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Academic experiences of information technology students: uncovering first-year challenges

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ABSTRACT
This study explored the learning experiences of first-year information technology students at the beginning of their studies. Identifying the early experiences is important, as we know they can predict later challenges and persistence in studies. We focus on a novel understanding of relations between learning approaches, self-efficacy and burnout experiences, and relations between these experiences and study progress. We combined the quantitative survey data and the qualitative interviews to create a detailed view of first-year challenges. Interview data was used to deepen the understanding about students' experiences. We found that burnout and self-efficacy correlated negatively with each other. Burnout also correlated negatively with organised studying, and positively with surface approach. Self-efficacy correlated negatively with surface approach. Study progress correlated negatively only with surface approach. Two-folded causal relationships are considered, and possible interventions to enhance students' self-efficacy, support them with time management and studying skills, and prevent burnout are discussed.

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Engineering education; self-efficacy; burnout; learning approaches

1. Introduction

Currently, there is a notable lack of highly skilled labour in the field of information and communication technologies (ICT) (Hyrynsalmi, Rantanen, and Hyrynsalmi 2021). Student attrition and drop-outs are common challenges in engineering education, especially in the field of information technology (IT). The graduation rates in IT in Finland are nearly the same as in the international ICT and engineering fields (Carnegie et al. 2018; Litzler and Young 2012), which means that almost half of the students do not graduate. Graduation rates are notably higher when considering all study fields (Vipunen 2021). Students' drop-out risk from the high school studies is highest during the first study year (Chen 2012), and similar findings have been made among IT students (Kori et al. 2015). Students who struggle progressing in their studies in the first study year are found to have delays in their graduation more likely (Haarala-Muhonen et al. 2017; Hailikari et al. 2020). First-semester performance features, like earned credits, seem to act as a predictor for students' later dropout in STEM fields (Kiss et al. 2019).

There are many reasons behind student attrition and delays, such as insufficient advising and support in the classroom and at the academic level, low grades and difficulties with conceptual

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understanding, low interest or low self-efficacy (Geisinger, Raman, and Raman 2013) and feelings of burnout (Bask and Salmela-Aro 2013; Beer and Lawson 2017). Students consider working during studies, lack of motivation, mental well-being and matters related to thesis work and organising studies to be the most common causes of delay in their studies in the higher education context (Liimatainen et al. 2011; TEK 2022). Especially in the field of IT, students often work during studies before graduation. In Finland, 54% of academic engineering and architecture students worked in their own fields in 2022 (TEK 2022). It is good that there is a demand for work, and working in one's own field while studying can enable a smooth transition to working life (Karhunen and Hynninen 2012). However, it is also a challenge to the completion of degrees and one reason for study delays (Liimatainen et al. 2011; TEK 2022).

Study-related stress has increased continuously and is alarmingly common among university students. Overall, approximately 40% of students have been found to have feelings of burnout (Rosales-Ricardo et al. 2021; Salmela-Aro et al. 2022; THL 2021). Burnout among university students is a widely recognised phenomenon, and many studies have been conducted to map out the overall situation (Asikainen et al. 2022; Salmela-Aro 2022; Walburg 2014). Research has shown negative correlations between burnout and academic achievement (Asikainen et al. 2022; Hyytinen et al. 2022; Madigan and Curran 2021). High levels of burnout, especially cynicism, also increase a risk to study dropout (Bask and Salmela-Aro 2013). Experienced burnout symptoms tend to increase within the study semester, and exhaustion in an initial phase of studies can therefore be seen as a subject of early concern and as a need of early support (Turhan et al. 2023, 8). Earlier research (e.g. Järvinen et al. 2022) has indicated that IT students seem to experience a notable amount of burnout in the early phase of their studies.

There are also indicators of relations between higher self-efficacy and lower burnout (Salmela-Aro and Upadyaya 2014). In turn, self-efficacy has been found to be related to higher academic achievement (Richardson, Abraham, and Bond 2012) and persistence in studies (Lent et al. 2016). The first-year students' experiences of academic self-efficacy are found to be a strong predictor of persistence decisions in studies already in the middle stages of the first semester (Walsh and Robinson Kurpius 2016). A sense of self-efficacy develops based on students' interpretations of their activities and performance, and many experiences of failure may diminish belief in one's own capability (Bandura 1997; van Dinther, Dochy, and Segers 2011). The learning approaches that students adopt seem to be correlated with study experiences and burnout. The surface approach towards studies has been found to correlate with higher burnout, and a deep approach with better study progression (Asikainen et al. 2020, 2022; Parpala et al. 2022). The learning approaches that students adopt in the first study year can also predict graduation times (Haarala-Muhonen et al. 2017). There is still limited research on how students' implementation of learning approaches is related to burnout and self-efficacy in the beginning of their studies and on the cause-and-effect relationships between these phenomena.

Learning is a multifaceted process influenced by a complex combination of personal characteristics, beliefs and feelings, motivations, orientations, learned habits and strategies, current life situations and contexts, the learning environments and communities. Similarly, various factors are related to students' academic performance (Richardson, Abraham, and Bond 2012). Therefore, research on learning experiences also requires a multifaceted approach, and students' own voices should be heard to determine the possible challenges and potentials. The shift from an upper secondary school to a university education requires adapting new kinds of learning environments and learning approaches, self-direction and absorbing increasingly challenging content in mathematics, programming, and other subjects (Andrews, Clark, and Knowles 2019; Jackson et al. 2006). For example, the introductory programming course that students face among the first studies is found to be universally challenging for students, and only about two third of students pass the course (Watson and Li 2014). At the same time, many students move on their own for the first time in their lives and live a new kind of life phase when they start university studies, thus facing new issues and uncertainty factors.

The first year and semester of studies thus seems to be overall critical for students from the psychological, social, and cognitive view (Conley et al. 2014; Corpus, Robinson, and Wormington 2020; Höhne and Zander 2019; Turhan et al. 2023), for their persistence (e.g. Chen 2012; Walsh and Robinson Kurpius 2016), and for study progress (Haarala-Muhonen et al. 2017; Kiss et al. 2019). Therefore, the transitional phase and the beginning of studies are important points for discovering students' experiences. Thus far, the early experiences of IT students, how they reflect their experiences and the reasons behind them have not been extensively studied. Research during the first year of study is particularly needed for recognising the students who may be at risk of dropout, understanding their challenges broadly and planning practical implications for supporting students right-time and enhancing their learning (Bork and Mondisa 2022). Better understanding of student experiences could help to better meet students' needs and expectations and to provide them with a substantial foundation for their academic and social integration and forthcoming studies (Goldrick-Rab, Carter, and Wagner 2007). That kind of understanding is needed for ensuring that students are coping and engaged in their studies and to prepare a sufficient workforce with deep conceptual understanding and creative problem-solving capabilities to manage and find solutions to new challenges in a changing society and environment.

In this study, we aim to gain an understanding of first-year IT students' burnout, self-efficacy and learning approaches by investigating the correlations between these experiences, and between these experiences and study progress, and highlighting students' own experiences based on interviews.

2. Theoretical background

2.1. Burnout among university students

Study burnout is a phenomenon that has been under much discussion as feelings of burnout among young people have become more common (Salmela-Aro and Read 2017). During the COVID-19 pandemic, students' well-being was significantly reduced further, and experiences of serious burnout increased, with 18% of students experiencing severe burnout, 24% experiencing increasing risk of burnout, and 29% experiencing exhaustion (Salmela-Aro 2022; Salmela-Aro et al. 2022). In the international context, the overall prevalence of the so-called burnout syndrome was nearly 40% (Rosales-Ricardo et al. 2021). Burnout can be understood and measured using three aspects: exhaustion, cynicism and inadequacy. Exhaustion refers to common fatigue and feelings of being overwhelmed by study demands like high workload and pressure in studies (Salmela-Aro 2017), or 'chronic fatigue resulting from overtaxing schoolwork' (Salmela-Aro et al. 2009, 48). Cynicism manifests as decreased interest and feelings of meaningfulness in studies, while inadequacy refers to low beliefs in one's own competencies and coping with studies (Salmela-Aro et al. 2009).

According to a meta-analysis of 29 studies, all of these three burnout symptoms are negative predictors of academic achievement, measured with grade point average (GPA), overall performance or exam performance (Madigan and Curran 2021). Asikainen et al. (2022) also found that all the burnout dimensions negatively correlated with study credits, and inadequacy and exhaustion correlated negatively with GPA. Correspondingly, Hyytinen et al. (2022) found that cynicism and inadequacy were negatively related with study credits at the end of the first study year. Experienced burnout is found to highly predict self-reported dropout intentions (Marôco et al. 2020). Especially experienced cynicism towards studies seems to increase and predict a risk of dropout (Bask and Salmela-Aro 2013; Turhan et al. 2023). Turhan et al. (2023) showed that students who reported higher burnout symptoms and increase of these experiences over the first semester, also reported higher dropout intentions. They also considered that specifically exhaustion could indicate burnout in the initial phase because it seems to be the first sign of developing burnout symptoms. Räisänen, Postareff, and Lindblom-Ylänne (2021) investigated the variation of experienced exhaustion among university students in a longitudinal study, and found out that at the group level the

exhaustion seemed to increase over studies. Burnout is recognised to be correlated with depressive symptoms (Salmela-Aro et al. 2009), and it can lead to delays in studies and decreased educational aspirations (Vasalampi, Salmela-Aro, and Nurmi 2009).

Relatively high learning demands without sufficient support may cause feelings of burnout. Jagodics et al. (2023) found that perceived school demands were positively correlated with experienced burnout. Especially high emotional demands were related to exhaustion. In turn, experienced school resources correlated negatively with burnout (Jagodics et al. 2023). Neumann, Finaly-Neumann, and Reichel (1990) found that learning flexibility, contact with faculty members and involvement in programme activities were negatively correlated with students' emotional exhaustion. Motives to attend university may also affect experienced feelings of burnout. Hyytinen et al. (2022) reported that personal–intellectual motive to attend university correlated negatively with experienced burnout in the first study year. Support and positive prompts given by teachers and a good faculty climate are negatively related to burnout (Salmela-Aro et al. 2008). Providing proper support and preventive interventions to students and considering their psychological needs can reduce the risk of burnout and can be protective factors against it (Madigan and Curran 2021; Salmela-Aro 2022; Salmela-Aro et al. 2008).

2.2. Learning approaches

Investigating students' approaches to learning enables an understanding of their different learning processes and strategies and the effects these have on learning (Lonka, Olkinuora, and Mäkinen 2004). Students' studying and learning approaches can be assessed using the *deep approach* and the *surface approach*. The deep approach also refers to a reflective or elaborative approach. Students who use this kind of deep strategy tend to think critically, process and combine information, aim to thoroughly understand learning content and find what is important. The surface approach is rehearsal or fragmented learning and learning by repeating and remembering the content by rote, aiming to cope with the course (Biggs, Kember, and Leung 2001; Entwistle 2009; Marton and Säljö 1976). *Organised studying* has been defined in its own approach, which means planning and managing time, organising studying and putting effort into studying (Asikainen et al. 2022; Entwistle 2009; Entwistle and McCune 2004).

Relatively little research has been conducted on the relationship between learning approaches and burnout. However, recent studies conducted among first-year university students have shown that the surface approach is positively correlated with all dimensions of burnout (Asikainen et al. 2020, 2022). In turn, organised studying and deep approach were negatively correlated with cynicism and inadequacy (Asikainen et al. 2022). Kyndt et al. (2011) have found out that autonomous motivation towards studies had a negative correlation with the surface approach, and positive correlation with deep approach, when students' perceived workload was high (Kyndt et al. 2011). The relationships between learning approaches and academic performance have also been recognised. Parpala et al. (2022) investigated how different learning profiles were related to academic achievement by using HowULearn survey and students' GPA's. They found out that the deep organised learning profile correlated with higher GPA (Parpala et al. 2022). Asikainen et al. (2020) also found that students with an organised study approach had a better study progression compared to students with an unorganised, deep approach. In other studies, the deep and strategic approaches have been found to correlate with GPA in the first study year (Sæle et al. 2017), and surface approach to correlate with lower academic achievement (Cassidy and Eachus 2000), but the relations between deep approach and academic achievement still remain partly weak or non-existent.

To guide students in organised and deep learning and to avoid surface learning, effective ways could be implementing learning methods, such as peer discussions and practices that encourage critical thinking and deep understanding (see Sæle et al. 2017). It is also important to ensure that the assessment methods encourage students to perform deep learning (Biggs, Kember, and Leung 2001). Support for organised studying skills and teaching or conducting study counselling about study techniques and time management for students is also essential (Kember et al. 1995;

Sæle et al. 2017). By giving students sufficient time to deeply process learning content and by ensuring that their workload is not too high, teachers can encourage students to process learning deeply and avoid fragmented surface approaches (Chambers 1992).

2.3. Self-efficacy

Self-efficacy beliefs are multidimensional, domain-specific assumptions and beliefs in one's own capability for performance (Zimmerman 2000). Self-efficacy beliefs are linked to motivation, feelings and actions, as self-efficacy 'refers to beliefs in one's capabilities to organise and execute the courses of action required to manage prospective situations' (Bandura 1995, 2). The scenarios and interpretations people create and visualise about their success and the goals they set for themselves are influenced by their beliefs in efficacy. Those with high beliefs typically imagine positive scenarios and see that failures are caused situationally and by not giving enough effort. In turn, those with low efficacy beliefs may see more troubled scenarios, have self-doubt and consider their low capabilities as a cause for failure (Bandura 1995). Physiological reactions and feelings, such as experienced stress, may affect students' perceptions of their self-efficacy (Zimmerman 2000).

Self-efficacy beliefs are future-oriented, and a long tradition of research has shown that they play an essential role in academic motivation, learning strategies and self-regulation (Zimmerman 2000). High self-efficacy beliefs have been shown to be positively related to academic performance (Honicke and Broadbent 2016; Lane, Lane, and Kyprianou 2004; Richardson, Abraham, and Bond 2012). Relations between learning approaches and self-efficacy are also investigated in several studies. Prat-Sala and Redford (2010) used Revised Approaches to Studying Inventory (RASI) to measure students' learning approaches and two question patterns to measure students' self-efficacy in reading and writing. They found out that deep and strategic (i.e. organised studying) study approaches correlated positively, and surface approach negatively with both self-efficacies. They also found out that within 4 months students with low self-efficacy tended to adopt more surface and less deep approaches for learning, while the approaches did not change among students with high self-efficacy (Prat-Sala and Redford 2010). Parpala et al. (2022) measured students' self-efficacy beliefs and learning approaches through HowULearn survey and found out that self-efficacy was highest among students with a deep organised learning profile. In a four-year longitudinal study, self-efficacy beliefs were negatively correlated with study burnout (Salmela-Aro and Upadyaya 2014). Only little research has been conducted on the relationship between self-efficacy and burnout, even if one's own beliefs about coping may be an important issue to protect from stress while facing challenging situations or distress during studies (Bandura 1997; Walburg 2014).

Self-efficacy has been found to be an important predictor of persistence (Lent et al. 2016) and persistence intentions (Hsu et al. 2021) in engineering majors. Recognising students' self-efficacy beliefs may be one way to anticipate possible challenges in learning, to identify the kind of support students need and to plan interventions that have a positive effect on students' beliefs. Changing to strength-concentrated pedagogy and assessment, positive feedback, providing applied and student development level-appropriate tasks in a safe learning environment and faculty encouragement may strengthen students' self-efficacy (Hsu et al. 2021; Salmela-Aro and Upadyaya 2014; van Dinther, Dochy, and Segers 2011). Among first-year engineers, feelings of understanding, learning the course content, computing abilities and motivation were most cited when students were asked to write factors, they considered to have an effect on their self-efficacy beliefs (Hutchison et al. 2006). Self-efficacy beliefs guide expectations of the future, and interpretations of past and earlier success influence self-efficacy beliefs and future scenarios (Bandura 1997). Therefore, prompting students to make more positive interpretations of their previous performance may encourage them to believe in their capabilities (Lane, Lane, and Kyprianou 2004).

3. Research questions

This study aims to investigate the learning experiences of IT students at the beginning of their studies. We are interested in learning approaches, self-efficacy, and burnout experiences, and how these experiences are related with study progress in the first study semester. We also examine how students reflect on their experiences after half a year of study.

RQ1

- *What kinds of experiences of burnout, self-efficacy beliefs and learning approaches do students undergo at the beginning of their studies?*
- *How do students describe and reflect on their experiences during their first study semester?*

RQ2

- *How are burnout, self-efficacy and learning approaches related to each other?*
- *How do students describe and reflect on the causes and consequences of their experiences?*

RQ3

- *How are learning approaches, study burnout and self-efficacy beliefs related to study progress?*

4. Methods

4.1. Data

First-year IT students' experiences were studied both quantitatively with the survey data and qualitatively with the interview data of a small group of students (Figure 1). Survey data were used to obtain an overview of students' experiences when they had studied approximately one month at the university and to investigate the correlations between the measured phenomena. Through

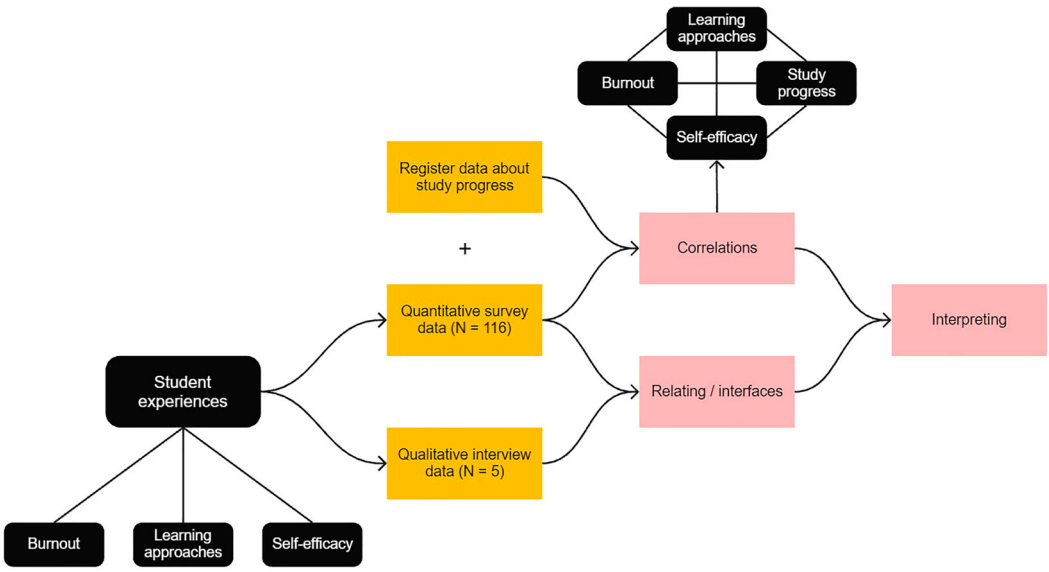

Figure 1. Illustration of the research approach. The black boxes describe the data collected from the students. The yellow boxes describe the methods of data collection. The red boxes describe the analysis.

the qualitative interview data, it was possible to deepen the perception of students' experiences and obtain insights into students' reflections on their experiences and the possible reasons and consequences behind them.

Students' experiences of their studies were collected through the HowULearn survey, which is a widely used and validated survey (for details, see Parpala and Lindblom-Ylänne 2012) containing different themes and question patterns. This first survey was conducted in the first period of studies and categorised into three sections: learning approaches (12 items), self-efficacy (5 items) and burnout (9 items) (Appendix 2). Students responded to each question on a five-point Likert scale, from fully disagree (1) to fully agree (5). The register data of students' study progression were connected with their survey responses to determine possible correlations between students' experiences and study progress. The total number of credits for the first autumn was used to measure the study progress.

In total, 116 first-year students studying in the degree programmes of information and software engineering, mathematical information technology, education technology or technology management responded to the survey in three cohorts in 2021–2023 (Figure 2). These study programmes were chosen because of the similarity of their basic studies in the first study year. Technology management is a new programme that started in 2023, that also has similar studies in the first year. The overall average response rate was 31.5%. More information about the respondents in each year is described in the table in Appendix 1.

As a follow-up, semi-structured interviews were conducted with five students at the end of the first semester after six months of study. The students who responded to the survey in autumn 2022 were asked to participate in the interviews. The students who reported their willingness were interviewed individually. In the interviews, the students ($N = 5$) were asked about their expectations and experiences in their study programme, their study methods, working with peers, challenges, self-efficacy beliefs in future studies, possible experiences of high workload and feelings of burnout, interests, motivation, and matters supporting their study well-being. When we use the concept of workload while talking about school-related exhaustion (Salmela-Aro et al. 2009), we mean the experienced workload and pressure due to study demands by students, as we do not measure the actual workload of students. The questions concerning studying with peers and burnout were adapted from Räisänen, Postareff, and Lindblom-Ylänne (2021) interview framework. Otherwise, the interview questions were developed together with the degree programmes' development team.

4.2. Analysis

The quantitative data were analysed using a structural equation model. A confirmatory factor analysis was used on the burnout, learning approaches and self-efficacy items. As the data were not normally distributed, the parameters were estimated using the maximum likelihood robust estimation method. Internal consistency was measured using Cronbach's alpha and Composite Reliability. The

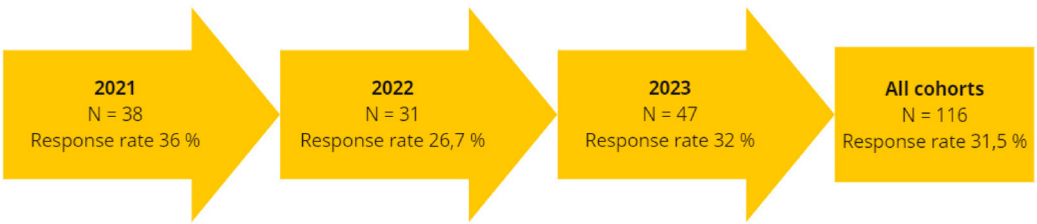

Figure 2. Number of respondents and response rates of each cohort in years 2021, 2022 and 2023 are described in the arrows. Total number of respondents and the total response rate of all the cohorts is described in the box on the right.

estimated model's goodness-of-fit was evaluated using comparative fit index (CFI), root mean square error of approximation (RMSEA) and standardised root mean square residual (SRMR). The cutoff criteria for the fit indexes, that indicate that the model fits to the data adequately, are CFI greater than .95, RMSEA less than .06 and SRMR less than .08 (Hu and Bentler 1999). The Akaike information criterion (AIC) was used to obtain the best-fit model. The models' explanatory power was calculated by using the R-square, where values .75, .50 and .25 are considered substantial, moderate, and weak, respectively (Hair, Ringle, and Sarstedt 2011). The statistical analyses were conducted using R software version 4.3.1 (R Core Team 2022) and the lavaan package (Rosseel 2012). There were two outliers in data concerning study progress due to the high number of credits, and therefore in the analysis of study progress and its correlations the number of data was two units smaller ($N = 114$).

The qualitative analysis followed quantitative analysis to create a detailed view of the studied phenomena. Quantitative analysis was used to build the general understanding of the students' experiences and correlations between these experiences and study progress. The role of qualitative data analysis was to explain quantitative findings on students' experiences and the cause–consequence relationships in more depth. With qualitative data analysis we aimed to answer underlying 'how' and 'why' questions that only quantitative analysis alone cannot reach. The qualitative interview data were analysed using theory-driven thematic analysis (Braun and Clarke 2006). Themes were discussed among authors until agreement was established. The interviews were coded based on the theoretical main concepts of burnout and its sub-dimensions (exhaustion, inadequacy, and cynicism), self-efficacy beliefs and different learning approaches (surface approach, deep approach and organised studying). The codes are described in more detail in Table 1.

5. Results

In the first chapter (5.1) we describe the factor analysis that were conducted for burnout, self-efficacy and learning approaches. In the next three chapters the overall experiences of burnout (5.2), learning approaches (5.3) and self-efficacy (5.4) among students are reported to answer RQ1. The findings about quantitative data are described in the beginning of each chapter to provide a general description of students' experiences. The qualitative findings follow quantitative findings to deepen the understanding about students' experiences through interview data. In chapter 5.5, first the structural equation model for the student experiences and study progress is presented in Figure 3. In sub-

Table 1. Description of the codes used in the analysis of the interviews.

Code	Description	Example
Exhaustion (burnout)	*Mentions about tiredness and high workload*	*'– the amount of work I had to do to keep up in some way, it surprised me. Which, in part, may have led to such a state of exhaustion'.*
Inadequacy (burnout)	*Mentions about comparing oneself to others and feelings or doubts about being not capable enough to proceed in the studies, too challenging studies*	*'– when you can't do the tasks yourself but you see that others can do them, that's where the feeling comes from'.*
Cynicism (burnout)	*Mentions about thoughts of giving up and loss of motivation or thoughts about one's suitability for a field*	*'– and if I don't succeed in those tasks, I kind of get the feeling that I should change my whole field'.*
Self-efficacy	*Mentions about future and coping in further studies*	*'That is, if you survive this one ordeal, then you will not have many more difficulties ahead'.*
Surface approach (learning approaches)	*Mentions about many repetitions, challenges in creating an overall picture of the lessons learned and challenges in obtaining a deep understanding of the content*	*'I, like, kind of understand what I'm reading and what I'm doing, but it's challenging to wrap them into one package because the whole field is so foreign to me'.*
Deep approach (learning approaches)	*Mentions of reflection, critical thinking, interest and flow-state while studying*	*'I like thinking to myself because you learn the most when you just reflect on it'.*
Organised studying (learning approaches)	*Mentions about planning studies and time management*	*'A challenge, of course, is the scheduling and planning. Mostly, if I work when I feel like it, it will not necessarily carry me too far yet'.*

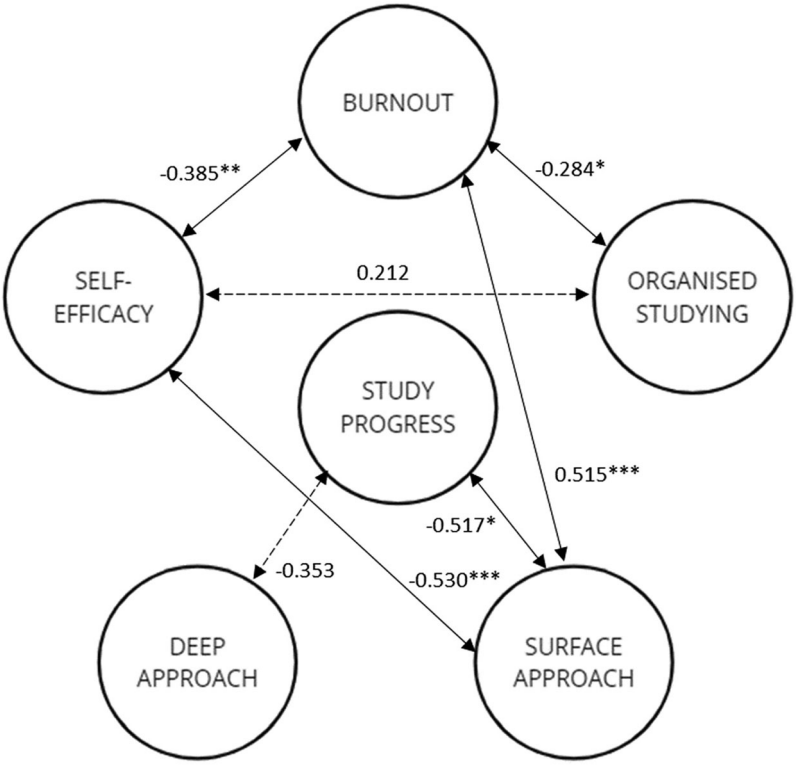

Figure 3. Correlations between burnout, self-efficacy, learning approaches and study progress. The lines describe the significant correlations found, and the dotted lines describe almost significant correlations. (* *p*-value < .05, ** *p*-value < .01, *** *p*-value < .001).

chapters, the correlations between burnout and self-efficacy (5.5.1), learning approaches and burnout (5.5.2), learning approaches and self-efficacy (5.5.3) are reported to answer RQ2, followed by qualitative findings. Correlations between study progress and burnout, self-efficacy and learning approaches (5.5.4) are reported to answer RQ3.

5.1. Factor analysis

A confirmatory factor analysis was used on the burnout, learning approaches and self-efficacy. For the correlation matrix of the burnout, learning approaches and self-efficacy items, and their means and variances, see Appendix 3.

In the analysis of exhaustion, cynicism and inadequacy were the first-order factors, and burnout was the second-order factor. All nine items were included to measure burnout from three different aspects: exhaustion (4 items), cynicism (3 items) and inadequacy (2 items). The factor loadings were all above .60 and Cronbach's alpha was .78, .82, and .64 and composite reliability was .78, .85, and .66 for exhaustion, cynicism, and inadequacy, respectively. For the sum variable of all the burnout dimensions Cronbach's alpha was .87 (Appendix 4).

A first-order factor analysis was performed on the learning approaches. A three-factor model was estimated, and the three latent factors (surface, organised, and deep learning) were found to be correlated. All 12 items were included to measure the learning approaches: surface (4 items), deep (4 items) and organised studying (4 items). The factor loadings were above .40, except for one organised item (loading = .29). Cronbach's alpha was .74, .71, and .66 and composite reliability was .74, .69, and .68 for surface, deep and organised studying, respectively (Appendix 5).

A first-order factor analysis was performed on the self-efficacy. All five items were included. The factor loadings were all above .70, and Cronbach's alpha and composite reliability were .92 (Appendix 6).

5.2. Burnout

Regarding RQ1, students' overall experiences of burnout were examined both as a sum variable of all the burnout dimensions, and by sub-dimensions of burnout. The experienced level of study burnout was 2.4 (SD = 0.78), on average, based on the sum variable of all the burnout dimensions. The sub-dimensions of burnout (inadequacy, exhaustion, and cynicism) were also examined separately. Inadequacy was the highest of these sub-dimensions in students' responses (mean = 2.7; SD = 1.05), followed by exhaustion (mean = 2.5; SD = 0.86) and cynicism (mean = 2.0; SD = 0.93).

To recognise the causes behind these symptoms, observing burnout is not sufficient alone, but we need to understand students' reflections on the underlying issues related to burnout experiences. The experiences of different burnout symptoms were also revealed based on the interview data. Experiences of high workload were familiar among the interviewees. There were mentions of having a high workload but still coping with the amount of work and not experiencing feelings of burnout, as well as more severe feelings of exhaustion, partly due to experiences about too much work. The amount, rapid pace and demands of work seemed to come as a surprise, as stated by student A:

> So, well, when I had no prior knowledge [regarding] the amount of work I had to do to keep up in some way, it surprised me. Which, in part, may have led to such a state of exhaustion. (Student A)

Moreover, the change from being in high school to being in university and the increasing demands of one's responsibilities seemed to cause feelings of a high workload, as described by student D:

> Since I came here straight from high school, I have noticed that there is much more personal responsibility. And this is where I noticed the workload. (Student D)

Comparison with peers and highly challenging tasks were mentioned as causing feelings of inadequacy. Feelings of inadequacy also raised the threshold of asking for help, even from peers or during guiding sessions with a small group, even leading to students completely skipping these sessions. The interviewees did not describe common feelings of loss of interest or motivation and did not seem to experience much cynicism in their studies. Nevertheless, feelings of inadequacy were mentioned to lead to doubts about coping with one's studies, which turned into feelings of giving up or even changing the study field (i.e. cynicism). According to student D, feelings of inadequacy in weekly tasks led to thoughts about one's suitability for a field of study:

> Uh well, yeah, sometimes, I feel that I can't manage, maybe just because of those weekly tasks. And if I don't succeed in those tasks, I kind of get the feeling that I should change my whole field. (Student D)

All the interviewees considered their motivation towards studies to be good or very high and their studies and field of study to be interesting and productive, even if they experienced time pressure or difficulty with the content, which sometimes challenged their motivation. As a counterforce to burnout and a resource for study, peers, free time, and hobbies were considered important for recovery. Having enough free time from studies was considered to maintain well-being in studies and prevent feelings of burnout. Peers and chatting with friends were often mentioned, and activities such as sports and hanging out with friends, which have nothing to do with studies and are a counterbalance to studying, were considered important. For example, Student D found that meeting older students and hearing about their experiences helped and served as good peer support:

> Yeah, just the fact that I get to meet people and hear about their experiences. Especially when … also the fact that there were a couple of times when I got to talk with older students and received some tips and so on. I've heard that I'm not the only one who's having a hard time. So, it has really helped me a lot. (Student D)

All in all, life outside of studies was seen as a protective factor that prevented burnout. However, other life challenges were also seen to have possible negative effects on studying. The common atmosphere in the university community was considered good and open. As presented above, meeting new people and getting to know fellow students were highly valued.

5.3. Learning approaches

Students' learning approaches were examined through three different approaches: deep approach, surface approach and organised studying, to answer RQ1. The average of the sum variable of the deep approach was high among the respondents (mean = 3.6; SD = 0.64), followed by the organised approach (mean = 3.1; SD = 0.74) and the surface approach (mean = 2.7; SD = 0.67), which were lower but still quite common approaches.

Interviews showed how students were reflecting their studying approaches. The interviewees described some challenges in creating an overall picture of the learning content and concepts and in achieving a deep understanding, which refers to the surface approach. One of these challenges is the demand for new content that requires repetition and fast assimilation. Learning content was seen as cumulative, and if one could not acquire weekly tasks and new content, it would be difficult to catch up later. A need for more personal, or 'face-to-face', support and help from teachers to complete the tasks was also called for. Student A described the challenges in perceiving entities and hoped for more guidance:

> That's pretty much what I wrestled with during that class—that I can't figure things out. I, like, kind of understand what I'm reading and what I'm doing, but it's challenging to wrap them into one package because the whole field is so foreign to me. What I might have needed was, in a way, a little more individual guidance or teaching. (Student A)

Organised studying was described as an area to be developed. All of the interviewees mentioned that they did not plan their time management. Different challenges in time management and self-direction were considered, and willingness to improve these skills and start to plan and schedule their studies more were highlighted. Student C did some of the tasks at the last moment but wanted to change his use of time and schedule his studies better in the future. Overall, the planning and scheduling of studies was seen as an objective state and helpful for managing studies:

> Well, sometimes I plan, but, well, usually what happens is that, for example, I did some of the programming demos the night before they had to be returned. But I am trying to shape, I guess, my use of time so that I can start planning better and submit demos on time. (Student C)

The field of study was described as interesting, and the learning content was considered appropriate. The interviewees shared their effort and aspiration for a deep approach, desire to understand the content and the joy of learning and understanding things after a long reflection. Student E described achieving a flow state while studying:

> Whenever there are moments such as when you code something and suddenly you notice that it's been hours and hours and so on, you haven't eaten or [done] anything [else], then you realise that this is the right place. (Student E)

It was mentioned several times that studying in groups encouraged students to reflect on their thoughts, think critically and expand their perceptions. Student C described more ideas coming across while working in group:

> Well, when studying in groups it is perhaps good when everyone has a different view on the matter, so someone can say some solution that you might not have thought of yourself, so there may be more ideas. (Student C)

Example above illustrates that working and discussing in groups, at its best, encouraged students to consider different, expanded viewpoints and better observe learning situations, which refers to a deep approach.

5.4. Self-efficacy

Students' experienced self-efficacy beliefs were examined as a sum variable to answer RQ1. Overall, self-efficacy beliefs were high among the students (mean = 4.0; SD = 0.75). In interviews, self-efficacy was reflected in previous courses and one's success with them, and coping in further studies was evaluated based on the interviewees' previous experiences. Those who had succeeded without any major problems in their earlier studies were more confident with their future, such as student B:

> I feel very confident because, well, I don't know, but based on what I've heard, many people consider Programming 1 and Programming 2 to be the hardest courses in their studies. That is, if you survive this one ordeal, then you will not have many more difficulties ahead. (Student B)

The interviews indicated that those who had previously struggled with their study content were more likely to be uncertain about coping in further studies.

5.5. Correlations between student experiences and study progress

The structural equation model for the student experiences and study progress is presented in Figure 3. The scaled goodness-of-fit indices were not quite adequate: CFI = .88; RMSEA = .06, 90% CI = [.05,.07]; SRMR = .08; AIC = 7947.9. Factor loadings of survey items are presented in Appendix 7.

5.5.1. Burnout in relation to self-efficacy

Self-efficacy was negatively correlated with burnout ($\beta = -.385$, $p < .01$). The higher the self-efficacy beliefs the students had, the lower their experiences of burnout. Those interviewees who had feelings of burnout also doubted their capability to cope with future studies. Student A considered the role of society when comparing oneself with others and when feeling inadequate:

> Perhaps our society, in particular, always wants us to make a comparison at some level, which, of course, is also a very harmful cycle. But perhaps it has changed into a feeling of inadequacy, so I wonder whether I'm able to do this and how it works. Will it even work? (Student A)

Conforming to the above, students described a cycle of having feelings of inadequacy and comparison with peers due to challenging content and high workload relative to time or previous skills in the field and of having feelings of burnout and exhaustion, which then made them judge their capability in coping in the field and further studies.

5.5.2. Burnout in relation to learning approaches

The surface approach to learning significantly positively correlated with burnout ($\beta = .515$, $p < .001$). Organised studying was significantly negatively correlated with burnout ($\beta = -.284$, $p < .05$). The deep approach was not correlated with burnout.

The relationships between the surface approach and burnout were also discussed in the interviews. If the learning content required numerous repetitions, as student A stated, or was difficult to understand (i.e. surface learning), then it would take much time and lead to feelings of inadequacy and exhaustion:

> So, there were weeks when I could internalise the taught content better, in which case, making demos didn't become a challenge. But then there were those weeks that I had deadlines for the practice work all at the same time, and then there was a week when I didn't immediately internalise the topic, which led to me watching lecture videos 100 times and making demos for several hours. (Student A)

Conversely, a high workload and time pressure were seen to encourage surface learning and to seek the easiest ways or 'shortcuts' to complete the tasks. Problems in personal life were also seen to hinder immersing oneself in work and working effectively (i.e. deep approach). According to student E, gaining an understanding (i.e. deep approach) takes time, and studying new things at a fast pace does not always allow reflection of matters:

> Well, there have not been any insurmountable challenges, but of course now that I've learned something new, then … Or, I think that, let me put it this way. It takes me a long time to reach a certain level of understanding. But when I finally understand something, then I'm really good at it. So, anyway, at least in the fall, new things came pretty quickly, and I didn't have enough time to digest everything. (Student E)

Time management and scheduling of studies were challenging. Difficulties in planning timetables and a surprise or an uneven distribution of schoolwork led to feelings of high workload and difficulties coping with studies. According to the interviewees, the schedule looked empty at first, but at some point, there were many activities going on at the same time and the work was piled up. Problems with timing also hindered students from working better than they would like. Student A described the challenges in coping with studies when there was time pressure:

> That they are just challenges in time management and that they are demanding, but they do not test motivation but rather the ability to cope. Which then … which is why it's so difficult when you want to do it. But then you face the reality that you can't do as much as you would like to, so … (Student A)

Sometimes, the challenging content would force students to spend much time on the tasks, causing difficulties in completing other tasks. Student B discussed the difficulty in predicting the amount of work to be done and the challenges in scheduling:

> At first, I felt like I didn't have nearly as much to do as I should have, just because a lot of the courses were online. Then, the schedule looked rather empty, and I would always feel like I should take more classes, so it wouldn't be this way. But luckily, I didn't because somewhere along the way, I felt that there was a little too much to do. (Student B)

All in all, the lack of planning or organising studies came across in every interview. Students recognised that more organised studying could help them to share the amount of work evenly, to finish tasks before last moments before deadlines, and thus prevent the work from collapsing.

5.5.3. Learning approaches in relation to self-efficacy

Self-efficacy was significantly negatively correlated with the surface approach ($\beta = -.530$, $p < .001$). The more the students adopted the surface approach to their studies, the lower their self-efficacy. Organised studying was almost significantly correlated with self-efficacy ($\beta = .212$, $p = .054$). Deep learning was not statistically significantly correlated with self-efficacy.

The challenges in the learning process and understanding content, which refers to surface learning, leading to decreased self-efficacy in one's capability to cope with tasks, were also discussed in the interviews. Self-efficacy was partially explained by previous experiences (Section 5.3), and the challenges in accomplishing tasks were considered to decrease beliefs of one's own capabilities. Student D described his/her challenges with internalising learning content had caused feelings of low capability, and considered whether he/she could cope with future studies:

> Oh well, when you feel like you can't do any of those tasks yourself, that you just need help all of the time, that's when you get a little bit of the feeling like you can't do anything yourself. - - I've been thinking a little bit about whether I'll be able to do well in this field of study. (Student D)

Student A then reflected that when workload was high, the learning results could be weaker and the deep understanding may not be achieved, even if earned points of weekly tasks are good:

> Let's say that it may be the case that the study results that I can remember are weaker. But when I think about whether I have learned or not, only time will tell. So, if I have a harder week, then I may not necessarily realize during that week if I get on average 7-8 points from the demos, then it may not necessarily be visible about how well I have internalized the tasks. Rather, it may come back to me later, that, okay, how is this so hard for me? Why don't I understand this? (Student A)

The comments reflect the kind of surface learning that may cause later difficulties with learning and feelings of low capability.

5.5.4. Study progress in relation to burnout, self-efficacy and learning approaches

Surface learning was negatively correlated with the total number of credits ($\beta = -.517$, $p < .05$). Deep learning had a weak indication of positive association with study progress ($\beta = -.353$, $p = .07$). Organised studying was not statistically significantly correlated with study progress. Self-efficacy and burnout were not significantly correlated with the total number of credits.

6. Discussion

This study extends our knowledge of the early academic obstacles that first-year IT students encounter, focusing on identifying their causes and consequences. The study adds to understanding about students' early experiences by investigating the relations between burnout, self-efficacy and learning approaches through the survey data, deepened and explained with qualitative interview data. We found out that burnout and self-efficacy correlated significantly negatively with each other. Self-efficacy correlated negatively, and burnout positively with surface approach. Burnout correlated negatively with organised studying. Self-efficacy, in turn, had a weak indication of positive correlation with organised studying. In relation to study progress, only surface approach correlated significantly negatively. Student reflections brought up underlying issues behind these experiences that the survey data alone did not reveal. Students seemed to be motivated to study, but some struggled with time management, high workload and low self-efficacy, and were adopting a surface approach to studies because of time pressure and the challenges with study content. Based on our findings, we suggest planning for additional support and teaching study skills in the beginning of the studies.

6.1. Burnout and self-efficacy beliefs

The students had some experiences of burnout, especially inadequacy and exhaustion, in the early phases of their studies. The greater the burnout the students experienced, the lower their experienced self-efficacy. The causality between these phenomena may be twofold: if students feel exhaustion or inadequacy, their future self-efficacy may decrease. Conversely, having a great sense of ability to cope with challenging situations decreases distress and anxiety (Bandura 1997). Therefore, self-efficacy may also be a protective factor against burnout. In turn, low self-efficacy may increase the probability of exhaustion while meeting challenges and experiencing pressure and a high workload in studies.

Even if some of the students experienced high levels of workload or struggled with the scheduling and challenging content, the interviews showed that their motivation was high despite the possible difficulties. The students stated that they were eager to learn and wanted to invest and put effort into their studies and that they found the study content interesting. The survey data also showed that cynicism was the lowest among the sub-dimensions of burnout. This means that the students did not struggle that much with the topics of interest, motivation, or meaningfulness of their studies. Hyytinen et al. (2022) similarly found that students experienced relatively high exhaustion and inadequacy, but less cynicism in their first study year. Feelings of interest and high motivation may be protective factors against feelings of burnout. Cynicism and inadequacy have been recognised to be correlated with each other (Väisänen et al. 2018). Based on the interview data, overwhelming challenges in the study content along with time pressure and comparing themselves to others led to feelings of low self-efficacy and feelings of inadequacy. This may have led further to feelings of exhaustion and even to cynicism, decreased motivation and doubts about one's ability to cope and even suitability for the field. Earlier study also shows that early experiences of exhaustion may act as a first signal of burnout (Turhan et al. 2023), while feelings of cynicism are considered to develop later (Turhan et al. 2022). It is therefore worth recognising and taking seriously the first signs of students' burnout symptoms.

Feelings of burnout have been recognised as a risk factor for student attrition in earlier studies (Bask and Salmela-Aro 2013) and self-efficacy as an important factor for persistence in studies (Lent et al. 2016). Therefore, students who experience both low self-efficacy and high burnout may be at increased risk of delayed studies or dropout. These challenges should be taken into account as early as possible to provide timely support to students in the early phases and to prevent the further development of burnout. Information about students' experiences can help identify those students for whom additional support may be necessary. Social, emotional, and informational support is considered a protective factor from burnout (Salmela-Aro 2022; Salmela-Aro et al. 2008; Väisänen et al. 2017). Teachers' caring and positive peer relationships play an important role in students' engagement (Fredricks 2011), and interactions and relationships between peers and faculty members are important for students' well-being and persistence in studies (Bork and Mondisa 2022; Väisänen et al. 2017). Awareness and easy access for student counselling services also plays an important role in supporting students' coping abilities and well-being (see e.g. Turhan et al. 2023).

The students reported that peers were an important source of maintenance of study well-being and that the threshold for asking for help from peers was low. Faculty encouragement has been suggested to promote students' self-efficacy (Hsu et al. 2021), which is linked to satisfaction with the field of study and connection to instructors (Micari and Pazos 2016). Forming home groups and 'your own teacher' system is one way to ensure that students have a time and place for discussions between each other and with at least one member of the teaching staff, who knows the overall picture of students' situations and the amount of the total, actual workload of students at the individual level, what kind of support they require and how they feel about their studies. This would make it easier to approach the staff, seek help during problem situations and ensure that everyone stays involved. Having free time, hanging out with friends, and engaging in sports and other activities were also described as important for study well-being. Students should have enough time for such activities in their lives as well.

6.2. Time and support for deep processing and organising studies

Surface approach was positively correlated with burnout, which is in accordance with previous research (Asikainen et al. 2020, 2022). In turn, the surface approach was negatively correlated with self-efficacy. The causalities between these experiences may be twofold. Students who need to repeat study content and have difficulty understanding concepts (i.e. surface approach) may have more feelings of burnout and lower beliefs about their learning. Self-efficacy builds on previous experiences of one's own performance (Bandura 1997). Therefore, students who adopt surface approach and have difficulties with creating a comprehensive understanding of the learning content, may gain beliefs about the inadequacy of their own abilities. Conversely, a high experienced workload and study demands, its resulting exhaustion and low beliefs in one's capability may steer students to use the surface approach in their learning. Earlier research has also shown that students with low self-efficacy beliefs are adopting more surface strategies during their studies (Prat-Sala and Redford 2010). The surface approach has been found to be negatively correlated with motivation, while the deep approach is positively correlated with motivation when students perceive a high workload (Kyndt et al. 2011). According to the interviews, the students seemed to be motivated, but some still struggled with the learning content, which should be quickly assimilated, and described feelings of inadequacy or exhaustion.

Lindblom-Ylänne, Parpala, and Postareff (2019) recognised that university students often adopt both surface and deep strategies rather than only the surface approach and that the use of surface strategies depends on varying factors, such as motivation and self-efficacy. The interviews showed that the students seemed to be both surface and deeply oriented. Although they wanted to understand and consider the content deeply, either the content was still too challenging or they needed to hurry because of deadlines, which drove them to take a surface-oriented attitude. The students also stated that the quality of learning decreased when there was much work to do

at the same time. Sometimes, this leads them to seek the easiest and fastest ways to complete their tasks, thus making the learning more surface. The contradiction between intentions and resources could be exhausting and decrease the motivation to study. The surface approach was also negatively correlated with study progress. This indicates that challenges in reaching a conceptual understanding and the need for repeating tasks may become obstacles to passing the courses. Surface learning may actually take more study time (Kember et al. 1995) because the time for studying, for example, is spent on numerous repetitions of watching videos, as one interviewee described, and therefore lead to delayed studies. Students who struggle with completing courses and adopt surface approach, may again experience increased symptoms of burnout and lowered self-efficacy beliefs.

Ensuring that students have time and peace to process learning content thoroughly and giving them sufficient advice may encourage them to take a deeper approach to their studies and make room for new insights, reflection and enjoyment in learning and understanding (Chambers 1992). Further, that could help them to develop and maintain positive beliefs about their capabilities (i.e. strong self-efficacy). Moreover, discussions about possible challenges or 'failures' in studies with peer groups and teachers can offer students a safe environment in which to reflect on and interpret their performance in a positive and constructive manner and build confidence in the future (Lane, Lane, and Kyprianou 2004). This is especially important in the field of IT, in which many of the subjects and future requirements are built on top of what was previously learned and further progress in studies can be difficult without proper conceptual understanding. Moreover, according to the interviewees, working in groups was also seen to enhance the deep orientation towards learning. If the group worked well together, students could obtain different views and reflect on their own and others' views and opinions and discuss them. Group-based learning may be a way to encourage students to adopt deep learning. In well-organised, group-based learning, the roles in the group are clear, and the members of the group have the same motivations and goals. The methods and targets of assessment should also be considered from the point of view of fostering deep conceptual learning (Biggs, Kember, and Leung 2001), and alternative ways to accomplish and assess the courses should also be considered (Entwistle 2009).

By contrast, organised studying approach was negatively correlated with burnout, and had an almost significant correlation with self-efficacy. Asikainen et al. (2022) also found that especially cynicism and inadequacy had a negative correlation with organised studying. All interviewees considered that they hardly planned their study timetable and studied only whenever their alertness was appropriate and when the deadlines were close. Nevertheless, the students aimed to start planning their studies better and felt that doing so would be helpful for their studies in the future. The students also described a surprising amount of work that was not distributed evenly during the semester; the schedule suddenly got filled, although it had previously been quite empty. Scheduling studies meaningfully could prevent feelings of exhaustion, and help believing in one's own capability to cope in studies. Future studies are needed regarding how students' burnout symptoms are connected to difficulties with organising studies, and if difficulties with organising studies can eventually worsen the burnout feelings.

Time and effort management skills are shown to be important also for academic achievement (Asikainen et al. 2020; Parpala et al. 2022). Matters related to the organisation of studies and a lack of guidance have been previously found to be among the 10 most important reasons for study delays (Liimatainen et al. 2011). According to Sæle et al. (2017), the strategic (i.e. organised) approach works as a mediator between deep approach and study success. Studying at a university requires students to be more self-directed than at a secondary school. Therefore, students who come directly from upper secondary schools would probably need more advice with study skills and scheduling and planning their studies right from the beginning.

6.3. Limitations

The investigated phenomena are multifaceted and could be measured also with different measurements and self-report surveys. However, the HowULearn survey is a highly validated survey and

widely used in the Finnish context to study these phenomena. Self-reports may always have some bias but enable examining students' perceptions among large cohorts. Despite the number of interviews being small, they provided in-depth insights to students' perceptions. However, further research would be needed to investigate more broadly the nature of cause–effect relationships between, and the reasons behind the students' experiences among larger cohorts using qualitative methods. Further research is also needed to understand the temporal development of students' experiences to see how experiences of burnout, self-efficacy and used learning approaches change over time.

The COVID-19 pandemic could have affected students' experiences, especially in autumn 2021, when COVID-19 restrictions were still in place. COVID-19 pandemic had psychological impacts on students worldwide, and the pandemic-related feelings of stress, anxiety, and isolation were reported (Browning et al. 2021). Pandemic and changes on study-related demands, like distance studies, may have had an impact also on students' learning experiences and burnout (see Salmela-Aro et al. 2022). In autumn 2022, when the survey was conducted for a second time, the restrictions were lifted in Finland, and in autumn 2023 the pandemic situation had calmed down. However, the averages of the results of all the three cohorts were similar; thus, it appears that the pre–post COVID-19 study arrangements did not affect the survey responses on average. Moreover, the COVID-19 pandemic could have had multiple long-term effects on students and their studies.

7. Conclusion

The development of interventions that support students in the beginning of their studies requires understanding the multidimensional connections of students' experienced burnout, self-efficacy, learning approaches, and students' own reflections about the causes and consequences behind these experiences. Burnout and self-efficacy had strong negative correlation between each other. Burnout correlated positively with surface approach to learning, and negatively with organised studying. Self-efficacy in turn correlated negatively with surface approach. Study progress correlated negatively only with the surface approach. We interpreted the results along with the interview data to understand the relationships between, the causes behind and the consequences of these phenomena. The causal relationships can be explained in two ways: high perceived workload causes exhaustion and feelings of inadequacy, thus affecting students' self-efficacy and leading them to doubt their own coping mechanisms and capabilities. Strong self-efficacy may protect from feelings of burnout, whereas low self-efficacy may increase the risk of burnout and further cynicism. Adopting the surface approach, and problems with organising studies may lead to feelings of burnout and low self-efficacy. In turn, low self-efficacy may lead to adopting the surface approach. At the same time, highly demanding studies with time pressure and high workload, which cause feelings of exhaustion, may lead students to adopt the surface approach as a coping strategy. Further, the surface approach is connected with low study progress.

The surface approach may not be a consciously chosen strategy for studying. Instead, it may also be a style of learning that arises from a conflict of expectations and capacity, in which knowledge remains fragmented, must be repeated and no deep understanding develops. Adopting a surface approach may be a consequence of time pressure, but may actually take more studying time, and together with challenges with organising studies lead to further challenges with burnout, self-efficacy and progressing in studies. Ensuring that students' actual workload in the first semester is reasonable, and providing opportunities and time to process the content to be studied can encourage the enactment of deep learning strategies. Discussions and meetings with teachers and peers in group situations can be a way to ensure the exchange of experiences between students and faculty and can offer students a place to reflect on and receive support from both peers and teachers during challenges in their first study year. These meetings can enhance students' engagement in their studies, offer more structure and include advice for students who struggle with time management and planning their studies. Understanding the effects of such interventions requires further research.

Students are likely to have the desire to understand and put effort into their studies. Therefore, more research is needed to develop learning environments that optimally support students' self-efficacy, prevent them from burdening themselves in their studies and encourage them to take the deep approach in their studies.

Disclosure statement

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Raija Hämäläinen a Full Professor (Ph.D.), works in the field of technology-enhanced learning at the Center for Research for Learning and Teaching at the University of Jyväskylä, Finland. Belonging to the elite global top 3%, the JYU research centre is among the leading European research groups in learning and teaching. Recently, Raija and her research group were awarded the European Commission's VET Excellence Award. The driving force for their research is a rapidly changing world in which structural change is reshaping learning and professional development. The preconditions for designing future learning and professional development are the analysis and understanding of learning and interaction processes and their contextual adaptations. Specifically, Raija and her group seek to understand learning and professional development by investigating how learning and interaction processes occur and unfold over time with novel methods, such as eye-tracking, heartrate variability and prosodic analysis of voice.

Lauri Kettunen is a professor of computational sciences at the University of Jyväskylä, Finland. He is also the Vice Dean responsible for education among the faculty of information technology and has been in charge of the planning and implementation of the new engineering degree programme at the university. His scientific research activities have focused on the intersecting field of technology, mathematics and IT.

Ethical statement

The study was approved by the Human Sciences Ethics Committee of the University of Jyväskylä: Approval number: 862/13.00.04.00/2021.

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Appendices

Appendix 1

Table A1. Total number of respondents and total number of all students in each year and in each study programme, and response rates of each group.

Degree programme	2021 Respondents/ response rate	2022 Respondents/ response rate	2023 Respondents/ (response rate)	Total respondents/ response rate
Information and software engineering	19/51.4%	13/33.3%	21/55.3%	53/46.5%
Mathematical information technology	13/21.7%	17/27.9%	16/21.9%	46/23.7%
Education technology	5/62.5%	1/6.3%	6/37.5%	12/30%
Technology management	–	–	4/20%	4/20%
All programs	38/36%	31/26.7%	47/32%	116/31.5%

Appendix 2

HowULearn survey items: learning approach items, self-efficacy items and burnout items.

Learning approach items.

Surface learning	
LEARN1	I often have trouble making sense of the things I have to learn.
LEARN3	Much of what I've learned seems no more than unrelated bits and pieces.
LEARN7	I am unable to understand the topics I need to learn because they are so complicated.
LEARN9	Often I have to repeat things in order to learn them.
Deep learning	
LEARN5	Ideas and perspectives I've come across while I'm studying make me contemplate them from all sides.
LEARN6	I look at evidence carefully to reach my own conclusion about what I'm studying.
LEARN11	I try to relate new material to my previous knowledge.
LEARN12	I try to relate what I have learned in one course to what I learn in other courses.
Organised learning	
LEARN2	I put a lot of effort into my studying.
LEARN4	On the whole, I've been systematic and organised in my studying.
LEARN8	I organise my study time carefully to make the best use of it.
LEARN10	I carefully prioritise my time to make sure I can fit everything in.

Self-efficacy items.

Self-efficacy	
SELF1	I believe I will do well in my studies.
SELF2	I'm certain I can understand the most difficult material in my studies
SELF3	I'm confident I can understand the basic concepts of my own study field.
SELF4	I expect to do well in my studies.
SELF5	I'm certain I can learn well the skills required in my study field.

Burnout items.

Exhaustion	
EXH1	I feel overwhelmed by the work related to my studies.
EXH2	I often sleep badly because of matters related to my studies.
EXH3	I brood over matters related to my studies during my free time.
EXH4	The pressure of my studies causes me problems in my close relationships with others.
Cynicism	
CYN1	I feel a lack of study motivation and often think of giving up.
CYN2	I feel that I am losing interest in my studies.
CYN3	I'm continually wondering whether my studies have any meaning.
Inadequacy	
INAD1	I often have feelings of inadequacy in my studies.
INAD2	I used to have higher expectations of my studies than I do now.

Appendix 3

Correlation matrix of the burnout items, their means and variances. In the lower triangular are item correlations (spearman) and in the upper triangular are significance levels of the correlations (p-values less than .05 are not shown).

Items	1.	2.	3.	4.	5.	6.	7.	8.	9.
1. EXH1	**1.00**								
2. EXH2	0.40	**1.00**							
3. EXH3	0.48	0.47	**1.00**						
4. EXH4	0.42	0.47	0.36	**1.00**					
5. CYN1	0.31	0.33	0.30	0.49	**1.00**				
6. CYN2	0.37	0.42	0.35	0.45	0.74	**1.00**			
7. CYN3	0.28	0.49	0.39	0.38	0.41	0.60	**1.00**		0.07
8. INAD1	0.45	0.41	0.48	0.38	0.44	0.49	0.46	**1.00**	
9. INAD2	0.34	0.28	0.43	0.37	0.44	0.42	0.17	0.48	**1.00**
Mean	2.82	2.02	3.08	1.90	1.92	1.91	2.14	2.75	2.59
Variance	1.25	1.08	1.39	1.07	1.10	1.10	1.39	1.58	1.41

Correlation matrix of the learning approach items, their means and variances. In the lower triangular are item correlations (spearman) and in the upper triangular are significance levels of the correlations (p-values less than .05 are not shown).

Items	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
1. LEARN1	**1.00**	0.52								0.37		
2. LEARN2	−0.06	**1.00**	0.56			0.12	0.72	0.05	0.05	0.29	0.58	0.39
3. LEARN3	0.52	−0.05	**1.00**					0.29		0.38		
4. LEARN4	−0.31	0.25	−0.37	**1.00**			0.06					
5. LEARN5	−0.21	0.21	−0.29	0.19	**1.00**			0.51	1.00	0.76		
6. LEARN6	−0.22	0.15	−0.27	0.27	0.38	**1.00**	0.16	0.33	1.00	0.35		
7. LEARN7	0.54	0.03	0.37	−0.18	−0.19	−0.13	**1.00**	0.41		0.14		
8. LEARN8	−0.22	0.18	−0.10	0.51	0.06	0.09	−0.08	**1.00**	0.32			
9. LEARN9	0.38	0.18	0.31	−0.19	0.00	0.00	0.32	−0.09	**1.00**	0.77	0.86	0.32
10. LEARN10	−0.08	0.10	−0.08	0.41	−0.03	0.09	−0.14	0.44	−0.03	**1.00**		
11. LEARN11	−0.38	0.05	−0.40	0.30	0.28	0.43	−0.26	0.23	−0.02	0.19	**1.00**	
12. LEARN12	−0.33	0.08	−0.40	0.29	0.32	0.33	−0.28	0.23	−0.09	0.19	0.66	**1.00**
Mean	2.43	3.41	2.47	3.16	3.53	3.14	2.46	3.16	3.47	2.72	4.05	3.81
Variance	0.72	0.89	0.76	0.91	0.77	0.97	0.88	1.13	0.84	1.45	0.55	0.76

Correlation matrix of the self-efficacy items, their means and variances. In the lower triangular are item correlations (spearman) and in the upper triangular are significance levels of the correlations (p-values less than .05 are not shown).

Items	1.	2.	3.	4.	5.
1. SELF1	**1.00**				
2. SELF2	0.62	**1.00**			
3. SELF3	0.53	0.59	**1.00**		
4. SELF4	0.66	0.70	0.58	**1.00**	
5. SELF5	0.60	0.74	0.71	0.69	**1.00**
Mean	4.03	3.67	4.24	3.84	4.00
Variance	0.68	0.90	0.67	0.76	0.73

Appendix 4

Confirmatory factor and reliability analysis of the burnout.

	Factor loading (standardised)	Std.err	z-value	R-square	Cronbach's alpha	Composite Reliability
EXH1	1.000 (.709)			.503	.78	.78
EXH2	.874 (.667)	.148	5.899***	.444		
EXH3	1.027 (.689)	.183	5.601***	.474		
EXH4	.863 (.661)	.150	5.744***	.437		
CYN1	1.000 (.837)			.701	.82	.85
CYN2	1.124 (.942)	.105	10.740***	.888		
CYN3	.816 (.608)	.117	6.987***	.369		
INAD1	1.000 (.775)			.601	.64	.66
INAD2	.741 (.609)	.148	5.000***	.370		
Exhaustion	1.000 (.859)			.739	.87	
Cynicism	.914 (.708)	.214	4.269***	.502		
Inadequacy	1.407 (.982)	.289	4.878***	.965		

Model fit statistics: CFI = .94; RMSEA = .09, 90% CI = [.05,.13]; SRMR = .06; AIC = 2817.611. *** *p*-value < .001.

Appendix 5

Confirmatory factor and reliability analysis of the learning approaches.

	Factor loading (standardised)	Std.err	z-value	R-square	Cronbach's alpha	Composite Reliability
Surface learning					.74	.74
LEARN1	1.000 (.852)			.726		
LEARN3	.798 (.663)	.129	6.170***	.439		
LEARN7	.834 (.643)	.141	5.918***	.414		
LEARN9	.567 (.446)	.128	4.432***	.199		
Deep learning					.71	.69
LEARN5	1.000 (.439)			.267		
LEARN6	1.321 (.517)	.383	3.451**	.586		
LEARN11	1.477 (.765)	.405	3.645***	.586		
LEARN12	1.693(.747)	.414	4.086***	.558		
Organised learning					.66	.68
LEARN4	1.000 (.817)			.668		
LEARN2	.344 (.285)	.141	2.448*	.082		
LEARN8	.890 (.654)	.134	6.634**	.428		
LEARN10	.865 (.561)	.156	5.542**	.314		

Model fit statistics: CFI = .96; RMSEA = .05, 90% CI = [.00,.08]; SRMR = .07; AIC = 3464.045. * *p*-value < .05, ** *p*-value < .01, *** *p*-value < .001.

Appendix 6

Confirmatory factor and reliability analysis of self-efficacy.

	Factor loading (standardised)	Std.err	z-value	R-square	Cronbach's alpha	Composite Reliability
Self-efficacy					.92	.92
SELF1	1.000 (.785)			.616		
SELF2	1.211 (.824)	.160	7.556***	.680		
SELF3	1.037 (.817)	.092	11.217***	.667		
SELF4	1.109 (.822)	.100	11.126***	.676		
SELF5	1.212 (.916)	.109	11.169***	.839		

Model fit statistics: CFI = .99; RMSEA = .10, 90% CI = [.00,.19]; SRMR = .03; AIC = 1081.734. *** *p*-value < .001.

Appendix 7

Factor loadings of survey items in the structural equation model.

	Factor loading (standardised)	Std.err	z-value	R-square
Burnout				.781
EXH1	1.000 (.739)			.546
EXH2	.819 (.648)	.137	5.978***	.420
EXH3	.937 (.665)	.168	5.566***	.443
EXH4	.818 (649)	.143	5.722***	.422
CYN1	1.000 (.848)			.720
CYN2	1.099 (.937)	.078	14.158***	.878
CYN3	.780 (.591)	.116	6.728***	.349
INAD1	1.000 (.759)			.576
INAD2	.765 (.614)	.112	6.827***	.377
Exhaustion	1.000 (743)			.553
Cynicism	1.167 (798)	.224	5.201***	.637
Inadequacy	1.521 (.976)	.229	6.629***	.952
Learning approaches				
Surface learning				
LEARN1	1.000 (.805)			.649
LEARN3	.843 (.654)	.127	6.635***	.428
LEARN7	.954 (.687)	.129	7.392***	.472
LEARN9	.610 (.457)	.128	4.751***	.209
Deep learning				
LEARN5	1.000 (.457)			.209
LEARN6	1.238 (.511)	.346	3.579***	.261
LEARN11	1.360 (.738)	.357	3.812***	.544
LEARN12	1.620 (.749)	.393	4.119***	.561
Organised learning				
LEARN4	1.000 (.761)			.579
LEARN2	.418 (.320)	.141	2.963**	.102
LEARN8	1.015 (.692)	.134	7.579***	.479
LEARN10	.928 (.558)	.166	5.605***	.311
Self-efficacy				.475
SELF1	1.000 (.800)			.639
SELF2	1.201 (.835)	.149	8.060***	.698
SELF3	1.002 (.803)	.090	11.124***	.644
SELF4	1.094 (.828)	.099	11.062***	.685
SELF5	1.165 (.897)	.098	11.943***	.805
Study progress				.171

Model fit statistics: CFI = .88; RMSEA = .06, 90% CI = [.04,.07]; SRMR = .08; AIC = 7947.895.
** *p*-value < .01, *** *p*-value < .001.