



Digital literacy, technological literacy, and internet literacy as predictors of attitude toward applying computer-supported education

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Abstract

Even though there is an abundance of research on computer supported education (CSE), digital literacy (DL), technological literacy (TL), and internet literacy (IL), the correlation between them and their effect on each other have not been analyzed in the literature. However, no study has been conducted on the correlation between and effect of CSE, DL, TL, and IL and which additionally explains their relationship to each other. This study aims to analyze the effect levels among the latent variables of DL, TL, and IL, and the attitude toward applying CSE and these latent variables' ratios to each other. For this purpose, eight hypotheses were developed after reviewing the literature. A relational descriptive model is used to detect the presence and extent of covariance. The participants of this study were 510 prospective teachers. Exploratory and confirmatory factor analysis of the scales were performed. The hypotheses of the research were tested with the structural equation model. As a result, it was revealed that DL, TL, and IL together significantly affect and explain the attitude towards CSE. Different suggestions have been developed based on the results of the research.

Keywords Literacy · Digital literacy · Technological literacy · Internet literacy · Computer-supported education

1 Introduction

With the rapid acceleration of the technological developments in the world and the advent of the COVID-19 pandemic, the needs, learning perspectives, learning styles, and habits of today's learners have changed and reshaped. Educators started

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to search for alternative methods to meet new learning needs in the technology age, and developing technologies have started to be used predominantly in learning environments including higher education (Darling-Hammond & Hylar, 2020; García-Peñalvo et al., 2021; Hadar et al., 2020). Research reveal that using technology-based teaching tools affect teachers' successful teaching performances (Hatlevik & Hatlevik, 2018; Howard et al., 2020). Therefore, examining the factors explaining teachers' technology integration in classrooms took considerable attention in the literature (Scherer et al., 2019), and provided a deeper understanding of the new roles, skills, and attitudes in the learning environments (Fraillon et al., 2014).

Using these new technologies in learning environments necessitates acquiring twenty-first Century skills including information, media, and information, communications, and technology (ICT) literacies (World Economic Forum, 2016). Since learning through the use of new technologies generally takes place in online environments (Kukulska-Hulme & Traxler, 2007), computer-supported education (CSE), which necessitates digital skills and new literacies, has started to be used more and more. As a result, new learners of the technology age need to improve new literacy skills such as digital, technological, and Internet literacy skills to keep up with the new requirements of CSE. Hence, it is thought that the relationship between digital literacy (DL), technological literacy (TL), Internet literacy (IL), and attitude toward applying CSE should be dwelt upon.

The purpose of this study was to analyze the effect of DL, TL, and IL level on attitude toward CSE, their explaining ratio, and their statistical significance. This study's biggest difference from similar studies in the literature is that there is no study conducted on the link between them, the effect of DL, TL, and IL, the attitude toward CSE, and their explaining ratio to each other. For this reason, it is essential to determine which variables affect prospective teachers' attitudes toward CSE and to what extent changes in these attitudes are explained under which variables, and to present a strong model.

2 Theoretical frameworks

Research have shown that developing technologies have started to be used predominantly in education. In recent studies on the teachers, prospective teachers, and CSE, a positive and significant relationship between academic success and the use of computers is reported (Akdeniz et al., 2017; Āzakar et al., 2016; Backer et al., 2022; Berkant, 2016). Since using CSE necessitates acquiring and improving new literacies, the most significant aspects that affect the attitudes toward CSE and new literacy skills will be explained in this section.

2.1 Computer-supported education

Computers and related new technologies have become one of the most important means of education, efficient learning, and teaching in the technology age. In the

literature, there are several terms related to the usage of computers in learning. Some of them are Computer Assisted Learning, Computer-Based Instruction, Computer-Aided Learning, and Computer Aided Instruction, which are also used instead of CSE (Schitteck et al., 2001). In CSE, a computer is used as a helpful tool for educators to enrich learning and teaching activities and improve their quality. In this study, CSE has been handled as an inclusive term for the above-mentioned ones.

The computer can be used for multiple purposes in the classroom including helping students in their learning process. Since CSE is using a computer to facilitate learning (Sharma, 2017), improve the learning and teaching process (Arslan, 2006), and combine learning principles with computer technologies (Uşun, 2000; Amiel, 2006), it uses different practices, simulations, and approaches to deliver knowledge and does assessments. Aktürk et al. (2008) defined CSE as the whole of the activities designed in the computer environment, directed by the teacher, and where the computer plays the role of a rich environment and platform in the learning-teaching process and the activities in which the learners interact. There is plenty of research underlying CSE's several advantages and its positive effect on learners in cognitive, affective, and psychomotor learning domains and skills (Asrifan et al., 2020; Barigham, 2019; Berkant, 2016; Haseski & İlic, 2020; Kan & Yel, 2019; Konstantinidou & Scherer, 2022; Lieberman & Linn, 1991; Lodhi et al., 2019; Munoz-Carril et al., 2021; Raji, 2019; Schacter & Fagnano, 1999).

Attitude is defined as the tendency of a person to show positive or negative behavior towards any event, thing, or person (Turgut & Baykul, 2013), and it is an element that directly affects the learning process. Attitudes of teachers and prospective teachers towards CSE are one of the most important factors for success in the CSE practice (Chen & Chen, 2012; Kutluca & Ekici, 2010; Ozdamli & Tavukcu, 2016; Yilmaz & Yilmaz, 2022). Moreover, it is reported that attitudes are also one of the essential determinants of CSE efficiency (Chen et al., 2018; Liaw et al., 2008).

2.2 Digital literacy

Literacy refers to a skill that can be improved (Kurudayıoğlu & Tüzel, 2010). Therefore, in general terms, literacy is a concept related to the person's perception and understanding of the life she/he lives and the objects and events in this life, and ascribing meaning to all relationships in her/his social life (Aşıcı, 2009). The broad meaning of the concept of literacy is closely related to the contexts in which this concept is articulated. The concept of literacy has been articulated with many concepts such as information, media, communication, science, environment, finance, health, language, culture, civil, visuality, and electronics, and it has taken its place in the literature (Karagülle et al., 2019). In addition to these, the articulation of the literacy concept to the digital concept has caused the usage of the "digital literacy" concept; the articulation of it to the technology has caused the usage of the "technology literacy" concept, and the articulation of it to the internet concept has caused the usage of "internet literacy" concept. All these concepts have started to take their place in both the literature and the practice.

Even though the notion of DL is not new, it started to be mentioned in the literature with the work of Gilster (1997). There are several definitions of DL in the literature. Buckingham (2015), states that DL is much more than a functional issue, such as learning to use a computer and keyboard or searching online. In other words, DL refers to various competencies related to the skillful use of computers and information technology, not just a functional use of computers. In a more global context, DL is defined as the ability to evaluate information from various sources, assess its trustworthiness and usefulness, and solve tasks by locating information (OECD, 2015).

Another perspective underlines the usage and contribution of DL in different areas of life, and the definitions underline this feature of DL. For instance, Huerta and Sandoval-Almazán (2007), define DL as an ability to assist people in their engagement with social and cultural activities through using several media. In a general sense, a person with DL can search and understand information, and express, share, and understand opinions or thoughts freely (Kwon & Hyun, 2014 as cited in Noh, 2017). Fraillon et al. (2013) had a broader definition of DL. According to their definition, it is an ability to investigate, create, and communicate via using computers to participate effectively in all areas of life including home, school, workplace, and society.

Eshet-Alkalai (2004) reports that DL consists of five literacies (Photo-visual, reproduction, branching, information, and socio-emotional) that are related to each other. These skills include, respectively, reading or comprehending the graphic and other multimedia information; combining different pieces of information; navigating the range of information; analyzing and evaluating the variety of information; and social sharing of information, adhering to online norms for collaboration and communication on the Internet (Eshet-Alkalai, 2012). Consequently, there is a common acknowledgment that DL is an essential competence for learners who are facing the challenging demands (the technological, informational, cognitive, and socio-emotional) of the digital age (List et al., 2020).

2.3 Technological literacy

TL is knowing what can be done with the technology, how to use the technology proficiently, and deciding on the type of the technology and the appropriate time/date for usage (Davies, 2011). In a pragmatist approach, TL may be defined as the capability to adopt, adapt, invent, and assess technology to affect own life, community, and environment positively (Hansen, 2003). In particular, it is using, managing, and evaluating technology for specific objectives (Becker et al., 2010; Georgina & Olson, 2008). In a broader sense, technologically literate person must attain a certain amount of fundamental knowledge about technology and some basic technical capabilities, such as identifying and fixing simple problems in the technological devices, employing an approach to solve problems, thinking critically about technological matters, and behave in accordance. (Gamire & Pearson, 2006).

Based on the relevant literature, Bauer and Ahooei (2018) defined TL as the capability to use relevant technology for effective and responsible communication, find solutions for issues, reach accurate information, and create information for a better learning process by

using problem-solving and critical thinking. In this study, Bauer and Ahooei's (2018) TL definition is grounded on.

2.4 Internet literacy

Similar to other literacies mentioned above, there are various definitions of IL in the literature. According to the definition of the Association of Colleges and Research Libraries (2010 as cited in Leung & Lee, 2012), IL is the ability to use computers, software applications, databases, and other technologies for an academic, work-related, or personal purpose. In a broader sense, IL is defined as the ability to assess, analyze, evaluate, and create online content (Lee & Chae, 2012; Livingstone, 2004). Besides, Vijayalakshmi et al. (2020) stated that IL includes effectively navigating and interacting on the Internet, such as downloading a file or accessing a video. As a result, IL is not only having the operational knowledge and essential skills to use a device, but also having information processing skills, such as interpreting, analyzing, and evaluating information in online messages (Kim & Yang, 2015).

An Internet literate individual should notice illegal and harmful content on the Internet, properly communicate on the Internet, protect own privacy, and take security measures (Fuji & Yoshida, 2015). Based on the relevant literature, IL can refer to the capability to access, understand, critique, and create information and communication content on the internet (Bauer & Ahooei, 2018; Livingstone, 2008). In this study, Bauer and Ahooei's (2018) IL definition is based on.

2.5 Research hypotheses

There is a vast amount of literature on the predictors of CSE such as teacher self-efficacy, academic self-efficacy, computer self-efficacy, attitudes to technology, and computer self-efficacy and anxiety (Yeşilyurt et al., 2016; Celik & Yesilyurt, 2013). Besides the literature on the predictors of CSE, other studies on CSE reveal that there is a relationship between CSE, DL, TL, and IL (Aslan & Zhu, 2017; Berkant, 2016; Calaguas & Consunji, 2022; Falloon, 2020; Ferdousi, 2019; Kara, 2020; Lai, 2017; Tour et al., 2021). DL, TL, and IL are also stated as the determinants, influencers, and predictors of CSE and attitudes towards CSE (Estes, 2019; Guillen, 2014; Schumacher & Morahan-Martin, 2001). There is an abundance of research on CSE, DL, TL, and IL. These research are generally based on only one of them and focus on the need for teachers and prospective teachers to acquire these competencies and their level. However, as it is known from the current scientific and research perspective, an independent variable is affected by more than one dependent variable at the same time. In addition to this, with the use of high-level analysis in the social sciences, the effect level of more independent variables and explaining ratios can be detected. As it is explained in the theoretical framework of this study, CSE independent variable affects DL, TL, and IL dependent variables. In this study, DL, TL, and IL level of effect on the attitude toward applying CSE both separately and together, their explaining ratio and their statistical significance are dwelt upon. This situation also reveals this study's biggest difference from similar studies in the literature. On the other hand, no study has been conducted on the link between and effect of DL, TL, and IL on the attitude

toward applying CSE and their explaining ratio to each other. For this reason, it is important to detect which variables affect prospective teachers' attitudes toward applying CSE and to what extent changes in these attitudes are explained under which variables and it is also important to put forward a concrete model in this subject.

To provide quality education with CSE, teachers should have basic skills in information literacy, computer literacy, and especially DL (Konstantinidou & Scherer, 2022). DL, with a dynamic and comprehensive structure, is a more comprehensive concept and regarded as an umbrella or roof (Bayrakçı, 2020; Güneş & Bahçivan, 2018). It is underlined that a teacher's DL skill means more than helping students with digital technology usage (Zhao et al., 2018). According to Martin and Grudziecki (2006), DL includes various types of literacies such as digital, media, information, and visual literacies. Similarly, it is argued that the concept of DL consists of technology, computer, information, media, communication, and visual literacy (Chetty et al., 2017; Covello & Lei, 2010). DL, IT literacy, computer literacy, and media literacy are used interchangeably, and the usage of different concepts reflects rapidly changing technology and the popularity of technology-related literacies. Since DL comprises not only basic ICT skills but also more advanced skills regarding the creative and critical use of digital tools, it is now defined as all engagements with digital technologies mediating most of the social interactions. According to Sefton-Green et al. (2009), DL includes a computer, technology, media, Internet, and it mediates most of our social interactions in varying degrees. This points out that DL can be considered as an influencing variable.

It is seen as essential for teachers to have a comprehensive understanding of technology to support teaching and learning (Compton & Compton, 2013; Forret et al., 2013). Similarly, TL and technology self-efficacy are determined as the most significant elements of the UNESCO's (2018) ICT qualification framework for teachers. The results of studies conducted in different countries on technology and technology education reveal that the perception, opinion, and literacy levels of teachers and prospective teachers are essential for CSE (Hasse, 2017; Lee et al., 2020).

Besides TL, IL is one of the essential skills and deals with an individual's competency, fluency, and knowledge in online environments. Therefore, IL is expected to affect the experience of the Internet and computer usage (Lee & Chae, 2012; Litt, 2013). In a study conducted by Miao et al. (2020), it is revealed the role of academic competence as a mediator between IL and academic achievement. Therefore, it is expected that IL will affect the attitude towards CSE.

Attitudes and self-efficacy perceptions of teachers and prospective teachers are the most important factors in achieving success in CSE practice. Analyzing the attitudes of prospective teachers towards CSE, their self-efficacy perceptions, and other variables that affect CSE is essential to improve the quality of higher education (Kutluca & Ekici, 2010). Therefore, there are numerous studies in which complex or various structural equation models are presented between various variables and CSE (Celik & Yesilyurt, 2013; Henseler et al., 2016; Hernández-Sellés et al., 2019, 2020; Molinillo et al., 2018; Yeşilyurt et al., 2016). Moreover, theoretical and empirical evidence about close relationships among DL, TL, IL, and CSE were presented in recent findings.

The aim of this study is to test the relationship among the latent variables of TL, DL, IL, and attitude toward CSE, their effect on each other, and the levels

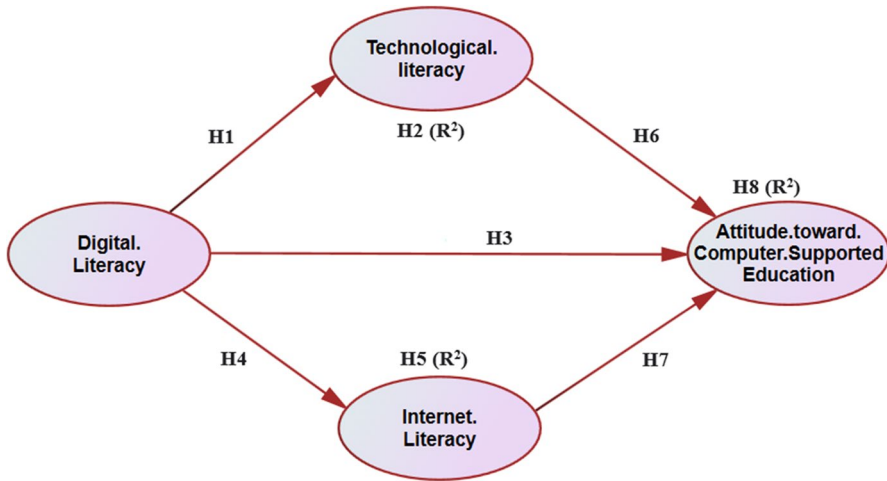


Fig. 1 Path diagram related to study hypothesis

of explanation. To reach this aim, the following eight research hypotheses, supported both theoretically and by the results of the related research, were tested:

- H1.** DL positively and significantly affects TL.
- H2.** DL significantly explains TL.
- H3.** DL positively and significantly affects attitude toward applying CSE.
- H4.** DL positively and significantly affects IL.
- H5.** DL significantly explains IL.
- H6.** TL positively and significantly affects attitude toward applying CSE.
- H7.** IL positively and significantly affects attitude toward applying CSE.
- H8.** DL, TL, and IL together explain attitude toward applying CSE.

One of the most important features of SEM is to develop hypotheses suitable for the general purpose of the research by taking the theoretical basis into account, and to test these hypotheses through a model. Therefore, the fact that the modification indexes of the model created and tested based on the theoretical information are at good fit or acceptable fit values embody the validity, reliability and practicality of the theoretical knowledge. The hypotheses and the path diagram to test the hypotheses in Fig. 1 were developed by the authors of this study.

3 Method

3.1 Research model

A relational descriptive model is used for determining the change or the degree of the change between two or among more than two variables (Karasar, 2012), and detecting the presence and extent of covariance. Therefore, it was used in this

study, and analyses were conducted using structural equation modeling. The eight hypotheses were tested, and the effect of prospective teachers' attitudes toward using CSE, DL, TL, and IL on each other and their relationship with each other were analyzed in this study.

3.2 Participants

The participants of this study were 510 prospective teachers studying at the education faculty of a state university in Turkey in the fall semester of the 2021–2022 academic year. Confirmatory factor analysis (CFA) and structural equation modeling (SEM) were used during the data analyses process. For this reason, the analysis method was decisive in determining the number of participants. There are different criteria for determining the size of the study group in the literature. Considering the sample size, Preacher and MacCallum (2002) stated that the minimum sample size should be between 100 and 250, or the number of items must be multiplied by at least three to determine the number of participants. Similarly, Bayram (2010) points out that the study group should be more than 200. According to Schumacker and Lomax (2010), 250–500 participants were used in many studies, and this number was sufficient for conducting SEM. In this context, it can be said that the number of participants in this study is sufficient.

3.3 Data analysis

After the data entry to the software package, the participants' demographic characteristics were analyzed and exploratory factor analyses of scales were completed. The validity and reliability of the scales were statistically appropriate. It is stated that if the study group of the research and the study group in which the scales were developed were different, reliability and validity of the scales may need to be re-examined (Ercan & Kan, 2004). The fact that the Kaiser-Meyer-Olkin (KMO) result is greater than .60 and the Bartlett test is significant indicates that the data set is suitable for factor analysis. According to Büyüköztürk (2007), calculations for the internal consistency coefficient of the whole scale and sub-dimensions can be done by using the Cronbach Alpha (α), which is one of the reliability estimation methods. Moreover, if the Cronbach Alpha (α) value is .60 and above, the scale is considered reliable, and if it is above .80, the scale is considered highly reliable (Kayış, 2006). Besides, for acceptable reliability coefficients, it can be said that a scale with a value above .70 is reliable (Field, 2017; Kline, 1999). In addition, the structure revealed by exploratory factor analysis (EFA) was also examined by CFA.

In EFA and CFA, especially in social sciences, the boundary value of factor loads can be lowered to 0.30 when the number of items in a scale is limited. Furthermore, although the content validity is affected by a factor load below 0.30, researchers can conduct the analyses without taking the related item from the scale (Osborne, 2014). As recommended by Arbuckle (2009), researchers used software

package, for the CFA of scales and SEM to examine the relationships. CFA, generally applied after EFA, brings out more exact statistical outcomes (Kline, 2015). Besides, researchers generated an SEM, which is a highly preferred model since it is better for the philosophy of discovery and confirmation in experimental or survey research (Bagozzi & Yi, 2012). The above-mentioned advantages are the reasons for using CFA and SEM. In the evaluation of the model goodness of fit, the following were used: The root mean square error of approximation (RMSEA), the standardized root mean square residual (SRMR), the goodness of fit index (GFI), the comparative fit index (CFI), the adjusted goodness of fit index (AGFI), the normed fit index (NFI), the chi-square/degrees of freedom ($X^2/sd = CMIN/DF$), and the level of significance (p) fit indexes. According to Tabachnick and Fidell (2013), these fit indexes should be taken into account for CFA and SEM. The following indicate good fit indexes: RMSEA value between 0 and 0.08; SRMR value between 0 and 0.10; AGFI value between 0.85 and 1.00; X^2/sd (CMIN/DF) value between 0 and 3, p value between 0.01 and 0.05, and the values of GFI, CFI and NFI between 0.90 and 1.00 (Barrett, 2007; Byrne, 2001; Hu & Bentler, 1999; Kline, 2015; Raju et al., 2002; Reisinger & Mavondo, 2006; Schermelleh-Engel et al., 2003). Besides, normality tests for CFA and SEM were based on a critical ratio below 10, since a problem may come up in the kurtosis value of distribution when the ratio is more than 10 (Kline, 2015; Mardia, 1974).

3.4 Data collection instruments

3.4.1 Digital literacy scale

The “DL Scale” consisting of six factors and 28 items and developed by Bayrakçı (2020) was used to determine the DL levels of prospective teachers. According to the Cronbach Alpha internal consistency analysis of the scale, the ethics and responsibility factor was $\alpha = .842$, general knowledge, and functional skills factor was $\alpha = .875$, daily use factor was $\alpha = .782$, professional production factor was $\alpha = .719$, confidentiality and security factor was $\alpha = .820$, social factor was $\alpha = .86$. Internal consistency analysis for the overall scale was $\alpha = .911$. The DL Scale included five-point Likert-type items and the items were evaluated with “strongly agree” (5), “agree” (4), “undecided” (3), “disagree” (2), and “strongly disagree” (1) options. The items in this scale are exemplified as follows: Ethics and responsibility factor; “I am aware of the ethical and legal responsibilities of cyberbullying (insulting, profanity, hate speech, etc.) and abuse in online environments (DL4).” General knowledge and functional skills factor; “I know what are licensed software, demo software, pirated software, malware and crack (DL8).” Daily usage factor; “I can use cloud computing technologies (Google Drive, iCloud, Dropbox etc.) effectively in daily life (DL15).” Professional production factor; “I can develop software/application based on digital technologies (DL20).” Privacy and security factor; “I know how to restrict applications’ access to my personal information (location, contacts, camera, etc.) (DL22).” Social factor; “With the help of digital technologies, I can change various images (photo, sound recording and video, etc.) and produce new content

(DL28).” In addition, the CFA of the scale was also performed and the fit indexes were found to be within acceptable limits. All items in the scale had the same structure and positive meaning.

After the analysis of the data, it was determined that the KMO value of the scale was .936. The results obtained from the KMO and Bartlett Sphericity tests ($\chi^2=6979.701$, $df=406$, $p=.000$) indicated that the data were suitable for factor analysis. The factor loads of the items varied between .693 and .362. The Cronbach Alpha values of the internal consistency coefficient of the scale were as follows: Ethics and responsibility factor $\alpha=.866$, general knowledge and functional skills factor $\alpha=.860$, daily use factor $\alpha=.810$, professional production factor $\alpha=.760$, privacy and security factor $\alpha=.765$, social factor $\alpha=.769$, and $\alpha=.922$ for the overall scale. This six-factor scale explained 61.716% of the total variance. The structure obtained as a result of EFA was tested with CFA. To obtain the appropriate (fit) values of the scale in terms of fit indexes, the modification indexes (M.I.) were taken into account. In line with the modification indexes and suggestions, four items were removed from the scale and six error covariances were created (e1-e2, e6-e7, e8-e9, e14-e17, e23-e25, and e27-e29). The CFA results of the scale are given in Fig. 2. When the modification indexes (p, X2/sd, GFI, CFI, NFI, AGFI, RMSEA, SRMR) given under the heading of data analysis were taken into account, the CFA fit indexes of the scale had “good fit” and “acceptable fit” values.

3.4.2 Technological literacy scale

The TL Scale, which consists of five factors and thirty-three items, was developed by Yiğit (2011). The Cronbach Alpha values of the internal consistency coefficient of the scale were as follows: Technological life-oriented skills factor $\alpha=.78$, nature of technology factor $\alpha=.73$, designed world factor $\alpha=.96$, design factor $\alpha=.63$, technology and society factor $\alpha=.66$, and $\alpha=.86$ for the overall scale. Three-point Likert-type items were included in the Technology Literacy Scale with “yes” (3), “undecided” (2), and “no” (1) options. The items in this scale are exemplified as follows: Skills for technological life factor; “Before using a technological product, I examine its positive and negative aspects” (TL4).” The nature of technology factor; “Technology has a great role in human interaction with society (TL18).” The designed world factor; “In solving problems, people process information with the help of technology (TL19).” Design factor; “Technological designs must be functional (TL29).” Technology and society factor; “Identification of the problem is an important element of the design process (TL30).”

In the data obtained in this study, first of all, four negative items were converted to positive. After the analysis, it was determined that the KMO value of the scale was .874. The results obtained from the KMO and Bartlett Sphericity tests ($\chi^2=4592.593$, $df=496$, $p=.000$) indicated that the data were suitable for factor analysis. The factor loads varied between .707 and .378. The Cronbach Alpha values of the internal consistency coefficient of the scale were as follows: Technological life-oriented skills factor $\alpha=.812$, nature of technology factor $\alpha=.721$, designed world factor $\alpha=.725$, design factor $\alpha=.705$, technology, society factor $\alpha=.711$, and $\alpha=.872$ for the overall scale. This five-factor scale explained 46.623% of the total variance. The structure obtained as a result of EFA was tested with CFA. To

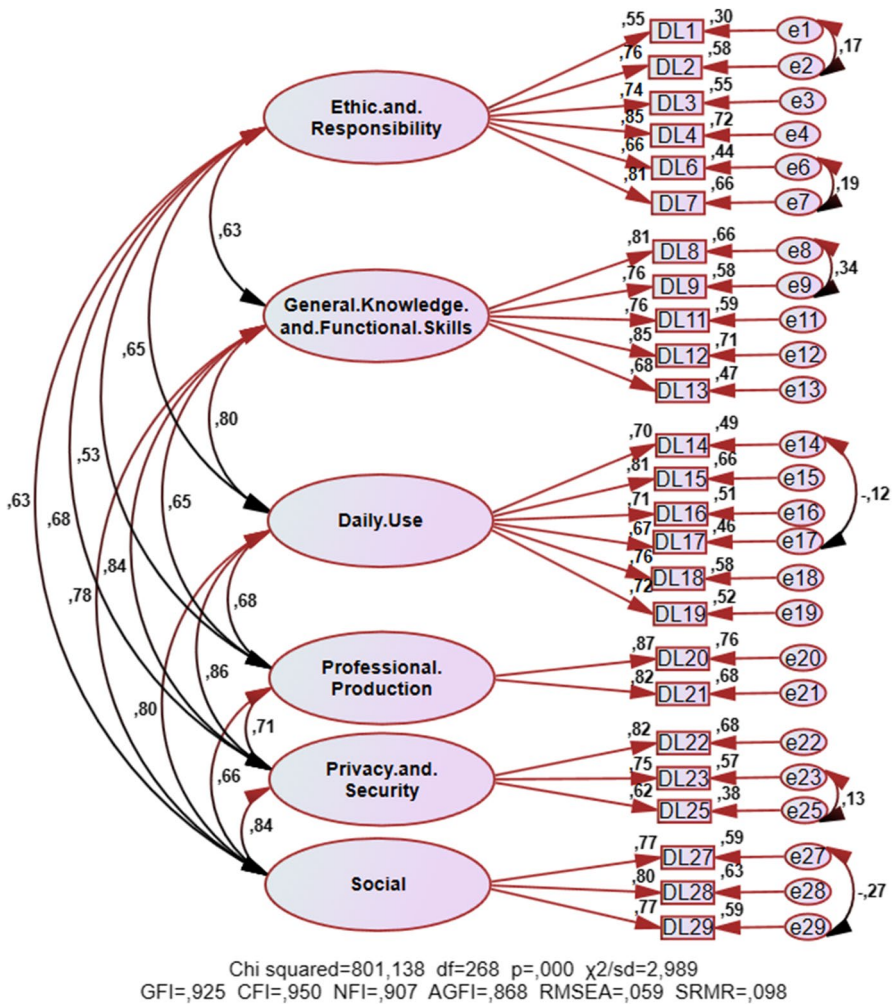


Fig. 2 Diagram for confirmatory factor analysis of the DL scale

obtain the appropriate (fit) values of the scale in terms of fit indexes, the modification indexes (M.I.) were taken into account. In line with the modification indexes and suggestions, eight items were removed from the scale and three error covariances were created (e1-e9, e12-e17, and e21-e22). The CFA results of the scale are given in Fig. 3. When the modification indexes (p , X^2/sd , GFI, CFI, NFI, AGFI, RMSEA, SRMR) given under the heading of data analysis were taken into account, the CFA fit indexes of the scale had “good fit” and “acceptable fit” values.

3.4.3 Internet literacy scale

“IL Self-Efficacy Scale for Pre-service Teachers” consisting of four factors and 16 items and developed by Yasan Ak (2020) was used to measure pre-service teachers’

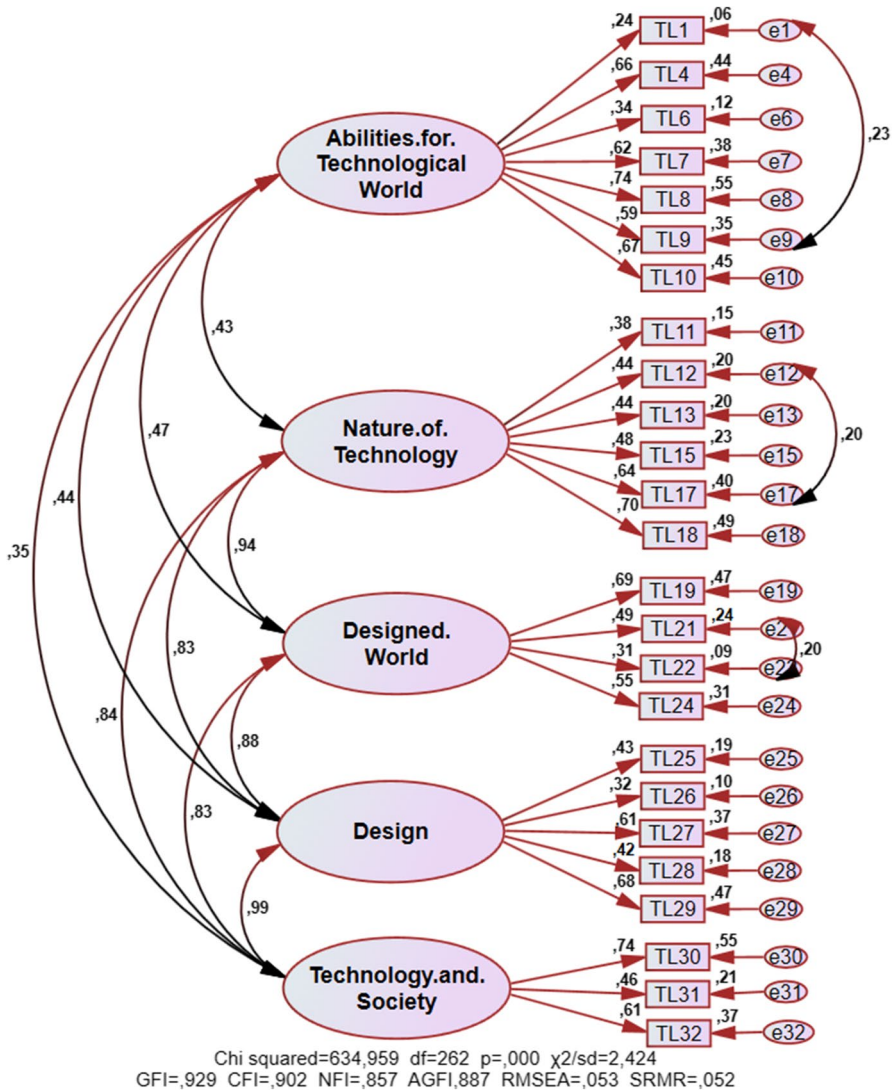


Fig. 3 Diagram for CFA of the TL scale

II. The Cronbach Alpha values of the internal consistency coefficient of the scale were as follows: Reliability factor $\alpha = .91$, creation factor $\alpha = .82$, technical information factor $\alpha = .85$, and information factor $\alpha = .72$. The scale was a seven-point Likert-type with “I have a lot of confidence in myself” (7), (6), (5), (4), (3), (2), (1) “I don’t trust myself at all.” options. The items in this scale are exemplified as follows: Creation factor; “I can create blogs (IL9).” Obtaining information factor; “I can use academic reference programs (e.g. Mendeley, Evernote, etc.) (IL15).” Safety factor; “I can distinguish whether information on the web is trustworthy (IL3).” Technical knowledge factor; “I can solve other Internet access problems (IL6).” In addition,

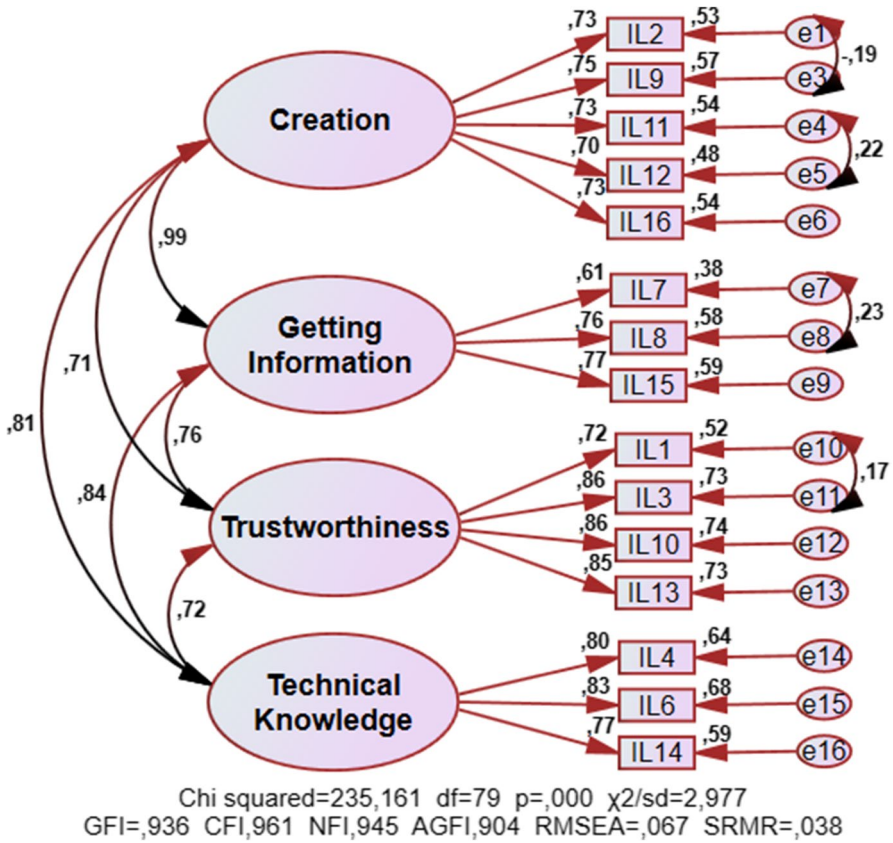


Fig. 4 Diagram for CFA of the IL scale

CFA of the scale was also performed and it was revealed that the fit indexes were within acceptable limits.

All items of the scale were positive and had the same structure. After the analysis, it was determined that the KMO value of the scale was .948. The results obtained from the KMO and Bartlett Sphericity tests ($\chi^2 = 5175.273$, $df = 120$, $p = .000$) indicated that the data were suitable for factor analysis. The factor loads varied between .768 and .446. The Cronbach Alpha values of the internal consistency coefficient of the scale were as follows: The creation factor was calculated as $\alpha = .875$, information acquisition factor $\alpha = .779$, safety factor $\alpha = .896$, technical knowledge factor $\alpha = .838$, and $\alpha = .940$ for the overall scale. This four-factor scale explained 72.053% of the total variance. The structure obtained as a result of EFA was tested with CFA. To obtain the appropriate (fit) values of the scale in terms of fit indexes, the modification indexes (M.I.) were taken into account. In line with the modification indexes and suggestions, one item was removed from the scale and four error covariances were created (e1-e3, e4-e5, e7-e8, and 10-e11). The CFA results of the scale are given in Fig. 4. When the modification indexes (p , X^2 /sd, GFI, CFI, NFI, AGFI,

RMSEA, SRMR) given under the heading of data analysis are taken into account, the CFA fit indexes of the scale had “good fit” and “acceptable fit” values.

3.4.4 The attitude scale toward applying computer supported education

To measure the attitudes of prospective teachers towards CSE, the “Attitude Scale Towards CSE” developed by Arslan (2006) and consisting of a single factor and 20 items was used. The reliability coefficient was calculated as .93. There were five-point Likert-type items with “strongly agree” (5), “agree” (4), “undecided” (3), “disagree” (2), and “strongly disagree” options. The items in this scale are exemplified as follows: I think computer is an effective teaching tool (ACSE18); I try to use computers in my lessons (ACSE20); students learn better in lessons where computers are used (ACSE8).

In the data obtained in this study, first of all, ten negative items were converted to positive. After the analysis, it was determined that the KMO value of the scale was .939. The results obtained from the KMO and Bartlett Sphericity tests ($\chi^2=5191.561$, $df=190$, $p=.000$) indicated that the data were suitable for factor analysis. The factor

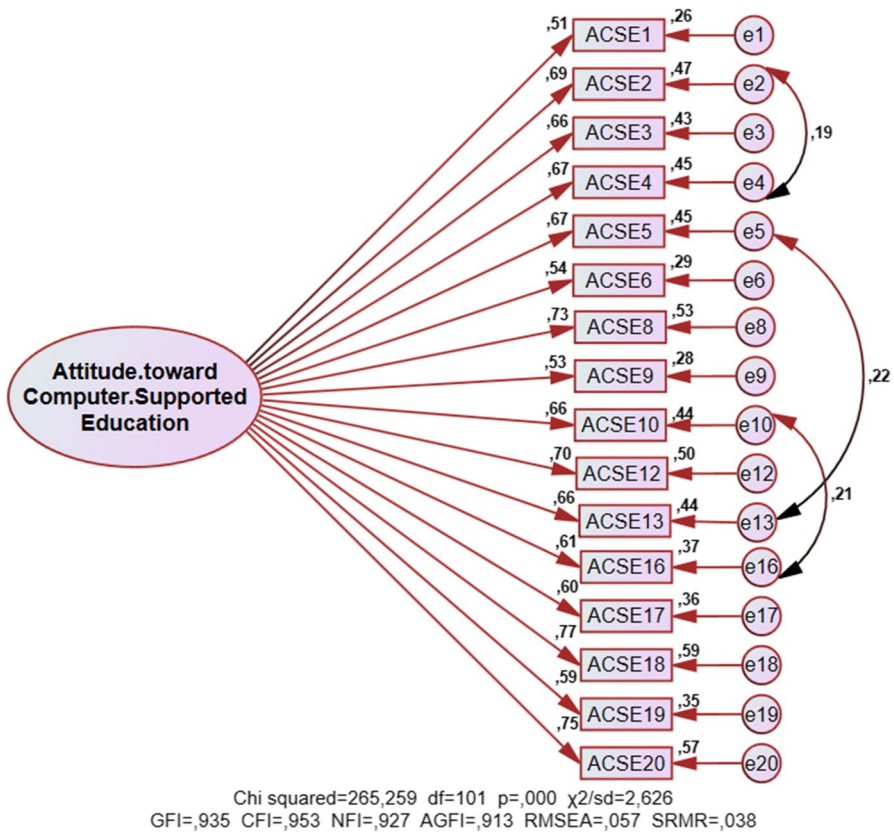


Fig. 5 Confirmatory factor analysis diagram of the attitude scale toward CSE

loads varied between .642 and .449. The internal consistency coefficient of the scale, Cronbach Alpha, was found to be .939. This single-factor scale explained 46.704% of the total variance. The structure obtained as a result of EFA was tested with CFA. To obtain the appropriate (fit) values of the scale in terms of fit indexes, the modification indexes (M.I.) were taken into account. In line with the modification indexes and suggestions, four items were removed from the scale and three error covariances were created (e2-e4, e5-e13, and e10-e16). The CFA results of the scale are given in Fig. 5. When the modification indexes (p , X^2/sd , GFI, CFI, NFI, AGFI, RMSEA, SRMR) given under the heading of data analysis were taken into account, the CFA fit indexes of the scale had “good fit” and “acceptable fit” values.

4 Results

As a result of this study, a model presenting the effect level of the latent variables of DL, TL, IL, and CSE on each other and their explaining ratios on each other was proposed. SEM as shown in Fig. 6 was built for this study.

The fit index was as follows: Chi squared = 6621.737; $df = 3128$; $p = .000$; χ^2/sd (CMIN/DF) = 2.117; GFI = .912; CFI = .967; NFI = .902; AGFI = .864; RMSEA = .047 and SRMR = .088. These results illustrate an acceptable and desired level of the model fit index.

There were six latent variables and 25 observed variables in the DL scale. Whereas DL1 and DL25 had the lowest effect coefficient, DL4 and DL21 had the highest effect coefficient hierarchically. Besides, the effect coefficients were between 0.89 and 0.46.

There were five latent variables and 25 observed variables in the TL scale. Whereas TL22, TL6, and TL26 had the lowest effect coefficient, TL30 and TL8 had the highest effect coefficient hierarchically. Besides, the effect coefficients were between 0.97 and 0.58.

There were four latent variables and 15 observed variables in the IL scale. Whereas IL2 and IL7 had the lowest effect coefficient, IL10 and IL3 had the highest effect coefficient hierarchically. Besides, the effect coefficients were between 0.98 and 0.78.

There were 16 observed variables in the attitude scale toward applying CSE. Whereas ACSE6 and ACSE9 had the lowest effect coefficient, ACSE18 and ACSE20 had the highest effect coefficient among the observed variables. Besides, the effect coefficients were between 0.78 and 0.55.

Considering the hypotheses, the following results were obtained. As shown in Fig. 6, it was confirmed that DL positively and significantly affected TL at a level of 0.45. The accuracy of the hypothesis that appeared in H1 (DL positively and significantly affects TL) was confirmed by this result. Furthermore, DL significantly explained TL at a ratio of 34%. To put it another way, it can be said that the change in TL was dependent on DL at a rate of 34%. The hypothesis in H2 (DL significantly explains TL) was confirmed by this result.

Regarding the third hypothesis, it was confirmed that DL positively and significantly affected attitude toward applying CSE at a level of 0.21. The accuracy of the hypothesis stated in H3 (DL positively and significantly affects attitude toward applying CSE)

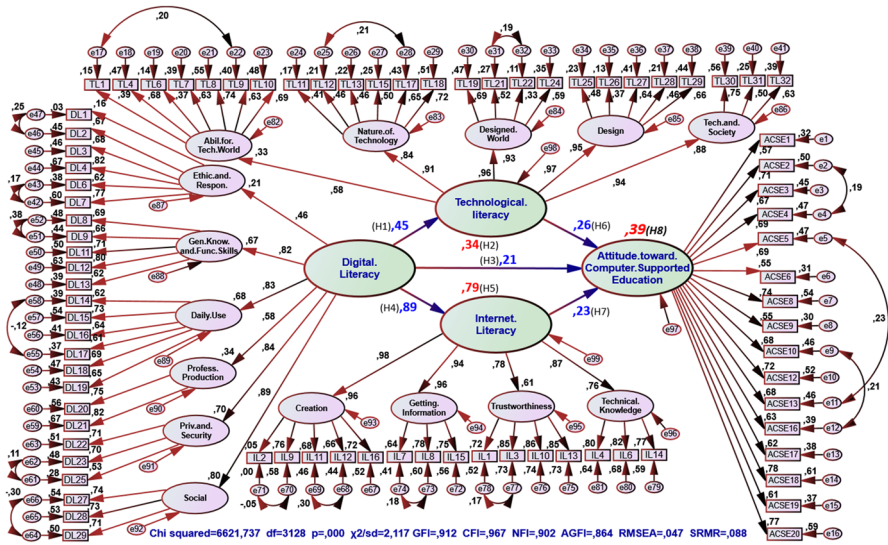


Fig. 6 Structural equation modeling and analysis results of hypothesis

was confirmed by this result. Nevertheless, as shown in Fig. 6, it was confirmed that DL affected IL at the highest level and the attitude toward applying CSE at the lowest level.

The study results also confirmed that DL affected IL positively and significantly at a level of 0.89. Therefore, the accuracy of the hypothesis stated in H4 (DL positively and significantly affects IL) was confirmed by this result. Moreover, it was confirmed that DL explained IL at a ratio of 79%. To put it another way, the change in IL arose from DL at a ratio of 79%. The hypothesis in H5 (DL significantly explains IL) was confirmed by this result.

According to the results, it was confirmed that TL affected the attitude toward applying CSE positively and significantly at a level of 0.26. The accuracy of the hypothesis that appeared in H6 (TL positively and significantly affects attitude toward applying CSE) was confirmed by this result. As a result, it was confirmed that IL positively and significantly affected the attitude toward applying CSE at a level of 0.23. The accuracy of the hypothesis stated in H7 (IL positively and significantly affects attitude toward applying CSE) was confirmed by this result.

Considering the last research hypothesis, it was confirmed that DL, TL, and IL together significantly explained the attitude toward applying CSE at a ratio of 39%. Therefore, H8 (DL, TL, and IL together explain attitude toward applying CSE) was confirmed.

5 Discussion

In this study, the effect level of the latent variables of DL, TL, IL, and the attitude toward CSE on each other and their explaining ratios on each other were tested. Hence, eight hypotheses were developed in the framework of the research theory. In

this section, the results of this study and other research results in the literature were discussed.

Considering the first hypothesis, it is found that the DL of prospective teachers positively and significantly affected TL. Moreover, considering the second hypothesis, it was confirmed that the DL of prospective teachers significantly explained TL. Prospective teachers need to have DL skills to use technology efficiently and functionally (List et al., 2020). In the literature, it is emphasized that there was a significant relationship between students' perceptions and beliefs about DL and their attitudes towards technology (García-Martín & García-Sánchez, 2017; Hatlevik et al., 2018; Lee et al., 2019). Similarly, teachers' DL had been regarded as an important element of ICT-supported education (Zhao et al., 2018). As a result of a study conducted by García-Martín and García-Sánchez (2017), prospective teachers' perceptions of the use of web 2.0 tools were positive and their DL skills had an impact on this situation. Moreover, the results of H1 and H2 overlapped with other research results. Accordingly, some studies revealed a positive relationship between DL and TL (Falloon, 2020; Potyrała & Tomczyk, 2021; Yondler & Blau, 2021).

Regarding the third hypothesis, it was confirmed that the DL of prospective teachers positively and significantly affected attitude toward applying CSE. There are similar findings in the literature. For instance, in a study by Ferdousi (2019), it was stated that computer use self-efficacy significantly affected learners' intention to use digital technology in their learning. In another study, it was found that prospective teachers' tool literacy and metacognitive self-regulating capabilities had predictive effects on their attitudes towards structuring personal learning environments with Web 2.0 tools (Lim & Newby, 2021). There were also other studies showing a positive relationship between DL and CSE (Tour et al., 2021; van Rensburg & Son, 2010).

Considering the fourth hypothesis, the result confirmed that prospective teachers' DL positively and significantly affected IL. Moreover, regarding the fifth hypothesis, it was confirmed that prospective teachers' DL significantly explained IL. According to Ilomäki et al. (2011), DL is using the computer to access information and transfer data, communicate with the help of the Internet, work in teams and use communication technologies effectively in daily work. The results of this study for H4 and H5 were consistent with other research results in the literature. Among the results of the studies, it was emphasized that there was a relationship between DL and IL (Bauer & Ahooui, 2018; Gui & Argentin, 2011; Koltay, 2011; Reddy et al., 2021; The Royal Society, 2012).

Regarding the sixth hypothesis, it was confirmed that prospective teachers' TL positively and significantly affected attitude toward applying CSE. In a study conducted by Santoso and Lestari (2019), it was revealed that TL significantly affected teaching competencies, and the teaching competencies were significantly influenced by TL and technology integration. In addition, according to the study by Hohlfeld et al. (2013), there was a relationship between TL and CSE. These results overlapped with the result of H6. Moreover, concerning the seventh hypothesis, it was confirmed that prospective teachers' IL positively significantly affected attitude toward applying CSE. Similarly, in a study conducted by Calaguas and Consunji (2022), a positive and significant effect of the Internet and information-seeking self-efficacy on computer-assisted online learning self-efficacy was revealed. Moreover,

in another study conducted by Wegmann et al. (2015), it was found that IL was a variable that affected and predicted the use of social networking sites accessed via computer. Accordingly, there are studies in the literature that shows a positive and significant relationship between IL and academic performance (Leung & Lee, 2012; McCoy, 2010; Miao et al., 2020). In addition to these, some studies reveal a positive relationship between IL and CSE (Lee & Chae, 2012; Lee et al., 2015; Schumacher & Morahan-Martin, 2001; Vernanda et al., 2018). As a result, the literature supported the result obtained from the H7 hypothesis.

Considering the eighth hypothesis, it is confirmed that prospective teachers' DL, TL, and IL together significantly explained attitude toward applying CSE. Similarly, some studies reveal positive prospective teachers' attitudes towards CSE (Aslan & Zhu, 2017; Kara, 2020; Önder et al., 2011). Moreover, among the results of meta-analysis studies on CSE in the literature, it is statistically more effective than traditional education (Anil et al., 2018; Cheung & Slavin, 2012; Dinçer, 2015; Jong & Van Joolingen, 1998; Kumar & Mahajan, 2013; Porebska & Wantuch, 2015; Rutten et al., 2012; Seo & Bryant, 2009; Trey & Khan, 2008; Wayangkau & Loupatty, 2017). Therefore, some research results supported the result of H8. Accordingly, Çam and Kiyici (2017) reported that prospective teachers' use of technological devices inside or outside the classroom may be useful for DL levels. Furthermore, in a study conducted by Link and Marz (2006), it was revealed that the majority of the students who had computer skills and knowledge had positive attitudes towards e-learning. Similarly, Khalifeh et al. (2020) reported that higher education students who were using personal computers, laptops, or tablets had a higher level of online learning ability and they were ready for CSE. There are other studies in the literature that have reported similar findings (Ellington et al., 2011; Ferdousi, 2019; Fister & McCarthy, 2008; Horton et al., 2011; Ozdamli & Tavukcu, 2016; Önder & Silay, 2016).

In terms of quality and functional education, teachers and prospective teachers need to have DL, TL, and IL, but it is not enough on its own. They also need to be compatible with each other and with CSE. It is stated that types of literacies such as 'information literacy' (Zurkowski, 1974), 'computer literacy' (Tsai, 2002), 'media literacy' (Christ & Potter, 1998), and recently, 'multi-modal literacy' (Heydon, 2007) do not have an effect on learning alone, and that relevant literacy skills can be beneficial by properly integrating with CSE (Liao, 2007). For this reason, the result of the eighth hypothesis (DL, TL, and IL of pre-service teachers significantly explained their attitude towards CSE) showed that these four variables supported, explained, and were compatible with each other statistically.

6 Conclusion

The theoretical information in the literature and the results of the research on the subject show that teachers' and prospective teachers' level of DL, TL, and IL predict their attitudes towards CSE. In other words, the theoretical knowledge and study results indicate that pre-service teachers' DL, TL, and IL levels significantly affect and explain their attitudes towards their CSE. However, no study could be found in the literature on the extent to which DL, TL, and IL levels both separately and

together affect or explain teachers' or prospective teachers' attitudes towards CSE. Therefore, the aim of this study is to test the relationship among the latent variables of TL, DL, IL, and attitude toward CSE, their effect on each other, and the levels of explanation.

As a result, it was revealed that DL, TL, and IL together significantly affected and explained the attitude towards CSE. In other words, it has been determined that DL, TL, and IL are important predictors of attitude towards CSE. Moreover, DL, TL, and IL exogeneous (external-independent) variables were found to significantly affect and explain, that is, predict the CSE endogeneous (intrinsic-dependent) variable. According to this result, prospective teachers' DL level should be determined and developed at first to have a positive and high level of attitude towards CSE. Determining the level of DL will affect prospective teachers' attitudes towards CSE, as well as their TL and IL positively and significantly. The results showed that the TL of prospective teachers also contributed to their attitude towards CSE. For this reason, prospective teachers' high attitudes towards CSE, and therefore their implementation of CSE, were closely related to a sufficient level of TL. In addition to these, it has been determined that IL is also effective in the attitude of prospective teachers towards CSE. Therefore, a sufficient IL level of prospective teachers will contribute to their high positive attitude towards CSE, thus contributing to their CSE. In short, the DL, TL, and IL levels of prospective teachers are essential in terms of their attitude towards CSE. In line with the results obtained in accordance with the general purpose of the research, it can be concluded that in order for prospective teachers to develop a positive attitude towards CSE and to conduct CSE, they should first acquire DL, TL, and IL skills. Therefore, the contents of the courses and program outputs in the pre-service education should ensure the achievements of these literacy types and increase the attitude towards CSE in a positive way.

7 Limitations

In addition to the contributions of the study, there are also some limitations that should be mentioned. Apart from DL, TL, and IL, other literacy types also affect attitude toward applying CSE. It is recommended that researchers conduct research on other variables that affect the attitude towards CSE, especially other types of literacy. Secondly, in this study, prospective teachers' DL, TL, and IL levels were determined according to their opinions through scales. In future research, DL, TL, IL, and applying CSE levels of prospective teachers can also be determined by empirical studies based on practice and observation. Thirdly, this study was conducted on prospective teachers. Future research can be done on teachers. In addition, studies that aim to determine the place of DL, TL, IL, and CSE variables in pre-service education course contents and program outputs can be conducted. Despite its limitations, this study contributes to the literature in terms of revealing the effect level and explanation ratio of DL, TL, and IL variables on attitude toward applying CSE and testing the accuracy of the hypotheses based on the theoretical basis.

Data availability The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Competing interests The authors have no competing interests to declare that are relevant to the content of this article.

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