Hoai My Bao Nguyen

Students' Experiences of Flow, Satisfaction, and Learning Outcome in an Online Learning Context.

Master's thesis in Psychology, specialization in learning – brain, behavior, environment
Supervisor: Sven Hroar Klempe
Co-supervisor: Christian A. Klöckner

May 2022

Master's thesis

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Sammendrag

Det har tidligere eksistert mangelfulle flyt-modeller i forskning som ikke samstemte med den originale flyt-teorien. Denne studien ser på effekten entydige tilbakemeldinger, klare mål og en balanse mellom utfordringer og ferdigheter har på studentenes flytopplevelse, og hvordan denne flytopplevelsen påvirker deres tilfredshet med foreleser, kursoppsettet, teknologien, interaksjonen, og læringsutfallet i digital læring. Dataene ble samlet inn ved hjelp av elektronisk spørreskjema i Norge (N = 230), hvorav 164 var kvinner og 65 menn. De fleste studentene lå i alderskategorien 20-25 år (61%), og den gjennomsnittlige studieprogresjonen var 2.27 år (SD = 1.528). Korrelasjonsanalyser ved hjelp av SPSS ble brukt som innledende analyser. En strukturell likningsmodell (SEM) ved hjelp av Stata ble brukt som hovedanalyse for å teste målemodellen (bekreftende faktoranalyse) og strukturmodellen. Resultatene indikerer at en balanse mellom utfordringer og ferdigheter og entydige tilbakemeldinger påvirker studentenes flytopplevelse i digital læring, der utfordring-ferdighet-balansen er den viktigste variabelen. Videre støtter også resultatene sammenhengen mellom studentenes flytopplevelser og deres tilfredshet med foreleser, kursoppsettet, teknologien, interaksjonen, og læringsutfallet i digital læring. Funnene i denne studien har implikasjoner og begrensninger knyttet til modellen.

Nøkkelord: Flyt, Utdanning, Digital læring, Studentenes tilfredshet, Læringsutbytte.

Abstract

Previous research on flow has used incomplete flow models as they were not in line with the original flow theory. The present study will investigate the effect unambiguous feedback, clear goals, and challenge-skill balance have on flow experience, and how the flow experience itself affects students' satisfaction with the instructor, course set-up, technology, interaction, and perceived learning outcome in online learning. Data was collected using online questionnaires in Norway (*N* = 230), of whom 164 were women and 65 were men. Most participants were in the age category 20-25 years (61%), and the mean year of study progression was 2.27 years (*SD* = 1.528). Preliminary correlation analyses were conducted using SPSS. A structural Equation Modelling (SEM) with Stata was selected as the main analysis to test the measurement model (confirmatory factor analyses) and the structural model. The results indicate that challenge-skill balance and unambiguous feedback affect students' flow experience, in which challenge-skill balance was the most important variable. The results also support the relationship between flow experience and students' satisfaction with the instructor, course set-up, technology, interaction, and perceived learning outcome in online learning. The findings of this study have implications and limitations concerning the model.

Keywords: Flow, Education, Online Learning, Student Satisfaction, Learning Outcome.

Acknowledgments

I want to thank my supervisors, Sven Hroar Klempe and Christian A. Klöckner, for their help during the last year. They have always been available and have given good advice on developing the hypothesis, designing the questionnaire, and running analyses. I also want to thank my boyfriend Chakib for all his patience, and support, and for keeping me sane during this process. And lastly, I want to thank my family for always supporting me, loving me unconditionally, and cheering me up as I finish this master thesis. If my father had still been here with us, I know he would be proud of me.

In the last two years of my education, the Covid-19 pandemic has changed how I work with the learning materials. The freedom of having a home office has given me the flexibility I needed. At the same time, the uncertainty around the pandemic has caused some challenges for my master's thesis. However, I am proud of the final product and grateful for the learning process during the master thesis.

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STUDENTS' EXPERIENCES OF FLOW, SATISFACTION, AND LEARNING OUTCOME IN AN ONLINE LEARNING CONTEXT

Introduction

As technology and its associated fields continue to evolve, it has impacted almost every aspect of life, including education. With technological advancement, learners can now access the learning material from anywhere and at any time. Statistics from official data conducted by several nationalities show that the use of online learning has increased over the years. Only in the USA, the number of students taking exclusively online courses has risen from 2.7 million to 3.3 million, and students taking at least one online course has risen from 2.8 million to 3.7 million from 2013 to 2018 (National Center for Educational Statistics, 2013; 2018). In Norway, the number of online learners in higher education has almost doubled, with a total of 7 450 registered in the year 2012 and 14 317 in 2018 (Direktoratet for høyere utdanning og kompetanse, 2012; 2018). This enrolment growth may have reached its peak when the vast majority of students had to switch from traditional classrooms to online learning environments during the national lockdown, as a consequence of the Covid-19 pandemic. According to European University Association's briefing in September 2020, a great majority (95%) of European universities converted to online learning at some point during the pandemic.

As in many aspects of life, changes come with questions, and education is no exception. While universities are ushering in a new era of digital transformation, students are demanding high-quality online learning options. Researchers and educationists are also eager to know the effectiveness of online learning. To understand the effectiveness of online learning, learners' perceptions of the experience must be considered. In terms of the student's engagement in learning activities, the theory of flow has been widely used to understand individual and contextual factors that promote students' engagement and learning (Csikszentmihalyi, 2014). *Flow* is a mental state where the individual gets completely absorbed in the activity in which he or she loses track of both time and self (Csikszentmihalyi, 1975/2000). The theory of flow has contributed fundamental aspects to positive psychology (Csikszentmihalyi, 2000), and has received great attention in education contexts (Csikszentmihalyi, 2014). Specifically, flow theory has advanced our understanding of students' engagement (i.e. the state of flow), factors that may promote it (i.e. conditions/antecedents of flow), and the outcomes of being in the state (consequences) (Keller & Landhäußer, 2012). Although studies have clear evidence of the outcomes the flow experience has on the individual, preconditions that lead to that mental state are somehow inconsistent in the body of research (Guo & Poole, 2009). Therefore, this paper will address possible antecedents of flow in respect of the original flow theory and based on prior research on the topic.

When viewing students as consumers, examining which factors that contribute to consumers' (i.e. students') satisfaction is as relevant as the experience itself. Although numerous studies have investigated students' satisfaction with online courses, the results are mixed. Students' satisfaction is a complex construct, which includes several factors (Bolliger & Halupa, 2012). Similarly, when assessing students' learning outcomes, the factors that contribute to student satisfaction must be included. To fully understand students' perception of the online learning environment and the effectiveness of using online learning, the present study will examine antecedents of flow, the flow experience, students' satisfaction factors, and learning outcome.

Theoretical and Empirical Background

Flow

The concept of flow has been of interest to researchers since it was introduced by Csikszentmihalyi in the '70s (1975/2000). Flow is a mental state of optimal experience in which the individual is so deeply involved and fully engaged in an activity, that nothing else seems to matter (Csikszentmihalyi, 1975/2000). In other terms, this mental state has also been referred to as being "in the zone", "in the groove", or "on the ball" (Csikszentmihalyi, 2014). In Csikszentmihalyi's early work (1975/2000), he started collecting numerous interviews of individuals with different life conditions, nationalities, and occupations on experiences with happiness in fields of art and sport. Despite their differences in profession, all the individuals were describing the same enjoyable feeling of being so immersed in their activity, that they would lose track of time and disregard their needs for food, water, and sleep. Furthermore, these individuals showed intrinsic motivation toward the activity, where the learning process itself seemed to be more important than the outcome (Csikszentmihalyi, 1975/2000). This phenomenon of flow has also been discovered in other activities. Studies have found that individuals experience flow in a wide variety of contexts, including gaming (Hsu & Lu, 2004), musical performances (Wrigley & Emmerson, 2013), online shopping (Novak, Hoffman, & Yung, 2000), navigating in a 3D virtual world (Nah, Eschenbrenner, & DeWester, 2011), work-related activities (Ceja & Navarro, 2011), and learning activities in classrooms (Shernoff, Csikszentmihalyi, Schneider, & Shernoff, 2014).

Since the flow theory was introduced, several researchers have dedicated a good amount of engagement to this phenomenon by measuring the concept in its components. Results from extensive research on the concept delineated nine core elements of flow (Table 1). Although these elements of flow might slightly differ qualitatively, the elements contain similar characteristics, including 1) challenge-skill balance, 2) action-awareness merging, 3) clear goals, 4) unambiguous feedback, 5) concentration, 6) control, 7) loss of self-consciousness, 8) time transformation, and 9) autotelic experience (Boniface, 2000; Csikszentmihalyi, 1990; Ellis, Voelkl, & Morris, 1994; Jackson & Marsh, 1996). In the majority of research on flow, flow is operationalized as a continuous construct rather than a discrete one (Abuhamdeh, 2000). In that case, flow is not defined by its intensity and can exist in greater or lesser degrees across a spectrum of consciousness (Jackson & March, 1996; Jackson & Eklund, 2002). Moreover, flow experiences are not necessarily rare or exceptional. Studies have shown that people also experience flow in everyday activities and not just in extreme activities or situations, including reading books (McGuillan & Conde, 1996), online shopping (Novak et al., 2000), and watching sports (Kim & Ko, 2019). These everyday episodes depict what is also called "micro" flow (Csikszentmihalyi 1975/ 2000).

Table 1

A Summarization of nine elements of Flow

Elements	Description of Dimension
Challenge-skills balance	The activity level of the challenge must be in balance with the individual's perceived skills. The match between skills and challenges defines the boundary between boredom (high skill and low challenge) and anxiety (high challenge and low skill).
Clear Goals	The individual has a strong sense of what should be done with the task at hand because the goals are clearly defined.
Unambiguous feedback	Precise and immediate feedback on how the individual is proceeding to achieve one's goal.
Action-awareness merging	Completely absorbed in the particular activity to the extent that what they are and what they are doing become one.

Concentration	Narrowing of focus and total concentration on the task/activity. The individual can easily tune out all distraction.
Control	A sense of being in control over the situation/activity without actively trying to be in control during flow.
Loss of self-consciousness	Concerns for the self disappears and the person becomes one with the activity
Time transformation	Loses track of time, and the individual's perception of time is distorted.
Autotelic experience	Presence of an intrinsically rewarding experience.

Note. Elements of flow were identified by Boniface (2000), Csikszentmihalyi (1990), Ellis and colleagues (1994), and Jackson and Marsh (1996).

Antecedents- and consequences of flow

While studies have examined the extent to which the nine elements of flow are present during activities, other types of flow research have investigated potential factors leading to flow (antecedents), and the effect of flow on performance and wellbeing (consequences). Conceptually, some of the nine dimensions of flow are closer to one another. For example, challenge-skill balance, clear goals, control, and unambiguous feedback can be considered as conditions required to achieve flow, while loss of self-consciousness, time transformation, control, concentration, autotelic experience, and merging action-awareness are understood as outcomes (Hamari & Koivisto, 2014; Nakamura & Csikszentmihalyi, 2002). The idea that there is a diversity of flow dimensions is grounded in evidence from psychometric data, in which certain dimensions were found to have stronger or weaker covariances with other dimensions of flow (Fournier et al., 2007; Hamari & Koivisto, 2014; Quinn, 2005; Riva et al., 2017).

Although Csikszentmihalyi did not directly develop a flow model differentiating antecedents and consequences of flow, there seemed to be an acceptance in the flow literature to investigate flow in relation to preconditions and outcomes. In Csikszentmihalyi's (2014) work, the nine elements of flow can be divided into preconditions (clear goals, skill-challenge balance, and immediate feedback), characteristics/dimensions (concentration, merging action and awareness, loss of reflective self-consciousness, control, time transformation, and autotelic experience), and outcomes (persistence, commitment, achievement, less anxiety, etc.) A similar differentiation of flow into preconditions, characteristics/dimensions and outcomes can be found in Keller & Landhäußer's (2012) model, where flow is seen as a sequence of pre-conditions (i.e., goals, feedback, demand-skill balance), components of the experience (e.g., sense of control, reduced self-consciousness), and consequences (e.g. affective, cognitive, physiological, and quality of performance). However, much debate on flow exists concerning the existence and strength of antecedents of flow.

Antecedents of flow. One of the most common and accepted conceptualizations of flow is to define flow in terms of challenge-skill balance. Moreover, the occurrence of the flow experience itself is depending on the match between the individual's skills and challenges (Csikszentmihalyi, 2014). Subsequent investigations of the challenge-skill balance have been supported by previous research. The idea that flow results directly from a balance between challenge and skill came from early research on play and the relationship between the difficulty of play and the individual's ability to perform those tasks (Csikszentmihalyi & Bennet, 1971; Keller & Bless, 2008). In Keller and Bless's (2008) experimental study, they found that the participants had positive subjective experiences and higher performance in a balanced condition compared to the control group. In a more recent study, Wu, Lu, and Lien (2021) found that challenge-skill balance contributed to flow states when comparing self-reported flow experiences with electroencephalograms (EEG) that measure real-time flow states in young students. Furthermore, a meta-analytic study by Fong, Zaleski & Leach (2014) found support for challenge-skill balance being a robust contributor to the flow state, along with clear goals and a sense of control.

However, the relationship between challenge and skill balance and the flow experience has not been consistent in the realm of research. While some experimental studies have shown that participants in a challenge-skill balance condition reported higher flow than the imbalance group (Wang & Hsu, 2014), others have supported the greater importance of an imbalance in challenge and skill compared to a balanced condition (Abuhamdeh & Csikszentmihalyi, 2009). Additionally, within the research on the imbalance between challenge and skill, there have been different arguments on what type of imbalance is more important (high challenge and low skills, or low challenge and high skills). A relatively challenging activity appeared to be more enjoyable than a relatively easy activity (i.e. high challenge and low skills; Abuhamdeh & Csikszentmihalyi, 2009). Contrarily, there is evidence suggesting that individuals may also enjoy activities with a challenge level slightly lower than their skill level (Clarke & Haworth, 1994).

Another issue regarding research on the balance between challenge and skills is that challenge-skill balance was not found within all contexts and domains. Moneta and

Csikszentmihalyi (1996) found that the balance between challenge and skill had a positive effect on students' perception of concentration, wishing to do the activity, involvement, and happiness, but the effect was not within all social contexts and dimensions of the experience. In this case, the challenge-skill balance may affect one dimension of experience within one context, but not in others. Furthermore, Moneta and Csikszentmihalyi (1999) found in a later study that 47% of the variance in self-reported concentration was explained by the balance of skill and challenge, while others have found that only 2-4% of the variance of emotional experience was explained by challenge-skill balance (Løvoll & Vittersø, 2014; Voelkl, 1990).

Compared to the importance of challenge-skill balance in flow research, there has been little attention to other antecedents of flow. In most activities with an expectation of success or outcome, clear goals within the individual's skill level should be settled to indicate the direction and aim of the activity. Having an overall goal and many realistically achievable subgoals will narrow down the focus toward things that matter (Csikszentmihalyi, 2008). Concerning goal accomplishment, unambiguous feedback is an evaluation of the performance and allows adjustments to be made to improve the skills (Csikszentmihalyi, 2008). Feedback may come from supervisors and peers who comment on the performance, or the activity itself that provides this information. Therefore, conditions like unambiguous feedback and clear goals can generate flow in terms of guiding where and when to put your attention (Csikszentmihalyi, 2014).

A possible explanation behind the lack of attention to other preconditions in flow research might be the usage of incomplete flow models. Guo and Poole (2009) argued that most studies have included only a partial set of flow preconditions, and the flow experience itself was treated with different constructs than the original flow theory. Despite the discrepancy between partial flow models and the original flow theory, which incorporates all preconditions and dimensions of flow experiences, these incomplete models have given informative results. For example, Novak, Hoffman, and Duhachek (2003) found that flow experiences were more prevalent among web users when using goal-directed activities compared to experimental activities regarding shopping behaviors. Clear goals (described as organizational resources) have also been found to facilitate work-related flow among employees (school teachers), along with self-efficacy beliefs (Salanova, Bakker & Llorens, 2006). In Guo and Ro's (2008) study, they revealed that having clear feedback was the most important factor for experiencing flow in classroom learning. Another study has incorporated both feedback and goals in flow research as one construct and found support for this dimension as preconditions to experience flow in a web environment (Chen, Wigand &

Nilan, 2000; Šimleša et al., 2018). To fully understand the flow concept, it is, therefore, necessary to study the original flow model, including all the preconditions and dimensions.

Consequences of flow. An important direction in flow research is the investigation of its potential outcomes. Numerous studies have shown that flow is associated with increased performance in education (Sumaya & Darling, 2018), in sports (Bakker et al., 2011), and at work (Bakker & van Woerkom, 2017). The flow experience was also positively associated with higher motivation (Mills & Fullagar, 2008), continuance in an activity (Guo, Liu & Liu, 2016), positive affect (Rogatko, 2009), and life satisfaction (Tian et al., 2022). These findings are in line with Csikszentmihalyi's (2014) description of flow as an "optimal experience". Engeser and Rheinberg (2008) pointed out that flow is improving subjective well-being because it is a highly functional state, and experiencing flow gives the individual more intrinsic motivation to carry out the further task and to re-engage in future activities that promotes flow. Hence, flow is not only an intriguing topic, but studying its outcomes of it can give a deeper understanding of the concept in respect of productivity, better human life, and happiness across the lifespan (Csikszentmihalyi, 1975/2000).

Flow in education

Since the term flow has been coined, many researchers have studied this particular experience from various viewpoints and with different purposes. Within education research, flow theory has been used to explain students' engagement (Shernoff et al., 2014), intrinsic motivation (Rheinberg & Engeser, 2018), and learning (Guo & Ro, 2008; Rossin, Ro, Klein & Guo, 2009; Wang & Chen, 2015). The flow literature has also captured other situations related to education, including teaching style (Barrett, 2010) and how flow within the classroom can crossover from teachers to students (Bakker, 2005).

Flow in a digital learning context. A growing field in flow literature is the research on flow experience in digital learning environments. Historically, while most studies on flow have been assessed in traditional classroom contexts (Egbert, 2004; Shernoff et al., 2014; Shernoff et al., 2016), little research has investigated learning using digital learning tools, also known as e-learning. Even lesser attention has been given to learning beyond traditional classroom settings (face-to-face), such as digital courses. As technology is progressing rapidly, there has been some effort trying to define and explore the differences between terminologies like e-learning, online learning, and distance learning environments (Moore, Dickson-Deane, & Galyen, 2011). For the sake of clarity, this paper will view the term *e-learning* as digital learning tools, and *digital courses* (lectures) as synonymous with online learning or distance learning environments. In a broader sense, these learning activities will be referred to as a *digital learning context*. With regards to flow in digital learning contexts, studies have shown that people experience flow when they are playing digital learning games (Chang, Warden, Liang, & Lin, 2018; Hsu & Lu, 2004), and are present in three-dimensional virtual learning environments (Doğan, Demir & Tüzün, 2021), using web-based learning platforms (Choi, Kim, & Kim, 2007), and video-based learning (Wang, Chiu & Lee, 2021).

Flow in digital courses. When it comes to research on digital courses, most studies have been conducted on students taking long-distance courses, which means the students are signing up for online classes from schools/universities that usually are not geographically available in their hometown, or if the instructor is physically located in a different place from the learner's. Therefore, distance learners can engage in learning from anywhere, at any time, and any place. Although scarcely, there has been some research on flow in distance learning (i.e. digital courses). For example, Liao (2006) found that students' perception of their skills, challenges, control, and interaction with instructor and interface (i.e. technological medium) had a direct effect on flow experiences in digital courses, which in turn had an indirect effect on their exploratory behaviors, sense of time distortion and intention to participate in a distance learning course. However, this study included only a partial set of antecedents of flow (i.e. challenge-skills balance) and did not involve all the dimensions from the original flow theory (e.g. clear goals and unambiguous feedback). In another study, Guo and colleagues (2016) included all the relevant antecedents from the original flow theory (i.e. challenge-skill balance, clear goals, and unambiguous feedback), in addition to the construct telepresence (i.e. a feeling of presence in the online learning environment), to investigate users experiences in an online environment and the impact of flow on their continuance intention. With the exception of feedback, they found support for challenge-skill balance, goals, and telepresence, having an impact on flow experience in an online environment (Guo et al., 2016). The impact challenge-skill balance, in addition to other flow antecedents (i.e. clear goals and unambiguous feedback), has on flow experience from previous research demonstrate that there is a need to further assess this relationship in a digital learning context.

Students' satisfaction and learning outcome

An essential part of assessing the students' success from online learning is to not underestimate their satisfaction with the learning process. Since, flow experience has been associated with positive correlates such as higher motivation (Mills & Fullagar, 2008), continuance in an activity (Guo et al., 2016), positive affect (Rogatko, 2009), and life satisfaction (Tian et al., 2022), it is expected that the flow experience affects students' satisfaction in a digital learning context. Indeed, several studies on online learners have supported the direct relationship between flow experience and student satisfaction (Lee & Choi, 2013; Rossin et al., 2009; Shin, 2006; Xao & Li, 2021). However, these studies did not differentiate what kind of aspect the students were satisfied with when they experienced flow. Moreover, students' satisfaction is a complex construct that includes many factors (Bolliger & Halupa, 2012). In online environments, factors that include instructor behavior (Geier, 2020), reliable technology (Harsasi & Sutawijaya, 2018), interaction (Johnson, Hornik, & Salas, 2008), and course-set up/content (Harsasi & Sutawijaya, 2018; Sebastianelli, Swift, & Tamimi, 2015), were found to be predictors of students' satisfaction. Hence, there is a need for distinguishing different types of student satisfaction when studying the relationship between flow experience and student satisfaction.

In any education context, students' academic achievement and satisfaction can be considered as complementary as both outcomes are important in describing the effectiveness of the learning activity. The effectiveness of a course can be assessed by students' direct performance (e.g. course grades) and by indirect performance measures (e.g. students' perception of their learning). While the former approach measures students' actual learning, the latter measures students' opinions or attitudes towards learning (Price & Randall, 2008). Although measuring students' course grades can yield informative information regarding students' actual mastery of the content and skill acquisition (Hachey, Wladis, & Conway, 2014), they are usually poor at explaining students' learning experiences. In designing, developing, and implementing online education, it is important to look at students' needs and expectations with online courses or programs. Without examining students' perceptions of their learning experiences, it will be difficult to improve their learning and evaluate the effectiveness of the course. In Eom, Wen, and Ashill's (2016) study on online students' perceived learning outcome and satisfaction, they found that perceived learning outcome was affected by students' intrinsic motivation (i.e. flow), but not by students' extrinsic motivation in online learning. With regard to research on flow in online activities, Rossin and colleagues (2009) found that flow experience was directly related to students' perceived learning, satisfaction, and perceived skill development, but not to objective learning performance. They further noted that it is reasonable to focus on these outcomes because students are likely to have a useful perception of their learning (Rossin et al., 2009). Following this line of thought, the present study will focus on the indirect measure of students' learning outcome, and assume that students' experiences of flow are associated with their perceived learning outcome, along with satisfaction with the instructor, technology, interaction, and course-set-up/content in online learning.

The present study

The rationale

Despite extensive research on the phenomena of flow, there has been a comparative deficit in the literature relating to flow in general, and flow in digital learning. To avoid the central problem in flow research with operationalizing flow (Guo and Poole, 2009), the present study will include all the nine core dimensions of flow according to the original flow theory (Csikszentmihalyi, 1975/2000), which were yielded from numerous research on the concept (Boniface, 2000; Csikszentmihalyi, 1990; Ellis et al., 1994; Jackson & Marsh, 1996). Since flow experience is primary depending on challenge-skill balance according to the original flow theory (Csikszentmihalyi 1975/2000) and from previous research (Fong et al., 2014; Keller & Bless, 2008; Wu et al., 2021), it is reasonable to assume that challenge-skill balance is, in fact, an antecedent of the flow experience.

Because incomplete flow models have been used in previous research (Guo & Poole, 2009), and the inconsistent results across studies regarding the importance of the relationship between challenge-skill balance and the flow experience (e.g. Abuhamdeh & Csikszentmihalyi, 2009; Clarke & Haworth, 1994; Løvoll & Vittersø, 2014; Moneta & Csikszentmihalyi, 1999; Voelkl, 1990; Wang & Hsu, 2014), it is necessary to also investigate the existence of other antecedents' association with the flow experience. In virtue of previous research on other preconditions of flow (e.g. Chen et al., 2000; Guo & Ro, 2008; Novak et al., 2003; Salanova et al., 2006; Šimleša et al., 2018), clear goals and unambiguous feedback are assumed to affect flow experience in the present study.

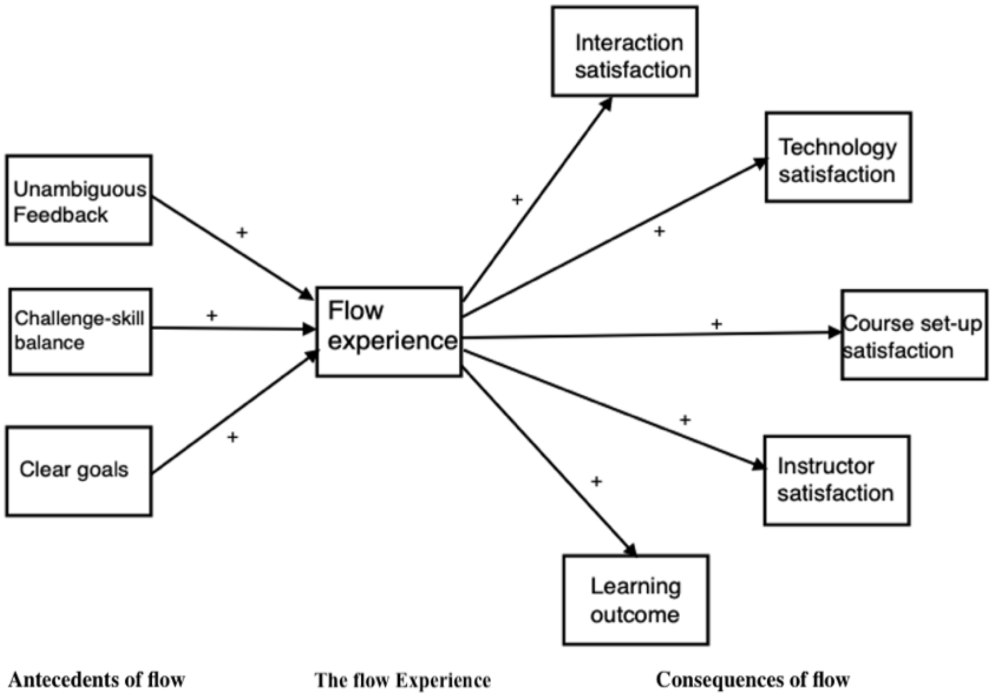
As highlighted by Bolliger & Halupa (2012), students' satisfaction is a complex construct, including instructor behavior (Geier, 2020), reliable technology (Harsasi & Sutawijaya, 2018), interaction (Johnson et al., 2008), and course-set up/content (Harsasi & Sutawijaya, 2018; Sebastianelli et al., 2015). Although previous studies found a direct relationship between flow experience and students' satisfaction (Lee & Choi, 2013; Rossin et al., 2009; Shin, 2006; Xao & Li, 2021), they did not distinguish the types of satisfaction factors. In order to fill this gap, the present study will conceptualize that flow experience in online learning will affect students' satisfaction with the instructor, course set-up, interaction, and technology. In a similar vein, it is expected that students' flow experiences will affect their perceived learning outcome in an online learning context.

The Research Model

Based on the theoretical and empirical background, the present study will address the relationships between antecedents of flow (i.e. challenge-skill, unambiguous feedback, and goals), the flow experience, satisfaction with the instructor, course set-up, interaction, technology, and perceived learning outcome, using a path-model. The conceptualized research model is illustrated in figure 1.

Figure 1.

The Research Model



Note. The present study uses a structural equation model approach. Arrows and symbols represent the direction and the sign of the paths. The variables *Challenge-skill balance*, *Unambiguous feedback,* and *Clear goals* are seen as antecedents of flow. The *Flow experience* variable includes factors like Action-awareness merging, Concentration, Control, Loss of self-consciousness, Time transformation, and Autotelic experience. The satisfaction variables (*Interaction, Technology, Course set-up,* and *Instructor*), and the variable *Learning outcome,* are viewed as consequences of flow.

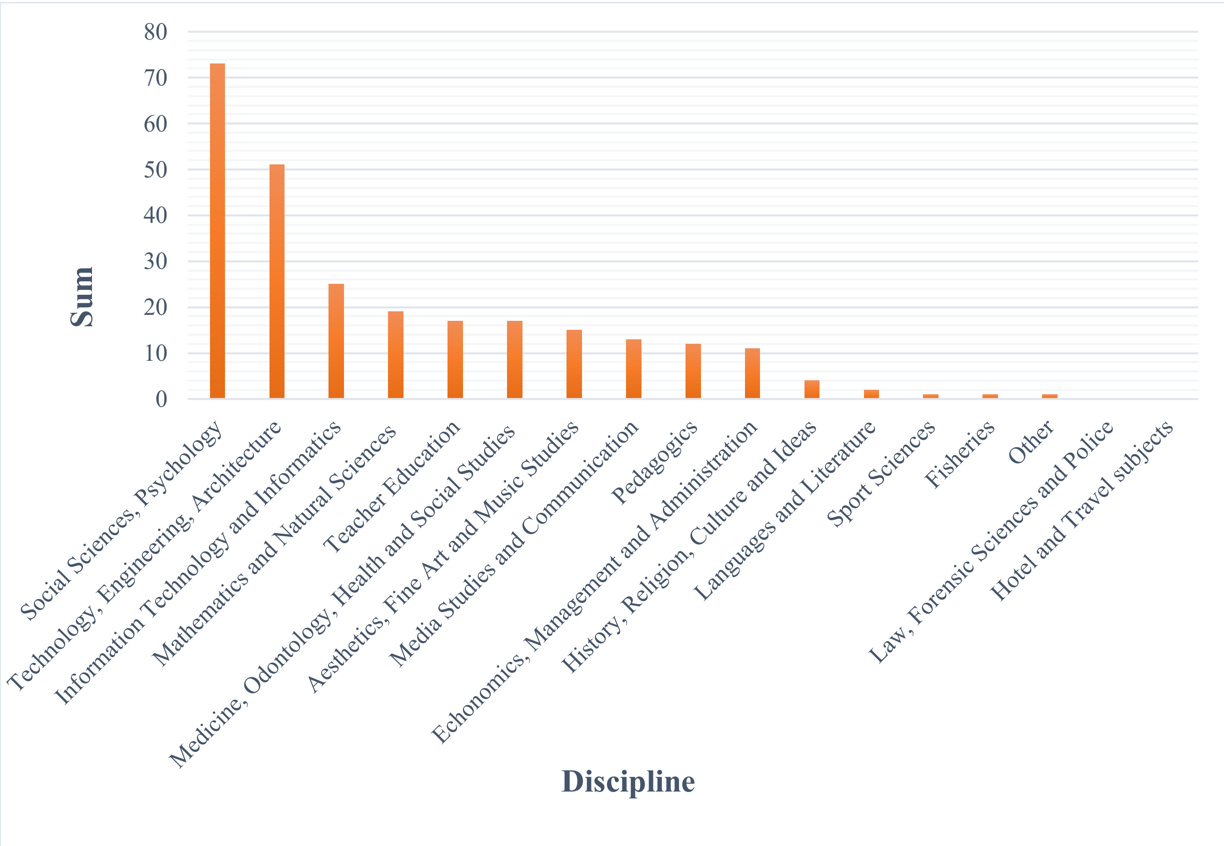
Method

Participants

Two hundred and thirty Norwegian students fully completed the survey (*N* = 230), of whom 164 were women and 65 were men. One participant did not identify as female or male. Given this data set, most participants were in the age category 20-25 years (61%). Others were 26-29 years (15.7%), under 20 years (12.6%), or over 30 years old (10%). While 11 participants reported studying part-time, 219 participants were studying full-time. The mean year of study progression was 2.27 years (*SD* = 1.528). There was a relatively good spread of disciplines, although it was dominated by fields of “Social Science and Psychology” and “Technology, Engineering, and Architecture” (Figure 2).

Figure 2.

Distribution of Respondents by Discipline



Data collection

The instrument. The online survey program Nettskjema was used for data collection. Nettskjema is a Norwegian tool developed at the University of Oslo for designing and conducting online surveys that are customized for research purposes (University of Oslo, 2020). Before launching the survey questionnaire to the actual target population, two supervisors and four students from different academic disciplines pretested the instrument and its measurements. Once the survey questionnaire was reviewed multiple times from an expert- and respondent-driven pre-test, a few modifications were made to improve the questions' clarity. The instrument consists of three main parts, including 1) demographic questions (gender, age, education status, participation in digital courses), 2) flow, and 3) satisfaction and perceived learning outcome. At the beginning of each section, the respondents were guided with a short text asking them to recall past experiences in online learning that they were participating in during the autumn school semester of 2021. To avoid missing values, all questions were mandatory. However, at the end of the questionnaire, there were two open-ended questions about students' perceptions of the advantages and disadvantages of online learning. These questions were non-mandatory, and will not be included in the main analysis. As answers to the open-ended questions can yield useful insights on the topic, a summary of these answers will be shown in the Appendix. The full questionnaire can be found in the Appendix.

Using the survey program Nettskjema, this study collected anonymous responses by disabling the option for IP address tracking and email address tracking before sending out the survey questionnaire. The survey only contained questions that were not traceable to the participant. In line with the guidelines from the Norwegian Center for Research Data (NSD), all participants were informed about their anonymity, as well as their participation was voluntary.

The procedure. The data was collected between October 19th and November 12th in the year 2021. Due to limited time and resources, a convenience sampling method was used to recruit university students. The questionnaire was distributed as web links posted on digital platforms, including Facebook's student groups, Blackboard Announcements, Innsida Bulletin Board, and e-mails. To get as many participants in many different campuses as possible, this survey was distributed among students from the Norwegian University of Science and Technology (NTNU), the University of Oslo (UiO), and the University of Bergen (UiB). No advantages or disadvantages were given by participating.

Variables and measurements

Challenge-Skill. To measure Challenge-Skill balance, the present study used the four items from the Flow State Scale (FSS), originally developed to measure a balance between challenge and skill in sports activities (Jackson & Marsh, 2016). The validity and reliability of the scale have been supported through Confirmatory Factor Analyses (CFA) (Jackson & Marsh, 1996; Jackson & Eklund, 2002). In the present study, the four items measuring Challenge were translated to Norwegian, and some of the word phrasings were slightly edited to better reflect the context of the study. However, the items were kept as close as the originals to maintain the same semantics of the sentences. For example, the original item "I was challenged, but I believed my skills would allow me to meet the challenge" (Jackson & Marsh, 1996) was modified to "I was challenged academically, but I believed my skills would allow me to meet the challenge in digital lectures" ("Jeg ble utfordret faglig, men jeg hadde tro på at mine kunnskaper ville gjøre meg i stand til å takle utfordringene i digitale undervisninger"). The participants answered on a five-point Likert scale on how much they agree or disagree with statements regarding a balance between challenge and skill, ranging from 1 = "Strongly disagree" to 5 = "Strongly agree". The scale consisted of positively worded items, and therefore no items needed to be reversed. The Cronbach's alphas from previous research were .80 (Jackson & Marsh, 1996). In the present study, Raykov's Rho value was .837, which indicates good reliability (Mehmetoglu & Jakobsen, 2017).

Feedback. Feedback in online courses was measured using four items from FSS (Jackson & Marsh) that measure participants' perception of unambiguous feedback in an activity. This scale was selected because of its robustness (Jackson & Marsh, 1996; Jackson & Eklund, 2002). The questions were translated to Norwegian, and some of the items had small edits in the present study. For example, "I had a good idea while I was performing about how well I was doing" (Jackson & Marsh, 1996) was rephrased to "I had a good idea of how well I was doing during the digital lectures" ("Mens de digitale undervisningene pågikk hadde jeg en sterk anelse om hvor bra jeg gjorde det"). The participants answered on a five-point Likert scale on how much they agree or disagree with feedback statements, ranging from 1 = "Strongly disagree" to 5 = "Strongly agree". The scale consisted of positively worded items. Previously, the internal consistency of the measure has been α = .85 (Jackson & Marsh, 1996). Raykov's reliability coefficient was above recommended threshold (> .70; Mehmetoglu & Jakobsen, 2017) in this present study (Table 2).

Goals. Four items from FSS (Jackson & Marsh) measuring clear goals, were used to measure the variable Goals in this study. The items were translated to Norwegian, with edited items such as "I knew clearly what I wanted to do this semester" ("Jeg visste tydelig hva jeg skulle gjøre dette semesteret") from the original "I knew clearly what I wanted to do" (Jackson & Marsh, 1996). The participants answered on a Likert scale of 1-5, from "Strongly disagree" to "Strongly agree". In line with the previous study showing good internal consistency of the scale (α = .84; Jackson & Marsh, 1996), Raykov's reliability coefficient was .856 in the present study.

Flow Experience. To measure the flow experience itself, the present study used 24 items from the FFS (Jackson & Marsh, 1996) that contained experiences of being in the flow state. This decision was based on the previous conceptualization of the flow experience in the literature (Nakamura & Csikszentmihalyi, 2002), and the correlation analyses between flow subdimensions and the flow experience (Guo & Ro, 2008). In the present study, the variable Flow experience contained items from Jackson and Marsh's (1996) subdimensions describing the flow state (Concentration, Control, Time transformation, Loss of self-consciousness, Action/activity-merging, and Autotelic experiences). All 24 items in the questionnaire were translated to Norwegian, with the format of a five-point Likert scale (1 = "Strongly disagree"; 5 = "Strongly agree"). The questions were all positively worded. The items in the present study were slightly edited from the original items to better fit the context of digital learning. Raykovs's reliability test revealed a high internal consistency with a value of .904.

Table 2

Descriptive statistics of Flow experience, Goals and Feedback

Variable	*M*	*SD*	*RRC*
Flow Experience	2.868	.761	.904
Challenge-Skill	3.171	.889	.837
Goals	3.100	1.002	.856
Feedback	2.607	.970	.910

Note. *RRC* = Raykov's reliability coefficients. Participants rated on a five-point Likert scale; 1 = "Strongly disagree"; 2 = "Disagree"; 3 = "Neutral"; 4 = "Agree"; and 5 = "Strongly agree".

Instructor. The variable Instructor was measured using four items from the Student Satisfaction Questionnaire (SSQ), developed by Bolliger and Halupa (2012) to measure students' perception of the instructor. These items were based on Bolliger and Martindale's (2004) Online Course Satisfaction Survey (OCSS) with the purpose of measuring students' attitudes towards distance (online) learning with a specific course. In the present study, the questions were translated to Norwegian, and some of the word phrasings had small adjustments in order to improve their clarity. For example, the original item "Class assignments were clearly communicated to me" was edited to "Digital information about mandatory activities was clearly communicated to me (e.g., work requirements, practices, assignments, tests, exams, etc.)" ("Digital informasjon om obligatoriske aktiviteter har vært kommunisert tydelig til meg (f.eks. arbeidskrav, øvingstimer, innleveringer, tester, eksamen, osv.)"). All of the four items were positively worded, and therefore no items needed to be reversed. The respondents were asked to answer the questions on a five-point Likert scale (ranging from 1 = "Strongly disagree" to 5 = "Strongly agree") on how much they agreed with the statements describing satisfaction with the instructor. A reliability test from a previous study has shown good internal consistency with this subscale, with α = .82 (Bolliger & Halupa, 2012). Raykov's reliability coefficients obtained in the present study were slightly lower (Table 3), but still within an acceptable level of <.70 (Mehmetoglu & Jakobsen, 2017).

Technology. Students' satisfaction with the technology was measured using Bolliger and Halupa's (2012) four items from SSQ. The questions were translated into Norwegian. New technologies in the learning context have emerged since the original questionnaire was developed. Hence, the four items measuring Technology in the present study were slightly modified to better capture today's modern learning context. For example, the original item "I am satisfied with how to navigate within WebCT (the course management system)" (Bolliger & Halupa, 2012) was adjusted to "I am satisfied with how to navigate in the digital learning system (e.g., Blackboard, Zoom, Teams, etc.)" ("Jeg er fornøyd med hvordan jeg kan navigere i det digitale læringssystemet (f.eks. Blackboard, Zoom, Teams, osv.)"). One of four items from the original "I am dissatisfied with download times of resources in WebCT" (Bolliger & Halupa, 2012) was positively reworded to "I am satisfied with download times of learning materials from the digital learning system (e.g. Blackboard, Zoom, Teams, etc.)" ("Jeg er fornøyd med tiden det tar å laste ned læringsmaterialer fra det digitale læringsysstemet (Blackboard, Zoom, Teams, osv.)"). It is worth noting that the original version was applied to a specific course (Bolliger & Halupa, 2012), while the present study contains questions about online courses in general. The subscale's internal reliability was α = .76 in Bolliger and Halupa's study (2012), while Raykov's Rho in the present study was .826.

Course Setup. To measure students' satisfaction with the course setup, four items from SSQ (Bolliger & Halupa, 2012) were selected. All items from the original questionnaire were positively worded, except one item. This item was edited positively from "I am dissatisfied with the level of self-directedness I am given" (Bolliger & Halupa, 2012) to "I am satisfied with the self-directedness I am given" ("Jeg er fornøyd med det selvstyrte ansvaret som jeg har fått"). In the present study, all items were positively worded, and translated to Norwegian. The internal reliability coefficient in Bolliger and Halupa (2012) was α = .60, which is often considered unacceptable by most researchers (Field, 2013). However, in the present study, the reliability value was at an acceptable level of .830 using Raykov's Rho (Mehmetoglu & Jakobsen, 2017). While the Cronbach's alpha is the most widely used measurement for assessing internal consistency (Field, 2013), the Raykov's reliability measure is commonly seen as more accurate than Cronbach's alpha (Mehmetoglu & Jakobsen, 2017) because it does not assume that items are equally related to the construct (Raykov, 2009).

Interaction. Four items were used to measure students' perceived satisfaction with the interaction online. These items were inspired by the four items measuring interaction from Bolliger and Halupa's (2012) SSQ. The biggest difference between Bolliger and Halupa's measurement of interaction and the present study's measurement of interaction is that the former does not separate students' interaction with teachers from students' interaction with peers. As satisfaction with teachers and satisfaction with peers are two different aspects, they should not be placed in the same question. To avoid asking for two things at once, the present study decomposed the item "I am satisfied with the quality of interaction between all involved parties" (Bolliger & Halupa, 2012) into two questions "I am satisfied with the quality of interaction between me and the teacher" and "I am satisfied with the quality of interaction between me and peers". All items were positively worded and translated into Norwegian. In the present study, the reliability coefficient (*RRC* = .869) was higher compared to Bolliger & Halupa's (2012) study (α = .60), which indicates that the items from the subscale measuring interaction satisfaction in the present study has better internal consistency than the previous study.

Outcome. To measure students' perceived learning outcomes, the four items from SSQ (Bolliger & Halupa, 2012) were selected. All the questions were positively worded in this study. The questions were "I am satisfied with the level of effort that is required this semester" ("Jeg er fornøyd med innsatsen som forventes av meg dette semesteret"), "I am satisfied with my performances in online sessions this semester" ("Jeg er fornøyd med mine prestasjoner i nettbasert læring dette semesteret"), "I believe I will be satisfied with my final grade in this semester" ("Jeg tror jeg kommer til å være fornøyd med karaktene jeg får fra dette semesteret"), and "I am able to apply what I have learned in online sessions" ("Jeg ser jeg kan bruke det jeg har lært av nettbasert læring"). Both internal reliability coefficients from a previous study (α = .72; Bolliger & Halupa, 2012) and the present study (*RCC* = .850) were acceptable, indicating the measurement is consistent within itself.

Table 3

Descriptive statistics of satisfaction variables

Variable	*M*	*SD*	*RRC*
Instructor	3.180	.860	.728
Technology	3.263	.947	.826
Course Setup	3.525	.988	.830
Interaction	3.013	1.042	.869
Outcome	3.285	.924	.850

Note. *RRC* = Raykov's reliability coefficients. Participants rated on a five-point Likert scale; 1 = "Strongly disagree"; 2 = "Disagree"; 3 = "Neutral"; 4 = "Agree"; and 5 = "Strongly agree".

Analysis

All statistical data analyses in this study were performed with the software programs SPSS (28.0.1.0 version) and Stata (17.0 version).

Preliminary analyses. As presented earlier, mean scores and standard deviation for all the nine variables (Challenge-Skills, Feedback, Goals, Flow-Experience, Instructor, Technology, Course Setup, Interaction, and Outcome) were calculated using SPSS. The internal reliability coefficients (Raykov's Rho) were tested with Stata. These results can be found in Table 2 and Table 3 in the "Variables and measurements" section.

In preparation for the subsequent SEM analysis, bivariate zero-order correlation analyses between all the new variables were conducted with SPSS to get familiar with the data (Kang & Anh, 2021). Even if the latent variables measure different aspects of the same thing, we would expect them to correlate with each other because they measure the same concept (Field, 2013). However, too high correlations ($r > .90$) between the latent variables might indicate a lack of discriminant validity (i.e. multicollinearity problem) (Field, 2013). This is also an important initial step to have an impression of the strongest and weakest variable association before the full-scale SEM analysis (Kang & Anh, 2021). Additionally, assumptions regarding outliers, multicollinearity, linearity, and multivariate normality (Kumar & Upadhaya, 2017) were also examined.

Measurement model tests. In line with the common procedure, a two-step approach was employed in the model to test the measurement model and the structural model (Anderson & Gerbing, 1988; Nova et al., 2000). SEM as a framework is composed of the measurement model and the structural model, in which the measurement model is concerned with the relationships between observed variables (indicators) and their respective latent variables (also known as a Confirmatory Factor Analysis), and the structural model estimates the relationships between the latent variables (Hair, Hult, Ringle & Sarstedt, 2017). In the first phase, model fit indices of the measurement model were tested with Stata using a confirmatory factor analysis (CFA) approach. These tests provide several useful indices for evaluating the overall model's goodness of fit, specifically to which extent the observed data fit the hypothesized model (Mehmetoglu & Jakobsen, 2017). These indices were used as guidelines for either accepting, adjusting, or rejecting the hypothesized model. Every change made to the model was based on improvement in the fit indices and the models' interpretability, which was primarily guided by objective (theory and research) and subjective evaluations. A table of factor loadings from the CFA can be found in the Appendix.

Discriminant and convergent validity tests were also performed to assess the extent to which the measures actually test the hypothesis or theory they are measuring (construct validity). All the validity tests were performed with Stata, except for the Heterotrait-Monotrait ratio (HTMT2), which was first calculated with SPSS (bivariate between-trait correlation and the within-trait correlations of constructs) and then with the HTMT online calculator (Hensler, 2022).

Structural model tests. In the second phase, the proposed structural model was tested using Stata. As recommended by Mehmetoglu & Jakobsen (2017), model fit indices of the structural model were also tested. Estimates from the direct effects of the latent variables will be presented in Table 9. Mediation analysis with a bootstrapping procedure was applied to assess the indirect effects of the structural model. A bootstrapped method was used in the mediation analysis to overcome the limitation of a nonnormal sample distribution (Hayes, 2009). A visualization of the structural model is displayed in Figure 3, with only significant relationships between the latent variables being presented graphically.

Results

Bivariate Zero-Order Correlations Analyses

Bivariate zero-order correlation analyses between all variables were performed to get familiar with the data before applying SEM. The magnitude of the significant correlations varies between .61 to .81, and they are all positive (Table 4). Significant correlations were found among all the included variables ($p < .001$), with the strongest correlations being observed between Feedback and Goals, and Flow Experience and Challenge-Skill, which may impose that there is a degree of relationship between the variables.

Table 4

Bivariate zero-order correlations between all the nine variables

Variable	1	2	3	4	5	6	7	8	9
(1)Goals	1								
(2)Challenge-Skills	.72*	1							
(3)Feedback	.81*	.73*	1						
(4)Flow Experience	.72*	.81*	.78*	1					
(5)Instructor	.68*	.64*	.66*	.71*	1				
(6)Technology	.61*	.59*	.62*	.67*	.75*	1			
(7)Course	.67*	.74*	.66*	.78*	.74*	.73*	1		
(8)Interaction	.63*	.70*	.71*	.79*	.78*	.76*	.79*	1	
(9)Outcome	.72*	.75*	.71*	.75*	.69*	.65*	.78*	.68*	.70*

Note. Pearsons's correlation coefficients (r). Significant correlations $p < .001$*.

The Measurement Model

Assumptions. Before the assessment of the structural model, certain assumptions must be examined prior to the analysis (Kumar & Upadhaya, 2017). The data for the present study were tested for outliers (Box plot), multicollinearity (Variance Inflation Factor – VIF), linearity (Scatterplot), and multivariate normality. While there were small indications of multicollinearity (some variables had $.80 < r < .90$), no individual VIF-values were above 10 (Field, 2013), indicating that multicollinearity is not a problem. Inspection from Box Plots and Scatterplots showed that there were no critical concerns about outliers and linearity. All the normality tests (Doornik-Hansen omnibus test, Henze-Zirkler's consistent test, Mardia's multivariate kurtosis – and skewness test) indicated a violation of multivariate normality ($p <$

.001). Hence, Satorra-Bentler standard error estimation was used in the following SEM analysis to correct this problem (Mehmetoglu & Jakobsen, 2017). When considering everything, the assumptions of SEM were not critically violated.

Reliability and validity. Individual item (construct) reliability was assessed based on factor loadings in their standardized form. The result shows that all items have acceptable loadings (>. 40; Mehmetoglu & Jakobsen, 2017) on their latent variable, except for the four items *f_time1*, *f_time2*, *f_time3*, and *f_time4* from the variable Flow Experience measuring time distortion. These items were removed due to relatively low factor loadings ranging from .149 to .287. This tendency of low factor loadings can also be seen in previous studies for the same items measuring time transformation (Jackson & Marsh, 1996; Marsh & Jackson 1999). Tables of factor loadings are shown in the Appendix.

The most common assessments of validity are convergent and discriminant validity (Mehmetoglu & Jakobsen, 2017). Convergent validity refers to how well a set of indicators is reflecting the same latent variable, while discriminant validity is about the distinctiveness of the latent variables (Mehemetoglu & Jakobsen, 2017). One method to evaluate convergent validity is to examine each latent variable's composite reliability (CR). If the CR value is above the recommended threshold of .70, then the latent variable would explain an average of 50% ($.70^2$) variance in its associated indicators (Mehmetoglu & Jakobsen, 2017). In this study, the CR values for all the latent variables were ranging from .700 to .964 (Table 5).

Another method commonly used to assess convergent validity is computing each latent variable's average variance extracted (AVE), which measures the amount of variance attributed to the construct relative to the amount of measurement error (Hair et al., 2017). Using the same logic as CR, an AVE value of a minimum of .50 indicates that the construct explains on average more than 50% of the variance of its indicators relative to the variance that remains in the error of the items (Hair et al., 2017). The results showed that all constructs have values above .50 (Table 5). Taking everything into consideration, we can state that convergent validity is acceptable for the present study.

Table 5

Composite Reliability and Convergent Validity of the Measurement Model

Construct	CR	AVE
Flow Experience	.964	.673
Feedback	.910	.716
Interaction	.894	.739
Goals	.856	.603
Outcome	.854	.590
Challenge-Skills	.821	.607
Technology	.789	.647
Course	.749	.595
Instructor	.700	.540

Note. CR = Composite Reliability. AVE = Average Variance Extracted.

Traditionally, the discriminant validity of each construct can be assessed by comparing AVE values with Squared correlations (SC) between latent variables (Fornell-Larcker criterion), where values of AVE should be higher than SC (Fornell & Larcker, 1981). When comparing AVE with SC in the present study, the values indicated a lack of discriminant validity for all the variables (i.e. AVEs < CRs). However, recent research has critically examined the performance of the Fornell-Larcker criterion, suggesting that the reliability approach in detecting discriminant validity was poor overall (Rönkkö & Evermann, 2013; Henseler, Ringle & Sarstedt, 2015), especially when indicator loadings vary between .60 and .80 or more (Voorhees, Brady, Calantone & Ramirez, 2016). Another approach to assess discriminant validity is calculating the Heterotrait-Monotrait (HTMT) ratio of the between-correlation to the within-correlations of constructs (Henseler, et al., 2015). The suggested threshold of HTMT values is below .90 if the path model includes constructs that are conceptually very similar (Hensler et al., 2015). From a conceptual viewpoint, there could be similarities between the constructs of technology satisfaction and course setup satisfaction, or instructor satisfaction and interaction satisfaction. All the HTMT2 (modified) values for the present study were below .90 (Table 6). The results from the HTMT method speak in favor of the discriminant validity of the constructs.

Table 6

HTMT2 Ratio for All Pairs of Constructs in the Measurement Model

Variable	1	2	3	4	5	6	7	8	9
(1)Flow Experience	-								
(2)Goal	.804	-							
(3)Feedback	.841	.855	-						
(4)Challenge-Skills	.892	.841	.836	-					
(5)Course Set-Up	.875	.781	.753	.884	-				
(6)Instructor	.856	.900	.798	.817	.897	-			
(7)Interaction	.901	.735	.802	.814	.855	.896	-		
(8)Technology	.823	.733	.717	.707	.881	.892	.900	-	
(9)Outcome	.830	.843	.780	.881	.896	.871	.789	.768	-

Note. HTMT2 = Heterotrait-Monotrait (modified ratio).

Model fit. To get a holistic view of the overall model fit, several fit indices were estimated, including the Chi-Squared test (X^2), Root Mean Squared Error of Approximation (RMSEA), Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), Standardized Root Mean Squared Residual (SRMR), and Minimum Discrepancy/degrees of freedom (CMIN/Df) (Gefen, Straub & Bourdreau, 2000; Mehmetoglu & Jakobsen, 2017). According to the results, the hypothesized model's Chi-squared value was statistically significant, $\chi^2(595) = 1390.26$, $p < .001$. However, as pointed out by Teo, Tsai, and Yang (2013), a non-significant p-level from a Chi-Squared test (i.e., indicating the model fits the data well) is uncommon in most SEM empirical research when a model includes many indicators. Therefore, several model fit indices must be accounted for. When dividing the Chi-squared statistic by the degrees of freedom (CMIN/df), the result obtained was within the desirable level (< 3; Gefen et al., 2000). As illustrated in Table 7, while there were acceptable levels of RMSEA and SRMR (< .10), the CFI value nearly surpass the cut off-point, and TLI did not exceed the cut-off point at all (≥ .90; Mehmetoglu & Jakobsen, 2017).

According to Mehmetoglu and Jakobsen (2017), one way to improve a poor or mediocre fitting model is to assess the correlated errors between pairs of indicators assisted by modification indices (MI) and theoretical insights. If the Chi-Square value (χ^2) reduction is greater than 3.84 when the parameter is free instead of constrained, then we can claim that the benefit of modifying the model outweighs the cost (Mehmetoglu & Jakobsen, 2017). In this case, there was one outstanding pair of correlated errors between items that have the highest drop in the Chi-Square value (χ^2), which is flow_cons4 and flow_cons3 (107.248). From a theoretical viewpoint, these items are also strongly overlapping in content. When the covariance between the error term was freed in the measurement model, the fit indices from the modified model were not substantially greater than the indices from the hypothesized model, as well as they were not within the desirable levels (Table 7). Thus, there is no purpose in adjusting the hypothesized model. In further analyses, we must acknowledge that our hypothesized model fit was mediocre and that not all fit indices met the expectations of an ideal fit.

Table 7

Fit Indices of the Measurement Model

Fit Index	Hypothesized Model	Model Modification	Cut-off	Model fit status
RMSEA	.077	.078	$\leq .10$	Acceptable
CFI	.889	.896	$\geq .90$	Not Acceptable
TLI	.875	.833	$\geq .90$	Not Acceptable
SRMR	.053	.053	$\leq .10$	Acceptable
Chi-Squared	$p < .001$	$p < .001$	$p > .05$	Not Acceptable
CMIN/df	2.337	2.403	≤ 3	Acceptable

Note. Model fit indices before modification (hypothesized model), and after modification (i.e. including correlation errors between indicators). RMSEA = Root Mean Squared Error of Approximation. CFI = Comparative Fit Index TLI = Tucker-Lewis Index. SRMR = Standardized Root Mean Squared Residual. CMIN/df = Minimum Discrepancy divided by degrees of freedom.

The Structural Model

The next procedure is to examine the fit of the structural model. With the exception of three fit indices (Chi-Square, CFI, and TLI), all the other fit indices RAMSEA, SRMR, and CMIN/df indicated an acceptable fit relative to conventional thresholds (Table 8). The overall Coefficient of Determination (R^2) is .890. The individual R^2 between the endogenous variables varies slightly. The total variance explained for Course (R^2 = .923), Flow Experience (R^2 = .821), Instructor (R^2 = .871), Interaction (R^2 = .856), Outcome (R^2 = .741), and Technology (R^2 = .719) are all high (Field, 2013).

Table 8

Fit Indices of the Structural Model

Fit Indices	Value	Cut-off	Model fit status
RMSEA	.083	$\leq$ .10	Acceptable
CFI	.863	$\geq$ .90	Not Acceptable
TLI	.853	$\geq$ .90	Not Acceptable
SRMR	.059	$\leq$ .10	Acceptable
Chi-Squared	$p < .001$	$p > .05$	Not Acceptable
CMIN/df	2.583	$\leq$ 3	Acceptable

Note. RMSEA = Root Mean Squared Error of Approximation. CFI = Comparative Fit Index TLI = Tucker-Lewis Index. SRMR = Standardized Root Mean Squared Residual. CMIN/df = Minimum Discrepancy/degrees of freedom.

Direct effects. A SEM analysis of the proposed structural model showed a significant direct relationship between all the predicted variables (p <. 05), except for Goals. The variable Goals did not significantly predict Flow Experience ($p > .05$). However, the proposed paths of Challenge-Skill to Flow Experience ($\beta = .645$, $p < .001$), of Feedback to Flow Experience ($\beta = .285$, $p < .05$), and the paths from Flow Experience to Technology ($\beta = .847$, $p < .001$), Instructor ($\beta = .933$, $p < .001$), Interaction ($\beta = .925$, $p < .001$), Course ($\beta = .960$, $p < .001$), and Outcome ($\beta = .861$, $p < .001$), were all significant (Table 9).

Table 9

Coefficients of direct effects between the latent variables in the Structural Model

Hypothesized Paths	*b*	*SE b*	β	*p*
Challenge-Skills → Flow Experience	.853	.080	.645	< .001**
Feedback → Flow Experience	.308	.113	.285	.011*
Goals → Flow Experience	.009	.101	.008	.953
Flow Experience → Course	.803	.012	.960	< .001**
Flow Experience → Instructor	.707	.026	.933	< .001**
Flow Experience → Interaction	.954	.011	.925	< .001**
Flow Experience → Outcome	.689	.021	.861	< .001**
Flow Experience → Technology	.867	026	.847	< .001**

Note. SEM-analysis with Satorra-Bentler Standard Errors (Quasi-Maximum Likelihood Estimation). Significant relationships with $p < .05$* and $p < .001$**.

Indirect effects. When analysing the indirect effects (with a bootstrapped procedure) between the latent variables in the structural model, the results showed that Challenge-Skill has a significant indirect effect on Technology (β = .344), Course (β = .387), Interaction (β = .393), Instructor (β = .350), and Outcome (β = .373), in which the 95% confidence intervals (CIs) did not include zero (Table 10). In the same manner, there were also a significant indirect effect of Feedback on Technology (β = .235), Course (β = .272), Interaction (β = .277), Instructor (β = .247), and Outcome (β = .263). These effect sizes are considered relatively large (Field, 2013). However, no significant indirect effects were found of Goals on all the other endogenous variables.

Table 10

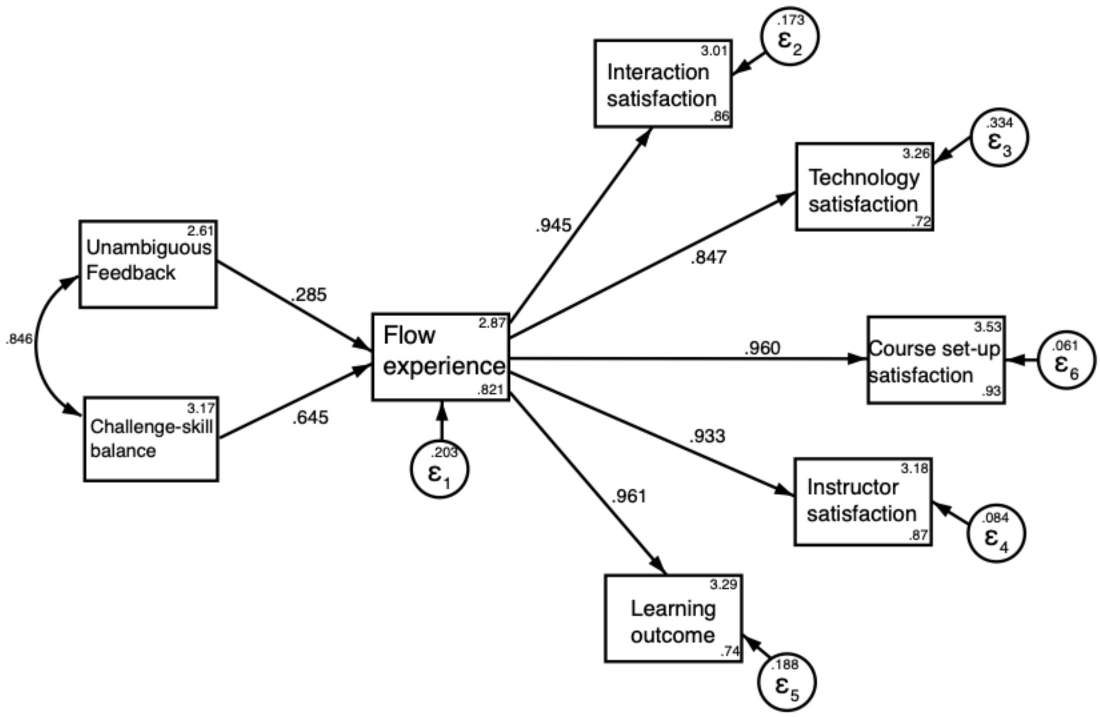
Significant coefficients of indirect effects in the Structural Model

Paths of indirect effects	β	Bootstrapped *SE*	Bootstrapped 95% *CI* Lower	Upper
Challenge-Skills → Flow Experience → Course	.387	.063	.306	.554
Challenge-Skills → Flow Experience → Instructor	.350	.050	.241	.436
Challenge-Skills → Flow Experience → Interaction	.393	.065	.334	.588
Challenge-Skills → Flow Experience → Outcome	.373	.058	.274	.501
Challenge-Skills → Flow Experience → Technology	.334	.051	.255	.455
Feedback→ Flow Experience → Course	.272	.055	.169	.386
Feedback → Flow Experience → Instructor	.247	.045	.131	.307
Feedback→ Flow Experience → Interaction	.277	.060	.180	.415
Feedback→ Flow Experience → Outcome	.263	.051	.151	.349
Feedback→ Flow Experience → Technology	.235	.048	.136	.323

Note. Mediation analysis with a bootstrapped procedure (1000 replications).

Figure 3.

The structural model with significant coefficients



Note. The path diagram shows associations between the latent variables. Coefficients on pointed arrows are standardized regression coefficients (β) of direct effects, values in rectangles are mean scores (top) and explained variance (bottom) for the particular variable, and ε is error variance associated with an endogenous variable.

Discussion

The objective of this current study was to investigate the relationship between several antecedents of flow (i.e. challenge-skill balance, unambiguous feedback, and clear goals), the flow experience itself, students' satisfaction with the instructor, course set-up, interaction, technology, and perceived learning outcome in a digital learning context. More specifically, this paper aimed to analyze whether unambiguous feedback, challenge-skill balance, and clear goals had an effect on flow experience, and whether flow experience had an effect on students' satisfaction with the instructor, course set-up, interaction, technology, and perceived learning outcome. This relationship was analyzed using a structural equation modeling approach. In the following section, the discussion will be divided into three parts. The first part will be an assessment of the findings from the analysis, the meaning of the results, and how these fit other findings in the existing literature. The second part will be dedicated to the limitations of this study. The final part will focus on implications and future research in this field.

Assessment of the findings

The bivariate zero-order correlation analyses showed that all variables had significant, positive correlations with each other, indicating that there is a relationship between the variables and that the relationships are pointing in the same direction (positive). This is a necessary preliminary step to examine whether the sign and size of the correlation coefficients match the theoretical empirical expectation (Kang & Anh, 2021), which they do in the present study. Although these preliminary correlation analyses can yield informative information about the relationship between the variables, it bears mentioning that correlation does not imply causality. In addition, a correlation analysis between two variables does not control for the influence of any other variables (Mehmetoglu & Jakobsen, 2017). When analyzing the structural model, the SEM analysis indicated that all the path coefficients were significant, except for the variable Goals (p >.05). This is contrary to the original flow theory, which emphasizes the importance of having clear goals in order to achieve flow (Csikszentmihalyi, 2008). While previous studies have shown that having clearly defined goals significantly contributed to flow experience (Guo & Ro, 2008), and that goal-directed activities promotes flow experiences more than experimental activities among web users (Novak et al., 2003), clear goals were not found to affect flow experience in the present study. This may call into question the importance of clear goals as an antecedent of flow.

A possible reason for this insignificant relationship between clear goals and flow experience may be related to how clear goals were measured. Three out of four items regarding clear goals were asking if the students had a feeling of what to do/achieve this semester. The questionnaire was distributed early in the semester (in October), at a time when it is natural that most students are yet to have defined clear goals for the semester. Ideally, the survey questionnaire should have been distributed at the end of the semester. On the other hand, if the questionnaire was distributed at the end of the semester, the students might have difficulties recalling past flow experiences accurately. Also, late data collection would affect the response rate due to exams, which are normally at the beginning of December/late November. However, the data collection was carried out until the beginning of November, which means that the questions regarding clear goals were relevant for most students. The most compelling explanation that clear goals did not affect flow experience might be due to the lack of settling clear subgoals in online courses. Most learning activities can be considered as long-term goal-directed (e.g. working towards an exam, project, assignment, etc.) where students' goals are often defined by the ending results (e.g. getting good grades, finishing the project, passing tests and assignments), which is solely an overall goal. As Csikszentmihalyi (2008) pointed out, having many subgoals (i.e. short-term), as well as an overall goal (i.e. long-term), that are realistically achievable will help students narrow down their focus and help students achieve concentration. As such, the online course environment must be organized in such a way that the students know what should be done, how to do it, and why they are doing it.

Although clear goals did not significantly predict flow experience, the present study found that a balance between challenge and skill ($\beta = .645$, $p < .001$), and unambiguous feedback ($\beta = .285$, $p < .05$), had a significant direct effect on students' experience of flow. These findings are in line with previous research (Fong et al., 2014; Guo & Ro, 2008; Keller & Bless, 2008; Wu et al., 2021), which imply the importance of challenge-skill balance and unambiguous feedback as antecedents of flow experience. The results can be interpreted as the more students perceive there is a balance between challenge and skill, the more they experience flow (having controlled for unambiguous feedback). By the same token, the more students perceive unambiguous feedback, the more they experience flow (when controlling for challenge-skill balance).

Furthermore, there were significant, direct paths between Flow experience and students' satisfaction with the technology ($\beta = .847$, $p < .001$), instructor ($\beta = .933$, $p < .001$), interaction ($\beta = .925$, $p < .001$), course set-up ($\beta = .960$, $p < .001$), and learning outcome ($\beta = .861$, $p < .001$). These findings support the idea that flow experience is related to students satisfaction and learning outcome, which was found in previous research (Rossin et al., 2009; Lee & Choi, 2013; Shin, 2006; Xao & Li, 2021). When analysing indirect effects (using a bootstrap method) within the structural model, the results showed that challenge-skill balance (via Flow Experience) had an indirect effect on Technology ($\beta = .344$), Course ($\beta = .387$), Interaction ($\beta = .393$), Instructor ($\beta = .350$), and Outcome ($\beta = .373$). Furthermore, there was also a significant indirect effect of Feedback (via Flow Experience) on Technology ($\beta = .235$), Course ($\beta = .272$), Interaction ($\beta = .277$), Instructor ($\beta = .247$), and Outcome ($\beta = .263$). All indirect effects sizes are considered as large (>. 25), except for the indirect effect of Feedback on Instructor and Feedback on Technology, which are medium (Kenny, 2021). Challenge-skill balance seems to be the variable with the highest effect sizes (both direct and indirect), suggesting that having a balance between challenge and skill is an important precondition in order to achieve the flow experience and satisfaction in online learning.

Even though the present study found significant direct and indirect effects in the structural model, the results should be interpreted with caution based on a moderately unsound model fit. As previously mentioned, some of the fit indices from the hypothesized measurement model and structural model were not within the recommended thresholds (i.e. CFI, TLI, and Chi-Square), while other fit indices had an acceptable value (i.e. RAMSEA, SRMR, and CMIN/df). One might ask why to follow these recommended thresholds, which are found to be insufficient in the present study, and still continue to use the hypothesized model in further analyses. Although fit indices can provide helpful information to assess the fit of the measurement and structural model, researchers cannot solely rely on a binary decision of a model fit (i.e. good/bad fit) based on fit indices. Simulation studies have shown that proper cut-off values can be changed when loadings and sample sizes are manipulated (Sharma, Mukherjee, Kumar & Dillon, 2005), suggesting that these index cut-offs are unreliable. In addition, the fit indices measure an average fit of the overall model, which means the researcher cannot assess the fit of individual parts of the model (Stone, 2021). Therefore, researchers may not solely rely on fit indices to determine a model's fit, but should also use theory and logic to assess which model fits better (Stone, 2021). According to Kang and Anh (2021), a poorly fitting model occurs commonly when the model is too simple to properly represent the data structure. One way to resolve this problem is to relax the constraints on the model by adding path covariances (Mehmetoglu & Jakobsen, 2017). In the present study, when freeing the covariance between one pair of correlated error terms (flow_cons4 and flow_cons3), the modification indices revealed no obvious amendments to the measurement model. The modification indices (CFI and TLI) were still below the cut-off values, and the Chi-Square value was still statistically significant. Hence, there was no need for a modified model. However, the purpose of the SEM analysis is to verify the proposed hypothetical theory, and not to increase the model fit. Any attempts to simply increase the goodness-of-fit may lead to an incorrect model setting, and as a consequence, the model will not properly reflect reality (Kanh & Anh, 2021). A model that has a strong justified theory, but fits the data poorly, may as well be as valid as a model that fits the data well, but has weak theoretical support (Stone, 2021). In such cases, researchers should not slavishly follow the fit indices, but use them as a guide to assess the model.

The coefficient of determination (R^2) is the amount of explained variation of one endogenous construct that can be caused by its relationship to all of the exogenous constructs

(Hair et al., 2017). In further SEM analysis, the results revealed that the overall R^2 (.890) and individual R^2 for Course (R^2 = .923), Flow Experience (R^2 = .821), Instructor (R^2 = .871), Interaction (R^2 = .856), Outcome (R^2 = .741), and Technology (R^2 = .719) are all high values (Field, 2013; Mehmetoglu & Jakobsen, 2017). This indicates high levels of the model's predictive power (Hair et al., 2017). However, problems with interpreting high R^2 often arise when the number of independent variables increases, regardless of the relevance and usefulness of the variables (Mehmetoglu & Jakobsen, 2017). This means that the more paths pointing toward a target construct, the higher its R^2 value. One way to avoid potential bias toward relatively complex models is using a corrected version, namely adjusted R^2 (Mehmetoglu & Jakobsen, 2017). Knowing this in hindsight, the adjusted coefficient of determination should be used in the present study. Although there are no thumb rules on how many arrows are acceptable to point at one construct, the present study hypothesized only three independent variables (feedback, goals, challenge-skill) pointing at one dependent variable (flow experience).

Although the HTMT values showed sufficient discriminant validity between the latent variables, the traditional method of assessing discriminant validity (i.e. comparing AVE with SC between the latent variables), indicated a lack of discriminant validity. This problem is related to the presence of multicollinearity, in which the correlation coefficients between the latent variables were found to be high (see Table 4). Insufficient discriminant validity may suggest that the measures used in the same model are not reflecting conceptually distinct constructs. For example, there could be conceptual similarities between instructor satisfaction and unambiguous feedback, as they both contain evaluations of instructors' presence and availability. Similarities between instructor satisfaction and interaction satisfaction can also exist, as both constructs measure the quality of communication. Several approaches can be used to treat discriminant validity problems, such as merging constructs into one overall measure, removal of items that cross-load on more than one latent variable, or dropping one (or more) variable that demonstrates insufficient discriminant validity (Hair et al., 2017). As dropping one (or more) variable seems to be a good idea, it can lead to specification error if the variable really belongs to the model. Likewise, the elimination of items can adverse consequences for the content validity of the construct, and combining the construct into one overall measure will reduce the complexity of the concept. In such cases, the best thing would be to simply acknowledge the presence of multicollinearity and discriminant validity problems, and be aware of its consequences when interpreting the results.

An instance worth mentioning from the result section is when individual item reliabilities were assessed based on standardized factor loadings (i.e. construct reliability), all the four items that contained questions about the feeling of time distortion had markedly low loadings on the construct Flow Experience (see the Appendix). Interestingly, these items also seemed troublesome in previous studies, in which they have yielded low factor loadings (Jackson & Marsh, 1996; Marsh & Jackson, 1999), as well as nonnormal distribution and low factor reliability (Chan & Ahern, 1999) when measuring the subdimension time transformation. Therefore, these items were removed from this present study. The tendency of low factor loadings of the individual time-transformation items on the Flow experience construct may be due to the concept of time transformation. As time transformation is related to the unusual perception of time passing quickly (or sometimes slowly) in a flow state (Csikszentmihalyi, 1975/2000), the concept is somewhat of a strange paradox where time seems to stand still and yet seems to be over in an instant. On a practical level, failures in factor loadings were expected in the present study. Some have even argued that the literature needs a common conceptual framework for studying subjective time, in which researchers must differentiate between conscious and unconscious mental representations (Thönes & Stocker, 2019). For example, according to Thönes and Stocker (2019), subjective time should be divided into two relatively distinct aspects; 1) temporal processing (primary unconscious processes), and 2) time perception (more conscious processes). The first aspect contains the processing of temporal information about order and simultaneity of events, and the latter aspect consists of time passage (speed of time and location of events) and time duration (the feeling of time being extended) (Thönes & Stocker, 2019). Therefore, subjective perception of time transformation can be a complex phenomenon. The concept behind time transformation is therefore questionable when measuring the flow experience, and an evaluation of the concept needs further research.

Limitations

In most studies that investigate flow experience in distance learning (i.e. a digital learning context), the participants have voluntarily signed up for online classes. In the present study, the data collection was conducted during the Covid-19 pandemic, at a time when the Norwegian government decided to continue with national restrictions and regulations in situations that involve social contact. As a consequence, nearly all lectures were held online. Needless to say, the participants in this study are students whom involuntary participated in digital lectures. This involuntary online learning may have impacted how the students answer the questions. Therefore, the generalizability of the results may come into question as the results might not be broadly applicable to all distance learners.

Another possible limitation regarding the present study is that the national restrictions and regulations due to the pandemic were not held constantly throughout the autumn semester of 2021. During data collection, some regions in Norway had their local regulations, in which the mayors had the mandate to further ease the restrictions. Accordingly, some universities in Norway reopened the classrooms and auditoriums where the lectures were held physically. However, many universities and faculties continued with full online lectures, or a hybrid version of it. The present study did not control for students who fully or partly participated in online classes. This could potentially affect how participants answer the questions regarding flow and satisfaction in online learning. However, at the beginning of each section of the questionnaire, the respondents were instructed to recall past experiences (flow and satisfaction) concerning digital lectures. Therefore, we give the respondents the benefit of the doubt, and assume that they answered the questions based on experiences with full online learning and not experiences with hybrid online learning.

All the questions from the survey contained positive experiences (i.e. flow and satisfaction). This study might have given a one-sided presentation of students' experiences in digital learning, as previously mentioned, these students did not voluntarily participate in digital learning and the restrictions were constantly shifting from month to month, from region to region. This sudden shift and uncertainty revolving around online learning may have affected how the students experience online learning. New studies have shown several concerns among Norwegian students, such as lack of social interaction, problems with the home office, technical challenges, and reduced motivation and effort due to the closure of campus during the pandemic (Almendingen et al., 2021). Others have found that nursing students in the Philippines considered having online learning during the Covid-19 outbreak to be stressful and had low satisfaction with online learning (Oducado & Estoque, 2021). Likewise, more than half of the students report that they prefer to turn off their camera during online learning because of anxiety (fear of being exposed, shame, shyness), desire to ensure privacy, and the possibility of other people walking into the background (Gherhes, Simon, & Para, 2021). In order to fully understand students' experiences in online learning, it is also important to investigate the other side of the coin. Therefore, the questionnaire in the present study also contained two open-ended questions about students' perceptions of the advantages and disadvantages of online learning (see Appendix). However, these answers were not part of the main analysis. The purpose of this study was to investigate antecedents of flow, the flow experience, and the consequences of being in flow in a digital learning context, as previous studies have shown that people experience flow when they are playing digital learning games (Chang et al., 2018; Hsu & Lu, 2004), are present in three-dimensional virtual learning environments (Doğan et al., 2021), using web-based learning platforms (Choi et al., 2007), video-based learning (Wang et al., 2021), and in distance learning (Liao, 2006). Since the findings in the present study were supported by previous findings in the field, this gives the results a better foothold.

Implications and future research

This research contributes to the understanding of learners' engagement (i.e. flow experience), preconditions that facilitate engagement (unambiguous feedback, challenge-skill balance), satisfaction (technology, instructor, course set-up, interaction, and technology), and perceived learning outcome in education. Knowledge about what facilitates students' flow, satisfaction, and learning outcome in a digital learning context can be used to explain important aspects of learning, human optimal experience, as well as the usage and productivity of technologies in education. Thus, this study can provide an important supplement to more traditional learning environments, such as learning face-to-face in classrooms.

Although previous research provided evidence of flow in a digital learning context, all the antecedents of flow have not been fully investigated. In order to fill this gap, the present study tries to test the flow model as originally formulated with challenge-skill balance, unambiguous feedback, and clear goals as antecedents of flow, while incorporating students' satisfaction variables. The results from this study highlight the important role of the proposed preconditions. In the future, the importance of flow's antecedents needs to be further investigated, especially the role of clear goals as this study did not find a significant effect of clear goals on flow experience, but a correlation between them was present.

In this study, all four items measuring time transformation were not included because the individual factor loadings were eminently low. As discussed earlier, the items measuring the concept of time transformation may be too simple as the perception of time can be quite complex. More attention to how this concept can be measured must be included in future research on flow.

In many cases, it would be appropriate to maintain the same learning goals for an online course as in a traditional course (face-to-face). For example, in most social science/business/computer software courses the content of the subjects is more theoretical, which makes it easier to transfer the same learning goals to online learning. However, in other disciplines, such as nursing/dentistry/medicine/chemistry, some aspects of education will very much depend on the type of course. Although some of the learning goals can be achieved online, it can be difficult or expensive to be practical. As the participants from the present study came from a variety of disciplines, their experiences with the online course may widely differ. A future replication study with a specific group of students engaged in one unit of the course will be able to control for the effect of subject matter when examining flow experiences and satisfaction in an online learning context.

Also, examining different types of online learning methods can be helpful for instructors to understand what type of method works better for the students in order to experience flow, satisfaction, and learning. For example, in Jayaratne and Moore's (2017) study they found that students preferred instructional activities (i.e. videos, PowerPoint with recorded narratives, quizzes, live video recordings, audios, case studies, reading materials, and hands-on projects) for online learning, but were not enthusiastic about discussion boards and forums. How these learning methods can provide flow is uncertain, and deserves more attention in future research.

Online education and traditional education (face-to-face classroom) share many qualities, in which the students are still required to attend class, learn the material, and submit assignments. Even though traditional classroom learning is the most typical pedagogical manner, very little research has been done to investigate online learning. In future research, a comparison between flow in fully online learning, hybrid learning (traditional and online), and traditional classroom learning (face-to-face) could be an interesting angle to fully understand the effectiveness of using online learning.

Conclusion

This study aimed to investigate how antecedents of flow (challenge skill balance, unambiguous feedback, and clear goals) affect students' flow experience in online learning, and how the flow experience itself is associated with students' satisfaction with the instructor, course set-up, interaction, technology, and perceived learning outcome. There are limitations in our proposed model (e.g. fit indices, time-items) and practical limitations with this study (e.g. generalisability). Much work remains to be done in this field to more fully understand the complexities of flow's role in online learning. Despite the limitations, this present study found that a balance between challenge and skill and unambiguous feedback were important antecedents of flow, with the former being the most important. The present study also found that the more the students experience flow, the more they are satisfied with the instructor, course set-up, interaction, technology, and perceived learning outcome. All this taken together, we can conclude that students, on average, experience flow in online learning when there is a balance between challenge and skill and unambiguous feedback, and that the experience itself affects students' satisfaction and perceived learning outcome.

References

Abuhamdeh, S. (2020). Investigating the "flow" experience: Key conceptual and operational issues. *Frontiers in psychology*, 158. doi: 10.3389/fpsyg.2020.00158

Abuhamdeh, S., & Csikszentmihalyi, M. (2009). Intrinsic and extrinsic motivational orientations in the competitive context: An examination of person-situation interactions. *Journal of personality*, *77*(5), 1615-1635. doi: 10.1111/j.1467-6494.2009.00594.x

Almendingen, K., Morseth, M. S., Gjølstad, E., Brevik, A., & Tørris, C. (2021). Student's experiences with online teaching following COVID-19 lockdown: A mixed-methods explorative study. *PloS one*, *16*(8), e0250378. doi: 10.1371/journal.pone.0250378

Anderson, J. C., & Gerbing, D. W. (1988). Structural equation modeling in practice: A review and recommended two-step approach. *Psychological Bulletin*, *103*(3), 411. doi: 10.1037/0033-2909.103.3.411

Bakker, A. B. (2005). Flow among music teachers and their students: The crossover of peak experiences. *Journal of vocational behavior*, *66*(1), 26-44. doi: 10.1016/j.jvb.2003.11.001

Bakker, A. B., Oerlemans, W., Demerouti, E., Slot, B. B., & Ali, D. K. (2011). Flow and performance: A study among talented Dutch soccer players. *Psychology of Sport and Exercise*, *12*(4), 442-450. doi: 10.1016/j.psychsport.2011.02.003

Bakker, A. B., & van Woerkom, M. (2017). Flow at work: A self-determination perspective. *Occupational Health Science*, *1*(1), 47-65. doi: 10.1007/s41542-017-0003-3

Barrett, T. (2010). The problem-based learning process as finding and being in flow. *Innovations in Education and Teaching International*, *47*(2), 165-174. doi: 10.1080/14703291003718901

Bolliger, D. U., & Halupa, C. (2012). Student perceptions of satisfaction and anxiety in an online doctoral program. *Distance Education*, *33*(1), 81-98. doi: 10.1080/01587919.2012.667961

Bolliger, D. U., & Martindale, T. (2004). Key factors for determining student satisfaction in online courses. *International Journal on E-learning*, *3*(1), 61-67.

Boniface, M. R. (2000). Towards an understanding of flow and other positive experience phenomena within outdoor and adventurous activities. *Journal of Adventure Education & Outdoor Learning*, *1*(1), 55-68. doi: 10.1080/14729670085200071

Ceja, L., & Navarro, J. (2011). Dynamic patterns of flow in the workplace: Characterizing within-individual variability using a complexity science approach. *Journal of Organizational Behavior*, *32*(4), 627-651. doi: 10.1002/job.747

Chan, T. S., & Ahern, T. C. (1999). Targeting motivation—adapting flow theory to instructional design. *Journal of Educational computing research*, *21*(2), 151-163. doi: 10.2190/UJ04-T5YB-YFXE-0BG2

Chang, C. C., Warden, C. A., Liang, C., & Lin, G. Y. (2018). Effects of digital game-based learning on achievement, flow, and overall cognitive load. *Australasian Journal of Educational Technology*, *34*(4). doi: 10.14742/ajet.2961

Chen, H., Wigand, R. T., & Nilan, M. (2000). Exploring web users' optimal flow experiences. *Information Technology & People*. doi: 10.1108/09593840010359473

Choi, D. H., Kim, J., & Kim, S. H. (2007). ERP training with a web-based electronic learning system: The flow theory perspective. *International Journal of Human-Computer Studies*, *65*(3), 223-243. doi: 10.1016/j.ijhcs.2006.10.002

Clarke, S. G., & Haworth, J. T. (1994). 'Flow'experience in the daily lives of sixth-form college students. *British Journal of Psychology*, *85*(4), 511-523. doi: 10.1111/j.2044-8295.1994.tb02538.x

Csikszentmihalyi, M. (1975/2000). *Beyond Boredom and Anxiety: Experiencing Flow in Work and Play (2nd ed.)*. Jossey Bass.

Csikzentmihaly, M. (1990). *Flow: The psychology of optimal experience* (Vol. 1990). Harper & Row.

Csikszentmihalyi, M. (2000). The contribution of flow to positive psychology. In Gillham J. E (Ed.), *The science of optimism and hope: Research essays in honor of Martin E. P. Seligman* (pp.387-395). Templeton Foundation Press.

Csikszentmihalyi, M. (2008). *Flow: The Psychology of Optimal Experience*. Harper Perennial.

Csikszentmihalyi, M. (2014). *Applications of flow in human development and education*. Springer.

Csikszentmihalyi, M., & Bennett, S. (1971). An exploratory model of play. *American anthropologist*, *73*(1), 45-58. doi: 10.1525/aa.1971.73.1.02a00040

Direktoratet for høyere utdanning og kompetanse. (2012). *Registrerte studenter (enkeltår)*. Database for statistikk og høyere utdanning. Retrieved April 25, 2022, from https://dbh.hkdir.no/tall-og-statistikk/statistikk-meny/studenter/statistikk-side/3.1?visningId=124&visKode=false&admdebug=false&columns=arstall&index=1&formel=222&hier=insttype!9!instkode!9!fakkode!9!ufakkode!9!progkode&sti=&p

aram=arstall%3D2012!9!semester%3D3!9!dep_id%3D1!9!organisering%3D3!9!kategori%3DS!9!nivakode%3DB3!8!B4!8!HK!8!YU!8!AR!8!LN!8!M2!8!ME!8!MX!8!HN!8!M5!8!PR

Direktoratet for høyere utdanning og kompetanse. (2018). *Registrerte studenter (enkeltår)*. Database for statistikk og høyere utdanning. Retrieved April 25th, 2022, from https://dbh.hkdir.no/tall-og-statistikk/statistikk-meny/studenter/statistikk-side/3.1?visningId=124&visKode=false&admdebug=false&columns=arstall&index=1&formel=222&hier=insttype!9!instkode!9!fakkode!9!ufakkode!9!progkode&sti=&param=nivakode%3DB3!8!B4!8!HK!8!YU!8!AR!8!LN!8!M2!8!ME!8!MX!8!HN!8!M5!8!PR!9!arstall%3D2018!9!organisering%3D3!9!dep_id%3D1!9!kategori%3DS!9!semester%3D3

Doğan, D., Demir, Ö., & Tüzün, H. (2021). Exploring the role of situational flow experience in learning through design in 3D multi-user virtual environments. *International Journal of Technology and Design Education*, 1-21. doi: 10.1007/s10798-021-09680-8

Egbert, J. (2004). A study of flow theory in the foreign language classroom. *Canadian modern language review*, *60*(5), 549-586. doi: 10.3138/cmlr.60.5.549

Ellis, G. D., Voelkl, J. E., & Morris, C. (1994). Measurement and analysis issues with explanation of variance in daily experience using the flow model. *Journal of leisure research*, *26*(4), 337-356. doi: 10.1080/00222216.1994.11969966

Engeser, S., & Rheinberg, F. (2008). Flow, performance, and moderators of challenge-skill balance. *Motivation and Emotion*, *32*(3), 158-172. doi: 10.1007/s11031-008-9102-4

Eom, S. B., & Ashill, N. (2016). The determinants of students' perceived learning outcomes and satisfaction in university online education: An update. *Decision Sciences Journal of Innovative Education*, *14*(2), 185-215. doi: 10.1111/dsji.12097

European University Association. (September, 2020). Briefing European higher education in the Covid-19 crisis. Retrieved from https://eua.eu/downloads/publications/briefing_european%20higher%20education%20in%20the%20covid-19%20crisis.pdf

Field, A. (2013). Discovering statistics using IBM SPSS statistics: and sex and drugs and rock 'n' roll (4th ed.). SAGE.

Fong, C. J., Zaleski, D. J., & Leach, J. K. (2015). The challenge–skill balance and antecedents of flow: A meta-analytic investigation. *The Journal of Positive Psychology*, *10*(5), 425-446. doi: 10.1080/17439760.2014.967799

Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of marketing research*, *18*(1), 39-50. doi: 10.1177/002224378101800104

Fournier, J., Gaudreau, P., Demontrond-Behr, P., Visioli, J., Forest, J., & Jackson, S. (2007). French translation of the Flow State Scale-2: Factor structure, cross-cultural invariance, and associations with goal attainment. *Psychology of sport and exercise*, *8*(6), 897-916. doi: 10.1016/j.psychsport.2006.07.007

Gefen, D., Straub, D., & Boudreau, M. C. (2000). Structural equation modeling and regression: Guidelines for research practice. *Communications of the association for information systems*, *4*(1), 7. doi: 10.17705/1CAIS.00407

Geier, M. T. (2021). Students' expectations and students' satisfaction: The mediating role of excellent teacher behaviors. *Teaching of Psychology*, *48*(1), 9-17. doi: 10.1177/0098628320959923

Gherheș, V., Șimon, S., & Para, I. (2021). Analysing students' reasons for keeping their webcams on or off during online classes. *Sustainability*, *13*(6), 3203. doi: 10.3390/su13063203

Guo, J., Liu, Z., & Liu, Y. (2016). Key success factors for the launch of government social media platform: Identifying the formation mechanism of continuance intention. *Computers in Human Behavior*, *55*, 750-763. doi: 10.1016/j.chb.2015.10.004

Guo, Y. M., & Poole, M. S. (2009). Antecedents of flow in online shopping: a test of alternative models. *Information Systems Journal*, *19*(4), 369-390. doi: 10.1111/j.1365-2575.2007.00292.x

Guo, Y. M., & Ro, Y. K. (2008). Capturing flow in the business classroom. *Decision Sciences Journal of Innovative Education*, *6*(2), 437-462. doi: 10.1111/j.1540-4609.2008.00185.x

Hachey, A. C., Wladis, C. W., & Conway, K. M. (2014). Do prior online course outcomes provide more information than GPA alone in predicting subsequent online course grades and retention? An observational study at an urban community college. *Computers & Education*, *72*, 59-67. doi: 10.1016/j.compedu.2013.10.012

Hair Jr, J. F., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2017). *A primer on partial least squares structural equation modeling (PLS-SEM)* (2nd ed.). Sage Publications Inc.

Hamari, J., & Koivisto, J. (2014). Measuring flow in gamification: Dispositional flow scale-2. *Computers in Human Behavior*, *40*, 133-143. doi: 10.1016/j.chb.2014.07.048

Harsasi, M., & Sutawijaya, A. (2018). Determinants of student satisfaction in online tutorial: A study of a distance education institution. *Turkish Online Journal of Distance Education*, *19*(1), 89-99. doi: 10.17718/tojde.382732

Hayes, A. F. (2009). Beyond Baron and Kenny: Statistical mediation analysis in the new millennium. *Communication Monographs*, *76*(4), 408-420. doi: 10.1080/03637750903310360

Henseler, J. (2022). *HTMT Online Calculator*. Henseler. Retrieved February 5 th, 2022 from http://www.henseler.com/htmt.html

Henseler, J., Ringle, C. M., & Sarstedt, M. (2015). A new criterion for assessing discriminant validity in variance-based structural equation modeling. *Journal of the academy of marketing science*, *43*(1), 115-135. doi: 10.1007/s11747-014-0403-8

Hsu, C. L., & Lu, H. P. (2004). Why do people play online games? An extended TAM with social influences and flow experience. *Information & management*, *41*(7), 853-868. doi: 10.1016/j.im.2003.08.014

Jackson, S. A., & Eklund, R. C. (2002). Assessing flow in physical activity: The flow state scale–2 and dispositional flow scale–2. *Journal of Sport and Exercise Psychology*, *24*(2), 133-150. doi: 10.1123/jsep.24.2.133

Jackson, S. A., & Marsh, H. W. (1996). Development and validation of a scale to measure optimal experience: The Flow State Scale. *Journal of sport and exercise psychology*, *18*(1), 17-35. doi: 10.1123/jsep.18.1.17

Jayaratne, K. S. U., & Moore, G. (2017). Perceptions of College Students toward Online Classes: Implications for Teaching Online. *NACTA Journal*, *61*(4), 304–309.

Johnson, R. D., Hornik, S., & Salas, E. (2008). An empirical examination of factors contributing to the creation of successful e-learning environments. *International Journal of Human-computer studies*, *66*(5), 356-369. doi: 10.1016/j.ijhcs.2007.11.003

Kaiser, H. F., & Rice, J. (1974). Little jiffy, mark IV. *Educational and psychological measurement*, *34*(1), 111-117. doi: 10.1177/001316447403400115

Kang, H., & Ahn, J. W. (2021). Model Setting and Interpretation of Results in Research Using Structural Equation Modeling: A Checklist with Guiding Questions for Reporting. *Asian Nursing Research*, *15*(3), 157-162. doi: 10.1016/j.anr.2021.06.001

Keller, J., & Bless, H. (2008). Flow and regulatory compatibility: An experimental approach to the flow model of intrinsic motivation. *Personality and social psychology bulletin*, *34*(2), 196-209. doi: 10.1177/0146167207310026

Keller, J., & Landhäußer, A. (2012). The flow model revisited. In S. Engeser (Ed.), *Advances* *in flow research*(pp. 51–64). Springer. doi: 10.1007/978-1-4614-2359-1_3

Kenny, D. A. (2021). *MEDIATION*. Retrieved April 25th, 2022, from https://davidakenny.net/cm/mediate.htm

Kim, D., & Ko, Y. J. (2019). The impact of virtual reality (VR) technology on sport spectators' flow experience and satisfaction. *Computers in human behavior*, *93*, 346-356. doi: 10.1016/j.chb.2018.12.040

Kumar, S., & Kumar, S. (2015). Structure equation modeling basic assumptions and concepts: A novice's guide. *Asian Journal of Management Sciences*, *3*(07), 25-28.

Lee, Y., & Choi, J. (2013). A structural equation model of predictors of online learning retention. *The Internet and Higher Education*, *16*, 36-42. doi: 10.1016/j.iheduc.2012.01.005

Liao, L. F. (2006). A flow theory perspective on learner motivation and behavior in distance education. *Distance Education*, *27*(1), 45-62. doi: 10.1080/01587910600653215

Løvoll, H. S., & Vittersø, J. (2014). Can balance be boring? A critique of the "challenges should match skills" hypotheses in flow theory. *Social indicators research*, *115*(1), 117-136. doi: 10.1007/s11205-012-0211-9

Marsh, H. W., & Jackson, S. A. (1999). Flow experience in sport: Construct validation of multidimensional, hierarchical state and trait responses. *Structural Equation Modeling: A Multidisciplinary Journal*, *6*(4), 343-371. doi: 10.1080/10705519909540140

Mehmetoglu, M., Jakobsen, T. G. (2017). *Applied Statistics using STATA: A Guide for the Social Sciences*. SAGE Publications.

Mills, M. J., & Fullagar, C. J. (2008). Motivation and flow: Toward an understanding of the dynamics of the relation in architecture students. *The Journal of Psychology*, *142*(5), 533-556. doi: 10.3200/JRLP.142.5.533-556

Moneta, G. B., & Csikszentmihalyi, M. (1996). The effect of perceived challenges and skills on the quality of subjective experience. *Journal of personality*, *64*(2), 275-310. doi: 10.1111/j.1467-6494.1996.tb00512.x

Moneta, G. B., & Csikszentmihalyi, M. (1999). Models of concentration in natural environments: A comparative approach based on streams of experiential data. *Social Behavior and Personality: an international journal*, *27*(6), 603-637. doi: 10.2224/sbp.1999.27.6.603

Moore, J. L., Dickson-Deane, C., & Galyen, K. (2011). e-Learning, online learning, and distance learning environments: Are they the same?. *The Internet and higher education*, *14*(2), 129-135. doi: 10.1016/j.iheduc.2010.10.001

McQuillan, J., & Conde, G. (1996). The conditions of flow in reading: Two studies of optimal experience. *Reading Psychology: An International Quarterly*, *17*(2), 109-135. doi: 10.1080/0270271960170201

Nah, F. F. H., Eschenbrenner, B., & DeWester, D. (2011). Enhancing brand equity through flow and telepresence: A comparison of 2D and 3D virtual worlds. *MIs Quarterly*, 731-747. doi: 10.2307/23042806

Nakamura, J., & Csikszentmihalyi, M. (2002). The concept of flow. In C. R. Snyder & S. J. Lopez (Eds.), *Handbook of positive psychology* (pp. 89-206). Oxford University Press. doi: 10.1093/oxfordhb/9780195187243.013.0018

National Center for Educational Statistics. (2013). *Number and percentage distribution of students enrolled at Title IV institutions, by controlling for institution, students level, level of institution, distance education status of student, and distance education status of institution: Unites States, fall 2013.* Retrieved April 25th, 2022, from https://nces.ed.gov/ipeds/search/ViewTable?tableId=11964&returnUrl=%2Fipeds%2Fsearch%2FView%3FresultType%3Dtable%26page%3D1%26sortBy%3Drelevance%26surveyComponents%3DFall%2520Enrollment%2520%28EF%29%26surveyComponents%3DFinance%2520%28F%29%26surveyComponents%3DAcademic%2520Libraries%2520%28AL%29%26surveyComponents%3DHuman%2520Resources%2520%28HR%29%26collectionYears%3D2018-19%26sources%3DTables%2BLibrary%26sc-source%3Dspring

National Center for Educational Statistics. (2018). *Number and percentage distribution of students enrolled at Title IV institutions, by controlling for institution, students level, level of institution, distance education status of student, and distance education status of institution: Unites States, fall 2018.* Retrieved April 25th, 2022, from https://nces.ed.gov/ipeds/search/ViewTable?tableId=26394&returnUrl=%2Fipeds%2Fsearch%2FView%3FresultType%3Dtable%26page%3D1%26sortBy%3Drelevance%26surveyComponents%3DFall%2520Enrollment%2520%28EF%29%26surveyComponents%3DFinance%2520%28F%29%26surveyComponents%3DAcademic%2520Libraries%2520%28AL%29%26surveyComponents%3DHuman%2520Resources%2520%28HR%29%26collectionYears%3D2018-19%26sources%3DTables%2BLibrary%26sc-source%3Dspring

Novak, T. P., Hoffman, D. L., & Duhachek, A. (2003). The influence of goal-directed and experiential activities on online flow experiences. *Journal of consumer psychology*, *13*(1-2), 3-16. doi: 10.1207/S15327663JCP13-1&2_13

Novak, T. P., Hoffman, D. L., & Yung, Y. F. (2000). Measuring the customer experience in online environments: A structural modeling approach. *Marketing Science*, *19*(1), 22-42. doi: 10.1287/mksc.19.1.22.15184

Oducado, R. M., & Estoque, H. (2021). Online learning in nursing education during the COVID-19 pandemic: Stress, satisfaction, and academic performance. *Journal of Nursing Practice*, *4*(2), 143-153. doi: 10.30994/jnp.v4i2.128

Price, B. A., & Randall, C. H. (2008). Assessing learning outcomes in quantitative courses: Using embedded questions for direct assessment. *Journal of Education for Business*, *83*(5), 288-294. doi: 10.3200/JOEB.83.5.288-294

Quinn, R. W. (2005). Flow in knowledge work: High performance experience in the design of national security technology. *Administrative science quarterly*, *50*(4), 610-641. doi: 10.2189/asqu.50.4.610

Raykov, T. (2009). Evaluation of scale reliability for unidimensional measures using latent variable modeling. *Measurement and Evaluation in Counseling and Development*, *42*(3), 223-232. doi: 10.1177/0748175609344096

Rheinberg, F., & Engeser, S. (2018). Intrinsic motivation and flow. In Heckhausen, J., Heckhausen H. (eds), *Motivation and action* (pp. 579-622). Springer, Cham. doi: 10.1007/978-3-319-65094-4_14

Riva, E. F., Riva, G., Talò, C., Boffi, M., Rainisio, N., Pola, L., ... & Inghilleri, P. (2017). Measuring dispositional flow: validity and reliability of the dispositional flow state scale 2, Italian version. *PloS one*, *12*(9), e0182201. doi: 10.1371/journal.pone.0182201

Rogatko, T. P. (2009). The influence of flow on positive affect in college students. *Journal of happiness studies*, *10*(2), 133-148. doi: 10.1007/s10902-007-9069-y

Rönkkö, M., & Evermann, J. (2013). A critical examination of common beliefs about partial least squares path modeling. *Organizational Research Methods*, *16*(3), 425-448. doi: 10.1177/1094428112474693

Rossin, D., Ro, Y. K., Klein, B. D., & Guo, Y. M. (2009). The effects of flow on learning outcomes in an online information management cou. *Journal of information systems education*, *20*(1), 87-98.

Salanova, M., Bakker, A. B., & Llorens, S. (2006). Flow at work: Evidence for an upward spiral of personal and organizational resources. *Journal of Happiness studies*, *7*(1), 1-22. doi: 10.1007/s10902-005-8854-8

Sebastianelli, R., Swift, C., & Tamimi, N. (2015). Factors affecting perceived learning, satisfaction, and quality in the online MBA: A structural equation modeling approach. *Journal of Education for Business*, *90*(6), 296-305. doi: 10.1080/08832323.2015.1038979

Sumaya, I. C., & Darling, E. (2018). Procrastination, flow, and academic performance in real time using the experience sampling method. *The Journal of Genetic Psychology*, *179*(3), 123-131. doi: 10.1080/00221325.2018.1449097

Sharma, S., Mukherjee, S., Kumar, A., & Dillon, W. R. (2005). A simulation study to investigate the use of cutoff values for assessing model fit in covariance structure models. *Journal of Business Research*, *58*(7), 935-943. doi: 10.1016/j.jbusres.2003.10.007

Shernoff, D. J., Csikszentmihalyi, M., Schneider, B., & Shernoff, E. S. (2014). Student engagement in high school classrooms from the perspective of flow theory. In Csikszentmihalyi, M. *Applications of flow in human development and education* (pp. 475-494). Springer. doi: 10.1007/978-94-017-9094-9_24

Shernoff, D. J., Kelly, S., Tonks, S. M., Anderson, B., Cavanagh, R. F., Sinha, S., & Abdi, B. (2016). Student engagement as a function of environmental complexity in high school classrooms. *Learning and Instruction*, *43*, 52-60. doi: 10.1016/j.learninstruc.2015.12.003

Shin, N. (2006). Online learner's 'flow'experience: an empirical study. *British Journal of Educational Technology*, *37*(5), 705-720. doi: 10.1111/j.1467-8535.2006.00641.x

Šimleša, M., Guegan, J., Blanchard, E., Tarpin-Bernard, F., & Buisine, S. (2018). The flow engine framework: A cognitive model of optimal human experience. *Europe's journal of psychology*, *14*(1), 232. doi: 10.23668/psycharchives.1280

Stone, B. M. (2021). The Ethical Use of Fit Indices in Structural Equation Modeling: Recommendations for Psychologists. *Frontiers in psychology*, *12*, 783226-783226. doi: 10.3389/fpsyg.2021.783226

Teo, T., Tsai, L. T., & Yang, C. C. (2013). Applying structural equation modeling (SEM) in educational research: An introduction. In *Application of structural equation modeling in educational research and practice* (pp. 1-21). Sense Publishers.

Thönes, S., & Stocker, K. (2019). A standard conceptual framework for the study of subjective time. *Consciousness and Cognition*, *71*, 114-122. doi: 10.1016/j.concog.2019.04.004

Tian, H., Zhou, W., Qiu, Y., & Zou, Z. (2022). The Role of Recreation Specialization and Self-Efficacy on Life Satisfaction: The Mediating Effect of Flow Experience. *International Journal of Environmental Research and Public Health*, *19*(6), 3243. doi: 10.3390/ijerph19063243

University of Oslo. (2020, February 7th). *Short Introduction to Nettskjema*. https://www.uio.no/english/services/it/adm-services/nettskjema/about-nettskjema.html

Voelkl, J. E. (1990). The challenge skill ratio of daily experiences among older adults residing in nursing homes. *Therapeutic Recreation Journal*, *24*(2), 7-17.

Voorhees, C. M., Brady, M. K., Calantone, R., & Ramirez, E. (2016). Discriminant validity testing in marketing: an analysis, causes for concern, and proposed remedies. *Journal of the academy of marketing science*, *44*(1), 119-134. doi: 10.1007/s11747-015-0455-4

Wang, C. C., & Hsu, M. C. (2014). An exploratory study using inexpensive electroencephalography (EEG) to understand flow experience in computer-based instruction. *Information & Management*, *51*(7), 912-923. doi: 10.1016/j.im.2014.05.010

Wang, S. T., & Chen, C. C. (2015). Path Analysis on the Factors Influencing Learning Outcome for Hospitality Interns--From the Flow Theory Perspective. *Journal of Education and Learning*, *4*(3), 25-44. doi: 10.5539/jel.v4n3p25

Wang, P. Y., Chiu, M. C., & Lee, Y. T. (2021). Effects of video lecture presentation style and questioning strategy on learner flow experience. *Innovations in Education and Teaching International*, *58*(4), 473-483. doi: 10.1080/14703297.2020.1754272

Wrigley, W. J., & Emmerson, S. B. (2013). The experience of the flow state in live music performance. *Psychology of Music*, *41*(3), 292-305. doi: 10.1177/0305735611425903

Wu, S. F., Lu, Y. L., & Lien, C. J. (2021). Detecting students' flow states and their construct through electroencephalogram: Reflective flow experiences, balance of challenge and skill, and sense of control. *Journal of Educational Computing Research*, *58*(8), 1515-1540. doi: 10.1177/0735633120944084

Xiao, Q., & Li, X. (2021). Exploring the Antecedents of Online Learning Satisfaction: Role of Flow and Comparison Between use Contexts. *International Journal of Computers, Communications & Control*, *16*(6). doi: 10.15837/ijccc.2021.

Appendix 1.1: The Questionnaire

Nettskjema Hjelp

Skjemaet skal være anonymt. **Lukk**

- Det lagres ingen informasjon automatisk om brukerkontoen din, selv om du skulle være logget inn
- Skjemaet skal ikke innholde spørsmål som gjør at svaret ditt kan kobles til deg som person. Dersom du mener skjemaet likevel stiller spørsmål som gjør det mulig å identifisere enkeltpersoner, meld fra til ansvarlig for skjemaet, **mhnguyen@stud.ntnu.no**.

Velkommen til å delta i en kartlegging av studentenes opplevelser med digital undervisning!

0 %

Obligatoriske felter er merket med stjerne *

Formål

Dette er et digitalt spørreskjema til alle studenter som deltar/har deltatt i digital undervisning dette semesteret høsten 2021. Det vil ta deg ca. 10 minutter. Spørreskjemaet inneholder spørsmål om studenters deltakelse i ulike undervisningsmetoder, tilfredshet med digital undervisning, og flyt-opplevelser i digital undervisning. *Flyt* er tendensen til å være så fullstendig oppslukt i en aktivitet at man glemmer tid og sted.

Anonymitet

Det er frivillig å delta i prosjektet. Det samles ikke inn sensitive data eller navn. Alle svarene fra deg er altså anonymisert. Enkeltpersoner vil derfor ikke kunne gjenkjennes i noen presentasjoner eller publikasjoner.

Resultatene fra studien publiseres først og fremst i en masteroppgave ved NTNU, Trondheim.

Muligheten for åpen tilgang til vitenskapelig publikasjon kan vurderes.

For ytterligere spørsmål knyttet til prosjektet, kontakt:

mhnguyen@stud.ntnu.no (student), eller
hroar.klempe@ntnu.no (veileder)

Jeg samtykker min deltakelse i undersøkelsen *

○ Ja, start undersøkelsen.

Neste side

Ansvarlig for skjemaet: **mhnguyen@stud.ntnu.no**.

NTNU

Vilkår

Personvern og vilkår for bruk
Nettskjema bruker informasjonskapsler
Tilgjengelighetserklæring

Ansvarlig for tjenesten

Nettskjema ved Universitetet i Oslo

Obligatoriske felter er merket med stjerne *

1. Bakgrunn

Kjønn *

- ○ Mann
- ○ Kvinne
- ○ Annet/Ønsker ikke å oppgi

Alder *

- ○ Under 20 år
- ○ 20-25 år
- ○ 26-29 år
- ○ 30 år, eller over

Er du student dette semesteret? *

- ○ Ja
- ○ Nei

Hvor langt har du kommet i ditt studium? *

Velg ...

Hvilket utdanningsområde tilhører du? *

(Du har muligheten for å velge flere svar)

- ☐ Estetiske fag, kunst- og musikkfag
- ☐ Fiskeri-, husdyr- og landbruksfag
- ☐ Historie, religion, idéfag
- ☐ Idrettsfag, kroppsøving og friluftsliv
- ☐ Informasjonsteknologi og informatikk
- ☐ Juridiske fag, rettsvitenskap, politi
- ☐ Lærer- og lektorutdanning
- ☐ Matematikk og naturfag
- ☐ Mediefag, bibliotekfag, journalistfag
- ☐ Medisin, odontologi, helse- og sosialfag
- ☐ Pedagogiske fag
- ☐ Reiselivsfag, hotellfag
- ☐ Samfunnsfag, psykologi
- ☐ Språk, litteratur
- ☐ Teknologi, ingeniørfag og arkitektur
- ☐ Økonomi og administrasjon
- ☐ Annet

Utdanningsprogresjon *

○ Studerer deltid ○ Studerer heltid

Deltakelse i student-aktive eller student-passive undervisningsmetoder

Hvor ofte deltok du på disse undervisningsmetodene dette semesteret? Svarene dine er basert på før gjenåpningen av Norge den 25.oktober.

	Aldri	Sjeldent (ca. 1 gang i måneden)	Noen ganger (flere ganger i måneden)	Ofte (ca. 1 gang i uka)	Hver dag/nesten hver dag (flere ganger i uka)
Fysisk vært på undervisning/forelesning (klasserom/auditorium, laboratoriet/felt) *	○	○	○	○	○
Sett/hørt på opptak av forelesning fra tidligere semestre *	○	○	○	○	○
Sett/hørt på opptak av forelesning *	○	○	○	○	○
Sett/hørt på korte (mindre enn 15 min) instruksjonsvideoer *	○	○	○	○	○
Sett/hørt på live-streamet forelesning (tradisjonell/monologisk/hovedsakelig enveis kommunikasjon) *	○	○	○	○	○
Deltatt på live-streamet digital undervisning (dialogisk/med student-deltakelse) *	○	○	○	○	○
Digital labundervisning *	○	○	○	○	○
Digital feltundervisning *	○	○	○	○	○
Digital klinisk undervisning/veiledning *	○	○	○	○	○
Digital veiledning *	○	○	○	○	○
Digital problembasert undervisning *	○	○	○	○	○
Digital gruppediskusjon organisert av lærer (f.eks. Blackboard Collaborate, Zoom Breakout rooms, Teams Breakout rooms, osv.) *	○	○	○	○	○
Digital gruppediskusjon organisert av studenter (f.eks. kollokvie eller tilsvarende) *	○	○	○	○	○

Videre kommer det spørsmål om opplevelser fra digital undervisning knyttet til undevisningsmetoder du har deltatt på

Forrige side   Neste side

2. Flyt-opplevelser i digital undervisning

Basert på svarene dine fra forrige side om deltakelse, vennligst svar på følgende spørsmål som best beskriver dine opplevelser i digital undervisning. Svarene dine er basert på de undervisningsformene du har deltatt mest på i dette semesteret (før gjenåpningen av Norge).

Disse spørsmålene handler om tanker og følelser du kan ha opplevd da den digitale undervisningen pågikk. Tenk på hvordan du følte da du deltok i de digitale undervisningene og velg det svaralternativet som passer best for din opplevelse for hvert spørsmål.

	Svært Uenig	Uenig	Nøytral	Enig	Svært enig
Jeg ble utfordret faglig, men jeg hadde tro på at mine kunnskaper ville gjøre meg i stand til å takle utfordringene i digitale undervisninger. *	○	○	○	○	○
Jeg trakk de riktige beslutningene uten å måtte tenke for mye eller prøve for hardt på dette. *	○	○	○	○	○
Jeg visste tydelig hva jeg skulle gjøre dette semesteret. *	○	○	○	○	○
Det var tydelig for meg at jeg gjorde det bra. *	○	○	○	○	○
Oppmerksomheten min var fokusert utelukkende på den digitale undervisningen. *	○	○	○	○	○
Jeg følte jeg hadde full kontroll over det jeg ble undervist i. *	○	○	○	○	○
Jeg var ikke bekymret over hva andre kanskje tenkte om meg. *	○	○	○	○	○
Det virket som om tiden endret seg (den gikk saktere eller raskere enn vanlig). *	○	○	○	○	○
Jeg nøt virkelig opplevelsen av å være i digitale undervisninger. *	○	○	○	○	○
Mine evner matchet de store utfordringene i digital undervisning. *	○	○	○	○	○
Det virket som om ting falt på plass av seg selv i digitale undervisninger. *	○	○	○	○	○
Jeg hadde en sterk følelse av hva jeg ville gjøre dette semesteret. *	○	○	○	○	○
Jeg var klar over hvor bra jeg presterte. *	○	○	○	○	○

Det krevde ikke mye innsats å holde fokus på hva som foregikk der og da. *	○	○	○	○	○
Mens forelesningene foregikk, følte jeg at jeg hadde alt under kontroll. *	○	○	○	○	○
Jeg var ikke bekymret over prestasjonene mine under den digitale deltakelsen. *	○	○	○	○	○
Måten tiden passerte på virket annerledes enn normalt. *	○	○	○	○	○
Jeg elsket følelsen av å være i digitale undervisninger, og jeg ønsker å oppleve den igjen. *	○	○	○	○	○
Jeg følte meg kompetent nok til å møte de vanskelige kravene i fagene. *	○	○	○	○	○
Jeg følte pensumrelaterte ting falt på plass av seg selv. *	○	○	○	○	○
Jeg visste hva jeg ønsket å oppnå dette semesteret. *	○	○	○	○	○
Mens de digitale undervisningene pågikk hadde jeg en sterk anelse om hvor bra jeg gjorde det. *	○	○	○	○	○
Jeg var fullt konsentrert. *	○	○	○	○	○
Jeg hadde en følelse av total kontroll. *	○	○	○	○	○
Jeg brydde meg ikke om hvordan jeg fremstod. *	○	○	○	○	○
Det føltes som om tiden stoppet under deltakelsen i den digitale undervisningen. *	○	○	○	○	○
Opplevelsen av å være i digitale undervisninger fikk meg til å føle meg bra. *	○	○	○	○	○
Ferdighetene mine hadde et like høyt nivå som de utfordringene jeg møtte. *	○	○	○	○	○
Jeg gjorde studierelaterte arbeid spontant og automatisk uten å måtte tenke (f.eks. regning, notatskriving, tegne modeller). *	○	○	○	○	○
Mine mål var tydelig definert. *	○	○	○	○	○

Jeg skjønte i de digitale undervisningene hvor bra jeg gjorde det underveis. *	○	○	○	○	○
Mitt konsentrasjonsnivå var høyt. *	○	○	○	○	○
Jeg følte jeg hadde full kontroll i den digitale undervisningen. *	○	○	○	○	○
Jeg brydde meg ikke om hva andre kanskje tenkte om meg. *	○	○	○	○	○
Noen ganger virket det som om tiden gikk saktere eller raskere i undervisningen. *	○	○	○	○	○
Opplevelsen av digital undervisning var ekstremt givende for meg. *	○	○	○	○	○

Forrige side   Neste side

3. Tilfredshet med digital undervisning

Vennligst svar på følgende spørsmål om hvor enig eller uenig du er med disse påstandene om nettbasert undervisning. Svarene dine er basert på de undervisningsformene du innledningsvis rapporterte at du har deltatt mest på i dette semesteret (før gjenåpningen av Norge). Det er ingen rette eller gale svar. Svar så ærlig som mulig.

	Svært uenig	Uenig	Nøytral	Enig	Svært enig
Digital informasjon om obligatoriske aktiviteter har vært kommunisert tydelig til meg (f.eks. arbeidskrav, øvingstimer, innleveringer, tester, eksamen, osv.). *	○	○	○	○	○
Jeg er fornøyd med bruken av gruppediskusjoner i det digitale læringssystemet (f.eks. Blackboard Collaborate, Zoom Breakout rooms, Teams Breakout rooms, osv.). *	○	○	○	○	○
Jeg er fornøyd med det digitale undervisningstilbudet. *	○	○	○	○	○
Jeg er fornøyd med kvaliteten på kommunikasjonen mellom meg og foreleser. *	○	○	○	○	○
Jeg er så fornøyd med nettbasert undervisning at jeg vil anbefale det til andre. *	○	○	○	○	○
Jeg er fornøyd med innsatsen som forventes av meg i dette semesteret. *	○	○	○	○	○
Evalueringer og tilbakemeldinger av obligatoriske aktiviteter har kommet i tide (f.eks. arbeidskrav, øvingstimer, innleveringer, tester, eksamen, osv.). *	○	○	○	○	○

Jeg er fornøyd med den nettbaserte kommunikasjonen (f.eks. Black-board, Zoom, Teams, osv.). *	○	○	○	○	○
Jeg er fornøyd med den fleksibiliteten digitale undervisninger har tilbudt meg. *	○	○	○	○	○
Jeg er fornøyd med kvaliteten på kommunikasjonen mellom meg og medstudenter. *	○	○	○	○	○
Jeg er mer fornøyd med nettbasert undervisning enn med fysisk undervisning. *	○	○	○	○	○
Jeg er fornøyd med mine prestasjoner i nettbasert læring dette semesteret. *	○	○	○	○	○
Jeg følte jeg var en del av klassen og tilhørte den nettbaserte undervisningen. *	○	○	○	○	○
Jeg er fornøyd med hvordan jeg kan navigere i det digitale læringssystemet (f.eks. Blackboard, Zoom, Teams, osv.). *	○	○	○	○	○
Jeg er fornøyd med det selvstyrte ansvaret som jeg har fått. *	○	○	○	○	○
Jeg er fornøyd med kvaliteten på kommunikasjonen i nettbasert undervisning. *	○	○	○	○	○
Jeg er så fornøyd med nettbasert undervisning at jeg ønsker å delta på liknende undervisningsform neste semester. *	○	○	○	○	○
Jeg tror jeg kommer til å være fornøyd med karakterene jeg får dette semesteret. *	○	○	○	○	○
Jeg er fornøyd med forelesernes tilstedeværelse og tilgjengelighet. *	○	○	○	○	○
Jeg er fornøyd med tiden det tar å laste ned læringsmaterialer fra det digitale læringssystemet (Black-board, Zoom, Teams, osv.). *	○	○	○	○	○
Jeg likte godt å jobbe med obligatoriske oppgaver under nettbasert læring (f.eks. innleveringer, prosjekter, arbeidskrav, øvingstimer, tester). *	○	○	○	○	○

Kommunikasjonen i nettbasert undervisning passer meg bra. *	○	○	○	○	○
Generelt sett, er jeg fornøyd med dette semesteret. *	○	○	○	○	○
Jeg ser jeg kan bruke det jeg har lært av nettbasert læring. *	○	○	○	○	○

Forrige side

Neste side

4. Kan du utdype hvordan du har opplevd digitale undervisninger før gjenåpningen av Norge?

Beskriv fordeler du opplever med digital undervisning.

(Valgfritt)

Beskriv utfordringer du opplever med digital undervisning.

(Valgfritt)

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NTNU

Vilkår

Personvern og vilkår for bruk
Nettskjema bruker informasjonskapsler
Tilgjengelighetserklæring

Ansvarlig for tjenesten

Nettskjema ved Universitetet i Oslo

Appendix 1.2: Results from Confirmatory factor analysis

Table 1

Factor Loadings of the Measurement model

Latent variable and indicators	Standardized λ	*RRC*
Challenge-Skills		.837
f_chaskills1	.664	
f_chaskills2	.744	
f_chaskills3	.781	
f_chaskills4	.810	
Goals		.856
f_go1	.710	
f_go2	.809	
f_go3	.771	
f_go4	.809	
Feedback		.910
f_feed1	.773	
f_feed2	.835	
f_feed3	.878	
f_feed4	.894	
Flow Experience		.904
f_conce1	.706	
f_conce2	.704	
f_conce3	.796	
f_conce4	.793	
f_awa1	.563	
f_awa2	.835	
f_awa3	.742	
f_awa4	.612	
f_contr1	.744	
f_contr2	.828	
f_contr3	.845	
f_contr4	.895	

f_loss1	.460	
f_loss2	.688	
f_loss3	.431	
f_loss4	.499	
f_time1	.287	
f_time2	.295	
f_time3	.149	
f_time4	.206	
f_auto1	.836	
f_auto2	.857	
f_auto3	.851	
f_auto4	.888	
Technology		.826
s_tech1	.707	
s_tech2	.885	
s_tech3	.666	
s_tech4	.651	
Course set-up		.830
s_course1	.823	
s_course2	.656	
s_course3	.757	
s_course4	.696	
Instructor		.728
s_instruct1	.596	
s_instruct2	.461	
s_instruct3	.694	
s_instruct4	.761	
Interaction		.869
s_inter1	.903	
s_inter2	.547	
s_inter3	.903	
s_inter4	.844	
Outcome		.850
s_outcome1	.723	

s_outcome2	.821
s_outcome3	.720
s_outcome4	.796

Note. λ = Factor loading coefficient. Satorra-Bentler Standard Errors (Quasi-Maximum Likelihood Estimation) was selected. RRC (Raykov's Reliability Coefficients) > .70 (Mehmetoglu & Jakobsen, 2017). The items f_time1, f_time2, f_time3, and f_time4 were removed from the model due to low factor loadings (<. 40; Mehmetoglu & Jakobsen, 2017).

Appendix 1.3: Summary of two open-ended questions

Figure 1.

Word cloud of students' perceptions on advantages of online learning

Note. Word cloud generated from the software program Tagul to highlight the most frequent words and phrases from students' perceptions of the advantages of online learning. *Flexibility* was the most frequent word.

Figure 2.

Word cloud of students' perceptions on disadvantages of online learning

Note. Word cloud generated from the software program Tagul to highlight the most frequent words and phrases from students' perceptions of the disadvantages of online learning. *Loneliness* was the most frequent word.

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