. It is thought that the advantages such as allocating class time for interactive activities (Zappe, Leicht, Messner, Litzinger, & Lee, 2009), teachers' presentation of different kinds of materials, and the ability of these materials to appeal individual differences (Lage, Platt, & Treglia, 2000; Mason, Shuman, & Cook, 2013) increased interest and participation of students (Enfield, 2013), the ability to ensure that students take their own responsibility (Thoms, 2012). Again, in the same way, the ability of students to reach the learning material whenever they want and progress in their individual speed may have helped students to be motivated. In addition, Hamdan, McKnight, McKnight, and Arfstrom (2013) emphasized that students are more motivated and secure in class as they are prepared for the lecture before the lecture in the FC model. On the other hand, Enfield (2013) presented some suggestions in terms of increasing learning motivation and suggested that weekly short exams are strong motivation sources for students to watch videos, and the presented videos should not be too long and should be appropriate for the level of students. Starting from these discussions, it can be concluded that active learning should be supported in order to increase learning motivation readiness of students, and learning environment should be individualized by resources and contents that are appropriate for students' level.

FLR's learner control and self-directed dimensions are significant as they are out-of-class implementations in the FC model (Durak, 2017). The findings demonstrate that students' learner control and self-directed learning levels are high. In the literature, it was emphasized that self-directed learning and student control are important in terms of providing effective learning in online learning environments

(Chizmar & Walbert, 1999; Poole, 2000). In online learning environments, factors such as online games, social media, and instant messages distract students' attention easily (Garrison, 1997). For this reason, it is important that online students possess skills of learning control and time management in FC and give place to activities that will improve these skills. In this model, students should have self-discipline in order to allocate enough time for lectures in online learning environments and publish messages related to discussions (Discenza, Howard, & Schenk, 2003; Roper, 2007).

High levels of readiness in the technology self-efficacy dimension of FLR, such as competency in computer/network skills that are necessary for online learning (carrying out receiving online information and main software functions), ensure that students are ready to receive courses in FC model. Tsai and Tsai (2010) indicate that students gave differences in terms of their technology self-efficacy, and for this reason, some students are not able to benefit from learning content. For this reason, Hung et al. (2010) suggest teachers to prepare special counselling activities towards online learning or provide special support to students who need education. From this point of view, online guidance provided in FC model will increase both the provision of technical education and support for online students and increase readiness to the learning process; in this way, students' chance of confronting with technical difficulties will be reduced. In addition, in order to prevent the situation that different technology self-efficacy levels constitute a barrier for teaching, Edmodo environment among the frequently used social media environments, which has a high perceived ease of use with its structure similar to Facebook.

In the communication self-efficacy dimension of FLR, it is seen that participants do not have self-confidence in online communication information and self-efficacy in general. FC model includes both online and face-to-face learning dimensions. Research findings demonstrate that timid students tend to involve in online environments more than traditional environments (Palloff & Pratt, 1999). In the FC model, the interaction aspect is more than the classic classrooms (Hao, 2016a). In FC, there is an opportunity for students to receive course content in both online and face-to-face environments and interact with peers and teachers simultaneously and asynchronously. Diversification of these interaction opportunities in order to increase student readiness in FC and encouraging students for communication through discussion settings in an online environment, instant questions, and feedbacks is considered as important in FC (Durak, 2017). Indeed, it was seen that students with higher levels of online communication self-efficacy feel considerably comfortable about participating in the lecture actively (McVay, 2001; Roper, 2007; Salaberry, 2000).

In doing previews dimension of FLR, the scores that students received are lower in comparison with other dimensions. In the FC model, students are required to review the out-of-class sources in order to actualize active learning (Peled et al., 2015). It will be difficult for students who are not prepared before the lecture to participate in learning activities actively. For this reason, in a successful FC model, it is important to review the out-of-class sources before the lecture. For this purpose, in the FC model, the teacher should design these out-of-class resources in an attractive way in order to make them review, and weekly lecture resources should have an appropriate content and length.

5.2 | FLR levels of students and participation

It is seen that FLR and its indicators influence engagement to course. This shows that students will engage more actively in programming teaching course designed according to the FC teaching model when students' learning readiness increases in teaching carried out with FC model. O'Flaherty and Phillips (2015) state that student engagement is an important variable affecting success in online activities.

Rutkowski and Moscinska (2013) considered in and out of class activities of FC model from the perspective of the steps of bloom taxonomy and stated that students actualize learnings at understanding and comprehending level by watching course contents and videos and actualize learnings at implementation, analysis, evaluation, and synthesis level by the in class and after class activities. These writers point out that students' cognitive and behavioural participation is the prerequisite for reaching the cognitive levels that are indicated in the steps of bloom taxonomy. Ensuring student participation is an important problem in terms of online environments (Yilmaz, 2017). In this study, it was reached to the result that students' FLR levels have a positive impact on participation. Starting from this result, it can be said that students' participation will be ensured by increasing their technology and communication self-efficacy. In this study, the Edmodo social educational network was employed with the purpose of facilitating students' use of technology and communication. Due to the fact that this environment can be downloaded on students' smartphones and has a mobile use option, it was ensured that students' technology and communication self-efficacy readiness levels are high. On the other hand, it is clear that students will participate in class as a result of having high learning motivations, being able to control their learning and having high readiness for doing previews. Ayan (2010) noted that using various informatics technology tools in online learning environments will increase students' motivation and self-directed learning indirectly (impact of innovation, diversification of communication channels, appealing to different sense etc.). In the study conducted by Vonderwell and Turner (2005). It was stated that online learning strengthens learning responsibilities, and students who have more control over learning and using the resources efficiently are also more willing to participate in the lecture. Starting from this point, it can be suggested for teachers to counsel students by giving responsibilities in the FC model and to benefit from different informatics technology tools while carrying out counselling activities.

5.3 | FLR level of students and attitudes towards programming

It has been found out that FLR and its indicators are influential on the attitude towards programming. In this study, out-of-class videos and e-sources were presented in order to teach the basic programming concepts in programming education, and it was required to complete the program tasks through program-based learning scenarios during and after the lecture. In order to complete the tasks given in the lecture, student's cognitive and effective participation should be high, and attitude towards the lecture should be positive (Anastasiadou & Karakos, 2011; Austin, 1987; Sacks, Bellisimo, & Mergendoller, 1993). Indeed, Levine and Donitsa-Schmidt (1998) indicated that computer competency and computer literacy are not only related with the level of information and implementations, yet it is directly correlated with an individual's attitudes towards the computer. From this point of view, it can be said that it is important to increase the attitudes towards programming in programming education. The finding that asserts that FLR level affects attitudes towards programming was reached. Accordingly, it can be said that attitudes towards programming can be improved by increasing students' levels of FLR in FC. Technology self-efficacy is important for increasing programming skills (Chen, 2014). It is thought that students' attitudes will change positively with higher technology self-efficacy, will face fewer difficulties both in activities performed on FC and in programming tasks, and will perform better.

According to Mazman (2013), as programming is a skill that an individual possesses, it is not used only for short-term purposes, yet it is possible to transfer it to problem-solving, presenting a product and other situations when it is necessary. It is important in terms of improving communication programming skills in the process of education (Durak, 2016). Communication of students in FC, both in class and out-of-class with their peers and teachers should be encouraged. In addition, it is important to increase learning motivation with the communication self-efficacy in order to provide a positive approach towards programming. When the literature is reviewed, various sources and interaction opportunities are provided for students to keep their motivation high by the nature of the FC model (Findlay-Thompson & Mombourquette, 2014). However, it is seen that the situation is not as given in practice, and many problems occur such as not participating to the online dimension of the model, and for this reason, failing in face-to-face dimension (Connor, Newman, & Deyoe, 2013; Wiginton, 2013). According to Talbert (2012), the teacher has the key role. The teacher should know the levels of self-management. And self-directed learning and self-efficacy readiness levels should communicate with students who have lower levels of readiness and endure that students have the opportunity of asking questions in and out of the class and of receiving feedback. Small quizzes should be carried out in order to lead students for doing previews out-of-class. The perception of difficulty will be reduced for students who interact more, fulfil the programming tasks, and receive help from teachers and peers in both online and face-to-face environments (Stelzer et al., 2009), and they will develop a positive attitude towards the lecture.

5.4 | FLR levels of students and programming self-efficacy

When the model results are examined, it is seen that FLR and its indicators are fully effective on programming self-efficacy. Also, the variable FLR affects programming self-efficacy the most strongly. It is thought that this is an expected result for the programming teaching carried out with the FC model. First of all, the FC model includes advantages of individual learning as well as active learning (Bishop & Verleger, 2013). Furthermore, the fact that students have to do previews in the FC model makes easier to understand programming, which is seen as a complicated and difficult process. In the study Wiginton (2013) conducted, he stated that the FC model has raised the beliefs of learners in themselves. This allows students to work harder to solve programming problems and to overcome difficult tasks.

Face-to-face and online lessons carried out in the FC model make positive contributions to developing basic computer skills (Yilmaz, 2017), writing and running programming codes, and making their error check, and therefore, it is considered that this positively reflects on programming self-efficacy. In addition to this, the beliefs of the learners who actively produce their own products for themselves are also developing. In his study, Enfield (2013) emphasized that students have more opportunities for practice and get feedback in different forms, thanks to FC model, and that this situation improves students' self-efficacy perceptions by developing their beliefs for themselves.

For example, in this study, the activities of "programming implementations, using basic programming concepts for solving the given problem situation, improving and analysis of the given implementation and debug." In this context, students were required to use the discussion environments for the problems they confronted in order to fulfil the programming tasks given as an out-of-class task. It can be said that students who have higher technology self-efficacy tend to receive support more than others. In a similar way, students with higher communication self-efficacy also participate actively and put an effort to fulfil programming tasks. It is thought that this effort and active participation will improve programming self-efficacy. Learning motivation can be effective in terms of students' maintenance of problem-based learning activities and being prepared for the lecture, participating actively, and presenting the perception that the course is difficult. As a result, starting from the idea of Knowles (1975), which suggests that "efforts and attempts towards fulfilling learning tasks will improve self-efficacy towards the course," it can be said that FLR dimensions are effective in terms of improving programming self-efficacy.

5.5 | FLR levels of students and communication

The findings indicate that FLR and its indicators, learner control, self-directed learning, and technology self-efficacy have an impact on communication intensity of the students. Accordingly, the higher the learner control and self-directed learning skills of the student are and the better the technology self-efficacy is, the higher the level of interaction with learner–learner/instructor/content in the programming teaching process designed according to FC teaching model is. In the FC model, it is important to use the instructions for accessing the online resources of the course during effective programming teaching process and provide a comfortable and flexible learning environment for the students in the process of conducting face-to-face activities in terms of interaction variable.

The results of the studies in the literature coincide with the results of this study. For example, Liaw, Huang, and Chen (2007) emphasized the importance of interaction as well as the characteristics features of the learner and the nature of teaching for the success in an effective e-learning environment. Thus, it is necessary to understand the target group well and to develop the interaction elements in line with the needs of the target group in order to develop the e-learning environments (Liaw et al., 2007). According to Demir, Yasar, Sert, and Yurdugül (2014), self-directed learning and technology self-efficacy are related to the student's easy adaptation to the online environment, easy access to information, and use of the environment in line with his/her targets. Based on this explanation, it is thought that self-directed learning and technology self-efficacy can be influential on learner–learner and learner–instructor interactions in online learning environments created especially within the scope of programming teaching in FC.

Demir-Kaymak and Horzum (2013) concluded that there is a high positive relationship between online learning readiness and interaction (learner–instructor/learner/content) in online learning. According to Gulbahar (2009), students who use online environments more effectively and comfortably have more effective learning experiences. Hao (2016b) found out that there was a positive relationship between technology self-efficacy and lesson perception and interaction elements in the FC model study that he conducted on middle school students for English courses. Furthermore, in the FC model in which individual learning activities are carried out, it is especially important to develop the interaction elements so that the student does not break away from the learning environment. On the other hand, learners who are afraid of programming teaching process and experiencing various difficulties can be made successful at learning programming by developing their interaction channels with elements in the learning process.

Research findings show that FLR indicators given as "communication self-efficacy, motivation for learning, and doing previews" do not affect interaction significantly. McLaughlin et al. (2013) determined that FC model increases the interaction of students with course resources yet does not affect students' long-term motivation and out-of-class engagements. In the aforementioned study, the writers pointed out that this situation may arise from the features of student groups and insufficient duration of implementation. These findings that were also obtained in the current study can be associated with the duration of implementation. For example, a preintroduction can be made before the implementation for the introduction of FC model and online environment and several weeks can be allocated for this purpose. In addition, student–student–teacher–content aspects of interaction were addressed. For this reason, it is thought that the aforementioned findings can be associated with student–student–teacher–content relationship. Therefore, in implementations that are conducted with different groups, these hypotheses, results that will be obtained, and results can be focused.

5.6 | Implications

The results of this study reveal the fact that two readiness dimensions in FC required special attention: technology self-efficacy and communication self-efficacy (Figure 3). Teachers may need to assist students to improve their use technology, knowledge, skills, and attitudes particularly for online learning contexts in FC model. For example, teachers may require to improve students' knowledge of technology use in terms of using course tools, before they start implementing in the FC model. Teachers can help students to form technology using skills and allocate sufficient time for class participation. Teachers should design interesting activities for students and put more efforts into increasing student interaction in a learning environment. For example, the teacher should encourage students to share their real-life experiences; express their ideas bravely, also in terms of issues related to online courses such as voting, group discussion, experience sharing, and commenting; give feedbacks to create more interaction; and encourage them to receive help when they confront a problem.

In the study, it was revealed that an increase in students' FLR levels in a programming education actualized by FC model will also have a positive impact on students' engagement, ATP, programming self-efficacy, and interaction levels in a programming course. From this point of view, it can be said that the difficulties related to programming that is addressed in the literature (low participation, motivation, etc.) can be handled through education that is actualized by using FC model. In addition, it can be said that carrying out studies towards increasing FLR levels while using the FC model before teaching might be important in order to overcome the challenges related to programming education.

The results of the study revealed that FLR and its indicators are important predictors of engagement, ATP, programming self-efficacy, and interaction intensity. From this point of view, it can be asserted that FLR levels should be determined at first in order to increase the efficiency of FC model and student participation, student interaction level, self-efficacy, and attitude in FC classrooms. On the other hand, students' knowledge and skills on FLR indicators should be increased in order to increase students' FLR levels. For this purpose, students should get more responsibility for their own learning experiences in the FC model. For instance, students should be able to determine how they will use time ideally in order to study out-of-class resources and do homework. In the case that students cannot realize their own self-control at the beginning of the education process, teachers should provide direct (face-to-face) counselling or an online environment. Furthermore, the design of the online course should be clear, and course resources should be organized appropriately. It would be encouraging to remind students frequently on deadlines and preparations that should be done before the lecture. FLR provided the necessities to realize active learning and in this was students can be encouraged to perform their programming duties successfully.

5.7 | Limitations and suggestions for future researchers

There are some limitations in this study. First of these is that the content covered in the research is limited to topics covered in the "I am learning programming" unit of Information Technologies and Software course and the Scratch applications. Future researchers can repeat the application with different scope, subject, and programming tool used. The application can be extended in terms of time and content. Videos, worksheets, and activities were used during the lesson within the scope of FC model. Regarding this, semistructured interviews can be made with the students, and their views on using different materials and the effects of these materials can be examined. On the other hand, it was seen that some participants were following the course contents mobile at home. The effects of the mobile e-learning environment were ignored. Whether or not there are differences between the students who use mobile online learning and who do not use in terms of FLR can be searched in future studies. It was assumed that the participants did previews before the lesson. In future applications, out-of-school support module may be added to determine whether learners do previews and the resources are reviewed prior to lesson or not.

In addition, students are required to report their own interaction preferences. Online environment daily usage data of the students can be examined by means of learning analysis techniques. Moreover, direction and conditions of interaction can be determined with the field notes and observation forms to be recorded weekly in a face-to-face environment.

Competence and readiness of the preservice and in-service teachers are just as important as the students' because they become the practitioners of the FC model. Studies can be conducted on the FLR status of teachers and teacher candidates. This study was planned within the framework of teaching programming at early age. Studies can be conducted with the students who take a programming course at university level by pursuing a similar process. In this study, the data were collected only with quantitative method. In the online and face-to-face learning process in FC, qualitative researches can be carried out on the variables that are thought to be influential in programming success and the subdimensions of FLR.

6 | CONCLUSION

This study examines the effect of students' FLR on engagement, programming self-efficacy, attitude towards programming, and interaction in information and technology classrooms in which FC model was applied and programming teaching was carried out. The results of the study reveal that FLR and its indicators are important predictors of engagement, attitude towards programming, programming self-efficacy, and interaction. It is expected that the results will guide practitioners on how to make students more ready to learn in classrooms where FC model is used. It is also believed that this study serves to raise awareness about the impact of students' readiness in FC on the subjects surrounding the attitudes and behaviours of students during the lesson.

Moreover, the results of this study are considered important to increase students' performances towards programming and overcome the challenges in programming teaching. The most striking result of this study is that the FC model is an effective option for providing the key components of the success of the education process in programming education, which are participation, interaction, self-efficacy, and learner attitude. It can be said that the FC model possesses important advantages in terms of creating the balance in programming education where the implementation-theory balance should not be overlooked for maximum student activity.

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