

Effects of autonomy and control on student motivation and functioning in higher education

Marius Ole Johansen

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Abstract

Central to higher education is providing a nurturing ground for development, growth, learning, and well-being for students. A principal component of a successful learning environment for students entails the experience of feeling motivated. Using Self-Determination Theory as a framework, this thesis investigates how the dichotomy of autonomy and control relates to autonomous motivation, and how autonomous motivation relates to student functioning.

The investigation is conducted through three independent studies. In the first study, a cross-sectional design was employed to investigate how autonomy support and thwarting relates to effort, engagement, learning, and vitality in higher education STEM students. Using structural equation modelling, results suggests that the experience of autonomy support positively predicts autonomous motivation and in turn engagement, effort, and learning, whereas autonomy thwarting negatively relates to the same outcome variables. In the second study, a randomized experiment was conducted in an introductory statistics course for university students. Students were given either a *generic* exercise set (where the assignments were based on a provided data set of dart scores) or a *relevant* exercise set (where the assignments were based on real research data regarding global warming), where it was hypothesized that the experimental group (i.e., the *relevant* data set) would be perceived as more autonomy supportive than the control group (i.e., the *generic* data set). Using a pre- and post-test measuring emotional affect it was found that the control group experienced a decrease in positive affect and an increase in negative affect during the assignment, while the experimental group remained unchanged. Finally, a path model showed significant relationships between the exercise type and student motivation and vitality. The final study utilized multiple real-time assessments to investigate the dichotomous relationship of perceived autonomy need satisfaction and frustration among higher education students, and how these components underpin perceived value, interest, and vitality. Using linear mixed effects models, results indicate that the satisfaction of the need for autonomy positively

predicted vitality, situational interest, and perceived value, whereas autonomy need frustration was negatively related to the same outcome variables.

To conclude, the studies highlight the importance of providing an autonomy supportive educational context for students. By acknowledging and taking the underlying processes that affect student motivation into account, teachers and instructors can promote autonomous forms of motivation which can increase learning, persistence, engagement, and vitality in students. The results from these studies further expand upon the knowledge as to what affects student motivation and functioning, and the diversity of the methodological approaches to the different studies provides strong support for the validity of the overall hypotheses.

Sammendrag

I høyere utdanning er det viktig å tilby en mulighet for utvikling, vekst, læring og velvære for studenter. En essensiell komponent av et vellykket læringsmiljø er at studenter føler seg motiverte. Ved å bruke Selvbestemmelsesteori som et teoretisk rammeverk undersøker jeg hvordan todelingen av autonomi og kontroll henger sammen med autonom motivasjon, og hvordan autonom motivasjon relateres til ulike aspekt knyttet til psykologisk funksjon hos studenter.

Avhandlingen er bygget på tre ulike studier. Den første studien benytter et tverrsnittstudie til å undersøke hvordan autonomistøtte og -hindring er knyttet til innsatsvilje, engasjement, læring og vitalitet hos realfagstudenter i høyere utdanninger. Resultater fra Structural Equal Modelling-analyse indikerer at opplevelser av autonomistøtte predikerer autonom motivasjon og igjen engasjement, innsatsvilje og læring, mens autonomihindring er negativt tilknyttet de samme variablene. Den andre studien består av et gruppeeksperiment utført i et introduksjonskurs i statistikk for universitetsstudenter. Studenter skulle løse enten et generisk oppgavesett (hvor oppgavene var basert på et datasett om dart-scoringer) eller et relevant oppgavesett (hvor oppgavene var basert på ekte forskningsdata om global oppvarming). Hypotesen var at den eksperimentelle gruppen (relevant datasett) ville oppleve øvelsen som mer autonomistøttende enn kontrollgruppen (generisk datasett). Resultater viser at studenter i kontrollgruppen opplevde en økning i negative emosjoner i løpet av øvelsen, og en reduksjon i positive emosjoner. Det ble ikke målt noen endringer i den eksperimentelle gruppen. En stimodell viste signifikante relasjoner mellom hvilket oppgavesett studentene mottok og motivasjon. Den siste studien brukte gjentatte målinger til å undersøke det todelt autonome behovet blant studenter i høyere utdanning, og hvordan de underliggende komponentene påvirker verdisyn på faginnhold, interesse og vitalitet. Resultater basert på blandede modell-analyser indikerer at tilfredsstillende av det grunnleggende autonome behovet predikerer vitalitet, interesse, og verdisyn, mens autonomifrustrasjon var negativt relatert til de samme utfallsvariablene.

Studiene peker på at det er viktig med en autonomistøttende utdanningskontekst for studenter. Ved å anerkjenne de underliggende prosessene som påvirker studentmotivasjon kan undervisere forsterke mer autonome former for motivasjon som igjen kan øke læringsutbytte, engasjement og velvære hos studenter. Resultatene fra disse studiene gir et bidrag om hva som påvirker studentmotivasjon og fungering, og de varierte metodikkene i studiene gir et solid grunnlag for validiteten i de overordnede funnene.

List of publications

- Paper I** Johansen, M. O., Eliassen, S., & Jeno, L. M. The bright and dark side of autonomy: How autonomy support and thwarting relate to student motivation and academic functioning. *In review – Frontiers in Education*.
- Paper II** Johansen, M. O., Eliassen, S., & Jeno, L. M. “Why is this relevant for me?”: Increasing content relevance enhances student motivation and vitality. *In review – Motivation Science*.
- Paper III** Johansen, M. O., Eliassen, S., & Jeno, L. M. Autonomy need satisfaction and frustration during a learning session affect perceived value, interest, and vitality among higher education students. *In review - Contemporary Educational Psychology*.

Declaration of contributions

	Paper I	Paper II	Paper III
Research design	MOJ, LMJ, SE	MOJ, LMJ, SE	MOJ, LMJ
Data collection	MOJ	MOJ	MOJ
Data analysis	MOJ, LMJ, SE	MOJ, LMJ, SE	MOJ, LMJ
Writing manuscript	MOJ, LMJ, SE	MOJ, LMJ, SE	MOJ, LMJ, SE
Comments on manuscript	LMJ, SE	LMJ, SE	LMJ, SE, CBS

Note. MOJ = Marius Ole Johansen; LMJ = Lucas Matias Jenø; SE = Sigrunn Eliassen; CBS = Christian Bianchi Strømme.

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Introduction

Norway, like many other countries, has placed substantial emphasis on academic achievements. Following the *Bologna Process* (Bologna, 2022), the Norwegian government started focusing on enhancing the quality of education and learning (Meld. St. 16, 2016). Especially, the white paper “Culture for quality in higher education” (Meld. St. 16, 2016) aims to underpin instructors’ competence in teaching and lecturing by introducing and developing systems and processes that promote and appreciate excellent instructors in higher education. In 2017, the Norwegian Ministry of Education and Research passed a legislation in which all teachers and lecturers were to utilize active learning methods in their respective educational settings instead of the classical classroom setting, where the student is a passive recipient of the learning material (Studietilsynsforordningen, 2017). This shift from a teacher-centered education to a student-centered view is supported by a plethora of research which indicates beneficial outcomes such as deeper learning (Deslauriers et al., 2019; Freeman et al., 2014) and higher academic achievements (Hyun, Ediger, & Lee, 2017; Sesen & Tarhan, 2010). Central to such a student-centered educational context is student *motivation* (Brophy, 1983). Motivation, which can be defined as the reason for acting or behaving in a specific way, is an important aspect of a person’s psychological experiences as it delineates the antecedent of human behavior and functioning (Pintrich et al., 1994). In educational settings, studies indicate that student motivation is imperative as it has been linked to achievements (Steinmayr et al., 2019; Keller, Neumann & Fischer, 2016; Muenks, Yang & Wigfield, 2018; Taylor et al., 2014), persistence (Howard et al., 2021; Simon et al., 2015; Yeager et al., 2014; Ntoumanis & Standage, 2009; Miller et al., 2021), drop-out intentions (Rumber & Rotermund, 2015; Haivas et al., 2013; Gillet et al., 2012), psychological well-being (Jiang & Tanaka, 2019; Howard et al., 2021; Deci & Ryan, 2008), and learning (Manganelli et al., 2019; Kpolovie et al., 2014; Cerasoli et al., 2014). Hence, albeit policy makers and educational ministries are emphasizing the use of effective learning methods in the classroom, research on underlying psychological aspects of student motivation and functioning remains an imperative task

(Meens et al., 2018; Niemec & Ryan, 2009; Reeve, 2009), especially since motivation generally declines as one progresses through educational levels (Young et al., 2018).

The main aim of this thesis is to investigate the relationship between student motivation and aspects of student functioning in higher education. Specifically, this thesis investigates the role of autonomy as an explanatory variable underlying student motivation and functioning. This thesis is underpinned by three independent papers, each prodding motivation, antecedents of motivation, and student functioning outcomes using three very different quantitative methodologies; Paper I) a cross sectional study; Paper II) a randomized experiment; Paper III) a repeated measures design. Self-Determination Theory (SDT; Ryan & Deci, 2017) was utilized throughout this work as a theoretical psychological framework. SDT is a macro theory on human motivation, personality, growth, and wellbeing, and is a particularly useful framework due to its prominent and concise concepts of the fundamental psychological constituents underpinning human behavior and motivation (Ryan et al., 2021). Further, a collective of four decades worth of research using both quantitative and qualitative methodologies has proven SDT to be a solid framework encompassing human motivation. Hence SDT was chosen as a theoretical basis for the research encompassed in this thesis (Ryan et al., 2021; Ryan & Deci, 2017; Freeman et al., 2014).

Albeit SDT has a lengthy track record of research both within and outside of the educational realm, it is important to extend the current knowledge and literature of the framework. As policymakers and legislators continuously change the trajectories and scopes of how educational contexts should construe teaching, the theoretical approaches to research in education must also reflect the current standings of what mirrors a good learning climate, thus research is required to encompass the modern classroom. Further, due to the ever-evolving technological industry and scientific breakthroughs, science, technology, engineering, and mathematics (STEM) students are more sought after than ever before (Hafni et al., 2020; Dou et al., 2019; Christe, 2013). However, research indicates a significant decline in motivation among higher education STEM students (Salmela-Aro, 2020; Young et al., 2018), hence it is important to fully understand which

factors influence and relate to motivation. Investigating what facilitates and maintains motivation and how motivation in turn affect student functioning is therefore a crucial task as it paves the horizon for enhancing future teaching and educational settings, where optimal student functioning entails feelings of mastery, higher academic achievements, goal orientation, awareness of effective learning strategies, and psychological wellbeing (Bergsmann et al., 2013; Ryan & Deci, 2017).

Self-Determination Theory

SDT delineates that human behaviors are functions of either conscious or non-conscious motives driven by joy, desires, interest, fear, conscience, and personal values and goals (Vansteenkiste et al., 2018; Ryan & Deci, 2017). Self-determined behavior is the locus of SDT; children have an innate curiosity and want to explore and interact with their surroundings; students pursue academic endeavors aligned with their own personal interests and values. It is due to the understanding of how the mechanisms behind these psychological mediators that underpin behavior and actions works that one can leverage change in people. Following a classical example from Ryan and Deci (2017), a teacher cannot readily improve a students' engagement or academic achievements by physically altering a student's brain tissue. Instead, preferred behavioral outcomes can be modified at the psychological level by altering the educational environment and appeal to the student's personal interests and values. Albeit self-determined behavior is located at a psychological level, motivation and behavior originating within an individual can be affected by social contexts originating from outside the individual. SDT recognizes this dialectic proximal relationship and postulates that although behaviors and actions can originate from self-determination, social contexts can influence, support, thwart, and diminish these behaviors (Vansteenkiste, Ryan & Soenens, 2020; Vansteenkiste et al., 2018; Ryan et al., 2021).

SDT and motivation

Etymologically, *motivation* is derived from the Latin word *motivus*, meaning *to move to act* (O'Brien, 2015). Psychological theories regarding motivation have historically focused on what energizes and gives rise to action. Albeit the arrival of cognitive theories in psychology was accompanied with many changes to our understanding of psychological phenomena (Ryan & Deci, 2017), theories encompassing motivation still retained a unitary interpretation of motivation as a construct. Although one could study motivation in terms of strength, there was no differentiation in terms of qualities of motivation (Ryan & Deci, 2017). For instance, in the early 1900s, Yerkes and Dodson proposed an inverse-squared relationship between motivation and performance, where low amounts of motivation yielded low performance, moderately motivated people would optimally perform, while high amounts of motivation again would yield poor results as one would be too excited about the activity to actually perform it properly (Broadhurst, 1959). In the mid-1950s, there were mainly two theories conceptualizing human motivation; expectancy-valence (EV; Feather, 1988) and cognitive-behavioral (CB; Pearl, 1985) theories. According to EV theories, behaviors and outcomes were directly linked to the strength of motivation, where motivation is the product of valence, or psychological value, and the probability of a person being able to complete the task. In a similar fashion, CB theories view motivation as a unitary construct where motivation was predicted from how strongly an individual believed he or she was able to attain an activity or outcome (Kalodner, 2011).

SDT differs from these cognitive theories by emphasizing that motivation can attain different qualities. Instead of treating motivation as a singular psychological phenomenon, SDT proposes that motivation can manifest in different forms, where some are volitional and other forms are external (Ryan & Deci, 2017). Volitional forms of motivation refer to behaviors driven by interest or perceived personal value, whilst external motivation refers to actions performed due to pressure (Núñez & León, 2016). Since sources of motivation differ, so does the impact of the various types of motives. Not only do they differ in strength, but they also differ in the behavioral outcomes of

the activity that energizes the different motives. Hence, it is imperative to differentiate motivation in order to account for the effects of the different types of motives (Howard et al., 2021; Ketonen et al., 2018; Martela et al., 2016).

As SDT is a meta-theory, it encompasses several sub-theories regarding human nature and behavior. Three of these sub-theories were utilized in the work of this thesis; Basic Psychological Needs Theory (BPNT), Cognitive Evaluation Theory (CET), and Organismic Integration Theory (OIT). Relationships Motivation Theory (RMT), Causality Orientation Theory (COT) and Goal Content Theory (GCT) are not employed in this thesis and will not be elaborated.

Basic Psychological Needs Theory

Throughout the advent of empirical psychology, several theories have approached the concept of needs. For instance, Hull (1943) postulated that humans have basic needs anchored in physiological processes that energizes behavior and actions. Following the work of Murray's need theory, SDT proposes that basic human needs are rooted at the psychological level contrary to a physiological level (Ryan & Deci, 2017). According to SDT, all humans have a core set of basic psychological needs that are essential for nurturing human growth, development, and functioning (Warburton et al., 2020; Ryan, 1995). These needs acts as nutrients that are fundamental constituents for growth and well-being. Parallel to how humans need to satisfy basic physiological needs for health (water, oxygen, vitamins), humans need to satisfy basic psychological needs in order to sustain and promote healthy development and mental vigor (Martinek et al., 2021; Cronin et al., 2019). These basic needs are considered objective as satisfaction (or deprivation) has psychologically observable effects in individuals (Ryan & Deci, 2017). And just as the satisfaction of these needs promote growth and wellbeing, the thwarting of these basic psychological needs has objective observable decrements in growth and wellbeing.

The first of these basic needs is the need for *competence* (White, 1959). In SDT, competence refers to the experience of mastery and development of skills, feeling effective in tasks, and embracing difficult tasks. The need for competence is satisfied when a person is operating effectively in the interaction with a context where one can express their skills and capabilities (Buzzai et al., 2021). However, this basic need is easily thwarted. Whenever faced with challenges that appear too difficult or experiencing interpersonal criticism, the satisfaction of this need is rapidly diminished.

The second basic need is the need for *relatedness* (Baumeister & Leary, 1995). Relatedness need concerns feelings of social connection, a sense of belonging, feeling cared for and caring for others, and the experience of having contributed in a social context. When the need for relatedness is satisfied, one experiences a harmony in which one feels close to others while pertaining a sense of being integral to a context extending outside oneself (Inguglia et al., 2018).

The final basic psychological need within BPNT is the need for autonomy (deCharms, 1968). Etymologically, autonomy is derived from the Greek words *auto* (meaning self) and *nomos* (meaning law) and concerns the self-regulation of one's own behavior and actions (Ryan & Deci, 2017). According to SDT, humans continuously refine their preferences and personal values while simultaneously finding conformity between them (Vansteenkiste & Ryan, 2013; Ryan, 1995). The experience of this unification is the sense of volition, or *autonomy*. Autonomy concerns self-endorsement of one's actions, and when acting autonomous, one engages wholeheartedly and embraces the activity since the experience is aligned with an internal endorsement. On the other hand, acting in contradiction to one's volition induces incongruence and a pressuring conflict between the intra-individual and the social context in which the behavior takes place (Howard et al., 2021; Vansteenkiste, Niemiec & Soenens, 2010). It is noteworthy that according to SDT, behaviors can be either self-regulated or controlled by some external force. This nuance will be discussed in a later section of this thesis.

According to basic need theory, a need as a psychological construct rest on two fundamental assumptions; I) the deprivation of the nutrients that promote and satisfy the need will result in directly observable decrepitated forms of growth, wellbeing, and integrity, and II) providing nutrients that satisfy the basic needs facilitates growth, development, and providing a stage for which one can reach one's true potential (Vansteenkiste et al., 2020). This definition of basic needs is distinct to SDT's view on motivation as *desires* does not constitute a motivational concept. For instance, one might desire or *want* better grades or social recognition, but the satisfaction of this desire will in no way or form promote and enhance one's health, development, and wellbeing. Contrary, this will likely be accompanied by more detrimental effects. In other words, to be a basic need there has to be an objective and observable positive outcome regarding development, growth, and wellbeing from satisfying this need (Tsoi et al., 2018; Ryan & Deci, 2017). Further, since psychological needs are delineated in terms of wellbeing versus illbeing, there must be an antagonistic function of satisfaction, a function of cost, or need *frustration*.

Albeit need satisfaction is congruent with psychological growth and well-being, there is an idiosyncratic difference between low fulfillment of need satisfaction and experiencing basic need frustration (Bartholomew et al., 2011). Need frustration is experienced when the basic psychological needs are thwarted and can be psychologically pathogenic (Vansteenkiste & Ryan, 2013). Following a metaphor by Vansteenkiste and Ryan (2013), a flower needs water and nutritious soil (i.e., need satisfaction) to fully bloom and reach its potential. There is however a big difference in not providing this flower with enough water and instead watering the plant with salt water, which can be a lot more destructive than not satisfying the basic needs. It should be noted that the relationship between need satisfaction and need frustration is asymmetrical. Low need satisfaction does not necessarily imply need frustration, but the frustration of basic needs entails low need satisfaction (Bartholomew et al., 2011). Corresponding with this distinction, SDT categorizes the social context as either basic need supportive or need thwarting (Costa et al., 2016; Vansteenkiste & Ryan, 2013). Hence, according to BPNT, the social context can either genially foster an individual's

needs or be antagonistic towards the needs. A low need satisfaction is congruent with a passive social context, whereas need frustration actively obstruct needs (Bartholomew et al., 2011).

Cognitive Evaluation Theory

Cognitive Evaluation Theory (CET; Ryan & Deci, 2017) concerns the conceptualization of *intrinsic motivation*. Intrinsic motivation refers to behaviors acted out solely due to the inherent joy and pleasure of the activity itself. According to SDT, intrinsic motivation is not a direct result of socio-contextual events but rather an innate human disposition (Ryan & Deci, 2017). Yet, even though intrinsic motivation lies within the human propensity, this inherent disposition can be enhanced or diminished. Consequently, CET concerns the social-contextual factors that can either facilitate, maintain, or undermine intrinsic motivation (Deci, 1992).

Central to CET is the concept of *perceived locus of causality* (deCharms, 1968). Perceived locus of causality refers to different levels of experiences of autonomy. For instance, when a behavior is intrinsically motivated, one would have an internal perceived locus of causality (I-PLOC). Contrary, when a conscious behavior fails to resonate with an individual's innate curiosity or interest, the behavior becomes an instrument to achieve an outcome that is detached from the activity itself, and one would have an external perceived locus of causality (E-PLOC), in which the motivation becomes pressured or *controlled* (Cheon et al., 2018; Cerasoli, Nicklin, & Ford, 2014). An important area of research within CET is the study of these external contingencies as they can alter the locus of causality. According to Ryan and Deci (2017), external rewards or punishments can incite a shift in perceived locus of causality, going from internal to external. Even though individuals initially can perform an action due to inherent enjoyment (i.e., being intrinsically motivated), the introduction of external rewards would change the perceived locus of the causality of the behavior, i.e., the individuals would perceive the activity as worth doing because of this external

contingency instead of an innate interest. In other words, the advent of these external contingencies was able to undermine intrinsic motivation. This is a noteworthy topic as it implies that even though one undermines intrinsic motivation, people can relate the extrinsic contingencies (i.e., the rewards) to a positive outcome. Yet, since the reason for doing an activity now is detached from the activity itself, the external contingencies thus become the instrument from which behavior functions, thus the engagement is controlled by an external force (Ryan & Deci, 2017).

The use of external rewards (or punishment) can be a powerful motivator (Núñez & León, 2015). For instance, if a student were told by the parents to get good grades on the next test, the individual may be less than likely to comply with this request. However, if a substantial monetary reward was offered, the motivation to pursue this request could increase. These specific (potent) types of rewards can motivate *immediate* behavior (Ryan & Deci, 2017), but the problem with facilitating this motivation lies in its *maintenance*. Subsequently, as soon as the reward is diminished or terminated, the ability to facilitate motivation over time rapidly diminishes (Ryan & Deci, 2013). However, if the reward is not expected for performing a task, the reward is not considered a controlling factor as the individual is not expecting a reward for doing a task.

As mentioned, potent rewards can undermine intrinsic motivation by shifting the locus of causality from internal to external. However, external contexts can influence an individual's perception of an activity (Ryan & Deci, 2017; Ntoumanis & Standage, 2009). Thus, the external context can influence, and even enhance, their motivation. However, this is only the case if the experienced event has a *functional significance* for the person. The effect as to the facilitation of shifting the locus of causality to more internal rests on the individual's interpretation. That is, it's not the external context itself that promote or facilitate intrinsic motivation, but rather it depends on if the external context has a consequential or purposeful psychological meaning for the individual (Ryan & Deci, 2000).

Organismic Integration Theory and need satisfaction

Although intrinsic motivation is considered the highest form of motivation as a phenomenon, individual behavior in general life are often governed by behaviors that are not always intrinsically motivated. Work, chores, and homework are practices that are expected of humans. Organismic Integration Theory (OIT) concerns how individuals assimilate and integrate behavioral regulations, resulting in a spectrum of types of autonomous motivations based on how humans assimilate and integrate experiences into a coherent propensity (Ryan & Deci, 2017). The process of transforming the perceived context into internal values and beliefs resonating with an individual's own personal values is known as *internalization* (Vansteenkiste et al., 2018). When an event or behavior is internalized, OIT postulates that the behavior is in congruence with the individual's self, and the behavior becomes self-endorsed, or *autonomous*.

According to OIT, internalization is related to the satisfaction of the need for *competence*. Ryan and Deci (2017) argue that this relationship originates from how one at a young age purposefully and willingly engage in activities to mimic other children and their parents, while experiencing mastery and challenges in doing so. As an adult, internalization keeps supporting the competence need as one finds a job or a position in which one will keep experiencing growth of skills or the feeling of efficacy and mastery over time. Yet, the satisfaction of the basic need for competence does not fully constitute internalization (Kopolovie et al., 2014). In everyday life, individuals will internalize social situations and interactions when experiencing a sense of belonging, a connection to others, or feeling cared for. The satisfaction of the basic need for *relatedness* is a major constituent in energizing the internalization process.

As mentioned, it is through internalization that humans can fulfill the need for competence and relatedness (Coterón et al., 2020; Ryan & Deci, 2013). However, autonomy has a special role in the internalization process in terms of need satisfaction. The satisfaction of the need for autonomy acts as a vessel through which the conformation of aligning contextual perceptions with personal values and interests (i.e.,

internalization) where the two other basic psychological needs are *actualized* (Ryan & Connell, 1989). Albeit the satisfaction of need competence and relatedness are important aspects of internalization, neither will function without autonomy need satisfaction. Individuals internalize competence to the fullest when they feel effective or mastery over an activity or behavior they initiated themselves. That is, to fully satisfy the need for competence one need to satisfy the need for autonomy. Likewise, humans experience interconnectedness to other people or a sense of belonging when they *willingly* partake in the interconnection (Ryan & Deci, 2017). One can thus witness an interrelation of internalization with the satisfaction of the basic needs.

Central to SDT is the notion that the social context can either support the three basic psychological needs, thus facilitation internalization, or be controlling or antagonistic towards them (Vansteenkiste et al., 2010). An autonomy-supportive environment facilitates the internalization process and underpins psychological integration of experiences (Ahn et al., 2021). Controlling environments are too challenging, autonomy thwarting, and undermine the natural impulse towards internalization, resulting in a lesser human potential. Another problem regarding internalization relates to the social context. As mentioned, in general life one will often do chores and work that not necessarily reflects someone's personal values and interests. Thus, these behaviors are not fully internalized and hence not intrinsic in nature (Phillips & Johnson, 2018). However, one can still experience motivation when performing these activities due to the satisfaction of competence or relatedness needs. Albeit this internalization will perhaps make someone feel effective and provide a sense of belonging, the internalization is not fully complete as the activities are not done volitionally (Milyavskaya & Koestner, 2011; Vansteenkiste et al., 2010; Ryan & Deci, 1995). These behaviors can alas be autonomously motivated albeit being pressured by an external social context, but never fully internalized.

In an educational context, the satisfaction of students' psychological need for autonomy is determined by the interpersonal context in the classroom (Ryan & Deci, 2017; Black & Deci, 2000; Kember et al., 2008). A teacher can be autonomy supportive

by for instance bringing the students' perspectives and beliefs into the learning content and making content more relatable to everyday life and settings that students are either familiar with or can relate to (Vansteenkiste et al., 2018; Terrón-López et al., 2017; Núñez et al., 2014). Further, teachers can acknowledge and accept the students' values and reference frames, acknowledge and respect negative emotions they could experience during learning activities (Terrón-López et al., 2017; Reeve, 2009), as well as allow students time to reflect and ask questions (Reeve & Cheon, 2021).

In contrast, autonomy thwarting is teacher behavior that directs students to behave in a certain way (Assor et al., 2005). Teacher autonomy thwarting actively overrides students' perspectives and beliefs in the classroom and replaces them with the teacher's own. However, a teacher presenting their own perspective in the classroom is not thwarting in itself, but the social context becomes controlling when the teacher *pressures* their own perspective onto the students (Assor, 2005). Hence, the teacher's behavior becomes autonomy thwarting when the activity pressures students into changing their behavior (Reeve, 2009). This controlling context can change the students' perceived locus of causality from internal (i.e., feeling self-endorsed) to external (i.e., feeling controlled). In the classroom, teachers can be autonomy thwarting by for instance intrusively interrupt ongoing activities, dismissing questions, actively failing to not recognize students' beliefs, or using controlling language. Autonomy thwarting teachers also tend to exhibit low patience in the classroom and not giving students time to either ask questions or not enough time to provide answers (Reeve, 2009). The experience of autonomy thwarting affects their functioning as it induces a sense of external control, where the behavior is instead a function of a feeling of duty to others or their own negative emotions (Reeve, 2009; Reeve, Nix, & Hamm, 2003).

Types of internalization

Central to OIT is the differentiation of the various types of motivations based on internalization. As previously mentioned, when *extrinsically* motivated, the reason for a

behavior becomes a means to achieve an outcome that is separate from the activity itself (Vansteenkiste, Niemiec & Soenens, 2010). Since the reason to attain these outcomes vary in degree of internalization, extrinsic motivation cannot be categorized by a homogenous phenomenon. Instead, OIT specifies in total five different types of regulatory types, each different in quality and perceived locus of causality (Figure 1), where some are considered autonomous whereas others are more controlling depending on the degree of autonomy (Ryan & Deci, 2021).

External regulation is considered the least autonomous form of motivation. When externally regulated, the behavior is motivated by external contingencies, such as rewards or punishment (Vansteenkiste, Niemiec & Soenens, 2010). Since the behavior is a function of an external factor, individuals will only act when the contingency is actualized. As mentioned earlier, the effect of external contingencies can be very effective, but since the behavior is controlled solely by this external factor, the behavior will not be energized as soon as the reward or punishment is terminated. In an educational setting, an externally regulated student will for instance study to avoid failing an exam, fearing to do the semester over again. Since the behavior is characterized by a direct dependency on some external contingency, the reason for behaving is controlled by this external factor and hence the perceived locus of causality is external.

Introjected regulation refers to a process in which behavior that was controlled by an external contingency is now taken “into” the person (Ryan & Deci, 2017). Albeit freed from external pressure, introjected regulated behavior refers to behavior in which the assimilation of the value or reasoning behind doing an activity is only partial. Although the origin of the behavior comes from within, it is still controlled. For instance, a student can work on their assignment due to feelings of guilt or shame if they don't. The origin of the motivation comes from within, but it is still pressured as the activity has yet to become assimilated with the student's own personal values or interests. Thus, although the regulation is based on contingencies originating from within an individual,

it is still considered a controlled form of motivation as the behavior is controlled from conditional feelings (Ryan et al., 2021).

Identified regulation is an internalization in which an individual is able to identify values or meaning behind a behavior or activity (Ryan et al., 2021). This recognition is often characterized with self-endorsement, i.e., a sense of volition and autonomy, and hence is considered a more autonomous internalization with an internal perceived locus of causality. Although identified regulation is considered more autonomous where individuals act out of recognizing personal meaning or relevance behind an activity, it is not necessarily fully internalized. For instance, a student might study extra on a specific topic as they recognize that this particular subject might help them later in their academic endeavors. The regulation is still not entirely embraced and fully aligned with the person's own values and interests, but the behavior is now volitional in nature compared to introjected regulation.

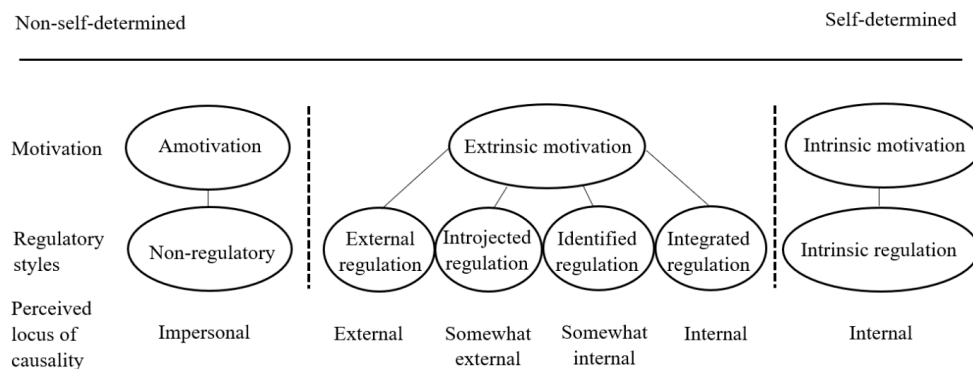
Integrated regulation is considered the most autonomous type of extrinsic motivation (Ryan & Deci, 2017). The integration occurs as an active transformative process of the identified regulation where the recognition of the behavior or activity is accompanied by a full assimilation and integration with an individual's own personal values, goals, and meanings. When integrated regulated, the behavior is more congruent with oneself, and hence the behavior is considered highly autonomous. The lack of an internal conflict between the behavior and internal values makes the behavior more authentic to the individual, and hence will be self-endorsed. A student that is integrated regulated will not only recognize personal value and meaning when studying but will also embrace the learning content as it for instance could be aligned with what the student wants to do for a living in the future.

Amotivation is somewhat separate from the autonomy spectrum but nonetheless an important regulation (Ryan & Deci, 2017). When someone is amotivated, the person is confined in a psychological state in which there is a complete absence of motivation

to act. Motivation is referring to intended behavior, but if a person finds no reason to act, the individual will have no intention to act and hence is considered amotivated.

Figure 1

The taxonomy of regulation styles according to level of autonomy



Note. Adapted from Ryan and Deci (2017, p. 193).

State of the art

Through the advent of modern experimental psychology, several theoretical frameworks and theories encompass human development, motivation, wellbeing, and functioning. However, due to the specific theoretical disposition of this thesis, the following literature review will mainly beset research conducted within the SDT perspective. Relevant studies were obtained through systematic searches in the online databases Google Scholar, Eric, and Web of Science. Relevant keywords included (often combined); autonomous motivation; controlled motivation; autonomy need satisfaction; autonomy need frustration; intrinsic motivation; extrinsic motivation; education; higher education; vitality; wellbeing; effort; positive/negative affect; engagement; interest; academic achievements; learning; self-determination theory; SDT; need satisfaction.

Autonomy support and thwarting

According to SDT, it is the interpersonal context in the classroom that can either support or thwart student autonomy and therefore affect to what extend the behavior has an internal or external perceived locus of causality (Black & Deci, 2000). As mentioned, it's the autonomy supportive behavior of the teacher that can nurture students' inner motivational resources (Reeve, 2009) in the classroom. When studying factors that facilitate motivation among higher education students, Kember et al. (2008) found that applying more practical and relevant elements to rather abstract topics would increase motivation among the students as it creates a more autonomy supportive environment. This is supported by a plethora of research across educational levels (see e.g., Terrón-López, 2017; Reeve, 2009; Kember et al., 2008; Frymier & Shulman, 1995). More recently, a review by Reeve and Cheon (2021) found that autonomy supportive teachers nurture and facilitate more autonomous forms of motivation among students. Based on a synthesis of 51 experiments, the authors concluded that teachers who provided rationales, avoided the use of controlling language, and provided students with time to

both think and ask questions fostered an autonomy-supportive learning climate (Reeve & Cheon, 2021). Further, Reeve (2009) reported that teachers who not only acknowledged, but also welcomed, negative emotions and connotations students experienced towards learning activities were also creating a more autonomy supportive classroom. While investigating the antecedents of autonomy among American adolescent students, Shen et al. (2009) found that teachers providing autonomy need support was positively related to autonomous motivation. Similar results have been reported by for instance Bronson (2016) where need satisfaction also predicted autonomous motivation in baccalaureate nurse students. This finding is also supported by a study among medical students where Feri et al. (2016) found that autonomy satisfaction positively predicted autonomous motivation. A more recent study by Ganotice et al. (2020) further corroborates this as they found need satisfaction to be a positive predictor of autonomous motivation among Chinese university students. In Croatia, Ljubin-Golub et al. (2020) conducted a study among 213 university students and reported similar results using structural equation modelling, where autonomy satisfaction was a positive predictor of autonomous motivation. A recent meta-study by Bureau et al. (2021) conducted over 144 studies and almost 80,000 students further corroborates this relationship where they found that autonomy need satisfaction was positively related to autonomous motivation.

In contrast to autonomy support, autonomy thwarting is controlling teacher behavior (Assor et al., 2005). In a classroom setting, a teacher is autonomy thwarting by for instance overriding the students' perspectives on subjects and replaces them with the teacher's own. Further, the use of controlling language and being dismissive are also considered autonomy thwarting in the classroom. Patall et al. (2018) conducted a diary study on high school students and hypothesized that thwarting practices in educational contexts found promote experiences of controlled motivation. Multilevel modelling provided support for this hypothesis, and it was found that autonomy thwarting practices positively predicted controlled motivation and undermined autonomous motivation. When students are subject to autonomy thwarting experiences, their positive functioning is weakened as it induces a sense of external pressure (Reeve, Nix, & Hamm, 2003). In

a longitudinal study, Cece et al. (2018) reported similar results where thwarting of autonomy need satisfaction predicted controlled forms of motivation. Using cluster analysis, Burgueño et al. (2022) support this claim where they also found that thwarting of autonomy was positively linked to controlled motivation among physical education students, a finding that is mirrored in a recent study by Cuevas-Campos et al. (2020). Path analysis indicated that whilst autonomy need satisfaction positively predicted autonomous motivation, the frustration of autonomy needs positively predicted controlled motivation. Rocchi and Pelletier (2017) reported similar findings in a study on motivation among coaches, where structural equation modelling indicated that autonomy need frustration positively predicted controlled motivation and was negatively related to autonomous motivation.

Autonomy's relation to aspects of student functioning

The concept of student functioning entails a broad spectrum of factors. This thesis focused on the psychological phenomena, or aspects, such as interest, vitality, emotional affect, engagement, perceived value, and effort.

From the SDT perspective, *interest* is considered the crux affect that concerns an individual's psychological relationship to an object, activity, or an idea that provides the appeal one desires at a certain moment (Deci, 1992). Interest pertains to an important factor of student functioning as several studies show that interest relates to a plethora of positive outcomes in educational contexts such as persistence (Ainley, Hidi & Berndorff, 2002), academic achievements (Harackiewicz et al., 2008), and student motivation (Ryan et al., 2021; Bolkan & Griffin, 2018). According to SDT, interest is directly related to the satisfaction of basic psychological needs, whereas in contrast, need frustration actively obstructs this development (Ryan et al., 2021). In a study among adolescent athletes, Reinboth et al. (2004) found that need satisfaction positively predicted interest in sports. Similarly, a cross-sectional study by Zhou et al. (2019) among primary students found that autonomy need satisfaction was positively related to

interest. This supports an earlier study by Minnaert et al. (2007), who also reported that autonomy need satisfaction positively predicted interest among secondary vocational students. Yet, these results contradict a recent study by Xiang et al. (2017), where no significant relationship between autonomy need satisfaction and interest was found.

Psychological wellbeing is a necessity for every student (and individual in general) and encompasses a wide spectrum of psychological phenomena (Ryan & Deci, 2013). A proxy for wellbeing is *subjective vitality* (Ryan & Deci, 2008). Within SDT, subjective vitality concerns an individual's awareness and tentativeness of experiencing aliveness and feeling energized. When someone is intrinsically motivated, the behavior is energized from within, hence one is more likely to experience feelings of vigor and aliveness (Tsoi et al., 2018). Contrary, behaviors with an external locus of causality are pressured and hence experienced as energy depleting. Alongside serving as a proxy for psychological wellbeing, vitality has also been linked to academic achievements and resilience in tasks and assignments (Garg & Sarkar, 2020; Vansteenkiste, Lens & Deci, 2006). According to SDT, the satisfaction of the basic psychological need for autonomy is a fundamental constituent in experiencing wellbeing, whereas need frustration undermines wellbeing (Ryan et al., 2021). In line with SDT tenets, studies have found that autonomy need satisfaction indeed is positively related to vitality among students (Black & Deci, 2000). In a study among adolescent students in physical education, Mouratidis et al. (2011) found that autonomy support was positively linked to experiences of high vitality. This result is supported in a study by Taylor and Lonsdale (2010), where autonomy need satisfaction positively predicted vitality among British and Chinese students. Similar results were reported by Ommundsen et al. (2010). A more recent study by Nishimura and Suzuki (2016) among undergraduate students in Japan support these findings, where structural equation modelling revealed that autonomy need satisfaction positively predicted vitality, while need frustration was negatively related to the same variable.

According to SDT, people have a natural tendency to be proactive by continuously refining preferences and values while finding conformity between them as

we grow (Ryan, 1995). This experience is considered the antecedent of autonomy; therefore, the concept of *personal value* is situated as an important constituent in experiencing autonomous motivation. Someone who acts autonomously acts based on the internalization of the activity in regard to their own sense of self and values (Vansteenkiste, Niemiec & Soenens, 2010). Hence, helping students see personal relevance and meaning in learning activities can foster motivation (Wagner et al., 2006). A study by Hulleman et al. (2010) found support for this line of reasoning in an experiment among college undergraduates, where the experimental condition was to induce a sense of value by providing a rationale for the learning activity. These results are supported by a similar study by Canning and Harackiewicz (2015). Further, in a study among high school students, Patall et al. (2013) investigated how autonomy need satisfaction was related to value. Subsequent hierarchical linear analyses provided support for this claim, where a positive relationship between perceived course value and autonomy need satisfaction was found when teachers identified the importance, relevance, and usefulness of the learning material. These results mirror a nationally representative smallest space analysis study among adolescent students in Israel (Assor et al., 2002). Albeit several more recent studies support these results (see e.g., Patall et al., 2018; Alley, 2019), similar results have been reported in studies outside of an educational context as well. For instance, Sousa et al. (2012) found that personal value was positively related to autonomy in a study among adult service employees. A more recent review study by Arieli et al. (2018) further corroborates these relations in work organizations.

When students are autonomous, they reflect, evaluate, and assimilate the learning content to be in line with their own goals and interests, and studies show that autonomously motivated students are more persistent and exert more *effort* into the learning activities (Reeve et al., 2002; Howard et al., 2021). Effort has been shown to correlate with both academic achievements, increased recollection, and perceived competence, hence it constitutes a wide aspect of student functioning (Schmid & Bogner, 2015). Contrary, when students are experiencing controlled motivation, they are exerting less effort into learning activities (Howard et al., 2021; Ntoumanis, 2001).

A review study by Ntoumanis and Standage (2009) found support for this claim, where results indicate that autonomous forms of motivation positively predict effort among physical education students. In education settings, *effort* constitutes an important aspect of student functioning as studies have shown that students who exert more effort in their tasks are associated with higher academic achievements (Xu et al., 2018; Lin et al., 2022). A meta-analysis over 36 studies from Vascuez et al. (2016) provides support for these relations, where it was reported that autonomy support positively predicts children's effort and academic achievements. A more recent study in China by Xu et al. (2021) further supports these relations, where it found that perceived autonomy support positively predicted effort among adolescent students. These results are further supported by Bai and Gu (2022), where autonomous motivation positively predicted effort among full-time online K-12 students. However, a study by Hagger et al. (2015) in Pakistan found no significant relationship between autonomous motivation in school and effort among high school students, but reported that out-of-school contexts, such as homework, were positively related to autonomy. Contrary to the SDT tenets, a study by Goodman et al. (2011) indicated that controlled motivation positively predicted effort as well among university students.

Since autonomously motivated students are regulating their behavior more internally, they are identifying and integrating the context or behavior in line with their own personal values and interest. Since the behavior is energized from within, autonomously motivated students are more likely to *engage* in the learning activity (Ryan et al., 2021; Skinner & Pitzer, 2016). Engagement serves as a proxy or manifestation of motivation (Alley, 2019). Specifically, *emotional engagement* concerns experiences of positive and negative emotions students experience when interacting with the social context (Reschly & Christenson, 2016), that is, the affect a student experiences when interacting with teachers, fellow students, or schoolwork. Thus, emotional engagement acts as an important aspect of everyday student functioning. A recent study by Azila-Gbettor (2021) that autonomous motivation predicted engagement among higher education students. A similar finding was reported in a study by Froilland and Worrell (2016), where results indicated that autonomous

motivation was positively related to engagement. Contrary, when students' motivation is controlled, they are more prone to disaffection and more likely to withdraw from their peers and interact less with the educational context (Skinner & Pitzer, 2016). A study by Haivas et al. (2016) corroborates this relation as the results indicated that controlled motivation negatively predicted engagement. These results are very similar to a study by Li et al. (2015), which found the same relationship among adult workers. In higher educational settings, Jang et al. (2009) reported similar results in a study among Korean university students.

Research gaps in current literature

Generally, research support the SDT tenets regarding the relationship between autonomy need satisfaction and frustration, autonomous and controlled motivation, and student functioning. When reviewing the literature, there are several knowledge gaps that are still unresolved. First, some studies encompass complex path diagrams depicting these relations (see e.g., Sheeran et al., 2020; Müller et al., 2021; Núñez and León, 2016; Demir, 2011; Alamer & Khateeb, 2021; Núñez et al., 2014; Vasconcellos et al., 2020), but there are few studies including the role of autonomy need frustration *and* autonomy thwarting in these models. A more complete picture of autonomy (i.e., the *dual process* behind autonomy need satisfaction and frustration) is needed to fully understand student functioning in order to delineate how satisfaction and frustration in sum affect motivation and student functioning. Further, an overwhelming number of studies are either in the context of physical education or encompassing lower educational levels (see e.g., Behzadnia et al., 2018; Krijgsman et al., 2017; Trigueros et al., 2019; Haerens et al., 2015; Rodrigues et al., 2019; Ntoumanis & Standage, 2009; Mouratidis et al., 2011; BURGUEÑO et al., 2022), hence it is important to conduct research in higher education as motivation declines as one progresses academically (Young et al., 2018). Moreover, studies on the effect of motivation on various learning outcomes have mainly focused on the direct effect of motivation on these outcomes in an active learning

environment. They have not highlighted any of the underlying mechanisms facilitating or undermining motivation, whereas higher education courses are usually following the traditional and passive lecture model (see e.g., Huguet et al., 2020; Abramovich et al., 2019; Cicuto & Torres, 2016; Zahay et al., 2017; Corkin et al., 2017; Hidayat & Kamalia, 2022; Perez-Poch et al., 2019; Burt, 2004). Since studies indicate a general decline in motivation as one progresses through the educational levels (Salmela-Aro, 2020; Young et al., 2018), it is important to investigate what undermines motivation and map which factors facilitate and promote student motivation, especially in higher STEM education where motivation rapidly diminishes (Young et al., 2018).

Aims and approach

By adding literature that outlines what facilitates and undermines internalization among students, this thesis may stimulate social context settings that better facilitate and maintain motivation. Such results could offer great insight and implications to policymakers, educational organizers, and educational staff.

The overarching aim and question asked in this thesis is “How does autonomy and control impact motivation and in turn affect student functioning in higher education?”. I approach this by asking three research questions:

- 1) How does autonomy support and thwarting facilitate student motivation? (Paper I & II)
- 2) Does creating a more autonomy supportive social context facilitate and promote student motivation? (Paper II)
- 3) How does facilitation and undermining of autonomy affect student functioning? (Paper I, II, & III).

The research questions were addressed in three different studies.

The aim of *Paper I* was to investigate the relationship between student perceptions of autonomy support and thwarting, students' autonomous and controlled motivations, and effort, engagement, learning, and vitality. These relations were investigated using a comprehensive structural equation model (SEM) derived from SDT tenets. The cross-sectional data were collected during a lecture in a mandatory introductory calculus course for STEM students.

In *Paper II*, the aim was to conduct a randomized experiment and investigate if creating a more autonomy supportive social context in the classroom would facilitate and enhance motivation, emotional affect, effort, and vitality. The intervention was conducted in a statistics course for university STEM students, focusing on laboratory assignments and exercises using the software *R* (Rstudio, 2022). The assignments usually encompass a traditional, generic problem (such as “What is the expected number of draws of a certain color from an urn”), whereas an experimental group received assignments aimed at promoting internalization by being more relevant to the students.

The aim of *Paper III* was to further delineate the role of autonomy need satisfaction and frustration in a repeated measures experiment during a learning activity. The students were taking part in mandatory seminar sessions in an introductory calculus course. A repeated measures design was employed to investigate the predictive role of need satisfaction and frustration in relation to perceived value, interest, and subjective vitality. Using an experience sampling method (ESM) approach highlighted not only temporal markers of directional effects, but also enabled the investigation of fluctuations of the psychological phenomena over time.

The studies all focus on autonomy as autonomy is the body through which internalization of the other basic psychological needs (i.e., relatedness and competence) are actualized, hence it is important to fully understand the role of autonomy before including relatedness and competence (Ryan & Connell, 1989). The studies vary greatly in methodological approach and analytical structure. Cross-sectional studies (Paper I) can provide valuable information as they allow data collection from large pools of

individuals (Wang & Cheng, 2020). A randomized between-subjects design (Paper II) allows subjects to be assigned to different treatment groups, hence one can investigate treatment effects (Erlebacher, 1977). An experience sampling method approach (Paper III) minimizes the risk of memory bias and enables measurements at both between- and within-levels (Kubey et al., 1996). Since all papers encompass a similar thematic, the different methodological and statistical approaches complement each other, hence providing a solid foundation of merit to the overall findings. For instance, Paper III utilizes single-item measurements, whereas Paper I and II use scales to measure constructs. Paper I uses a cross sectional design, whereas Paper II uses a pre-test and a post-test, and in Paper III we used repeated measurements.

Methods

The following section pertains the methodological approach to the three studies in this thesis: study samples, measurements, reliability and validity, statistical analyses, experimental designs, and ethical concerns.

Study samples

All participants in the three concurrent studies were higher education STEM students. In Paper I, the participants (n = 414) were recruited from an introductory calculus course mandatory to STEM students. The data were collected October 2019 and again in October 2021. In Paper II, the students (n = 67) were recruited during mandatory laboratory assignments in a statistics course for STEM students. The data is based on a convenient sample and were collected October 2019. For Paper III, the students (n = 124) were recruited from mandatory seminars in an introductory calculus course. The data were collected October 2021.

Measurements

The scales in this thesis used to measure the psychological phenomena of interest were all retrieved from www.selfdeterminationtheory.org (SDT; 2022) or retrieved from published validation studies. Initial translation of these scales into Norwegian was done by the first author, then back-and-forth translated by the co-authors and finally probed with pilot studies followed by an affirmatory assessment of the general understanding of the items with the test students. This methodological approach is following scientific recommendations when translating scales (Cha et al., 2007; Harkness et al., 2004; Prieto, 1992; Candell & Hulin, 1986).

Reliability and validity

In experimental psychology, reliability refers to the consistency of the findings (Tavakol & Dennick, 2011). That is, if researchers are able to consistently replicate results, they are considered reliable. For Studies I and II, the reliability was measured using a common approach when researching multiple-item measures of psychological phenomena, the Cronbach's alpha. The alpha provides a measure of consistency of a scale and ranges from 0 to 1, where values around .70 are considered acceptable, values around .80 are considered very good, and values above .90 are considered excellent (Tavakol & Dennick, 2011). For Study I, the Cronbach's alphas were all acceptable, ranging from .70 to .96, except for controlled motivation which had a Cronbach's alpha of .60. For Study II, the Cronbach's alphas were all acceptable, ranging from .83 to .94.

Validity concerns to what extent a test statistic measures what it pertains to assess (Fabrigar et al., 2020). There are two main categories utilized to assess validity: content-related (face and construct validity) and criterion related (concurrent and predictive validity). Face validity refers to the degree of which the test appears to measure what it at face value is supposed to assess. Construct validity refers to the extent of which a measure assesses a specific theoretical construct. Concurrent validity concerns a measurement's ability to correspond to concurrently known external criterion (i.e., a measure has concurrent validity when validated by a similar measure with an already validated concurrent measure). Finally, predictive validity concerns a measure's ability to predict a future criterion. Content-related validity were addressed by providing the participating students with general information regarding the studies, as well as using scales that had been previously validated. Criterion-related validity were addressed by using the appropriate scales for each measure in the surveys.

Statistical analyses

Preliminary analyses (i.e., descriptive statistics, Cronbach's alphas, factor analyses) were performed across all three papers. Primary analyses consisted of Person's correlations; independent samples' t-tests; Wilcoxon rank tests; structural equation modeling; linear mixed effects modeling. All statistical analyses were conducted using R (R core team, 2022). We assessed normality of the study variables based on skewness and kurtosis. Missing data were assessed using Little's missing completely at random (MCAR; Li, 2013) test, and consequently imputed (Schafer & Graham, 2002) using multivariate imputations via chained equations in R. Gender differences were investigated using t-tests across all study variables. For an overview over the methodological and statistical approaches to the papers, see Table 1.

Research design for Paper I

In order to investigate the proposed model in Paper I, we used a cross sectional design. Structural equation modelling (SEM) was employed to assess the relationships between the study variables in the model, where it was hypothesized that engagement, vitality, learning, and effort were predicted by perceived autonomy support and thwarting mediated through autonomous and controlled motivation. SEM is a multivariate statistical analysis technique using a series of statistical methods to assess relationships and latent constructs (Kline, 2016). Following a confirmatory factor analysis to establish the structure of the measurements, the conventional model fit indices Standardized Root Mean Squared Residual (SRMR), Comparative Fit Index (CFI), Tucker–Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA), and chi-square (χ^2) were utilized to determine goodness-of-fit for the SEM model. A good model fit is indicated by $SRMR < .08$, $CFI > .90$, $TLI > .95$, $RMSEA < .08$. Finally, $\chi^2 p > .05$ is considered an indication of a good fit (Shi, Lee, & Maydeu-Olivares, 2018).

Research design for Paper II

A randomized experiment was conducted to investigate the effect of making learning content more relevant to students. The students were randomly assigned to a control group (receiving a traditional, generic exercise set) or an experimental group (receiving a relevant and interesting exercise set) in a higher education statistics course. A pre- and post-test measuring emotional affect were employed. As a Shapiro-Wilk test revealed non-normality among some of the study variables, a Wilcoxon rank test was conducted to determine differences between all groups instead of an ANOVA. The post-test also contained a cross-sectional study using path analyses to investigate a proposed model in which the experimental condition predicts perceived value which in turn predicts vitality, negative affect, and effort, mediated through the autonomous regulations. In contrast to a full SEM, path analyses do not include a measurement model of the study constructs, hence the variables are not treated as latent. Goodness-of-fit were as in Paper I assessed based on SRMR, CFI, TLI, RMSEA and χ^2 .

Research design for Paper III

An experience sampling method (ESM) approach were conducted to investigate the dichotomous relationship of how autonomy need satisfaction and frustration affects perceived value, interest, and vitality among students. The participants were recruited from mandatory seminars in an introductory level calculus course for STEM students. The duration of the seminars spanned 90 minutes, where data were collected at three fixed time measurements ($T_1 = 10$ minutes, $T_2 = 40$ minutes, $T_3 = 90$ minutes). Linear mixed effects modelling was employed to investigate the relationships between the variables. Further, intraclass correlation coefficient (ICC) analyses allow insight into intra-individual fluctuations of the study variables among the students. Finally, the nesting of the data allows investigations of effects both at the within- and between-level.

Ethical concerns

All participation were voluntary throughout the studies (Paper I, II, & III), and no rewards were given for participating. Students were provided with information about the studies, the students could withdraw from the studies at any time, and no identifying data were handled or collected to ensure anonymity. All studies received approval from the Norwegian Centre for Research Data (NSD) and System for Risk and compliance (RETTE). See Appendix I for the information letters for the participants in the studies.

Table 1*Overview of the methodological approaches to the three papers*

	Paper I	Paper II	Paper III
Sample characteristics			
Student level	Bsc	Bsc	Bsc
Sample size	414	67	124
Design	Cross-sectional	Randomized experiment	ESM
Analyses			
SEM	x		
t-test	x	x	x
Path analysis		x	
Wilcoxon rank test		x	
Linear mixed effects modelling			x
Scales			
LCQ	x		
IBQ	x		
SRQ-L	x		
SVS	x	x	x
IMI	x	x	x
EM	x		
PANAS		x	
SIMS		x	
BPNSFS			x

Note. LCQ (Learning Climate Questionnaire) was used to measure students' perceived autonomy support. IBQ (Interpersonal Behaviors Questionnaire) was used to measure autonomy thwarting. SRQ-L (Self-Regulation Questionnaire) was used to assess autonomous and controlled motivation. SVS (Subjective Vitality Scales) was used to measure subjective vitality. IMI (Intrinsic Motivation Inventory) was used to measure effort, value, and interest/enjoyment. EM (Emotional Engagement from the Four Aspects of Engagement Scales) was used to assess emotional engagement. PANAS (Positive and Negative Affects Scale) was used to measure positive and negative affect. SIMS (Situational Motivation Scale) was used to measure situational motivation. BPNSFS (Basic Psychological Need Satisfaction and Frustration Scale, Diary measures) was used to measure autonomy need satisfaction and frustration.

Results

In the following section, the findings from the three studies in this thesis are presented. The emphasis of this section is not to summarize all the results from each study, which is extensively presented in each individual paper, but I will rather synthesize results that address the overall research aims of this thesis.

First, we found that students experiencing autonomy support reported higher levels of autonomous motivation (Paper I and II). Specifically, in Paper I it was found that autonomy support was positively related to autonomous motivation and negatively related to controlled motivation. Mirroring the relationship between autonomy support and autonomous motivation, we found that students reporting higher levels of autonomy thwarting experienced more controlled motivation. Further, we found that autonomy thwarting was negatively related to experiences of autonomous motivation. We also found a negative correlation between autonomous and controlled motivation, implying that students who experienced autonomous motivation felt less controlled and vice versa. These results are mirrored in Paper II, where we conducted a randomized experiment. By providing an autonomy-supportive context (i.e., providing a rationale), we found that students in the experimental group (autonomy-supportive) reported higher levels of autonomous motivation, whereas the control group (non-autonomy-supportive) experienced controlled motivation.

Next, we found that the provision of autonomy support was positively related to student functioning (Paper I, II, & III). For instance, we found that students experiencing an autonomy-supportive learning context exerted more effort in their classes (Paper I & II). Likewise, we found that students who exerted less effort in their academic endeavors reported higher levels of controlled motivation (Paper I & II). More specifically, the result indicates that effort is mediated by the provision or thwarting of autonomy through autonomous and controlled motivation (Paper I). We found similar results in Paper II, where students who received an autonomy-supportive rationale for the assignment reported higher effort, whereas students in the control group exerted significantly less

effort into the assignment. Further, the provided rationale (Paper II) was positively linked to perceived value of the learning content among the students, implying that an autonomy-supportive context can foster identified regulations (Paper II). These results are supported by Paper III, where autonomy satisfaction was found to be positively linked to perceived value, whereas students who saw little value in the learning content reported higher levels of autonomy frustration.

Across all papers we found that autonomous and controlled motivation was linked to various experiences of vitality (Paper I, II, & III). In the randomized experiment (Paper II), we found that students in the experimental condition reported significantly higher levels of vitality relative to the control group. This is further corroborated as we found that autonomy was positively linked to vitality in the longitudinal study (Paper III). However, contradicting these results, we found no evidence for any relationship between autonomous motivation and vitality in Paper I. Further, we found that students experiencing autonomy-thwarting environments reported lower levels of vitality (Paper I & III). Specifically, results from the randomized experiment (Paper II) show a significant difference in reported vitality, where the control group scored lower than the experimental group. Moreover, we found that vitality was negatively linked to autonomy thwarting when mediated through controlled motivation (Paper I). Likewise, we found that controlled motivation was negatively linked to engagement, whereas autonomously motivated students were more engaged with the learning content (Paper I).

Finally, we found that providing an autonomy-supportive context facilitated autonomous regulations, whereas autonomy thwarting undermined autonomous motivations and enhanced controlled regulations (Paper I & II).

Discussion

The main aim of this thesis was to investigate the relationship between the dichotomous nature of autonomy (autonomy support/satisfaction vs. thwarting/frustration) and student functioning in higher educational contexts. The following section will discuss implications based on the three independent studies encompassed in this thesis.

How autonomy support and thwarting facilitate or undermine student motivation

Investigating what facilitates and maintains motivation is central to all educational institutions. According to SDT, the root at which behavior is considered self-endorsed or controlled is governed by the satisfaction of basic psychological needs, or more specifically as emphasized throughout this thesis, the need for *autonomy* (Ryan & Deci, 2017).

In Paper I, the social context was a typical lecture in a calculus topic, that is, a lecturer holding a monologue where the auditorium could room 350 students at a time. We found that students who perceived this social context as autonomy supportive were experiencing higher autonomous motivation. An implication could be that students who internalize the content and self-regulate the activity in a better way are more likely to feel motivated during these lectures. Since the data were collected simultaneously from the same lecture, this means that individual students perceived the lecture in different ways. Albeit this calculus course specifically was mandatory for all STEM students, the contents of the course could be internalized differently depending on the educational background of the students. Students pursuing numerical branches like physics, mathematics, and statistics could view the course content as more relevant to their backgrounds compared to less abstract STEM disciplines like biology or geology. In Paper II, we conducted a randomized experiment with the aim of investigating if providing a more relevant assignment could increase student motivation. The results indicate that students who received the “relevant” exercise set internalized the content

compared to the control group. By providing autonomy support, or in this case, a rationale, we found that the context could facilitate more autonomous self-regulation in the form of identified or integrated regulation among the students. This finding directly mirrors the results and implications from Paper I. An interpretation of this is that even for abstract or less tangible topics like calculus and statistics, the learning content can be self-regulated depending on how the students internalize the activity. It is innate human behavior for students to be curious and active, striving to self-regulate and develop by integrating experiences into a unified sense of self through a dialectical interaction with the social context (Vansteenkiste & Ryan, 2013). Our results support SDT tenets, where the interpersonal context in the classroom can promote and facilitate the experience of autonomous motivation. In the classroom, it is the autonomy-supportive behavior of the teacher that can nurture students' inner motivation (Reeve, 2009) and influence to what extent the behavior has an internal or external perceived locus of causality (Black & Deci, 2000). When students feel self-endorsed in educational settings, they are consequently more likely to endorse the learning content in an autonomy-supportive way, and will feel more autonomously motivated (Reeve, 2011). Our results are supported by for instance Hagger et al. (2015), who found that autonomy support was positively related to autonomous motivation among high school students in mathematics. In a higher education chemistry course, Black and Deci (2000) reported similar findings where autonomy support predicted autonomous regulations. More recently, Ljubin-Golub et al. (2020) corroborate these findings in a cross-sectional study among Croatian university students in psychology, where they also reported a positive relationship between autonomy support and autonomous motivation. Albeit several cross-sectional studies yield further support to our findings (see e.g., Feri et al., 2016; Bronson, 2016; Abula et al., 2020), we add to the methodological approach by using a randomized between-subject experiment (Paper II). This enables the investigation of direct effects of the treatment, that is, investigating the direct effect that providing an autonomy supportive context has on student functioning, both in terms of modeling (SEM, Paper II) and comparative analysis, where we for instance found significant

increases in student motivation in the experimental group (Paper II) relative to the control group.

We also found (Paper I) that students who experienced the lectures as autonomy thwarting were linked to experiences of controlled motivation, that is, the more autonomy thwarting the social context was perceived, the more the students experienced controlled motivation. Autonomy thwarting is associated with behaviors that pressure students to behave in certain ways (Assor et al., 2005), for instance by using controlling language, dismissing questions and perceptions the students could have towards the subject, or failing to make the content resonate with the students' personal values and interests. Following the reasoning from the previous section, we find that some students perceive the lectures as very autonomy thwarting whereas other students perceive the context as less thwarting, implying that the social context (i.e., the lecture) can both be autonomy supportive or thwarting towards the students depending on how they internalize the activity. This finding suggests that the underlying mechanism explaining controlled motivation has different pathways than what underly autonomous motivation. Autonomy thwarting contexts can induce a difficulty for students to fully accept and assimilate the learning content and therefore obstruct experiences of volition. Thus, in agreement with what hypothesized in Paper I, we find that autonomy thwarting was negatively linked to autonomous motivation, and positively linked to experiences of controlled motivation. This finding is supported by a recent diary study by Patall et al. (2018), who also reported a negative relationship between autonomy thwarting and autonomous motivation among high-school science students. Similar results have been reported by Cece et al. (2018) where autonomy thwarting was negatively related to autonomous motivation among adolescent physical education students. These results are further supported by a recent study by Burgueño et al. (2022), who also found that need-thwarting was negatively related to autonomous motivation, and positively linked to controlled motivation. However, our results contradict a more recent cross-sectional study by Mouratidis et al. (2018), where no relationship between autonomy support and controlled motivation were found. Similar to our study (Paper I), Mouratidis et al. (2018) used an aggregate for controlled motivation, that is, they averaged introjected regulation

and external regulation into a single construct. Albeit a factor analysis indicated that the underlying items cross loaded into this single construct, they reported low reliability for this construct based on Cronbach's alpha. This reduction of dimensionality could fail to account for shared variance between the underlying regulations, hence they were unable to detect any significant relationship between autonomy support and controlled motivation.

How creating more autonomy supportive contexts facilitate student motivation

For a student to internalize learning content, teachers can be autonomy supportive by for instance explaining the meaning or content relevance to the students (Canning & Harackiewicz, 2015). According to SDT, humans have an innate tendency to be proactive by continuously refining preferences and values while finding conformity between them while we grow and develop (Ryan, 1995). This experience is considered the antecedent of autonomy. Therefore, the concept of *personal value* is located as an important constituent in experiencing autonomous motivation. An individual acting autonomously acts based upon the internalization of the activity in relation to their own sense of self (Vansteenkiste, Niemiec & Soenens, 2010). Hence, helping students see personal relevance and meaning in learning activities can foster motivation (Wagner et al., 2006).

In Paper II, we conducted a randomized experiment in which one group of students was given a more "relevant" statistics assignment whereas the other group was provided with a traditional, less tangible exercise set. The assumption herein was that providing a rationale would make the assignment resonate with the student's own interests and values, thus fostering motivation. In the experimental condition, the students received an exercise encompassing global warming, and were to conduct tests to see that temperatures and ice mass had changed over the last decades. In line with what we hypothesized in Paper II, results indicated that students who received the experimental condition reported higher levels of autonomous regulation, that is,

experiences of autonomy. When we made the assignment more relevant to the students, we provided a rationale which enabled the students to link the learning activity to something more tangible and relevant from their perspectives. Albeit the underlying exercises for the two groups were identical in terms of statistical techniques and programming, the results indicate that the social context were perceived differently among the experimental group. Thus, our results provide support for SDT, which postulates that if the provided rationale is to be personally endorsed by the students, teachers must assimilate the students' frame of reference so that the content is meaningful from the students' perspectives (Canning & Harackiewicz, 2015). In this study (Paper II), the curriculum remained unchanged, but the assignments were perceived differently depending on how the students perceived the value of the assignments. This implies that this learning activity was more connected to the students' own personal values and interests, hence fostering more autonomous forms of self-regulation. More specifically, we found (Paper II) that the experimental group experienced higher levels of autonomous regulation compared to the control group, and lower levels of extrinsic regulation. Establishing links between the classroom material and students' own interests and values can therefore facilitate more autonomously regulated behaviors, meaning they act truer to themselves. In higher educations, most studies on content relevance have focused on enhancing relevance by asking students to link the course content to their own interests and future goals (see e.g., Harackiewicz & Priniski, 2018; Harackiewicz et al., 2016; Gaspard et al., 2015; Canning & Harackiewicz, 2015) instead of investigating the effect of making assignments more relevant for students (Paper II). Thus, we make an important contribution to the field by investigating the direct effect on autonomous and controlled motivation by providing an autonomy supportive learning context.

How the facilitation and undermining of autonomy affect student functioning

According to SDT, basic psychological need satisfaction underly students' autonomous regulation which leads to full functioning students experiencing affective (vitality), behavioral (effort), and cognitive (learning) benefits, whereas basic psychological need frustration underly controlled regulation and poor student functioning (Ryan & Deci, 2017).

In Paper I, we found that students who perceived the social context as autonomy supportive reported higher levels of autonomous motivation and in turn higher engagement. When students self-regulate in an optimal way, they are likely to value the learning material and associate the educational context with positive emotions (Paper II; Assor et al., 2002). Hence, our results indicate that they are more likely to engage with the content (Paper I), where the students participate more actively in learning situations and showing enthusiasm (Reschly & Christenson, 2016). Further, we found (Paper I) that students who experienced controlled motivation were less engaging with the educational context. This finding is mirrored in SDT, where controlled motivated students are more prone to disaffection and more likely to experience negative emotions (Skinner & Pitzer, 2016; Paper II). More specifically, students who internalize the learning content (i.e., regulate the educational context) in a more autonomous way, are more likely to value the reason for studying calculus and hence are more emotionally engaged in the activity. Similarly, we find (Paper I) that students who studied out of either external or internal pressure were more disengaged. Similar results have been found among high school student Froiland and Worrell (2016) adding validity to our results. Further support of our findings is given by Assor et al. (2005) and Jang et al. (2009). Note however, that subsequent indirect effects analyses (Paper I) indicate that autonomy support positively predicts engagement when mediated through both autonomous and controlled motivation, whereas autonomy thwarting was similarly negatively related. An important takeaway is that albeit the direct effect of controlled motivation on engagement was negative, the indirect effect mediated through controlled motivation from autonomy support on engagement was positive. An interpretation of

this result is that the negative effect from controlled motivation undermines or suppresses the effect from autonomy support. Hence, an implication is thus that fostering autonomy supportive learning contexts are imperative in facilitating engagement in students.

In line with our hypotheses (Paper II & III), we found that experiences of autonomy were positively related to vitality. In Paper II, the social context encompassed students working on statistics assignments in a classroom, where we found that providing an autonomy supportive rationale was positively linked to autonomous self-regulations which in turn positively predicted vitality. We found a very similar beta coefficient for a similar relationship in Paper III, where we found that autonomy need satisfaction predicted vitality in a repeated measures design throughout a mandatory calculus seminar. This indicates that students who experience need satisfaction and autonomy support are more likely to experience feelings of vigor and being energized. According to SDT, attempts to control one's behavior is psychologically depleting (Ryan & Deci, 2008), hence undermining autonomy will negatively affect vitality (Tsoi et al., 2018; Martela et al., 2016; González-Cutre & Sicilia, 2019; Liu et al., 2018; Nix et al., 1999). However, in Paper I we found no relationship between autonomous motivation and vitality. Similar results are reported by Martinek et al. (2021), Earl et al. (2017), and Costa et al. (2016). Albeit the two other studies (Paper II & III) in this thesis provide support for autonomy's role in predicting vitality, the interpretation of these results should be more nuanced than the other outcome variables encompassing student functioning. This is because vitality is a *general trait* extending beyond the educational context (Ryan & Deci, 2017). Albeit the measures of subjective vitality are reliable, the experiences of this vitality can vary from student to student, and notably, within each student. Being a multidetermined trait, vitality can be affected by out-of-school factors such as nutrient intake, dehydration, lack of exercise, and sleep deprivation (Cheon, Reeve, Lee & Lee, 2018). Hence, factors outside of higher education can potentially override the effect of autonomy on vitality in the classroom.

Results from Paper I indicate that students who experience autonomous forms of motivation exert more effort in the learning activities. Likewise, students who experienced low autonomous motivation put less effort in the course material (Paper I). According to SDT, as autonomously motivated students are internalizing their behaviors in a more autonomy regulating way, they reflect, evaluate, and integrate the learning context to be in line with their own personal interests and values. This provides an internal source of energy and hence autonomously motivated students are more persistent and exert more effort in their academic endeavors (Howard et al., 2021). Yet, contrary to our hypotheses, we found some discrepancies regarding controlled motivation and effort. SDT postulates that albeit autonomously motivated students will naturally gravitate towards their activities and therefore more willingly exert effort into the learning activity (Vansteenkiste et al., 2018), controlled behavior becomes pressured which can be perceived as energy depleting; hence students are less likely to exert effort in their learning activities (Vansteenkiste et al., 2018). In Paper II, we found no significant relationship between controlled motivation and effort, and in Paper I we found that controlled motivation was *positively* related to effort, contrary to our initial hypotheses. An implication could be that effort as a construct could be hard to measure in these academic settings. For instance, the students in both Paper I and II were from very different academic disciplines (biology, geology, informatics, physics, mathematics, etc.). Even though the courses were mandatory, some academic disciplines are possibly more likely to perform better in baseline calculus and statistics courses. If a student is following a mathematical STEM discipline, this student might exert less effort in this calculus course compared to a student who may have less interest in pursuing numerical disciplines in the future, thus a student could be highly motivated and put less effort in the course due to “natural” skill due to the disciplinary background whereas students from different disciplinary backgrounds might have to put extra effort into the course while experiencing less motivation.

Limitations and future research

There are several limitations regarding this thesis and the included studies that should be highlighted and addressed.

- 1) The thesis focused solely on autonomy, as opposed to the remaining constituents in basic needs theory, namely competence and relatedness. Albeit autonomy need satisfaction is important, the two other basic needs are also heavily related to motivation, wellbeing, and development (Niemeec & Ryan, 2009). Future studies should therefore include relatedness and competence as constituents when modelling student motivation and functioning. This would give us a more complete picture of the human behavior as studies have shown that these constituents can also impact student motivation and well-being (see e.g., Wang et al., 2019; Vasconcellos et al., 2020; Ryan & Deci, 2021). However, understanding the role of autonomy and its “bright” and “dark” manifestation is important as it allows us to understand the mechanisms leading to student motivation and functioning.
- 2) The use of cross-sectional research designs (Paper I) has implications regarding causality as the temporal dimension cannot be accounted for, and hence one cannot infer path directionality of the study variables. However, the path directionality in the model in Paper I is based on strong theoretical SDT propositions and previous research (see e.g., Cheon, Reeve, Lee & Lee, 2018; Núñez & León, 2016; Milyavskaya & Koestner, 2011), thus this design is considered appropriate for the purpose of this study (Bollen & Pearl, 2013). Nevertheless, future studies should conduct longitudinal designs to investigate the relationships to avoid any potential temporal issues.
- 3) I have used SDT as the only theoretically framework throughout the thesis. Different theories such as neo-behaviorism (Suppes, 1975), family motivation (Chiu & Xihua, 2008), or expectancy theories (Bandura, 1989) could be a supplement providing other perspectives on human behavior. However, the

strength of SDT is the broad theorization that accounts for students' motivation and student functioning from a unifying and integrative perspective.

- 4) The studies used student self-report measures. That is, instead of objective measures like grades or test scores, students' self-reported perceived experiences were recorded. Self-reported measures are reliable in many circumstances (Benton, Duchon, & Pallett, 2013), but they are susceptible to memory bias when the measurements become comprehensive (Pekrun, 2020). Further, self-reported measures have been shown to be less reliable among lower performing students (Kuncel, Crede, & Thomas, 2005). Conversely, SDT argues that self-reporting is important as it is the students' *own* perceptions of autonomy support that matters in a classroom (Ntoumanis, 2005).
- 5) The use of single-item measures (Paper III) should be addressed. Albeit multiple item measures have better psychometric properties (Fisher et al., 2016), the use of single-item measures lessen the burden on participating students and are preferred in ESM studies due to the ability to capture immediate experiences (hence avoiding memory bias).
- 6) All studies investigated vitality, which is a trait of experiencing well-being. But we did not include any measurements for ill-being. This would be interesting given that we measured need frustration, which has been more linked to maladjustment, compared to need satisfaction (Vansteenkiste & Ryan, 2013). Future researchers should include this variable as well to map an even more comprehensive picture of psychological functioning.
- 7) The use of aggregates for autonomous and controlled motivation should be highlighted (Paper I). Controlled motivation encompasses two different types of regulations; external and introjected regulation (Howard et al., 2021). The discrepancies regarding controlled motivation can also be discussed in terms of reliability. Where the Cronbach's alpha (Paper I) was low; the alpha could reflect dimensionality. According to SDT, motivation is a multidimensional construct represented by distinct types of motives based on internalization. Treating motivation as a multifaceted construct can make models intricate with analytical

implications, and although various methods for aggregating the types of motivation have been presented, research is lacking in terms of the implications of which aggregation to use (Howard et al., 2020). Treating each motivational construct independently (Paper II) allows each motive to be modelled. This undermines the continuum of self-determination and no longer acknowledges the continuum as a distinct factor. This can result in artificially inflated inter-regulation correlations, resulting in problems with both effect sizes and path directionality (Howard et al., 2020). Instead, one could opt to use higher-order models, where intrinsic motivation and identified regulation are combined in a single aggregate; autonomous motivation. Likewise, introjected regulation and external regulation can be combined into controlled motivation (Paper I). This approach is unable to account for all motivational constructs, but it does provide insight of the dichotomous nature of self-determination allowing the investigation of external and internal perceived loci of causality.

Perspectives

Macroeconomic events, the development of new technologies, and globalization can affect the curriculum and content in higher educations (Ryan & Deci, 2017). But how learning is conveyed is not governed by these social constructs. Based on this thesis, there are some implications that can be highlighted.

Although legislators and educational ministries call for active learning environments, the passive, large-scale lectures are still the norm in higher educations (Deslauriers et al., 2019; Freeman et al., 2014; Huguet et al., 2020; Abramovich et al., 2019;). The proximal crux of the educational context falls on the lecturer in most of these settings (Cicuto & Torres, 2016; Zahay et al., 2017), and there are several student-centered approaches in higher educations that could be utilized to facilitate a more active learning environment. Noteworthy are flipped-classrooms, student peer reviews, and problem-based learning. However, as is apparent from the results of this thesis, instructors can facilitate and foster motivation “passively” as well by promoting better self-regulation among the students. As shown, when students are able to recognize personal value and meaning behind the learning activities, they internalize the context in a better way which can facilitate motivation, wellbeing, and student functioning. Thus, by making learning content that mirrors the students’ interests and relating the content to their everyday life, they are more likely to be autonomously motivated. However, administrative obstacles such as time constraints, accountability, and controlling pressure to follow standard teaching procedures can inherently create difficulties.

A follow-up question to the previous section could be formulated as “Then how can an educational system create and facilitate learning contexts that promote student motivation?”. According to Ryan and Deci (2017), there are two approaches educational institutions can employ to facilitate an autonomy supportive learning climate. Educators and educational staff can for instance create optimal learning conditions based on SDT perspectives. This however can be costly both in terms of time and monetary expenses. Another approach would be to start at the top of the organization level, promoting

autonomy-supportive environments in the form of regulations and policies. This approach is also more likely to implement changes as all levels are involved. Further, seminars and workshops delineating the importance of creating autonomy-supportive classrooms could be conducted for educators and lecturers.

To conclude, this thesis responds to recent calls for the investigation of the dual process underpinning autonomy and student functioning in higher education. The results indicate that satisfaction of the basic psychological need for autonomy facilitates autonomous motivations which in turn positively relate to desired aspects of student functioning. When instructors or educators provide autonomy-supportive social contexts for students, they promote and facilitate motivation which again can promote student functioning. In sum, this thesis provides an investigative overlook into the dual-process mechanisms of autonomy need satisfaction and frustration facilitating and promoting student motivation in higher educational settings.

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Appendix I

This section pertains to the ethical concerns regarding participation of the three studies and includes the information letters the students received.



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Kjære student i MAT101!

Ved bioCEED holdes det nå en doktorgradsstudie med formål å kartlegge studenters forhold til matematikk ved universitetet. Vi vil derfor undersøke spesielt dine holdninger til dette emnet, og ditt bidrag vil spille en svært viktig rolle i dette prosjektet!

Selve undersøkelsen tar ca. 10 minutter å fullføre. Det er helt frivillig å delta i undersøkelsen. Hvis du velger å delta, kan du når som helst trekke deg fra undersøkelsen uten å oppgi noen grunn. Vi vil utelukkende bruke opplysningene til formålet som er omtalt i dette skrivet. Dine svar vil bli behandlet konfidensielt av prosjektleder Marius Ole Johansen og i samsvar med personvernregelverket. Foreleser/emneansvarlig vil ikke ha tilgang til din respons. Spørreskjemaene vil bli slettet når studien er fullført.

Studien er per dags dato meldt inn til Personvernombudet for forskning, Norsk Samfunnsvitenskapelig Datatjenester (NSD).

Med vennlig hilsen,

Stipendiat Marius Ole Johansen

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Centre for Excellence in Biology Education

Kjære student i STAT101!

Ved bioCEED holdes det nå en doktorgradsstudie med formål å kartlegge studenters forhold til statistikk ved universitetet. Vi vil derfor undersøke spesielt dine holdninger til dette emnet, og ditt bidrag vil spille en svært viktig rolle i dette prosjektet!

Selve undersøkelsen tar ca. 10 minutter å fullføre og er helt anonym. Det er helt frivillig å delta i undersøkelsen. Hvis du velger å delta, kan du når som helst trekke deg fra undersøkelsen uten å oppgi noen grunn. Vi vil utelukkende bruke opplysningene til formålet som er omtalt i dette skrevet. Dine svar vil bli behandlet konfidensielt av prosjektleder Marius Ole Johansen og i samsvar med personvernregelverket. Foreleser/emneansvarlig vil ikke ha tilgang til dine svar. Spørreskjemaene vil bli slettet når studien er fullført. Studien er meldt inn til Personvernombudet for forskning, Norsk Samfunnsvitenskapelig Datatjenester (NSD).

Undersøkelsen består av 2 deler. Del 1 er et kort innledningsspørreskjema som skal besvares **for** du begynner på dataøvingen. Når du er ferdig med det kan du begynne med dataøvingen. **Etter** du er ferdig med oppgavene i dataøvingen kan du fylle ut del 2 av undersøkelsen. Vennligst besvar alle spørsmålene og svar så ærlig som mulig!

Med vennlig hilsen,

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Centre for Excellence in Biology Education

Kjære student i MAT111!

Ved bioCEED holdes det nå en doktorgradsstudie med formål å kartlegge studenters forhold til matematikk ved universitetet. Vi vil derfor undersøke spesielt dine holdninger til dette emnet, og ditt bidrag vil spille en svært viktig rolle i dette prosjektet!

I denne undersøkelsen ønsker vi å følge deg gjennom denne gruppeøkten. Dette spørreskjemaet består av 3 deler, hvor vi ønsker at du fyller ut del 1 ved starten på gruppeøkten, del 2 etter 45 minutter og del 3 når du er ferdig. Undersøkelsene tar ca. 1 minutt å fullføre, består av 5 spørsmål, og er helt anonym. Det er helt frivillig å delta i undersøkelsen. Hvis du velger å delta, kan du når som helst trekke deg fra undersøkelsen uten å oppgi noen grunn. Vi vil utelukkende bruke opplysningene til formålet som er omtalt i dette skrivet. Dine svar vil bli behandlet konfidensielt av prosjektleder Marius Ole Johansen og i samsvar med personvernregelverket. Foreleser/emneansvarlig vil ikke ha tilgang til dine svar. Spørreskjemaene vil bli slettet når studien er fullført. Studien er meldt inn til RETTE (Risiko og ETTErlevelse i forskningsprosjekter) som er universitetets system for behandling av personvern.

Vennligst besvar alle spørsmålene og svar så ærlig som mulig!

Med vennlig hilsen,

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The bright and dark side of autonomy: How autonomy support and thwarting relate to student motivation and academic functioning

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According to Self-Determination Theory, autonomy support is essential in fostering optimal learning, growth, and functioning in students across all levels. In contrast, autonomy thwarting is associated with student malfunctioning. The purpose of the current study was to investigate the relationship between perceptions of autonomy support and thwarting, students' autonomous and controlled motivations, and aspects of student functioning in a higher education setting. The sample consisted of 414 Norwegian university students recruited from introductory calculus courses. Structural equation modeling indicated that perceived autonomy support predicts autonomous motivation and is negatively linked to controlled motivation. Autonomy thwarting is negatively linked to autonomous motivation and positively predicts controlled motivation. We found that autonomous motivation predicts engagement, effort, and learning. Controlled motivation is negatively linked to vitality and engagement, and positively predicts effort. The results are in line with the tenets of Self-Determination Theory, and the present study highlights the importance of providing an autonomy supportive environment during higher education lectures.

KEYWORDS

self-determination theory (SDT), autonomous motivation, controlled motivation, autonomy support, autonomy thwarting, higher education

Introduction

Creating conditions for optimal student functioning in higher education contexts is an important task for instructors. Facilitating students to engage in learning activities and still possess a surplus of mental energy at the end of the day can be difficult, but nonetheless it is important for optimal growth, development, and psychological wellbeing (Strauss and Volkwein, 2002). Optimal student functioning is imperative as it relates to time management, learning awareness, academic achievements, and the ability to manage negative coping skills (Disch et al., 2000). Teacher autonomy support has been shown to be both a direct and indirect contributor to such student functioning (Kaplan, 2018). Although there exist a plethora of studies indicating that autonomy support is positively related to a myriad of academic outcomes (see e.g., Milyavskaya and Koestner, 2011; Núñez and León, 2016; Ryan and Deci, 2017; Cheon et al., 2018), less is known about how teacher autonomy thwarting

affects student functioning. That is, does teacher control reduce autonomous motivation and increase controlled motivation, and does this impact student functioning in the same way that autonomous motivation does? The aim of this study is to examine the correlates of how perceived autonomy support and thwarting can impact student motivation and in turn effort, engagement, vitality, and learning. By doing this, we investigate the «bright» and «dark» manifestations of student motivation which has received more attention recently, but not in higher education specifically (Haerens et al., 2015; Kubicek et al., 2017; Rodrigues et al., 2020). We investigate these relations using Self-Determination Theory (SDT; Ryan and Deci, 2017) among higher education STEM students in a calculus course.

Motivation and self-determination theory

Human motivation, which can be defined as the reason for behaving in a certain way, is an important constituent of a person's psychological experiences as it underpins human behavior and functioning (Pintrich et al., 1994). In educational settings, student motivation has been linked to academic achievements (Keller et al., 2016; Muenks et al., 2018), effort (Howard et al., 2021), drop-out intentions (Haivas et al., 2013; Rumberger and Rotermund, 2016), learning (Cerasoli et al., 2014; Manganeli et al., 2019), and psychological wellbeing (Howard et al., 2021). Hence, research on the underlying psychological aspects of student motivation and functioning remains an imperative task for educational institutions (Meens et al., 2018), especially since motivation generally declines as one progresses the educational ladder (Young et al., 2018).

Self-determination theory is a multi-dimensional meta-theory encompassing human motivation, development, and growth (Deci and Ryan, 2008; Ryan and Deci, 2017) in which different types of motivation can be distinguished depending on their level of self-determination (Ryan and Deci, 2000a; Vansteenkiste et al., 2018). According to SDT, volitional, or autonomous, forms of motivation refer to actions driven by a personal interest, whereas external, or controlling, motivation refers to behaviors driven by pressure (Núñez and León, 2016). As the sources of motivation differ, so can the impact of the various types of motivations. Not only can they differ in strength and maintainability, but they also differ in the behavioral outcomes of the activity that energizes the different motivations. Hence, it is important to differentiate motivation as a construct to account for the effects of the different types of motivations (Vansteenkiste et al., 2010; Martela et al., 2016; Howard et al., 2021).

Autonomous motivation is the most self-determined class and refers to a sense of volition or willingness to perform tasks (Ryan et al., 2006), and consists of intrinsic motivation (enacting out of the inherent pleasure and joy of the activity itself), integrated regulation (when the reason for doing an activity is not only because it is personally meaningful, but the activity is more deeply aligned with personal values and interests), and identified regulation (when someone recognizes personal relevance or utility of the learning content; Vansteenkiste et al., 2018). Research shows that autonomous motivation plays a vital role in facilitating learning and growth as it has been linked to increased academic achievements and psychological wellbeing (Taylor et al., 2014).

When students are autonomously motivated, they self-endorse their reason to study and experience a sense of psychological freedom which has been linked to increased feelings of vitality, creativity, time management, and effort (Vansteenkiste et al., 2006; Yeager et al., 2014).

In contrast, when learning activities fail to resonate with a student's innate curiosity or they are unable to recognize any meaningful merit behind the learning content, the learning activity becomes an instrument to achieve outcomes that are detached from the learning activity, and motivation becomes pressured or controlled (Cerasoli et al., 2014; Cheon et al., 2020). Controlled motivation can be separated into two categories; external regulation (acting out of external contingencies such as studying to avoid punishment) and introjected regulation (the controlling pressure originating from within, such as acting out of shame, guilt, or pride; Pelletier et al., 2002; Reeve et al., 2002; Cerasoli et al., 2014). Consequently, externally regulated students will feel forced to commit to activities and experience less freedom and self-endorsement, creating an external locus of causality (Ryan and Deci, 2000b). Studies show that students experiencing controlled motivation are often linked to undesirable outcomes such as less engagement, increased anxiety, superficial processing of the learning material, increased drop out intentions, and reduced psychological wellbeing (Vansteenkiste et al., 2006). A recent meta-analysis by Howard et al. (2021) found that autonomous motivation positively relates to effort, engagement, academic performance, and vitality, while controlling forms of motivation relate to anxiety, avoidance, and reduced experiences of vitality and physical wellbeing.

Autonomy support and thwarting

In any learning activity, interpersonal contexts can either support or thwart student autonomy and thus affect to what extent a student's motivation is autonomous or controlled (Black and Deci, 2000). In a classroom setting, autonomy support can be facilitated through instructor behaviors that nurture and develop students' inner motivational resources (Reeve, 2009). When studying factors that facilitate motivation among higher education students, Kember et al. (2008) found that applying more relevant elements to abstract topics could increase student motivation. Providing a rationale in educational learning activities can both resonate with students' interests as well as help them recognize the importance of the learning content. This is supported by a plethora of research across educational levels (see e.g., Kember et al., 2008; Reeve, 2009; Terrón-López et al., 2017). More recently, based on a synthesis of 51 experiments, Reeve and Cheon (2021) concluded that teachers who provided rationales, avoided the use of controlling language, and provided students with time to think and ask questions fostered an autonomy supportive learning context (Reeve and Cheon, 2021). Further, Reeve (2009) reported that instructors that welcomed and acknowledged any negative emotions or connotations students experienced could also foster a more autonomy supportive learning climate. Research shows that students who experience autonomy support in the classroom achieve better grades (Okada, 2021), are more creative (Núñez and León, 2015), engage more with the learning content (Jiang and Tanaka, 2022), experience more

positive emotions (Oriol-Granado et al., 2017), and experience increased psychological wellbeing (Moller et al., 2006).

Moreover, in a study among adolescent students, Shen et al. (2009) found that students who experienced the learning context as autonomy supportive reported higher levels of autonomous motivation. Similar results were reported by Bronson (2016) where autonomy support also predicted autonomous motivation among nursing students, a finding that is also supported by a study among medical students by Feri et al. (2016). A more recent study by Ganotice et al. (2020) further corroborates this where autonomy support was found to be a positive predictor of autonomous motivation in Chinese university students.

In contrast to autonomy support, autonomy thwarting is instructor behavior that directs students to think or behave in a specific way (Assor et al., 2005). In a classroom setting, a teacher is autonomy thwarting by for instance overriding the students' perspectives on subjects and replaces them with the teacher's own. It should be noted that a teacher presenting their own perspective during a learning activity is not in itself thwarting, but it becomes controlling when the instructor pressures their own perspective onto the students (Assor et al., 2005). In other words, the instructor's behavior becomes autonomy thwarting when the learning activity pressures students into changing their behaviors. When this happens, the student's locus of causality changes from internal (doing something autonomously) to external (doing something for a controlled reason; Reeve, 2009). Instructors can be autonomy thwarting by intrusively interrupt activities and being dismissive. Autonomy thwarting instructors tend to be impatient with students by for instance not giving them enough time to provide answers in class (Reeve, 2009). When students experience autonomy thwarting, their positive functioning is weakened as it induces a sense of external pressure, and they experience a feeling of duty to either some external contingency, to others, or to one's negative emotion (Reeve et al., 2003). Research shows that students experiencing autonomy thwarting are more prone to anxiety (Patall et al., 2018), have lower psychological wellbeing (Ryan and Deci, 2017), engage less with the learning content (Reeve et al., 2004), and achieve lower grades than autonomy supported students (Vansteenkiste et al., 2004). Patall et al. (2018) conducted a diary study on high school students and found that thwarting practices in educational contexts promote experiences of controlled motivation and undermined autonomous motivation. When students are subject to autonomy thwarting experiences, their positive functioning is weakened as it induces a sense of external pressure (Reeve et al., 2003). In a similar longitudinal study, Cece et al. (2018) reported similar results where autonomy thwarting was positively related to controlled forms of motivation. A more recent study by BURGUEÑO et al. (2022) further support this claim where they also reported that autonomy thwarting was positively linked to controlled motivation among physical education students.

Correlates of motivation and student functioning

When students are autonomously motivated, they reflect, evaluate, and integrate the learning content in line with their

own personal interests and goals, and studies have shown that autonomously motivated students exert more effort into learning activities (Reeve et al., 2002; Joussemet et al., 2004; Howard et al., 2021) and are more resilient when facing challenging assignments (Xu et al., 2018, 2021; Lin et al., 2022). Effort has been shown to correlate with both academic achievements, increased recollection, and perceived competence, hence it constitutes a wide aspect of student functioning (Schmid and Bogner, 2015; Xu et al., 2018). Contrary, when students are experiencing controlled motivation, research shows that they are exerting less effort into learning activities (Ntoumanis, 2001; Howard et al., 2021). A review study by Ntoumanis and Standage (2009) corroborates this claim, where results indicate that autonomous forms of motivation positively predict exerted effort in physical education students. A meta-analysis spanning 36 studies from Vasquez et al. (2016) provides further support for these relations, where it was reported that experiences of autonomy positively predicted children's efforts and academic achievements. Similarly, a more recent study in China by Xu et al. (2021) reported that perceived autonomy support positively predicted effort among adolescent students. However, a study by Hagger et al. (2015) in Pakistan found no significant relationship between autonomous motivation in school and effort in high school students, but reported that out-of-school contexts, such as homework, were positively related to autonomy. Contrary to the SDT tenets, a study by Goodman et al. (2011) indicated that controlled motivation positively predicted effort as well among university students.

Autonomously motivated students engage more actively in their learning activities and show higher interest in topics since they endorse their own actions by integrating the learning outcomes with their own personal values and goals (Ryan et al., 2010). Engagement can be considered a manifestation of motivation, i.e., the student's engagement in the learning activity (Alley, 2019). *Emotional* engagement refers to the positive and negative affects students experience when interacting with the educational context (i.e., the instructors, their peers, and the learning material; Reschly and Christenson, 2016). According to SDT, it lies in human nature to be proactive and internalize new knowledge, and when autonomously motivated, students are more likely to engage with the educational context (Skinner and Pitzer, 2016). Studies show that autonomous motivation is positively linked to engagement among higher education students (Azila-Gbetteo et al., 2021), and engagement has been shown to increase learning effectiveness among higher education students (Hu and Hui, 2012; Datu et al., 2016). Further, when autonomously motivated, students are more persisting in their tasks and assignments, and more likely to interact with the learning content since they can connect the material to their own personal values and interests. This claim is backed by a recent study by Azila-Gbetteo et al. (2021), where it was found that autonomous motivation predicted engagement in higher education students. In contrast, when students experience a controlling educational context, individuals are more prone to disaffection and more likely to withdraw from their peers and interact less with the learning context (Skinner and Pitzer, 2016), and research indicates that controlled motivation is negatively related to engagement (Haivas et al., 2013; Li et al., 2015).

Autonomous and self-endorsed students act out of their own volition and are more likely to behave true to themselves. Consequentially, students can experience a psychological freedom

in the classroom which is often associated with feelings of vigor and rejuvenation. Studies have shown that autonomously motivated students also show an enhanced interest in their learning content (Kaur et al., 2014). When students are interested in topics it can yield deeper understanding as research has shown that interest is related to higher academic performance (Hidi et al., 2004). A study by Black and Deci (2000) found that autonomously motivated students achieved higher learning outcomes relative to controlled motivated students. These findings were similar to the findings by Roth et al. (2007) and Guay et al. (2016). Not only do autonomously motivated students achieve better academically relative to controlled students, but they are also associated with experiences of higher vitality and vigor (Bye et al., 2007; Núñez and León, 2016; Cheon et al., 2018). Subjective vitality can be defined as one's attentiveness to experiencing energy and aliveness (Ryan and Frederick, 1997), and has been linked to psychological wellbeing in students as it often is associated with feelings of better self-esteem, being spirited, enthusiastic and spontaneous, and negatively related to feelings of anxiety and stress. In a study among adolescent students in physical education, Mouratidis et al. (2011) reported that autonomously motivated students experienced higher levels of vitality. This result is supported in a study by Taylor and Lonsdale (2010), among British and Chinese students, and similar results were reported in a more recent study by Nishimura and Suzuki (2016) among undergraduate students in Japan. In contrast, controlled motivation is associated with pressure where students are experiencing less positive emotions (Nix et al., 1999), and a recent study by Tsoi et al. (2018) found that controlled motivation is negatively related to vitality.

Present study

The main aim of this study is to propose a comprehensive dual process model based on SDT tenets where we investigate the dual process of autonomy support and thwarting, and how it relates to aspects of student functioning (i.e., effort, engagement, vitality, and learning) mediated through autonomous and controlled motivation. In light of SDT's conceptualization and previous research, we hypothesize that (1) autonomy support positively predicts autonomous motivation which in turn positively predicts effort, engagement, vitality, and learning, (2) that autonomy thwarting positively predicts controlled motivation which in turn negatively predicts effort, engagement, vitality, and learning, and finally, and (3) we expect autonomy support to negatively predict controlled motivation and autonomy thwarting to negatively predict autonomous motivation. Although research has previously investigated autonomy satisfaction and frustration in relation to student functioning in higher education, few have investigated a dual process model focusing on autonomy (i.e., autonomy support vs. thwarting). Thus, we expand the current literature. First, as opposed to other studies (e.g., Núñez et al., 2014; Núñez and León, 2016; Neufeld and Malin, 2020; Lozano-Jiménez et al., 2021; Jiang and Tanaka, 2022), we investigate a dual process model where student functioning is related to autonomy support vs. thwarting. This is imperative in understanding the dual process behind autonomy underpinning student functioning.

Further, in contrast to Patall et al. (2018), Neufeld and Malin (2020), and Vergara-Torres et al. (2020), we investigate a more comprehensive model by including effort, engagement, and learning as student functioning outcome variables alongside vitality. Although vitality is an important constituent of student functioning, these phenomena constitute a broadened proxy for student functioning as they have been shown to be associated with school resilience (Brooks et al., 2016), drop out intentions (Rumberger and Rotermund, 2016), anxiety (Quintero et al., 2022), and academic achievements (Christenson et al., 2012). Hence this is an important contribution to the current literature as it enables us to simultaneously investigate the effects of autonomy support and thwarting on academic functioning in higher education.

Materials and methods

Participants

The participants consisted of 414 (51% males) STEM students from introductory calculus courses at a Norwegian university. To protect participants' anonymity, age was asked in intervals (58.70% were 18–19, 36.96% were 20–21 years, and 4.34% were >21 years).

Procedure

Students were asked to participate in the study before the lectures started. Students that agreed to participate were given permission to complete the surveys 15 min before the end of the lecture session. We conducted the survey mid-term to ensure that the students were familiar with both the scope and content of the courses as well as the lecturers. Students participating in this study did not miss lecture content. During the study, the lecture was halted in agreement with the lecturer, and students who did not participate in the study were given an extra break. No reward was offered for participation.

Several ethical considerations were taken in the current study. First, the study obtained formal approval from the Norwegian Centre for Research Data (NSD). Next, the students received written information about the project, and were informed that they could withdraw from the study at any given time. The study was anonymous, and the data were treated confidentially.

Measures

Perceived autonomy support

We used the 6-item version of the Learning Climate Questionnaire (LCQ) to measure students' perceived autonomy support (Black and Deci, 2000). Students responded on a seven-point Likert scale, ranging from 1 (not true at all) to 7 (very true). An item example is "My instructor encouraged me to ask questions." In earlier studies, this scale has been shown to be both valid and reliable among higher education students (Williams and Deci, 1996). The Cronbach's alpha for the current study was $\alpha = 0.86$.

Perceived autonomy thwarting

Autonomy thwarting was measured using the 4-item autonomy thwarting subscale within the Interpersonal Behaviors Questionnaire (IBQ; Rocchi et al., 2017). Autonomy thwarting was measured on a seven-point Likert scale ranging from 1 (not true at all) to 7 (very true), and previous studies have found reliable results for this scale among higher education students (Rocchi et al., 2017). An item example is “My lecturer pressures me to do things their way.” The Cronbach’s alpha was found to be $\alpha = 0.70$.

Autonomous and controlled motivation

We employed the 12-item The Self-Regulation Questionnaire (SRQ-L) to measure autonomous and controlled motivation (Ryan and Connell, 1989). The students were presented with three statements (e.g., “I will likely follow my instructor’s suggestions for studying mathematics”) followed by either autonomous (“Because he/she seems to have insight about how best to learn the material”) or controlled (“Because I would get a bad grade if I didn’t do what he/she suggests”) reasons for doing that specific behavior. Students answered on a seven-point Likert scale ranging from 1 (not true at all) to 7 (very true). The scale has been found to be reliable among higher education students (Williams and Deci, 1996), and the Cronbach’s alpha for this scale was found to be $\alpha = 0.90$ for autonomous motivation and $\alpha = 0.60$ for controlled motivation.

Subjective vitality

We employed the seven-item Subjective Vitality Scales to measure the students’ vitality (Ryan and Frederick, 1997). The vitality construct was measured on a seven-point Likert scale ranging from 1 (not true at all) to 7 (very true). The Subjective Vitality Scales has been found to be reliable in higher education (Bostic et al., 2000). An item example is “I have energy and spirit.” The Cronbach’s alpha for the current study was found to be $\alpha = 0.89$.

Effort

We used the five-item Effort Scale from the Intrinsic Motivation Inventory (Ryan et al., 1983) to measure the students’ efforts. An item example is “I put a lot of effort into this.” The students responded on a seven-point Likert scale ranging from 1 (not true at all) to 7 (very true). Previous research has found this scale to be reliable (Ostrow and Heffernan, 2018), and the Cronbach’s alpha for our study was found to be $\alpha = 0.81$.

Emotional engagement

To measure emotional engagement, we employed the sub-scale Emotional engagement from the Four aspects of Engagement scale (Reeve and Tseng, 2011). This sub-scale consists of four items and the students were asked to answer on a seven-point Likert scale ranging from 1 (not true at all) to 7 (very true). An item example is “I enjoy learning new things in class.” The scale has been shown to be reliable in educational settings (Reeve and Tseng, 2011). The Cronbach’s alpha for this scale was $\alpha = 0.96$.

Learning

A four-item questionnaire was used to measure students’ self-reported learning during the last 2 weeks. The questionnaire was adapted from Jenó et al. (2017). The students were asked to answer on a seven-point Likert scale ranging from 1 (not true at all) to 7

(very true). An item example is “I’ve learned a lot during the last 2 weeks.” The Cronbach’s alpha for this scale was $\alpha = 0.78$.

Analytical strategy

All statistical analyses were performed using R (RStudio, 2020). We used the “lavaan” package (Rosseel, 2012) to analyze our measurement model, structural equation model, and to test our study hypotheses. A confirmatory factor analysis was performed to establish the structure of the measurements. We utilized the conventional model fit indices Standardized Root Mean Squared Residual (SRMR), Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA) and χ^2 to determine goodness-of-fit for our SEM model, where a good model fit is indicated by SRMR < 0.08 (perfect fit: 0.00), CFI > 0.90 (perfect fit: 1.00), TLI > 0.95 (perfect fit: 1.00), and RMSEA < 0.08 (perfect fit: 0.00), and finally $\chi^2 p > 0.05$ is considered an indication of a good fit (Shi et al., 2018). For inadequate model fits, we employed modification indices (Jorgensen, 2017) to re-specify the model using proposed changes with modification index values > 10 assuming the model changes were in line with SDT tenets.

Results

Descriptive analysis

Of the 414 students that participated in the study, 25 students (6%) did not complete the whole questionnaire. Little’s missing completely at random (MCAR; Li, 2013) test indicated that the missing data were missing completely at random ($p > 0.05$). The missing data were therefore imputed (Schafer and Graham, 2002) using the MICE (Multivariate Imputation via Chained Equations) package for R (RStudio, 2020). Across all study variables, we found no gender differences (p ’s > 0.05), hence we collapsed gender across all variables.

The study variables are all within a normal distribution (Table 1). Correlational analyses show that autonomy support positively correlates with autonomous motivation, learning, effort, engagement, and vitality, and negatively with autonomy thwarting (Table 2). Autonomy thwarting correlates positively with controlled motivation, and negatively with learning, engagement, and vitality.

The relationship between autonomy support and thwarting, autonomous and controlled motivation, and effort, engagement, learning, and vitality

To test our main hypotheses (i.e., autonomy support positively predicts autonomous motivation which in turn predicts engagement, effort, learning, and vitality; autonomy thwarting

TABLE 1 Descriptive statistics for main variables.

	M	Range	SD	Skw.	Kurt.	α	Number of items
Autonomy support	4.23	1–7	0.82	−0.89	0.70	0.86	6
Autonomy thwarting	3.09	1–7	0.56	−0.29	0.16	0.70	4
Autonomous motivation	5.03	1–7	0.84	0.22	−0.85	0.90	5
Controlled motivation	4.11	1–7	0.43	0.84	0.85	0.60	7
Learning	3.73	1–7	0.23	0.01	−0.62	0.78	4
Effort	5.07	1–7	0.58	−0.73	1.48	0.81	5
Engagement	4.33	1–7	1.01	−0.06	−0.59	0.96	4
Vitality	3.87	1–7	0.80	−0.17	0.14	0.89	7

TABLE 2 Correlations of the main variables.

	1	2	3	4	5	6	7	8
1. Autonomy support	–							
2. Autonomy thwarting	−0.38**	–						
3. Autonomous motivation	0.47**	−0.37**	–					
4. Controlled motivation	−0.48**	0.50**	−0.30**	–				
5. Learning	0.30**	−0.21**	0.37**	−0.10*	–			
6. Effort	0.22**	0.01	0.28**	−0.04	0.25**	–		
7. Emotional engagement	0.67**	−0.38**	0.81**	−0.51**	0.42**	0.33**	–	
8. Vitality	0.47**	−0.36**	0.46**	−0.44**	0.38**	0.36**	0.60**	–

* $p < 0.05$, ** $p < 0.01$.

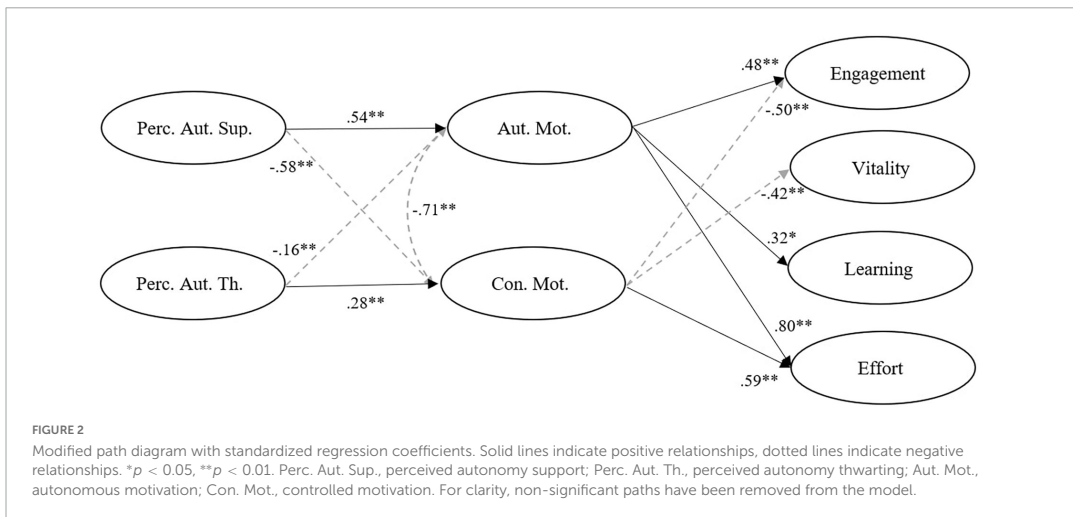
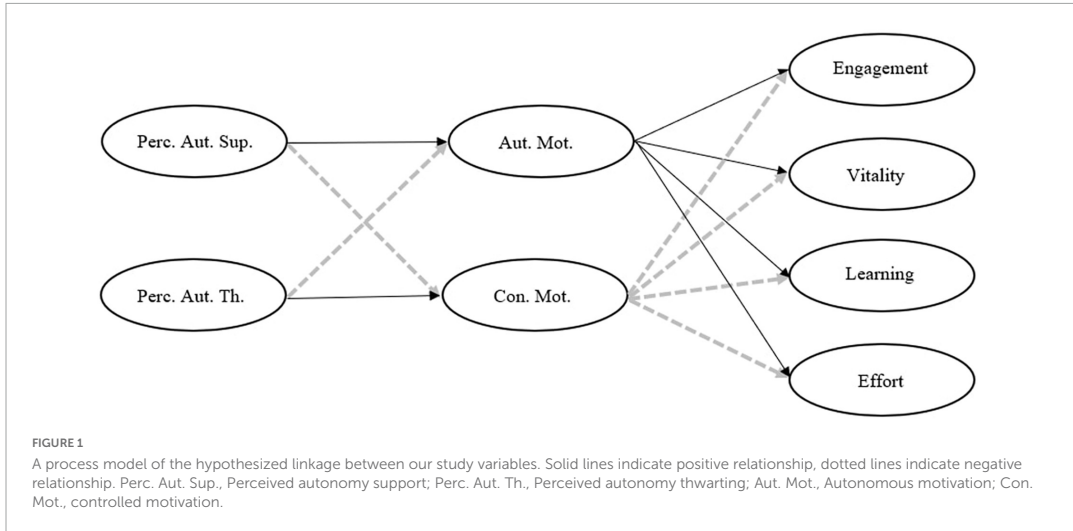
positively predicts controlled motivation which in turn negatively predicts engagement, effort, learning, and vitality; autonomy support negatively predicts controlled motivation and autonomy thwarting negatively predicts autonomous motivation), we used structural equation modeling (SEM) to investigate the relationships between our study variables. It should be noted that the causal delineations of the SEM model pathways are based on theoretical assumptions anchored in SDT tenets and prior studies and cannot be proven in this study as it encompasses cross-sectional data.

First, we investigated a measurement model to verify the relationship between the variables and their corresponding item measures. The measurement model indicated acceptable fits, with CFI = 0.95, TLI = 0.92, RMSEA = 0.12 (CI = 0.11, 0.13), and SRMR = 0.03. Our initial proposed model (Figure 1) indicated poor model fit, with CFI = 0.76, TLI = 0.74, RMSEA = 0.13 (CI:0.11, 0.13), and SRMR = 0.076. Employing modification index algorithm (Jorgensen, 2017) to our baseline model indicated that autonomous motivation should covary with controlled motivation, and that some items should covary [only items measuring the same construct were included in the modifications; item 2 and 3 from LCQ (autonomy support); item 1 and 3 from IBQ (autonomy thwarting)]. The re-specified model (Figure 2) indicated acceptable model fit, with CFI = 0.91, TLI = 0.85, RMSEA = 0.12 (CI = 0.111, 0.135), and SRMR = 0.058. To check if the re-specified model was better compared to the baseline model, we utilized a chi-square difference test. We found a significant difference between the two models ($p < 0.01$), where the re-specified model ($\chi^2 = 3531$, $df = 531$) had a lower AIC (8004) and BIC (8169) relative to the base model ($\chi^2 = 4,586$; $df = 534$; AIC: 28,446; BIC: 28,816), indicating that the re-specified model better fits the data.

Our final model indicates that autonomy support positively predicts autonomous motivation and negatively predicts controlled motivation, whereas autonomy thwarting negatively predicts autonomous motivation and positively predicts controlled motivation, in line with our hypothesis. Autonomous motivation positively predicts engagement, learning, and effort, but we found no significant relationship between autonomous motivation and vitality in our model. Controlled motivation negatively predicts engagement and vitality, but positively predicts effort. We found no significant relationship between controlled motivation and learning. Finally, autonomous motivation and controlled motivation negatively covary. Due to the high correlation between autonomous and controlled motivation ($r = -0.71$), the potential presence of collinearity must be addressed. However, testing for collinearity for all variables using variance inflation factor revealed no issues (VIF < 10 for all variables; Hair et al., 1995).

Indirect effects

An analysis of the indirect effects for our process model (Table 3) indicates that autonomy support predicts engagement through autonomous and controlled motivation. Autonomy support predicts learning and effort through autonomous motivation and negatively predicts effort through controlled motivation. Autonomy thwarting negatively predicts engagement through autonomous motivation, and negatively through controlled motivation. Further, autonomy thwarting negatively predicts vitality through controlled motivation.



Discussion

The main aim of this study was to propose and investigate a comprehensive dual process model in which student functioning is related to autonomy support and thwarting mediated through autonomous and controlled motivation. Generally, the results supported our initial hypotheses, although there were some discrepancies. In line with our predictions, autonomy support positively predicts autonomous motivation, and negatively predicts controlled motivation. Autonomy thwarting negatively predicts autonomous motivation, and positively predicts controlled motivation. Further, autonomous motivation positively predicts engagement, effort, and learning, in line with our prediction. In our study, however, we did not find any (significant) relationship between autonomous motivation and vitality, but rather we

found that controlled motivation negatively predicts vitality. These results are similar in magnitude to a study by Tsoi et al. (2018) conducted on pharmacy students. It is important to recognize that our measurement of controlled motivation had low reliability ($\alpha = 0.60$). Since internal consistency entails to what extent the items measure the same construct, this low alpha could reflect a matter of dimensionality in our variable. This can be explained by the fact that controlled motivation consists of two very different types of motivations, namely, external regulation and introjected regulation (Cerasoli et al., 2014; Howard et al., 2021). SDT postulates that motivation is a multidimensional construct represented by a continuum of distinct types of motivations (i.e., the extrinsic regulations and intrinsic motivation). This conceptualization can lead to very complicated models when motivation is comprised of distinct

TABLE 3 Indirect effects of the relationships of the re-specified model.

Independent variable	Mediator	Dependent variable	Z	Indirect effect (standardized β)
Autonomy support	Autonomous motivation	Engagement	6.21***	0.26
Autonomy support	Autonomous motivation	Vitality	1.81	0.10
Autonomy support	Autonomous motivation	Learning	3.07***	0.17
Autonomy support	Autonomous motivation	Effort	5.89***	0.43
Autonomy support	Controlled motivation	Engagement	6.71***	0.29
Autonomy support	Controlled motivation	Vitality	3.86***	0.24
Autonomy support	Controlled motivation	Learning	1.02	0.06
Autonomy support	Controlled motivation	Effort	-4.49***	-0.34
Autonomy thwarting	Autonomous motivation	Engagement	-3.28**	-0.07
Autonomy thwarting	Autonomous motivation	Vitality	-1.64	-0.03
Autonomy thwarting	Autonomous motivation	Learning	-2.41*	-0.05
Autonomy thwarting	Autonomous motivation	Effort	-3.26*	-0.13
Autonomy thwarting	Controlled motivation	Engagement	-5.44***	-0.14
Autonomy thwarting	Controlled motivation	Vitality	-3.55***	-0.12
Autonomy thwarting	Controlled motivation	Learning	-1.01	-0.03
Autonomy thwarting	Controlled motivation	Effort	4.01***	0.16

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

constructs (external regulation, introjected regulation, identified regulation, and integrated regulation). There has, however, been interest in the empirical differences between the varied strategies of aggregation of this construct (Howard et al., 2020). On one hand, The Relative Autonomy Index (RAI; Grolnick and Ryan, 1989) represents the degree of relative autonomy as a single score. This reasoning is based on the autonomy continuum where each motivational construct is ordered, where identified and intrinsic motives increase the level of relative autonomy whereas external and introjected regulations decrease the score. This scoring system is highly aligned with the continuum of self-determined motivation, but it fails to address the role of each motivational construct in a model. Conversely, one could treat each motivational construct individually (Howard et al., 2020). The strength of this approach is rooted in its comprehensiveness where all motivational constructs can be modeled based on regulations. However, this approach downplays the continuum of self-determined motivation and no longer treats the autonomy continuum as a distinct factor. This can result in enhanced inter-regulation correlations as the effects of each motivational construct are amalgamated, resulting in potential erroneous effect sizes and even problems with effect directionality (Howard et al., 2020). Another approach is using higher-order models, where intrinsic and identified regulations are combined into autonomous motivation and introjected and external regulation are combined into controlled motivation. Although similar to the RAI approach in terms of not accounting for all the different motivational constructs, it does, however, present a dichotomous outlook of self-determination by investigating the effects of experiencing self-determination vs. experiencing a lack of self-determination (Howard et al., 2020). Alongside allowing the examination of indirect effects (Phillips and Johnson, 2018), higher order-models will often have easily interpretable results as an emblematic utilization of this approach

may indicate a positive relation between autonomous motivation and, e.g., effort, whereas controlled motivation may negatively relate to the same variable (Howard et al., 2020).

Autonomously motivated students have often been associated with higher productiveness and willingness to put more effort into their assignments and learning activities (Ryan and Frederick, 1997). This claim is supported by our results, where we found that autonomous motivation positively predicts effort. Whenever learning activities are self-endorsed and carried out due to the students' own volitions, they are more willingly putting effort into learning activities (Mouratidis et al., 2011; Vansteenkiste et al., 2018). A similar result was also found by Feng et al. (2019), where they investigated homework effort in mathematics and found that autonomous motivation predicted effort with a very similar order of magnitude compared to our results. Further, we found that autonomy support has a positive indirect effect on effort mediated through autonomous motivation, and a negative indirect effect on effort mediated through controlled motivation. Students' ability to exert effort and persist is an important constituent in students' daily lives as effort has been shown to be a predictor of academic achievements (Komarraju and Nadler, 2013; Jiang et al., 2019). Yet, contrary to our initial hypothesis, our results indicate that controlled motivation positively predict effort as well. This could be explained by the fact that controlled motivation consists of two different types of motivations (external regulation and introjected regulation; Howard et al., 2021), hence our results must be interpreted in a more nuanced way. However, this finding is supported by a study by Goodman et al. (2011) on university students where they also found that controlled motivation positively predicts effort. Yet, the magnitude of the regression onto effort from autonomous motivation is considerably larger relative to controlled motivation according to our results. Interestingly, revisiting the indirect effect analysis (Table 3) we

can see that autonomy support strongly affects effort through both autonomous motivation and controlled motivation, while autonomy thwarting has a weaker effect on effort through both autonomous and controlled motivation.

Students who experience autonomy support and are self-endorsed during learning activities are more likely to value the learning material and associate the learning context with positive emotions (Assor et al., 2002). Hence, they are more likely to show emotional engagement, where they participate more actively in learning situations by showing involvement and enthusiasm. According to SDT, engagement can be considered an aspect of self-determined motivation (Skinner and Pitzer, 2016). It is human nature to be innately curious with a natural strive to learn and internalize, and fundamental to SDT is the core idea that when the basic need for autonomy is met by an educational autonomy supportive context, individuals will actively engage with the context (Skinner and Pitzer, 2016). This is mirrored in our results as well, where we observed a very high correlation between emotional engagement and autonomous motivation. Emotional engagement is an important constituent in higher education as previous research has shown that emotional engagement is linked to achievements and educational attainment (Elffers et al., 2012). In terms of our SEM model, we found that autonomous motivation positively predicts emotional engagement, a finding that is similar to a study by Froiland and Worrell (2016). Further, we found that controlling motivation negatively predicts engagement, a result that resemble those of Assor et al. (2005) and Jang et al. (2009). The results indicate that autonomy support positively predicts engagement mediated by both autonomous and controlled motivation with a very similar effect size, while autonomy thwarting negatively predicts engagement through both autonomous and controlled motivation. This is an interesting result as the direct effect of controlled motivation on engagement was negative, whereas the indirect effect (mediated through controlled motivation) from autonomy support on engagement was positive. This finding suggests that providing autonomy support in the classroom thus is pivotal in fostering engagement among students. In contrast, autonomy thwarting negatively predicts engagement mediated by both autonomous and controlled motivation.

In line with what we hypothesized, we found that autonomy support positively predicts autonomous motivation. When students are autonomy supported in a classroom setting, they are consequently more likely to endorse the course material in an autonomy supportive way, and hence will experience more autonomous forms of motivation (Reeve, 2009). Our findings support earlier similar research (Hagger et al., 2015) at a lower academic level, and hence we expand the theoretical implications to higher education numeracy courses. Further, as expected, autonomy support negatively predicts controlled motivation. When students are provided with an autonomy supportive learning climate, they are more likely to internalize the learning content in a less controlling way, thus one would expect autonomy support to negatively predict controlled motivation. However, our results contradict a study by Mouratidis et al. (2018) in which no significant relationship between autonomy support and controlled motivation was detected.

Although our analysis indicates that autonomous motivation does not predict vitality (neither directly nor indirectly), indirect effects analysis indicates that autonomy support positively

predicts vitality mediated through controlled motivation. Further, controlled motivation directly negatively predicts vitality whereas autonomy thwarting negatively predicts vitality mediated through both controlled and autonomous motivation. And although similar findings have been reported before (Tsoi et al., 2018), some discussion regarding vitality as a variable is needed. Our results indicate that students pursuing the course in a controlled way experience less vitality. However, whereas the other outcome variables of our proposed model, i.e., engagement, learning, and effort, are subject relevant, vitality is a *general trait* which could be multidetermined beyond the context of the classroom (Ryan and Deci, 2017). Even though the feelings of being energized and vital are experiences students can report reliably (Ryan and Deci, 2017), experiences of vitality vary individually from person to person, and more noticeably, it varies within people. Adequate nutrient and liquid intake, sleep deprivation, exercise, and social interactions are examples of out-of-school contexts that directly affect vitality (Ryan and Frederick, 1997; Núñez and León, 2016; Cheon et al., 2018), hence the results surrounding vitality needs to be interpreted in a more nuanced way in our model.

Finally, in agreement with SDT tenets and our hypothesis, we found that autonomy thwarting negatively predicts autonomous motivation and positively predicts controlled motivation. Since autonomy thwarting is associated with a behavior or environment that pressures students to behave or act in a certain way (Assor et al., 2005), one would expect that students who experience autonomy thwarting will experience autonomous motivation to a lesser extent since the reason for the behavior has an external locus detached from the learning activity itself. Autonomy thwarting instructors tend to dismiss students' perspectives and use controlling practices and language; hence it can be difficult for students to fully accept the learning content and experience volition and self-endorsement. These findings have also been reported in a previous longitudinal diary study by Patall et al. (2018).

Limitations

There are several limitations worth mentioning when interpreting the results of our study. First, our study is cross-sectional in nature, hence we cannot infer causality. However, path directionality in our process model is based on strong theoretical propositions derived from SDT tenets and previous empirical research that supports our line of reasoning (e.g., Milyavskaya and Koestner, 2011; Yeager et al., 2014; Núñez and León, 2016; Cheon et al., 2018). Our strategy is thus appropriate for the purpose of our study (Bollen and Pearl, 2013). However, we recommend future studies to employ a longitudinal design throughout a semester to investigate how perceived autonomy support and thwarting impact changes in autonomous and controlled motivation to avoid any potential temporal issues.

Second, our study only focused on autonomy, as opposed to the remaining constituents in basic needs theory, namely, competence and relatedness. Future studies should include all three basic psychological needs to encompass the omitted aspects as studies show that both the need for competence and relatedness are important constituents for optimal learning outcomes (Niemeck and Ryan, 2009; Beachboard et al., 2011).

Third, it is worth pointing out the construct validity of one of the study variables, *controlled motivation*. Calculation of Cronbach's alpha (0.60) implies there could be reason to question the internal consistency. Although the scale has shown good internal consistency in previous research (Williams and Deci, 1996; Black and Deci, 2000), a very similar Cronbach's alpha (0.55) was found in a more recent construct validity study (Hendo-Milewska, 2019). It is, however, important to recognize that this variable is a construct consisting of two very different types of motives, i.e., external regulation and introjected regulation (Cerasoli et al., 2014). We therefore recommend future research to replicate our study using these motives independently instead of a compound approach. Further, it is worth noting that this implies that we are using a non-unidimensional construct as a single factor in our SEM model. However, according to item response theory there are a number of studies that have explored the robustness of variables used in models that violate unidimensionality assumptions, and generally the findings indicate that variables do not incur bias given that there is a strong general factor within the data (Dragow and Parsons, 1983; Kirisci et al., 2001).

Finally, our study employed a self-report measure of learning. That is, we measured students' perceived learning, as opposed to an objective measure such as grades or test scores. Previous research has shown that perceived learning is a reliable measure of learning (Benton et al., 2013; Ratelle and Duchesne, 2014). However, caution is advised as self-reports are prone to memory bias (Pekrun, 2020) and have been shown to be less reliable among weaker students (Kuncel et al., 2005), hence future studies should include more objective measures of learning and other outcomes to investigate the relation between teacher support and thwarting, and student motivation.

Conclusion

To conclude, our study presented a comprehensive dual-process model delineating how autonomy support and autonomy thwarting underpin a proxy for student functioning. This study expands on previous research by exploring an investigative SDT model in a higher education calculus course to study how perceived autonomy support and thwarting affect student motivation and in turn, important aspects related to a good learning climate in an authentic classroom setting. The present study is the first study to investigate the dual process behind how perceived autonomy support and thwarting affect engagement, effort, vitality, and learning, indirectly through autonomous and controlled motivation simultaneously in a higher education setting. Students function better in a learning environment when they experience

autonomy support, thus it is imperative for researchers to highlight the importance of an autonomy supportive learning environment.

We encourage future researchers to replicate and expand our study by implementing similar models in other disciplines in higher education.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by the Norwegian Social Science Data Services. The patients/participants provided their written informed consent to participate in this study.

Author contributions

MJ: conceptualization, methodology, formal analysis, software, writing—original draft, and investigation. LJ: conceptualization, methodology, writing—review and editing, and supervision. SE: conceptualization, writing—review and editing, and supervision. All authors contributed to the article and approved the submitted version.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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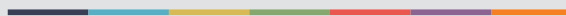
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