

## Are Schools Alienating Digitally Engaged Students? Longitudinal Relations between Digital Engagement and School Engagement

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### Abstract

*This article examined digital learning engagement as the out-of-school learning component that reflects informally emerging socio-digital participation. The gap hypothesis proposes that students who prefer learning with digital technologies outside of school are less engaged in traditional school. This hypothesis was approached from the framework of connected learning, referring to the process of connecting self-regulated and interest-driven learning across formal and informal contexts. We tested this hypothesis with longitudinal data. It was of interest how digital engagement, operationalized as a general digital learning preference, wish for digital schoolwork, and their interaction, is related to traditional school engagement. This was examined both cross-sectionally in three time points and longitudinally across three years. The participants were 1,705 (43.7% female) 7th–9th graders (13–15 years old) from 27 schools in Helsinki, Finland. We explored the structure of correlations between latent constructs at each time point separately, and finally, to evaluate longitudinal relations between digital engagement and school engagement we specified latent cross-lagged panel models. The results indicate that students holding a stronger general digital learning preference experienced higher schoolwork engagement, both contemporaneously and over time, indicating successful connected learning. However, the results also showed support for the gap hypothesis: Students who preferred digital learning but did not have the chance to digitally engage at school, experienced a decrease in school engagement over time. The article shows that there is a need to examine the reciprocal interactive processes between the learners and their social ecologies inside and outside school more closely.*

*Keywords: connected learning; digital engagement; schoolwork engagement; gap hypothesis; longitudinal analysis*



## 1. Introduction

Connecting learning across in-school and out-of-school contexts has been a continuous challenge in education (e.g., Malcolm, Hodgkinson, & Colley, 2003) and the novel informal learning opportunities provided by digital media have highlighted tensions between informal and formal practices of learning (Ito et al., 2013). In general, previous research shows that the more students spend time engaging with digital media the more skills they are able to acquire (EU kids online, 2014). When these informally cultivated digital practices are successfully connected with academic learning practices, such students are likely to flourish and extend their potentials (Ito et al., 2013). Yet, Finnish young people are not provided sufficient structured support in school for cultivating advanced digital competences, as digital technologies are used at Finnish school seldom and mostly for shallow training of basic digital skills (European Parliament, 2015; European Commission, 2017; Hakkarainen, Hietajärvi, Alho, Lonka, & Salmela-Aro, 2015). In this condition, an increased gap or misfit between a digitally engaged learner and the learning environment may occur. The gap hypothesis proposes that students who prefer learning with digital technologies outside of school are less engaged in traditional school. This is problematic because school engagement is crucial for students' learning, academic development, and well-being (Salmela-Aro & Upadyaya, 2012; Upadyaya & Salmela-Aro, 2013). Thus, promoting practices that connect informal and formal learning as well as support school engagement should be the main goals of modern pedagogical practices. However, in comparison to other PISA countries, technology-enhanced pedagogies appear to be not so widely adopted in Finnish schools (OECD, 2015), and utilizing digital technologies successfully in education calls for transformations in the social practices of schooling, which appear to be happening very slowly (Hakkarainen, 2009). Such transformations are nevertheless needed, as the schooling system should prepare students for the current technology-rich innovation-driven society that calls for collaborative solving of complex non-routine problems and cultivating associated personal and social competences. Toward that end, it is important to learn creative and academic practices of using socio-digital technologies (Hakkarainen et al., 2015). The conventional individualist, acquisition-oriented, and teacher-centered educational practices prevailing at school are considered to be a major hindrance to creating such a workforce (Robinson, 2011).

The present study addresses the conditions of continuity and discontinuity between these informal and formal contexts of learning, and how these can be seen as either indicators of connected learning or the 'gap' and how such interconnections are reflected in learners' school engagement. The assumption of the gap between adolescents' digital and academic engagement is not a new, it originates from Prensky's (2001) introduction of the controversial concept of digital natives (see also Bennett & Maton, 2010). The argument is that due to extended socialization in using socio-digital technologies, adolescents are often very comfortable with various socio-digital tools and applications and are able to fluently learn novel applications (Hakkarainen et al., 2015). It is developmentally significant that young generations have cognitively socialized to a radically different social and technological environment than the older generations (Wexler, 2006). The earlier and the more intensively young people adapt to the transforming cognitive, social, and cultural environment, the stronger the impact of this environment on their intellectual, emotional, behavioural, and social engagement is likely to be (Moisala et al, 2016a; 2016b; Ritella & Hakkarainen, 2012).

The gap hypothesis stems from the idea that in schools, digital immigrants, who are not sharing the same 'language', are teaching digital natives (Hakkarainen et al, 2015; Prensky, 2001). Although Prensky's digital natives are teachers of today, it is suggested that the gap between some students' progressive use of digital media outside of the classroom and the traditional pedagogies of most schools is still growing (Ito et al., 2013). However, the gap can emerge for various reasons and can reflect various psychological processes. For instance, the students' out-of-school interests and competencies may not be socially recognized leading to experiences of withdrawal and disengagement (Rajala, Kumpulainen, Hilppö, Paananen, & Lipponen, 2015). It is also possible that the students' out-of-school practices of working with learning and knowledge are critically different from the traditional practices of school (Kumpulainen & Sefton-Green, 2012, McFarlane, 2015). Such situation may cause discontinuities, for instance, between individual versus social learning, externally regulated teaching versus self-initiated inquiry learning, and working with pre-digested textbook context versus navigating through open knowledge and media spaces. Despite the controversy over the original



concepts of digital natives and digital immigrants, it seems that there indeed are gaps between connecting (digital) learning across in-school and out-of-school contexts.

## 2. Digital engagement and school engagement

The early empirical findings tapping into the concept of digital natives revealed that students do not share the same experiences and competencies with digital media, ranging from students that engage in a wide range of digital activities do not participate in similar activities at all, with a spread of moderate participators in between (Bennett & Maton, 2010). A year-long ethnographic investigation of Ito and colleagues (2010; see also Barron, 2006) revealed diverging but partially overlapping genres of socio-digital participation. Most adolescents use digital technologies for shallow friendship oriented *hanging out* with an extended network of friends. A much smaller proportion of young people use the emerging socio-digital technologies for pursuing their interests *messing around* with like-minded peers at social and digital networks. A significant but relatively small group of young people are *geeking out* by developing their technological and creative socio-digital competences (Li, Hietajärvi, Palonen, Salmela-Aro, & Hakkarainen, 2017). Presumably interest-driven socio-digital participation fosters learning and development of young people and may assist in cultivating considerable student expertise (Olson & Bruner, 1996) concerning digital learning and activity. By relying on Bereiter and Scardamalia's (1993) notion of progressive problem solving and Hatano and Inagaki's (1992) adaptive expertise, Hakkarainen and colleagues (2000) constructed measures for assessing to what extent young people have developed such crucial aspects of student expertise as putting effort to using digital technologies at the edge of competences and enjoying working with challenging problems with digital technologies. Hence, a significant proportion of young people pursue their interest online, are supported by their more competent peers and have learned considerable digital competences through intensive socio-digital participation. It is also typical for young people to learn through active, although not always very deep, personal and social exploration rather than learn by passively consuming pre-determined information (Hietajärvi, Seppä, & Hakkarainen, 2016; Li et al, 2017). From the viewpoint of gap hypothesis, it is claimed that active socio-digital participators and especially those who have developed sophisticated peer learning and digital competences in informal contexts, may not get sufficient social recognition of their capabilities and, therefore, might feel alienated and experience mismatch between their personal and school practices, indicating inadequate person-environment fit. Consequently, this has been suggested to be among the factors contributing to lower school engagement of those actively digitally engaging students, pointing to the gap between adolescents' digital and school-related engagement (see, e.g., Prensky 2001; Halonen, Hietajärvi, Lonka, & Salmela-Aro, 2017; Kumpulainen & Sefton-Green, 2012; Salmela-Aro, Muotka, Alho, Hakkarainen, & Lonka, 2016a; Selwyn, 2006).

Empirically, there appears, however, to be both continuities and discontinuities between young peoples' digital learning engagement and school engagement. Case studies have described students' informal interest-driven learning practices that can both facilitate and obstruct academic engagement (Deng, Connelly & Lau, 2016; Gurung & Rutledge, 2014), and have also suggested that integrating practices of informal digital learning engagement in schoolwork can enhance student engagement (Clements, 2015; Esteves, 2012). Larger scale quantitative studies, although scarcer, point to a similar direction: digital participation is related to both self-directed learning and student engagement (Laird & Kuh, 2005; Rashid & Ashgar, 2016). Previous studies supporting the gap hypothesis, in turn, have suggested that that students' reporting more cynicism towards school also reported that they would be more engaged in their schoolwork if they were able to use more digital technologies (Halonen et al., 2017; Salmela-Aro et al., 2016a). Hakkarainen and colleagues (2000) already reported similar finding among a large sample of Finnish primary and secondary students. Yet, other studies offer both positive and negative relations between out-of-school digital learning engagement and student engagement depending on the actual activities (Hietajärvi, Salmela-Aro, Tuominen, Hakkarainen, & Lonka, 2019; Junco, 2012a, 2012b). In terms of adopting digital pedagogies in school, previous studies indicate that integrating digital technologies and media in education in general appears to offer mainly positive results



regarding engagement and performance (Chen, Lambert, & Guidry, 2010; Junco, 2011; Sung, Chan, & Liu, 2016; Tamim, Bernard, Borokhovski, Abrami, & Schmid, 2011).

### 3. The conceptual framework

In the present study, the gap hypothesis is approached from the framework of connected learning (Ito et al, 2013; Kumpulainen & Sefton-Green, 2012). Connected learning refers to the process of connecting adolescents' self-regulated and interest-driven learning (Barron, 2006) across formal and informal contexts, in the reciprocal interactive processes between the learners and their social ecologies (Nardi & O'Day, 2000). Connected learning is anchored to interest rather than mere friendship-driven socio-digital participation (Ito et al., 2010). Connected learning emerges when young people find contexts for pursuing their interests, network with like-minded peers, and when academic institutions recognize the value of informally developed knowledge and competences and allow interest-driven learning to be relevant in school (Ito et al., 2013). Further, it involves extensive peer-to-peer learning and supports learning processes relevant for academic achievements, civil activity, and, perhaps, also for professional career.

Connected learning takes into account a wide range of learning contexts, whereas in the present study, we focused on digital learning engagement as the out-of-school learning component. More precisely, we conceptualize digital learning engagement as reflecting informally emerging socio-digital participation (Hakkarainen, Hietajärvi, Alho, Lonka, & Salmela-Aro, 2015) including a considerable degree of self-regulated (Boekarts & Minnaert, 1999, see also Panadero & Järvelä, 2015) learning embedded on the contexts of their peer supported interest-driven learning ecologies (Barron, 2006). It needs to be noted that although self-regulated learning is an internal process, it is embedded in digital and social context and environment and it is assisted and influenced by social interaction (Panadero & Järvelä, 2015). As such, we consider digital learning engagement as situated within the ecologies of connected learning. Specifically, we operationalized digital learning engagement with two constructs. More precisely, we operationalized digital learning engagement as being expressed through having a *digital learning preference*, a preference for cultivation of adaptive student expertise concerning digital learning and problem-solving (Hakkarainen et al, 2000) as well as showing different degrees of *wish for digital schoolwork*, that is, wish for connecting this digital learning to the context of school.

In addition, in this study we extend the gap hypothesis to contribute to the wider research on school engagement (Fredricks, Blumenfeld & Paris, 2004), operationalized as *schoolwork engagement* (Upadyaya & Salmela-Aro, 2013), a generally positive disposition towards school and schoolwork that is considered a key outcome and indicator of connected learning (Ito et al., 2013). Specifically, we utilized the framework of connected learning to provide novel empirical information of the antecedents of school engagement combining it with the framework of demands-resources model extended to academic well-being (Salmela-Aro & Upadyaya, 2014). In doing so, the present study attempts to provide insights into the psychological processes underlying successful experiences of connected learning, or, conversely, an experience of disengagement. According to this model, possible relations between digital learning engagement and school engagement can be viewed as resulting from the balance between the psychological demands of the situation and the resources available to overcome these demands, conceptualized over two processes, the energy-depleting process and the motivational process (Demerouti, Bakker, Nachreiner & Schaufeli, 2001; Salmela-Aro & Upadyaya, 2014).

Digital learning engagement can function over both these processes by increasing the demands and depleting energy (e.g., multitasking, interruptions, cognitive load) or providing extended resources cultivating engagement (e.g. knowledge building and utilization, peer support) (Barron, 2006; Ito et al., 2013; Salmela-Aro & Upadyaya, 2014). Congruence between digital learning engagement and school engagement can be conceptualized as a condition of successful connected learning, in which the resources gained in out-of-school digital activities are successfully connected to in-school learning. In turn, the gap can be used to conceptualize



a condition of discontinuity where these interest-driven digital learning practices collide with, for instance, strong external regulation and teacher-centered practices, and informally developed competencies and practices of learning are not utilized in school. Similar discontinuity may follow if students, in their informal practices, have learned to rely on intensive peer-to-peer learning but are expected to work mostly alone at school. These discontinuities and contradictions in the possibilities to utilize the resources gained in out-of-school learning may consequently decrease students' engagement with schoolwork.

#### 4. Research aim and hypotheses

Previous research indicates that active digital learning engagement is related to both positive and negative school-related outcomes, but there is little knowledge concerning the conditions by which these positive or negative outcomes come to be. Moreover, most previous studies were conducted in higher education context, and no longitudinal designs have come to our knowledge. Therefore, the present study was conducted in upper comprehensive school and with a longitudinal design. More precisely, the present study empirically focuses on the question of *how digital learning engagement is related to school engagement both cross-sectionally and over time, while taking into account how wishing to use more, or less, digital technologies in schoolwork moderates the longitudinal relationship*. The present research aimed to examine processes of continuity and discontinuity between out-of-school digital learning engagement and school engagement, utilizing both the broader framework of connected learning combined with the demands-resources model (Salmela-Aro & Upadyaya, 2014) as tools to interpret the processes underlying the gap.

Towards that end, by combining the framework of connected learning with the demands-resources model (Salmela-Aro & Upadyaya, 2014) we expected that (Hypothesis 1) having a digital learning preference would be reflected as also having a positive disposition towards school indicated by a positive relation to schoolwork engagement (both cross-sectionally and longitudinally). The positive relation was expected due to the supposedly increased psychological resources (Salmela-Aro & Upadyaya, 2014) resulting from the informal self-regulated and connected learning happening in the process (Barron, 2006, see also Hietajärvi et al., 2019). In contrast, we expected that (Hypothesis 2) reporting a higher wish for digital schoolwork, that is, experiencing a discontinuity between the practices of one's informal interest-driven learning and academic learning, would be negatively related to schoolwork engagement both cross-sectionally and longitudinally (Kumpulainen & Sefton-Green, 2012). In particular, we hypothesized that (Hypothesis 3) the negative relation from a wish for digital schoolwork and school engagement would be explained especially by interaction between digital learning preference and the wish for digital schoolwork, resulting in a condition of discontinuity. In other words, we expected that the combination of having a digital learning preference without the possibility to connect it to academic learning would lead to lower school engagement.

#### 5. Method

##### 5.1 Participants

There was a total of 1,705 (43.7% male) participants from 27 schools in Helsinki. The data were collected annually in spring following the same students across grades 7 (age ~14 yrs., n = 1272), 8 (age ~15 yrs., n = 1150) and 9 (age ~16 yrs., n = 903) over the upper comprehensive school. Of all participants 1,090 (64%) participated in the study at least at two time points over the data collection period and 530 (31%) participated in all the waves. The participants filled in a self-report questionnaire on digital engagement and academic well-being. Participation in the study was voluntary and informed consent forms were collected from the students and from their parents. Data collection was organized as a convenience sample, that is, all teachers



in the schools that were able to organize data collection administered the questionnaires during school hours and all students that were attending at the time of data collection and were willing to take the questionnaire were included as participants. Because of the data collection procedure the reasons for attrition may be due to either the schools or the teachers' inability to incorporate the data collection into their timeframe, the students being absent during the data collection or unwilling to respond. Despite this, the number of students that participated in at least two waves was satisfactory. The study protocol was approved by the University of Helsinki Ethical Review Board in the Humanities and Social and Behavioural Sciences.

## 5.2 Measures

The means, standard deviations and measures of internal consistency for all constructs used in this study are shown in Table 1.

### 5.2.1 Digital learning engagement

Digital learning engagement was conceptualized as, on one hand, showing orientation towards learning with technologies in general, and on the other hand, expressing enthusiasm towards using more socio-digital technologies in formal schoolwork. These were measured with two constructs both measured on a scale from 1 (= not at all true) to 5 (= very true). *Digital learning preference* (DLP; Hakkarainen et al., 2000; see also Halonen et al., 2017) was measured with four items that assessed having a preference towards learning and solving problems with digital technologies (e.g. "It's fun to learn to use digital technologies, because it offers continuously new challenges"). Rather than merely assessing interest in using digital technology, the items have been designed so that they trace students' orientation toward *learning* with and about digital technology, and, thereby related to cultivation of adaptive student expertise concerning digital learning and problem-solving.

*Wish for digital schoolwork* (WDS; Hakkarainen et al., 2000; see also Halonen et al., 2017; Salmela-Aro et al, 2016a) was measured with three items that directly tapped into the gap hypothesis by assessing motivation and possibilities towards using more digital technologies in school and its perceived effect on school engagement with three items (e.g., "I'm more engaged in my schoolwork when I'm able to use digital technologies"). In other words, the scale assessed whether or not the student favoured the use of more digital technologies in schoolwork. Higher scores indicated a stronger wish towards using *more* technologies in schoolwork.

Table 1

*Raw means, standard deviations and measures of internal consistencies of the constructs used in the models*

		Mean	S.E.	S.D.	Cronbach's Alpha	S.E.
Digital learning preference	Time 1	2.95	0.03	1.05	0.89	0.01
	Time 2	2.83	0.03	1.13	0.90	0.01
	Time 3	2.77	0.04	1.08	0.90	0.01
Wish for digital schoolwork	Time 1	3.34	0.03	1.21	0.91	0.01
	Time 2	3.08	0.04	1.24	0.92	0.01
	Time 3	2.84	0.04	1.18	0.92	0.01
Schoolwork engagement	Time 1	4.25	0.04	1.48	0.94	0.00
	Time 2	4.33	0.05	1.52	0.95	0.00
	Time 3	4.34	0.05	1.48	0.94	0.00



### 5.2.2 School engagement

*School engagement* was assessed using the schoolwork engagement inventory (i.e., EDA abbreviated from energy, dedication, and absorption; Salmela-Aro & Upadyaya, 2012) measuring a trait-like long-term study-related positive state of mind. The inventory consists of three subscales, each including three items, measuring energy (e.g., “When I study, I feel I’m bursting with energy”), dedication (e.g., “I am enthusiastic about my studies”), and absorption (e.g., “Time flies when I’m studying”). However, schoolwork engagement is often specified as a unidimensional measurement model representing a generally positive study-related frame of mind (Salmela-Aro & Upadyaya, 2012). The items were rated on a scale ranging from 1 (‘never’) to 7 (‘every day’).

### 5.3 Analysis strategy

We followed an analysis strategy in which we first ran preliminary analyses for screening the data and ensuring that the latent constructs we used carried the same meaning across gender and time. Second, we analysed gender differences in the means of latent constructs. Third, to test Hypotheses 1 and 2, we examined the partial correlations between our latent constructs separately in each point of measurement and specified the longitudinal model. Finally, to test Hypothesis 3 we added the latent interaction to the longitudinal model. The more detailed steps in the analysis procedure are described as follows.

First, as preliminary analysis, the data were screened for the number and patterns of missing values using the IBM Statistical Package for Social Sciences, version 25 (SPSS). The missing values were assessed longitudinally and at each time point separately. Second, we specified and tested the measurement model using a confirmatory factor analysis approach (CFA). Residuals of the same items were allowed to be correlated over time. The analyses were conducted using Mplus 8.0 (Muthén & Muthén, 2018) in conjunction with R and RStudio (R Core Team, 2018) with the package MplusAutomation (Hallquist & Wiley, 2018). Maximum likelihood with standard errors robust for non-normality (MLR) was used as the estimator and missing data was handled with full information maximum likelihood estimation (FIML). The complex survey data option (Muthén & Muthén, 2018; see also Asparouhov & Muthén, 2006; Muthén & Satorra, 1995) was used in all analyses to correct for non-independence at the class level. Invariance of the measurement model across the factor structure (configural), factor loadings (metric) and item intercepts (scalar) was tested to ensure that the measures held the same meaning across gender and over time.

The model fits (see e.g. Hu & Bentler, 1998) were evaluated based on the chi-square value as well as the root mean square error of approximation (RMSEA) with an approximate acceptable cutoff value of less than .08, standardized root mean residual (SRMR) with an approximate cutoff or less than .08, and, incremental indexes such as the comparative fit index (CFI) and the Tucker-Lewis index (TLI) with approximate acceptable cutoff values of greater than .9. In evaluating measurement invariance, we relied on the conventional criteria of evaluating change in RMSEA and CFI (Chen, 2007; for more discussion on measurement invariance testing, see Putnick & Bornstein, 2016). Finally, after confirming that the measurement model represented sufficiently the same constructs across both gender and time, we explored mean differences across gender by regressing each latent factor on gender.

To test the cross-sectional parts of hypotheses 1 and 2, that is, to evaluate how digital learning engagement and school engagement are related within a time point, we explored the gender-controlled partial correlations between the latent variables. This was done by visualizing the latent variable partial correlations by plotting the variables as nodes in a EBICglasso-regularized network (Epskamp & Fried, 2018) using the R-package qgraph (Epskamp, Cramer, Waldorp, Schmittmann, & Borsboom, 2012). Partial correlations are presented, so the edges in the latent partial correlation network can be interpreted similarly as regression path coefficients, as they are controlled for gender as well as each other, but without assuming any direction of effects. This type of modelling allows for a powerful measurement error corrected modelling and visualization of contemporaneous relations between latent variables when the direction of effects cannot be inferred from the data (Guyon, Falissard, & Kop, 2017).



Then, to test the longitudinal parts of Hypotheses 1 and 2, that is, to evaluate how digital learning engagement and school engagement are related over time, we specified latent longitudinal panel models (L-CLPM; Little, Preacher, Selig & Card, 2007). The CLPM is especially useful for identifying the relations between variables across time and can be applied to identify a possible causal relationship between variables measured at different time points. The CLPM accounts for stability over time through the inclusion of autoregressive parameters. More precisely, the autoregressive effects describe the stability of individual differences from one measurement point to the next, whereas the cross-lagged effects describe the effect of a variable on another measured at a later occasion. Taking into account autoregressive effects, cross-lagged effects in the present study can be interpreted as predicting change over time (Selig & Little, 2012). Moreover, our models were specified using a latent measurement model, so that the variables were free of measurement error (Little et al., 2007).

Further, in our models mean differences across gender were controlled for by regressing each latent variable on gender. The model was specified with both autoregressive and crossed paths specified between successive time points and the paths from Time 1 to Time 2 were constrained equal with paths from Time 2 to Time 3 to achieve a simpler model. The cost of acquiring a simpler model in comparison to an unconstrained model was evaluated by examining the change in fit indices RMSEA and CFI as well as the Bayesian information criterion (BIC), which penalizes complexity (Raftery, 1995). Finally, to test Hypothesis 3, that is, to examine the presence of a condition of discontinuity, we included latent interactions between digital learning preference and a wish for digital schoolwork as predictors of schoolwork engagement. The latent interactions were estimated using the latent moderated structural equations (LMS) approach (Klein & Moosbrugger, 2000) implemented in Mplus (Muthén & Muthén, 2018) as a maximum likelihood-based approach, which, in general can be viewed as recommendable (see e.g. Marsh, Wen & Hau, 2004).

## 6. Results

### 6.1 Preliminary results

There were less than 10% missing values overall at each time point. Based on Little's MCAR test, the data were not missing completely at random longitudinally ( $\chi^2(7346) = 7702.84, p = .003$ ). Looking at each time point separately the data were missing completely at random at Time 1 and Time 2 ( $\chi^2(805) = 823.04, p = .322$ ; T2:  $\chi^2(488) = 527.56, p = .105$ ), whereas at Time 3 the MCAR assumption did not hold ( $\chi^2(388) = 509.86, p < .001$ ).

#### 6.1.1 Measurement model

First, we specified a baseline measurement model in the first time point and continued to test for measurement invariance across gender. The baseline model (see Figure 1) fitted the data acceptably ( $\chi^2(101) = 611.21, \chi^2$  scaling correction factor (cf) = 1.20,  $p < .001$ , RMSEA = .063, CFI = .956, TLI = .948, SRMR = .032).



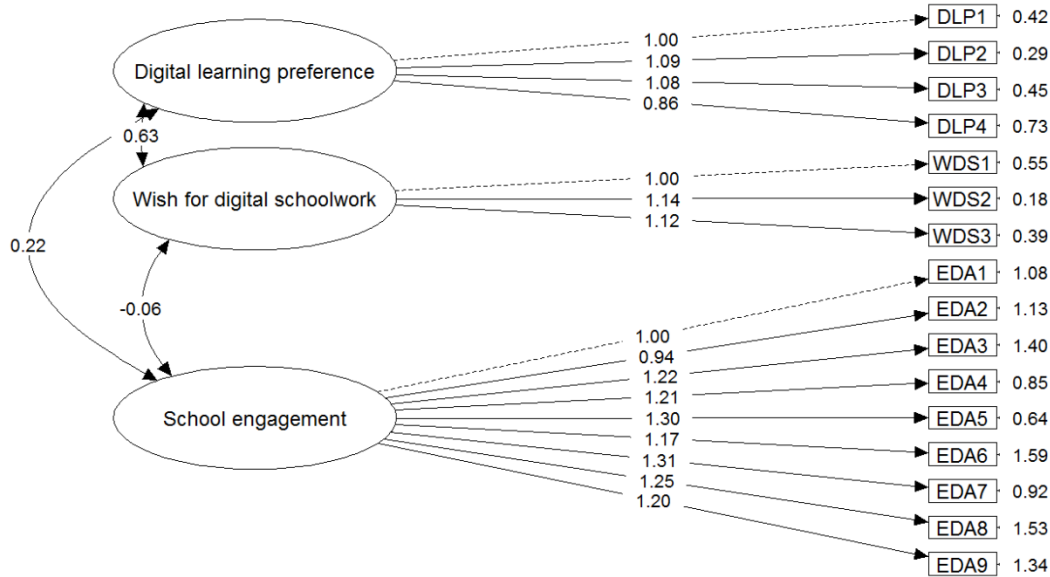


Figure 1. The baseline measurement model for Time 1 with unstandardized factor loadings.

We then proceeded to evaluate the measurement invariance across gender and time (model fit indices as well as the factor loadings and  $r^2$  for the scalar longitudinal measurement model are presented in the Appendices). The results indicated that there were no considerable differences in the measurement model between boys and girls and that the constructs we measured did not change in their meaning over time (for details see Appendix A). Then, to control for mean differences across gender, we regressed each latent factor on gender. The model fit did not decline and the modification indices did not suggest any direct effects between the factor indicators and gender. Regarding mean differences across gender (see Table 2) the model indicated that male participants scored higher in digital learning preference than female participants and wished for digital schoolwork at each time point, whereas in schoolwork engagement there were no gender differences.



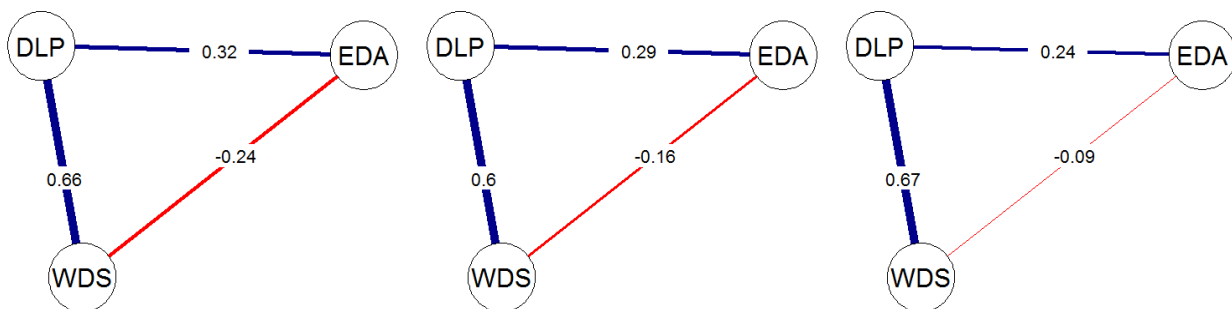
Table 2  
*Mean differences across gender in the latent variables*

		Gender			
		$\beta$	S.E.	95% C.I.	<i>p</i>
Digital learning preference	Time 1	.88	.05	0.77 - 0.98	<.001
	Time 2	.94	.06	0.83 - 1.05	<.001
	Time 3	.73	.06	0.60 - 0.85	<.001
Wish for digital schoolwork	Time 1	.72	.07	0.58 - 0.85	<.001
	Time 2	.73	.07	0.59 - 0.86	<.001
	Time 3	.63	.07	0.49 - 0.76	<.001
Schoolwork engagement	Time 1	-.02	.08	-0.17 - 0.14	.815
	Time 2	.06	.09	-0.12 - 0.23	.530
	Time 3	-.13	.08	-0.29 - 0.03	.122

*Note: Gender code: 0, 'female'; 1, 'male'. The estimate to be interpreted as how the 'male' group differs from the 'female' group.*

### 6.2 Cross-sectional relations between digital learning engagement and school engagement

To answer how digital learning preference and a wish for digital schoolwork are related to schoolwork engagement cross-sectionally, we examined the contemporaneous partial correlations between the latent variables. The correlation coefficients were extracted from the latent measurement model with scalar invariance constraints and gender as a covariate. The latent variables showed a similar pattern of relations with each other at all time points as can be inferred from Figure 2 (for zero-order correlations see Appendix C). The results indicated that when controlled for each other, digital learning preference was positively related to both a wish for digital schoolwork and schoolwork engagement, supporting Hypothesis 1. However, when controlled for digital learning preference, a wish for digital schoolwork was negatively related to schoolwork engagement, supporting Hypothesis 2.



*Figure 2. Cross-sectional gender-controlled latent variable partial correlation networks. Note: DLP, Digital learning preference; WDS, Wish for digital schoolwork; EDA, Schoolwork engagement. Network estimated with EBICglasso regularization (see Epskamp & Fried, 2018). Nodes placed by Fruchterman-Reingold algorithm (Fruchterman & Reingold, 1991). Blue indicates positive correlations, red negative, and the width*



and colour of the edges correspond to the absolute value of the correlations: the stronger the correlation, the thicker and more saturated the edge (see Espkamp et al., 2012).

This pattern of partial correlations gives a reason to suspect that the effect of digital learning preference on schoolwork engagement might be moderated by a wish for digital schoolwork, in which case there would be discontinuity between out-of-school digital learning and the possibilities to connect this to school. In other words, how the digital learning preference is related to school engagement would depend on the participants' motivation and possibilities in using technologies in school, or the students' personal digital learning practices' fit with the pedagogical practices at school.

### 6.3 Longitudinal relations between socio-digital participation and academic well-being

To answer how digital learning preference and a wish for digital schoolwork are related to schoolwork engagement longitudinally, we specified the latent longitudinal panel model. The model fitted the data well ( $\chi^2(1096) = 3151.59$ ,  $cf = 1.11$ ,  $p < .001$ ,  $RMSEA = .034$ ,  $CFI = .944$ ,  $TLI = .940$ ,  $SRMR = .038$ ) and the model fit did not differ considerably from the unconstrained measurement model. In addition, Bayesian Information Criterion (BIC) favoured the model ( $BIC = 142676.60$ ) over the more complex unconstrained model ( $BIC = 142703.41$ ).

We then included the hypothesized latent interaction. The interaction term was statistically significant and resulted in a slightly better fit as indicated by the log-likelihood chi-square difference ( $\Delta\chi^2 = 7.23$ ,  $df = 1$ ,  $p = .007$ ). Thus, the results presented are from the model with stationarity assumed and the latent interaction included. All unstandardized structural model parameters are presented in Table 3 and statistically significant structural parameters are illustrated in Figure 3.



Table 3

*Autoregressive and cross-lagged parameters and latent interactions of the longitudinal panel model*

Outcome	Predictor	From Time to Time+1					From Time to Time+2				
		est	S.E.	95% C.I.		p	est	S.E.	95% C.I.		p
Digital learning preference ←	DLP	.48	.04	.40	to .56	.000	.22	.08	.07	to .38	.005
	WDS	.04	.03	-.03	to .10	.308	.06	.05	-.05	to .16	.306
	EDA	.04	.03	-.02	to .10	.165	.03	.04	-.05	to .10	.449
Wish for digital schoolwork ←	DLP	.04	.04	-.04	to .12	.297	.08	.06	-.05	to .20	.239
	WDS	.49	.04	.41	to .56	.000	.15	.06	.04	to .27	.011
	EDA	.02	.03	-.03	to .07	.509	-.01	.04	-.10	to .07	.774
Schoolwork engagement ←	DLP	.15	.05	.05	to .25	.004	-.15	.08	-.30	to .01	.060
	WDS	-.08	.04	-.16	to .01	.067	.13	.07	.00	to .26	.054
	EDA	.56	.03	.50	to .62	.000	.14	.04	.06	to .21	.000
	DLP*WDS	-.08	.03	-.13	to -.02	.008	-	-	-	-	-

*Note: DLP, Digital learning preference; WDS, Wish for digital schoolwork; EDA, Schoolwork engagement (energy, dedication, absorption).*

The model indicated that, first, the effects of the same construct on itself over time were moderately strong and somewhat carried over for two years, indicating that the constructs are quite stable over time. Beyond these autoregressive effects the model also revealed that digital learning preference predicted higher schoolwork engagement, supporting Hypothesis 1. A wish for digital schoolwork had only a weak and statistically insignificant negative effect on schoolwork engagement. However, their interaction predicted schoolwork engagement negatively in line with Hypothesis 3.

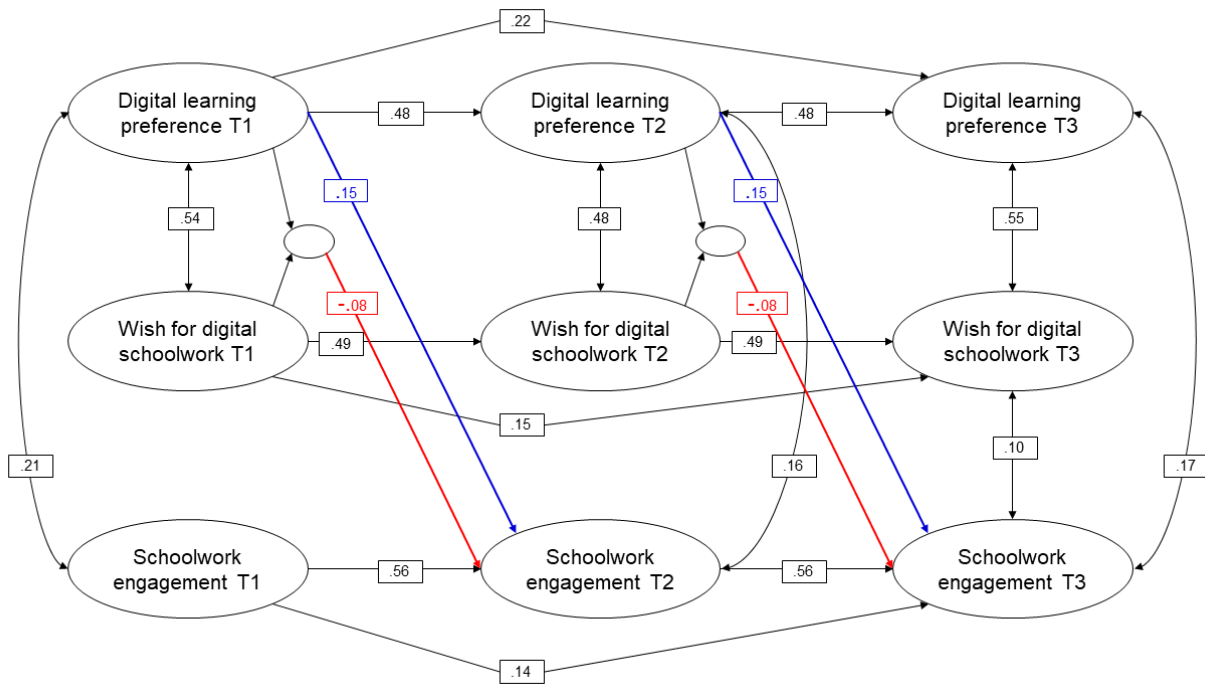


Figure 3. Structural parameters of the longitudinal panel model. Note: Cross-lagged paths with positive coefficients highlighted in blue, negative in red. Only paths significant at  $p < .05$  illustrated for clarity. Gender effects omitted for clarity.

A closer inspection of the interaction (see Figure 4) indicated that a wish for digital schoolwork predicted lower future schoolwork engagement only for those students that had reported a higher digital learning preference. For those students reporting lower digital learning preference there appeared to be no effect between a wish for digital schoolwork and schoolwork engagement.

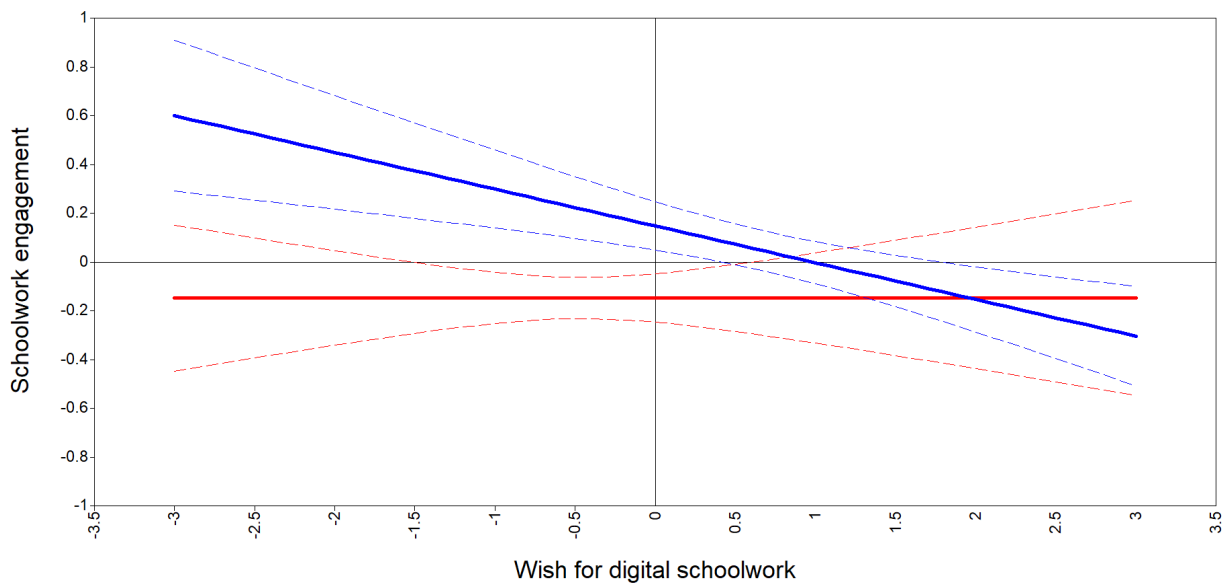


Figure 4. Schoolwork Engagement regressed on Wish for digital schoolwork with differing levels ( $\pm 1$  SD) of Digital learning preference. Note: the blue line represents high digital learning preference (+1SD), the red line low digital learning preference (-1SD); dashed lines represent 95% confidence intervals.



## 7. Discussion

The present study aimed to investigate connected learning in terms of examining the conditions of continuity and discontinuity emerging between students' self-regulated and interest-driven informal learning in the digital contexts and their school engagement. Previous research has shown that contextual factors such as parental affect, teacher support and mastery-supportive classroom atmosphere promote higher school engagement (Upadyaya & Salmela-Aro, 2013), and the present study sheds light on how orientation toward learning through digital tools and orientation toward developing socio-digital competencies might be related to the equation. The present results support the gap hypothesis, but also reveal signs of connected learning, connecting digital learning engagement with schoolwork engagement. More precisely, we expected that having a digital learning preference would be reflected in having a positive study-related state of mind (Hypothesis 1), that wishing to use more digital tools in schoolwork would be negatively related to school engagement (Hypothesis 2), and that especially the combination of an individual disposition towards digital learning and a lack of contextual support would lead to lower school engagement (Hypothesis 3) and thus represented a condition of discontinuity.

The present cross-sectional results give support for all our hypotheses, whereas the present longitudinal data only supports Hypotheses 1 and 3. Cross-sectionally, we observed that digital learning preference is positively correlated to both a wish for digital schoolwork and schoolwork engagement. Wishing for more digital schoolwork, in turn, was negatively correlated to schoolwork engagement. Longitudinally, digital learning preference predicted higher schoolwork engagement across time and the interaction between digital learning preference and a wish for digital schoolwork predicted later schoolwork engagement negatively. The directions of the effects appeared very clear: schoolwork engagement did not predict increases or decreases in either digital learning preference or wish for digital schoolwork, indicating that these indeed work as antecedents for school engagement.

The present results might be interpreted in various ways. From the viewpoint of connected learning framework, the positive association between digital learning engagement and school engagement might indicate successes in connecting learning across informal and formal contexts. This is understandable because the items in the digital learning preference scale trace the participants' orientation toward cultivating their adaptive expertise of learning through digital technologies; such efforts may generalize from digital to other spheres of learning. This is also in line with previous studies showing a positive relation between digital and academic engagement (Laird & Kuh, 2005; Rashid & Ashgar, 2016), and gives support to the previous findings with a longitudinal component included. Thus, the present results also indicate that adopting more sophisticated digital practices and competencies might help students build novel resources for schoolwork, thus contributing to higher school engagement over time in line with the demands-resources model (Hietajärvi et al., 2019; Salmela-Aro & Upadyaya, 2014). Such resources could involve students' spontaneous use of digital technologies for academic purposes, such as seeking school-relevant knowledge from the internet or reciprocally helping one another in schoolwork (Hietajärvi, Seppä, & Hakkarainen, 2016; Li et al., 2017). Further, given that especially students with high digital learning preference and low wish for digital schoolwork experienced higher later school engagement, we can argue that informal digital learning engagement, if recognized and taken into account in schools, can foster connected learning (Ito et al., 2013). Data from our related studies indicate, however, that digital technologies were used rather infrequently at school and mostly for pretty basic purposes at the time of collecting the present data (Halonen et al., 2017). In previous research, especially those digitally oriented students who appeared to feel inadequate and alienated at school wished for an opportunity to use more digital technologies at their schoolwork (Salmela-Aro et al., 2016a). The results of the present study also revealed evidence of the gap, indicating that connecting learning across contexts is challenging. The results of this study indicate that not being able to incorporate the prior experiences and practices of students into the formal learning environment creates, for some students, an experience of discontinuity contributing to feelings of disengagement (Rajala et al., 2015). These were students who reported to have cultivated high levels of digital expertise, and could even be described as 'geeking out' (Ito et al., 2010). For other, digitally less engaged students, wish for digital schoolwork appeared irrelevant regarding changes in school engagement over time.



Taken together, both the cross-sectional and longitudinal results showed support for a more nuanced understanding of the gap hypothesis: students who, on one hand, hold a disposition for learning with and about digital tools, but on the other hand, experience being not capable of deploying this competence in school, experience decline in their school engagement. Conversely, it is noteworthy that holding a stronger orientation towards learning with digital tools contributed to a higher school engagement possibly due to the increased psychological resources gained in the process, given that the students' needs in terms of digital schoolwork are in congruence.

### 7.1 Methodological reflections and limitations

The present study used a large longitudinal sample of adolescents, which strengthens the inferences that can be drawn from the analyses. However, the sample was not representative; it was a convenience sample collected from Helsinki and, therefore, cannot be generalizable across Finland or beyond. A replication study with a representative sample, possibly with students of different ages, various parts of Finland and from different academic contexts (high school, vocational school), would be needed. The data were based on self-reports, so the actual digital participation practices of the students were not assessed. Further, the present investigation addressed mostly young people's informal digital activities because out-of-school socio-digital participation was far more intensive than within school one. Thus, we were not able to actually trace the actual behaviour of participants either with digital technologies or in school; nor were we able to actually examine the pedagogical practices or technology use in school. We cannot, for instance, say anything about how students with different levels of digital learning preference approach and behave when working on learning tasks or what kind of learning tasks they are presented with, including digital technologies or not. We acknowledge that this can make all the difference and thus future studies should include multi-level data of students' informal and formal learning activity. Moreover, future studies should better approach the qualitative differences in adolescents' digital learning engagement, for instance, by mixed methods data on their interest-driven pursuits, and why and how they engage with digital technologies to support them (for this kind of initial efforts, see Hietajärvi et al., 2016; Li et al., 2017). Further, school engagement is but a one indicator of academic functioning, and we should look into different ways of conceptualizing the emergence of connected learning or the gap, future studies should also take into account academic achievement, as well as indicators other than school engagement regarding motivation and well-being.

The cross-lagged panel model we used to analyse the longitudinal relations allowed us to examine how digital learning engagement predicted change in school engagement over time, and as such gives us grounds to present inferences regarding the temporal ordering on these effects with a large number of participants. The methodological choice of using latent variables allowed us to model the relations without measurement error (e.g., Little et al., 2007) but we did not separate between-participant and within-participant variances, which affects the inferences that we can draw, especially limiting stronger causal inferences (Hamaker, Kuiper, & Grasman, 2015).

The inclusion of the latent interaction allowed us to model the gap conditional between individual and perceived contextual factors, but without a multi-level setting and actually tracing the school-level practices we cannot truly establish detailed aspects of the postulated gap between the students' informal digital practices and the schools' digital pedagogical practices. There can be considerable differences between teachers, schools, districts and countries in how digital tools are implemented in teaching and learning. Consequently, the gap is likely to be more observable in some schools than others and with some students rather than others. Moreover, it appears that the interplay between students' digital and academic engagement is complex rather than straightforward. National efforts of digitalizing practices of learning and teaching in Finland are likely to have significant impact on future manifestations of the gap to be revealed by collecting empirical data. After we carried out the present study, Finnish matriculation examination (the only high-stake test in Finland) has been digitalized and major efforts of digitalization of school are underway so as to meet societal challenges and overcome the gap. Our research network has developed novel self-report instruments for tracing in details the extent and focus of within school use of digital technologies and associated pedagogic approaches together with young people's informal socio-digital practices.



Further, looking for the gap hypothesis only through students who use more, or less, digital technologies or how much they would like to use digital technologies does not appear to be fruitful. It is crucial to collect detailed longitudinal data of students' transforming informal and formal ecologies of socio-digital participation that are likely to change from one cohort to the next. Moreover, investigating relations between digital and school engagement calls for investigating qualitatively different levels (or genres) of socio-digital participation because interest-driven creative and academic practices are more likely to foster young people's learning and development. Moreover, students come from different backgrounds and contexts, which is reflected in how they experience digital learning engagement in terms of learning and how these experiences collide or connect with the educational practices of school (Howard, Ma, & Yang, 2016; Ito et al., 2013). This can position students unequally and contribute to a digital competence gap.

For instance, investigations of Barron and colleagues (2009) indicate that students who have cultivated advanced levels of digital competence often come from advantaged homes and have parents who provide structured support for school as well as digital learning, and foster the development interest-driven technical and creative capabilities. Disadvantaged students, in turn, may not only have limited parental guidance of the school activity but also restricted access to tools, practices, or social support relevant for building advanced digital competences increasing dangers of educational exclusion or exposure to maladaptive patterns of digital engagement. To counter these risks, all students should be provided with tools to cultivate their digital practices and capitalize on the connected learning possibilities. From the schools' viewpoint, the problem to be solved is how the pedagogical solutions around digital tools are implemented so that the students' out-of-school practices are acknowledged to best support students' personal and collaborative learning and development within a network of connected learning. Toward that end, it appears critical to engage students learning by using digital technologies for sustained collaborative effort of building and creating knowledge and media (Paavola & Hakkarainen, 2014).

## 8. Conclusion

Our results are among the first to directly assess the gap hypothesis with larger scale quantitative and longitudinal data. The results indicate that the gap hypothesis was supported under the following condition: students who express a disposition to solve problems and learn with digital technologies out of school and, would prefer to use more technologies for learning in school, experience a discontinuity between out-of-school and in-school learning and report lower later school engagement. However, the results also indicate that students who hold a disposition towards digital learning but do not experience a discontinuity in connecting it to schoolwork, experience higher later school engagement. The finding that digital learning preference predicted higher school engagement provides indirect evidence for some aspects of connected learning in schools instead of the gap. Based on the results we emphasize that the manifestation of the gap vs. connected learning is dependent on multiple factors, both individual (the level of digital and school engagement) and contextual (the prevailing digital-pedagogic practices of schools). These need to be taken into account in future research. Multiple methodologies and richer data sets are needed to reveal more about the adolescents' truly connected learning experiences – or the lack of them. This study was one step forward in demonstrating and understanding the complexity of this issue. There is an obvious need to examine the reciprocal interactive processes between the learners and their social ecologies inside and outside school more closely in order to support the intellectual development and school engagement of our youth. Towards that end it seems essential to also enhance the educational practices in schools so that the informal learning gained in out-of-school digital engagement can be recognized and supported across all students.





## Keypoints

- Cross-sectional and longitudinal results showed both continuity and discontinuity in connecting out-of-school digital learning and school.
- Digital learning preference was related to higher schoolwork engagement.
- Wish for digital schoolwork was related to lower schoolwork engagement.
- Students who preferred digital learning experienced increased schoolwork engagement over time, especially when connected to in-school digital schoolwork.
- Students who preferred digital learning but did not have sufficient possibilities to connect it to schoolwork, experienced decline in schoolwork engagement.

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**APPENDICES**

Appendix A

*Model fit indices in the measurement invariance testing*

	DF	$\chi^2$	cf	p	RMSEA	CFI	TLI	SRMR
<b>Gender invariance</b>								
Configural	202	672.83	1.20	<.001	.061	.956	.947	.038
Metric	215	698.93	1.18	<.001	.060	.955	.949	.042
Scalar	228	764.67	1.17	<.001	.062	.950	.947	.044
<b>Time invariance</b>								
Configural	996	2873.84	1.12	<.001	.033	.951	.944	.032
Metric	1022	2917.99	1.11	<.001	.033	.950	.945	.033
Scalar	1048	3138.72	1.11	<.001	.034	.945	.941	.034
Scalar + gender as covariate	1087	3115.52	1.11	<.001	.034	.945	.941	.034

Appendix B

*Unstandardized factor loadings and r<sup>2</sup> of the longitudinal measurement model with scalar invariance constraints*

	Factor loadings			Time 1		Time 2		Time 3	
	DLP1	WDS1	EDA1	r <sup>2</sup>	S.E.	r <sup>2</sup>	S.E.	r <sup>2</sup>	S.E.
DLP1 <sup>1</sup>	1.00	.00	.00	.71	.02	.75	.02	.71	.02
DLP2	1.07	.00	.00	.80	.02	.81	.02	.82	.02
DLP3	1.06	.00	.00	.72	.02	.77	.02	.76	.02
DLP4	.83	.00	.00	.49	.02	.52	.02	.49	.03
WDS1 <sup>1</sup>	.00	1.00	.00	.69	.02	.72	.02	.74	.02
WDS2	.00	1.11	.00	.89	.01	.89	.01	.89	.02
WDS3	.00	1.05	.00	.78	.02	.80	.02	.80	.02
EDA1 <sup>1</sup>	.00	.00	1.00	.58	.02	.61	.02	.55	.03
EDA2	.00	.00	.95	.55	.02	.58	.02	.52	.02
EDA3	.00	.00	1.21	.61	.02	.70	.02	.66	.02
EDA4	.00	.00	1.23	.73	.02	.80	.02	.79	.02
EDA5	.00	.00	1.28	.79	.01	.86	.01	.80	.01
EDA6	.00	.00	1.18	.57	.02	.65	.02	.56	.03
EDA7	.00	.00	1.29	.73	.02	.78	.02	.75	.02
EDA8	.00	.00	1.26	.61	.02	.68	.02	.65	.02
EDA9	.00	.00	1.18	.61	.02	.65	.02	.64	.02

*Note: <sup>1</sup>Marker variable for latent variable scale setting, loading fixed at 1. DLP - Digital learning preference, WDS - Wish for digital schoolwork, EDA - Schoolwork engagement.*



Appendix C

*Latent variable correlations of the longitudinal measurement model with scalar invariance constraints*

	1	2	3	4	5	6	7	8	9
1. Digital learning preference 1	1								
2. Wish for digital schoolwork 1	.61**	1							
3. Schoolwork engagement 1	.19**	-.04	1						
4. Digital learning preference 2	.64**	.40**	.15**	1					
5. Wish for digital schoolwork 2	.41**	.61**	.03	.59**	1				
6. Schoolwork engagement 2	.16**	-.08	.61**	.21**	.03	1			
7. Digital learning preference 3	.60**	.4**	.18**	.64**	.43**	.16**	1		
8. Wish for digital schoolwork 3	.42**	.54**	.03	.44**	.59**	.01	.66**	1	
9. Schoolwork engagement 3	.08*	-.03	.49**	.13**	.04	.62**	.20**	.07	1

Note: \*\*  $p < .001$ , \*  $p < .05$ .

Appendix D

Materials to reproduce the results can be found here: <https://osf.io/2hk3y/>