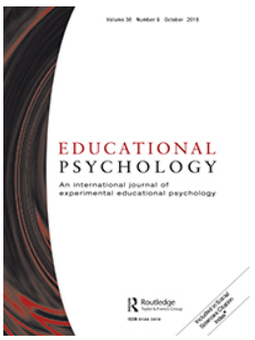

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A prospective investigation of students' academic achievement and dropout in higher education: a Self-Determination Theory approach

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ABSTRACT

We investigate a model based on Self-Determination Theory (SDT) to predict academic achievement and dropout intentions among biology students in higher education in Norway. Students ($n = 754$) from a representative national sample participated in this cross-sectional study. The results align with our hypotheses and SDT assumptions. The model explains a substantial amount of the variance in academic achievement and dropout intentions. Specifically, autonomous motivation and perceived competence positively predict academic achievement and negatively predict dropout intentions. Controlled motivation is unrelated to academic achievement and is a positive predictor of dropout intentions. Furthermore, significant indirect effects show that need-supportive teachers and students' intrinsic aspirations positively predict academic achievement and negatively predict dropout intentions, via autonomous motivation and perceived competence. We recommend teachers to support students' need for autonomy, competence and relatedness, by providing choice and volition to facilitate autonomous motivation, and give students effectance-relevant feedback and optimal challenges to increase perceived competence.

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KEYWORDS
Academic achievement; motivation; tertiary; teacher motivation

Introduction

Developments in the labour market and societal demands require an increasing number of high-achieving students to graduate within the Science, Technology, Engineering, and Mathematics fields (STEM; Xie, Fang, & Shauman, 2015). Academic achievement is important for a range of educational outcomes and studies have shown that students' achievement is linked to future job performance (Kuncel, Credé, & Thomas, 2005), intention to persist in education (Hardre & Reeve, 2003; Ruban & McCoach, 2005), and actual dropout (Battin-Pearson et al., 2000; Freeney & O'Connell, 2012). According to the OECD (2017), students who complete a higher education degree are more likely to be employed, have higher wages, and have less depression

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compared to students who do not have a higher education degree. Consequently, student academic achievement and dropout are strongly linked and are important success factors in higher education.

Despite increased emphasis and financial incentives in STEM-education in Norway (Ministry of Education & Research, 2015; Schmidt, 2007), the Norwegian education system faces several challenges: students in Norway have low motivation, high dropout rates, and underachieve in science and technology (OECD, 2014). Reports on dropout in higher education suggest that 25% of the student mass never complete their bachelor STEM-education degree (Ministry of Education & Research, 2016; Statistics Norway, 2015). Only 43% of the students complete their degree within the stipulated time (Ministry of Education & Research, 2016). Similar results are found in other European countries and in the United States (Snyder, Brey, & Dillow, 2016; Vossensteyn et al., 2015).

Recent evaluations in higher education investigating causes of dropout suggest that reasons for leaving education include feelings of not belonging to the university, concern about attaining future aspirations, and poor peer relationships, whereas reasons for staying include positive teacher–student interactions and gaining an understanding of university processes (Delaney, 2008; OECD, 2012, 2014; Thomas, 2012). Other studies suggest that positive emotions (satisfaction and enjoyment) are related to academic achievement and persistence in higher education, whereas negative emotions (boredom and anxiety) are positively related to dropout (Duque, 2014; Respondek, Seufert, Stupnisky, & Nett, 2017). Furthermore, a systematic review of dropout in EU member states, Norway, and Switzerland suggests investigating malleable factors such as student motivation in order to understand dropout better (Larsen, Kornbeck, Kristensen, Larsen, & Sommersel, 2013). Because of possible negative consequences such as loss of knowledge and economic loss to the individual, the institution, and society (Falch, Johannesen, & Str⊘m, 2009; OECD, 2015), it is regarded as important to investigate the aspiration, belongingness, and motivation of students as antecedents of dropout and achievement.

The main goal of this study is thus to test a comprehensive motivational model of dropout and academic achievement among higher education students by using a Self-Determination Theory approach (SDT; Ryan & Deci, 2017). Addressing these different motivational pulls of dropout is especially important due to the declining motivation in higher education students (Brahm, Jenert, & Wagner, 2016).

Perceived competence, autonomous motivation, dropout, and academic achievement

As opposed to most approaches to academic achievement and dropout (Bean, 1980; Tinto, 1975), SDT (Ryan & Deci, 2017) embraces a growth-centred approach to understand why some students are motivated, why some are likely to dropout, and why some achieve at a higher level. Furthermore, the theory suggests which societal conditions either support or thwart students' motivation. SDT differentiates motivation as classes that vary in relative autonomy. Autonomous motivation encompasses behaviours high in autonomy, that is, done out of choice, with a sense of volition and

self-endorsement. In contrast, controlled motivation is very low in autonomy and concerns activities done for a separate consequence (e.g. obtaining or avoiding external or internal contingencies; Deci & Ryan, 2000). Autonomous motivation, as opposed to controlled motivation, is associated with high-quality functioning, positive psychological well-being, and behavioural outcomes such as persistence and achievement in school (Guay, Ratelle, & Chanal, 2008).

Research has shown that autonomous motivation and perceived competence positively predict students' academic achievement (Feri, Soemantri, & Jusuf, 2016; Jeno, Grytnes, & Vandvik, 2017). Furthermore, autonomous motivation and perceived competence have shown to predict above-average students' grades, above and beyond the effect of Stanford Achievement Test scores (Miserandino, 1996). A meta-analysis of students' psychological correlates of academic achievement in higher education found that perceived competence was the strongest predictor of the students' Grade Point Average, followed by students' goals, self-regulatory capacities, and intrinsic motivation (Richardson, Abraham, & Bond, 2012). Studies have shown similar patterns in dropout. Litalien and Guay (2015) found in a prospective study that graduate students' perceived competence negatively predicted dropout intentions. Furthermore, both perceived competence and autonomous motivation have been shown to predict dropout intentions among diverse student samples (Hardre & Reeve, 2003; Lavigne, Vallerand, & Miquelon, 2007; Otis, Grouzet, & Pelletier, 2005; Vallerand, Fortier, & Guay, 1997). Consistent with previous studies, autonomous motivation and perceived competence may be considered important and strong predictors of dropout and academic achievement.

Need-support, internalisation, goal aspirations, dropout, and academic achievement

According to SDT, satisfaction of the basic needs for autonomy (experience of choice and self-endorsement), competence (feeling efficacious), and relatedness (being cared for) is assumed to facilitate students' autonomous motivation, persistence, and learning (Ryan & Deci, 2017). In an educational context, teachers are the primary provider of need-support and have been shown to have a strong effect on students' dropout and academic achievement (Niemiec & Ryan, 2009; Ryan & Deci, 2017). Need-supportive teachers are defined as teachers who identify, nurture, and develop students' inner motivational resources during instruction (Kusurkar, Croiset, Olle, & Cate, 2011). Thus, teachers either nurture or stifle students' natural growth tendencies. Need-support and need-satisfaction are important for student motivation and aspiration, and are theorised to be necessary for individuals across cultures, genders, and developmental stages (Ryan & Deci, 2017). Several studies have shown, both experimentally and correlationally, that teachers who are need-supportive, have students who exhibit less pressure and tension (Benita, Roth, & Deci, 2014; Study 1), more intrinsic motivation (Black & Deci, 2000), and higher well-being (Rocchi, Pelletier, Cheung, Baxter, & Beaudry, 2017). Further, according to SDT, need-support and relatedness are considered important factors for students' internalisation, that is, transforming external values and behaviours into self-regulation (Baumeister & Leary, 1995; Ryan & Deci, 2017).

Whereas autonomy and competence have been shown to be the most important factors for intrinsic motivation, relatedness is considered the proximal factor for internalisation (Deci, Ryan, & Williams, 1996; Ryan & Deci, 2017).

Students' personal goals have previously been considered important for students' dropout and academic achievement (Tinto, 1993). According to SDT, there are two different types of goal aspirations that students can pursue that affect their psychological health and learning: intrinsic (personal growth, community, physical health) and extrinsic (money, fame, image) (Kasser & Ryan, 1996). It is assumed by SDT that both basic need-satisfaction and need-support will promote intrinsic aspirations, whereas need-frustration and need-thwarting will enhance extrinsic aspirations (Kasser, Ryan, Zax, & Sameroff, 1995). Research by Vansteenkiste, Simons, Lens, Sheldon, and Deci (2004) found that framing a learning goal as intrinsic in a need-supportive way relative to an extrinsic goal in a controlling way, enhanced students' autonomous motivation, persistence, and deeper learning. Moreover, intrinsic aspiration has been found to uniquely predict mastery orientation, whereas neither extrinsic aspiration nor the sum of both intrinsic and extrinsic aspirations enhances performance motivation. (Vansteenkiste et al., 2004). Lastly, intrinsic aspiration, as opposed to extrinsic aspiration, has been shown to have an indirect effect on academic meaning and academic achievement among college students and upper-secondary students (Fryer, Ginns, & Walker, 2014; Utvaer, 2013). Hence, holding intrinsic aspirations is related to beneficial outcomes due their support for the basic psychological needs, especially in need-supportive contexts. Conversely, pursuing an extrinsic goal is not linked to beneficial outcomes such as autonomous motivation and learning.

The present study

Although previous studies have investigated dropout intentions and academic achievement, there are several limitations to these studies. To our knowledge, no previous studies have tested an integrative model of SDT and investigated how aspirations relate to students' motivation, competence, dropout intentions, and academic achievement within higher education. Moreover, no studies have investigated these motivational dynamics of academic achievement and dropout among a higher education sample in a Norwegian context (Hovdhaugen, 2009; Koutsogeorgopoulou, 2016; Mastekaasa & Hansen, 2005).

Consequently, by using a SDT approach, the main aim of the current study is to investigate a motivational model of higher education students' dropout and academic achievement (Figure 1). Moreover, we specify our model in accordance with theoretical assumptions, and the level of generality of the measured constructs (Vallerand & Ratelle, 2002). That is, the antecedent predictors in our model (i.e. need-support, relatedness, intrinsic aspiration, extrinsic aspiration) are all measured at a general level, and assumed to enhance autonomous motivation and perceived competence. The mediators in the model (i.e. perceived competence, autonomous motivation, controlled motivation) are contextual factors of the students' biology competence and motivation, and are thus assumed to mediate the relation between teachers' need-support, relatedness at the university, and goal aspiration for studying biology on

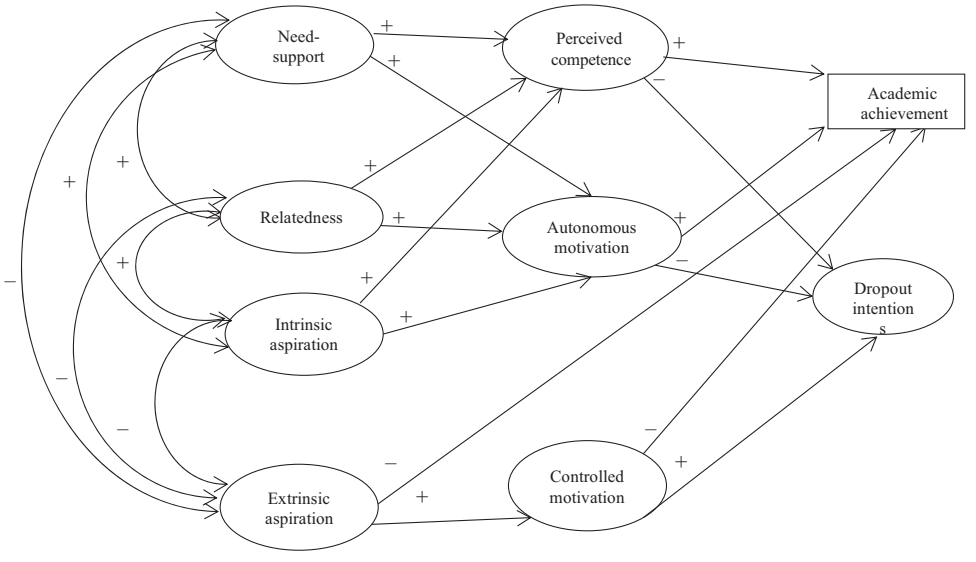

Figure 1. The SEM-model depicts the hypothesised relations between the measured constructs. The model proposes the indirect effects of need-support, relatedness, and intrinsic aspiration in positively predicting academic achievement and negatively predicting dropout intentions through perceived competence and autonomous motivation. A positive indirect effect of extrinsic aspiration on dropout intentions through controlled motivation is specified.

dropout and academic achievement. A previous systematic review and a meta-analysis have shown indirect support for this line of reasoning (Larsen et al., 2013; Robbins, Oh, Le, & Button, 2009). A second aim of the study is to investigate the underlying motivational factors of dropout and academic achievement. That is, through which factors do our predictor variables account for unique variance in our dependent variables. Hence, we investigate whether intrinsic goal aspiration, need-support, and relatedness indirectly account for less dropout intentions and higher academic achievement through students' motivation and competence.

Method

The study is based on data from the bioCEED Survey 2015 (Hole et al., 2016). The bioCEED Survey 2015 is a baseline national representative study of Bachelor and Master students of biology, and higher education biology educators in Norway. The main aim of the bioCEED Survey 2015 was to map the higher education students' and teachers' experiences and attitudes towards biology education, learning in practice and the laboratory, and students' approaches to learning, work experience, and prospective goals in education and work life (Hole et al., 2016). The current investigation employs cross-sectional data from the student sample.

Participants

Participants were 754 biology students in higher education. We obtained a 42.5% response rate, which is similar to other national representative studies in higher

education in Norway (Bakken, Damen, & Keller, 2015; B⊘yum, 2013; Holm & Skåtun, 2017). Participants consisted of 249 males (33%) and 500 females (66%), while five did not report their gender. Age was asked in four intervals; under 20 (6.8%), 21–25 (69.2%), 26–30 (16.4%), and above 35 (2.9%). In our sample, educational level was differentiated between bachelor students ($n = 454$; 60.5%) and master students ($n = 297$; 39.5%).

Procedure

All principals of all higher education institutions that offer general biology in Norway were contacted to participate in this study. Selection criteria were based on an overview of applicable biology education programmes in Norway offered from the Norwegian Universities and Colleges Admission Services. In addition, information provided from each participating institution's web-page was evaluated. Institutions that offered specialised biology education were excluded from the sample for comparative purposes (Hole et al., 2016). All nine institutions agreed to participate. The data were collected from mid-February 2015 to mid-March 2015. The students were recruited by means of an Internet survey (Survey Xact). Participating students had the opportunity to win one of two iPads.

Ethical considerations were addressed by obtaining formal approval from The Norwegian Social Science Data Services for Research. The students were informed that participation was voluntary, that the information they provided would be treated confidentially, and that any personal identifiable information would be deleted immediately after the end of the study. They were also informed that they could withdraw from the study at any time.

Measures

The employed scales are validated and retrieved from studies in which the scales have shown acceptable reliability and validity. The scales were translated into Norwegian by the two first authors of the bioCEED Survey 2015 (Hole et al., 2016), and then back-translated by a native English-speaking biologist. In instances of disagreement, a discussion was invoked to ensure the psychological meaning of the item, following recommendations from Harkness and Schoua-Glusberg (1998) and comparable studies (Deci et al., 2001). Due to the present theoretical approach of SDT, the scales were retrieved from SDT's homepage (www.selfdeterminationtheory.org) where the scales are freely available. Furthermore, pilot-testing and 'thinking-out-loud' procedures (Persaud, 2012; van Teijingen & Hundley, 2001) showed satisfactory psychometrics of the scales (i.e. reliability tests and factor analyses), prior to data collection.

Need-support

Six items measuring students' perception of need-supportive lecturers were retrieved from the Learning Climate Questionnaire (LCQ; Williams & Deci, 1996). The LCQ was originally developed for medical students and has been shown to predict both autonomous motivation and beneficial educational outcomes (Black & Deci, 2000;

Reeve, 2002). The students were asked to respond on a 7-point Likert-scale ranging from 1 (strongly disagree) to 7 (strongly agree). An example item is 'My lecturers listen to how I like to do things'. Previous studies using the LCQ have shown good reliability (Black & Deci, 2000; Williams, Grow, Freedman, Ryan, & Deci, 1996). In the current sample, we achieved high (DeVellis, 2017) Cronbach's alpha ($\alpha = 0.88$).

Relatedness

Two items retrieved from the Basic Psychological Needs Scale (BPNS; Deci et al., 2001) were used to assess students' relatedness at University (e.g. 'People in biology courses care about me'). Responses were made on a 7-point Likert-scale ranging from 1 (not at all true) to 7 (very true). Previous studies in educational settings with higher education students and in prosocial settings have shown acceptable validity and reliability of this subscale (Gagné, 2003; Jeno et al., 2017). The items produced high Cronbach's alpha ($\alpha = 0.82$).

Aspirations

Four items from the Aspiration Index (Kasser & Ryan, 1993) were used to assess the importance of students' intrinsic (e.g. 'How important was the following reason for your decision to study; to work for the betterment of society') and extrinsic (e.g. 'How important was the following reason for your decision to study; to be rich') aspirations. The scale was developed using higher education students and has been showed to predict reliably students' well-being (Niemiec, Ryan, & Deci, 2009; Ryan et al., 1999). Students made responses on a 7-point Likert-scale ranging from 1 (not at all true) to 7 (very true). Studies using the aspiration scale have shown good factorial structure and acceptable alpha levels (Kasser et al., 1995; Kasser & Ryan, 1993). High reliability levels were found for extrinsic aspiration ($\alpha = 0.79$) and for intrinsic aspiration ($\alpha = 0.88$).

Autonomous and controlled motivation

Twelve items from the Self-Regulation Questionnaire-L (SRQ-L; Ryan & Connell, 1989) were used to assess why students participate in biology learning activities (e.g. 'I will participate in biology courses because I feel proud of myself if I do well in biology'). The scale consists of two subscales: autonomous and controlled motivation. The scale was originally developed to tap children's reasons (i.e. intrinsic, identified, introjected, and external) for behaviour in an educational and prosocial domain, but has been refined and adapted to measure higher education students' autonomous and controlled reasons for behaviour in education (Williams & Deci, 1996). Both subscales consist of 6 items each, and responses used a 7-point Likert-scale ranging from 1 (not at all true) to 7 (very true). Previous studies have reported good reliability (Black & Deci, 2000; Williams et al., 1996). The present study found acceptable indices (Cortina, 1993; Ntoumanis, 2005) for autonomous motivation ($\alpha = 0.69$), and for controlled motivation ($\alpha = 0.69$).

Perceived competence

Four items from the Perceived Competence Scale (WWilliams & Deci, 1996) assessed students' perceived competence in their biology course (e.g. 'I am able to achieve my goals in this course'). The scale was originally developed to measure medical students' competence in interviewing, and the scale has proved to have good face, construct, and internal validity. Students were asked to respond on a 7-point Likert-scale ranging from 1 (not at all true) to 7 (very true). Previous studies show good consistency for the scale (Black & Deci, 2000; Jeno & Diseth, 2014). Alpha level was high in our sample ($\alpha = 0.91$).

Dropout intentions

Three items adapted from Hardre and Reeve (2003) were employed in order to assess students' dropout intentions (e.g. 'I have often considered quitting biology'). The scale has been shown to predict actual dropout behaviour and proven reliable among college students (Guiffrida, Lynch, Wall, & Abel, 2013; Vallerand et al., 1997). Students were asked to respond on a 7-point Likert-scale ranging from 1 (strongly disagree) to 7 (strongly agree). The present study found an alpha level of $\alpha = 0.67$.

Academic achievement

In order to collect the students' prospective academic achievements, the students were asked to provide us with their student number or personal identification number. The final grades in biology were collected after the end of the academic semester through the universities/colleges. In cases where a student had studied several biology subjects, an average of all grades was used. The student and personal numbers were deleted after this process and not linked to the rest of the questionnaire. Of the 754 students in our sample, 309 provided us with the necessary information to retrieve their biology grades. Thus, for the academic achievement measure, the sample size is 309. In 2015 (Ministry of Education & Research, 2016), 13% of the Norwegian students received an A, 27% B, 29% C, 15% D, 8% E, and 8% F. In our sample, 9.7% received an A, 37.7% B, 31.3% C, 15. 2% D, 3.1% E, and 2.6% failed (F). The present study sample seems fairly representative of the student mass as a whole in terms of academic achievement levels, even though our sample consists only of biology students.

Missing data

Missing data were handled by using the full information maximum likelihood (FIML) method, which is the recommended method when handling missing data (Byrne, 2016; Schafer & Graham, 2002). FIML performs parameter analyses without imputing or deleting cases by partitioning all cases into subsets comprising the same pattern of missing cases (Byrne, 2016, p. 399). Furthermore, FIML is the most efficient, consistent, and asymptotically unbiased technique to handle missing values in SEM analyses (Kline, 2011). Missing values ranged from 2.3 to 19.1% for some items. High missing values are likely due to data being collected online, which is a potential problem in internet surveys (Schmidt, 1997).

Analytical strategy

All descriptive analyses were done through IBM SPSS 23, whereas all multivariate analyses were done through AMOS 23 (Arbuckle, 2013).

Structural equation modeling (SEM)

All variables in the model were treated as continuous latent variables, except achievement which was an observed variable. We tested the statistical model in a two-step process in which we first tested the measurement model and then the structural model. The adequacy of the full SEM-model was tested for the total sample followed by multi-group analyses (Vandenberg & Lance, 2000). The multi-group analyses tested for the invariance of the model across genders (male, female) and levels (BA-level, MA-level). Our main focus in the multi-group analyses was to test whether the structural paths among the variables were invariant across the groups. This is due to theorization SDT that states that need-support, need-satisfaction, and motivation are invariant across gender and age (Ryan & Deci, 2017). SEM is assessed by means of several goodness-of-fit indices. The Comparative Fit Index (CFI) assesses how well the hypothesised model fits the sample data (Hu & Bentler, 1995). A Chi-square (χ^2)/degrees of freedom (df) ratio represents the difference between the unrestricted and restricted covariance matrix (Byrne, 2016). The Root Mean Square Estimate Approximation (RMSEA) represents how well the model would fit the population if optimal parameters were available (Byrne, 2016). According to Hu and Bentler (1999), values $>$ 0.95 of CFI are considered a good model fit, and RMSEA $<$ 0.05 represents an excellent fit. Lastly, a χ^2/df ratio $<$2 and a χ^2 of $p > .05$ are considered to indicate a model that represents the data well. However, recently a CFI value as low as $>$0.90 and an RMSEA as high as $<$0.08 have been considered to indicate an acceptable model fit (Byrne, 2016; Kline, 2011).

Indirect effects

To test our secondary aim, and the specific hypotheses for indirect effects in the SEM-model, we conducted several Sobel tests (Sobel, 1982). We employed the following formula to calculate the indirect effects using regression coefficients and standard errors; $z = \frac{ab}{\sqrt{(b^2 + \mathrm{SE}^a) + (a^2 SE_b^2)}}$ where a is the regression coefficient between the independent variable and the mediator, and b is the regression coefficient from the mediator to the dependent variable. Lastly, SE_a is the standard error between the independent variable and the mediator, while SE_b is the standard error between the mediator and the dependent variable.

Results

Descriptive analyses

Descriptive analyses of the confirmatory factor analyses show acceptable factor loadings and levels of skewness and kurtosis (Byrne, 2016; Kline, 2011). Furthermore, all

Table 1. Descriptive statistics for the study variables including mean (*M*), range, standard deviation (*SD*), skewness (skw), kurtosis (kurt), and Cronbach's alpha.

		Range					
	M	Potential	Actual	*SD*	Skw.	Kurt.	α
Need support	4.66	1–7	1–7	1.03	−0.27	0.73	0.88
Relatedness	5.64	1–7	1–7	1.32	−0.92	0.37	0.82
Extrinsic aspiration	2.57	1–7	1–7	1.34	0.70	−0.01	0.79
Intrinsic aspiration	5.08	1–7	1–7	1.49	−0.61	−0.24	0.88
Perceived competence	5.55	1–7	1.25–7	1.08	−0.58	−0.04	0.91
Autonomous motivation	5.83	1–7	2.80–7	0.76	−0.86	0.66	0.69
Controlled motivation	3.81	1–7	1–6.83	1.10	−0.30	−0.12	0.69
Dropout intentions	1.95	1–7	1–7	1.20	1.62	2.70	0.67
Academic achievement	4.41	1–6 (F–A)	1–6	1.07	−0.90	1.10	

factor loadings for each latent variable are significant ($p < .05$). Means, standard deviations, skewness, kurtosis, and correlational matrix for both the latent and observed variables are presented in Table 1. Bivariate correlations in the matrix are in the expected hypothesised directions (Table 2). All effects are small ($r < 0.30$) in magnitude, except for between need-support and perceived competence, extrinsic aspiration and controlled motivation, perceived competence and dropout intention, and autonomous motivation and controlled motivation, which are all medium ($r = 0.30$ to 0.49) in magnitude (Cohen, 1988).

Due to high missing values in the academic achievement variable, we conducted an omnibus test to test for mean differences between students who provided us with academic achievement scores (dummy coded 1) on the study variables, and those students who did not provide us with such information (dummy coded 2). We conducted a one-way MANOVA in order to increase the protection against an inflated Type 1 error as a function of multiple testing of correlated variables (Tabachnick & Fidell, 2007). Results revealed no-significance for the multivariate test, and thus did not qualify for follow-up analyses, $\Lambda = 0.98$, $F(8, 571) = 1.07$, $p = .37$, $\eta^2 = 0.01$. The analysis revealed only one main effect: participants who had not provided us with information to collect academic achievement scores had a significantly higher mean value on dropout intentions, $F(1, 578) = 4.48$, $p < .05$, $\eta^2 = 0.008$, observed power = 0.56. Hence, we included the academic achievement variable in our model.

SEM analysis

In our initial model, diagnostics revealed misspecification with some poor goodness-of-fit indices, $\chi^2 = 1535.84$ (444), $p < .001$, CMIN/DF = 3.459, CFI = 0.87, and RMSEA = 0.04 (90% CI: 0.035–0.039). Moreover, two of the error terms in controlled motivation (items 5 and 6) were highly related, and covariance between them improved the model fit as a whole. Modification indices (MI) suggested a parameter change in chi-square if the error terms covaried ($\chi^2 = 1.26$). Such improper error covariations may occur when using real data (Bentler & Chou, 1987) and must be grounded in theory and/or empirical research (Byrne, 2016). Both items measure introjection (a partly internalised external regulation; a type of controlled motivation), and in the questionnaire, item 6

Table 2. Correlation matrix of the study variables.

		1	2	3	4	5	6	7	8	9
1	Need support	–								
2	Relatedness	0.29*	–							
3	Extrinsic aspiration	0.02	−0.01	–						
4	Intrinsic aspiration	0.14*	0.11*	0.02	–					
5	Perceived competence	0.30*	0.19*	0.01	0.01	–				
6	Autonomous motivation	0.29*	0.21*	0.04	0.27*	0.21*	–			
7	Controlled motivation	−0.03	0.02	0.30*	0.11*	−0.12*	0.31*	–		
8	Dropout	−0.22*	−0.18**	0.07	−0.07	−0.33*	−0.17*	0.11*	–	
9	Academic achievement	0.14**	0.12**	−0.21*	−0.03	0.28*	0.18*	−0.08	−0.15*	–

Note: *$p < .01$.
**$p < .05$.
Academic achievement is an observed variable of biology grades. All variables ranges from 1 to 7, except academic achievement which ranges from 1 to 6 (F–A).

was subsequent to item 5. Because the respondents may have understood them similarly (Aish & Jöreskog, 1990), this error covariation might be due to characteristics in the items and respondents. Furthermore, this procedure of covariation has been found in a similar study (Evans & Bonneville-Roussy, 2015) using the same scale and overarching theoretical approach. Lastly, modification indices suggested removing one item in the autonomous motivation subscale of SRQ-L ('Because I think the lecturers seem to have insight about how to learn the material'). The diagnostics of the final model (Figure 2) produced adequate goodness-of-fit indices, χ^2= 1190.66 (413), $p < .001$, CMIN/DF = 2.88, CFI = 0.91, and RMSEA = 0.03 (90% CI: 0.030–0.035) predicting dropout intentions ($R^2 = 0.20$) and academic achievement ($R^2 = 0.20$). To compare the initial model with the final model we conducted a $\Delta\chi^2$ difference test (Table 3). Results show a significant difference between the models, $\Delta\chi^2 = 345.18$ (31), $p < .001$, indicating that the models are not equivalent and that the final model has a significantly better model fit.

The results of the final model show that both perceived competence and autonomous motivation positively and significantly predict academic achievement, while extrinsic motivation negatively predicts academic achievement. The association between controlled motivation and academic achievement is not significant. Further, perceived competence and autonomous motivation negatively and significantly predict dropout intentions, while controlled motivation positively predicts dropout intentions. Need-support, relatedness, and intrinsic aspiration are positive predictors of perceived competence and autonomous motivation. Extrinsic aspiration is a positive predictor of controlled motivation and negative predictor of achievement.

Multi-group comparison

Analyses of the final model for the four groups (male/female and BA/MA-level) suggested that it might be possible to use the same path diagram for each group, primarily because of acceptable RMSEA-values. When tested separately for each group, CFI ranged from 0.88 to 0.91, and RMSEA was between 0.051 (0.046–0.056) and 0.055 (0.049–0.061). To further test the validity of the SEM-model, we conducted invariance tests of the structural model across two groups simultaneously (i.e. across gender (males vs. females) and across levels (i.e. BA- vs. MA-level). In these multi-group

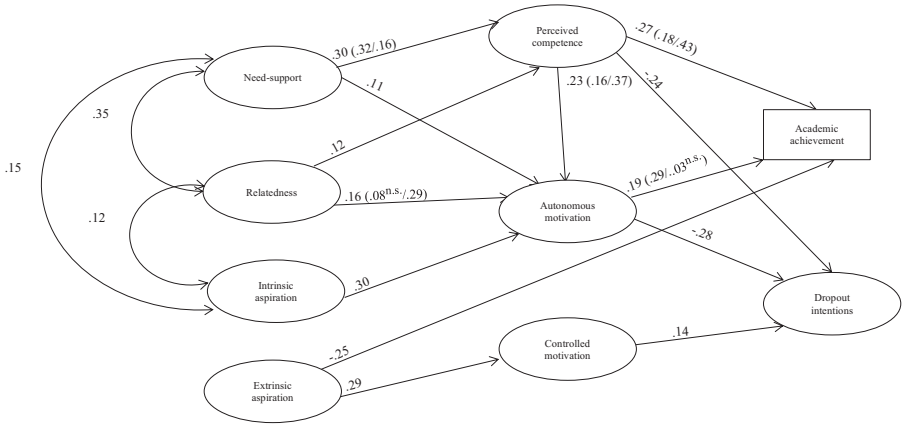

Figure 2. Final motivational model with standardised regression coefficients for total sample (Bachelor and Master students). For clarity, the measurement model is not shown. Additionally, only significant different paths between Bachelor and Master students are shown. Non-significant paths for multi-groups analysis for either Bachelor or Master students are indicated (n.s.).

Table 3. Model fit indices for the models.

Models	χ^2	df	CFI	RMSEA (90% CI)	AIC	BIC	χ^2 difference
Model 1							
Initial hypothesised model	1535.84	444	0.87	0.037 (0.35–0.39)	1767.84	1772.24	
Model 2							
Final baseline model	1190.66	413	0.91	0.033 (0.030–0.036)	1582.33	1587.69	
Model 1 vs. Model 2							345.18 (31)***
Model 3							
Model 2 vs. Model 3 multi-group analysis by gender							35.94 (26)
Model 4							
Model 2 vs. Model 4 multi-group analysis by level							39.72 (26)*

Note: ***significant at $p < .001$.
*significant at $p < .05$.

analyses, parameters were estimated for two groups at the same time. See Table 3 for model comparison results. We analysed the difference between the unconstrained model (final baseline model) and the constrained models (constrained by gender for model 3 and level for model 4). A chi-square difference test revealed a significant different model only for model 4 (i.e. level). That is, the constrained model for gender did not differ significantly from the unconstrained model. Whereas, the constrained model did differ significantly from the unconstrained model for level. A chi-square difference test between level was conducted for each path. Each individual effect was checked whether significant or not. See Figure 2 for comparison between each individual path. Specifically, need-support was a stronger predictor of perceived competence for bachelor students. Relatedness was a significant predictor of autonomous motivation for master students. Perceived competence was a

Table 4. Indirect effects of the hypothesised relationships in the final model for the total sample.

Independent variable	Mediator	Dependent variable	*z*	Indirect effect
Need-support	Perceived competence	Academic achievement	3.61***	0.08
Need-support	Autonomous motivation	Academic achievement	1.72†	0.02
Intrinsic aspiration	Autonomous motivation	Academic achievement	2.53*	0.06
Relatedness	Perceived competence	Academic achievement	2.23*	0.03
Need-support	Perceived competence	Dropout	−3.77***	−0.07
Need-support	Autonomous motivation	Dropout	−1.98*	−0.03
Relatedness	Autonomous motivation	Dropout	−2.54*	−0.05
Relatedness	Perceived competence	Dropout	−2.27*	−0.03
Intrinsic aspiration	Autonomous motivation	Dropout	−3.73***	−0.08
Extrinsic aspiration	Controlled motivation	Dropout	2.24*	0.04

Note: *$p < .05$.
***$p < .001$.
†$p < .05$ one-tailed.

stronger predictor of academic achievement for master students, whereas autonomous motivation was a significant predictor of academic achievement for bachelor students.

Indirect effects

The results of the indirect effect analyses for the total sample show that need-support predicts academic achievement through perceived competence ($\beta = 0.08$, $p < .001$) and autonomous motivation ($\beta = 0.02$, $p < .05$) (Table 4). Intrinsic aspiration positively predicts autonomous motivation, which in turn predicts academic achievement ($\beta = 0.06$, $p < .05$). Need-support predicts perceived competence ($\beta = -0.07$, $p < .001$) and autonomous motivation ($\beta = -0.03$, $p < .05$), which in turn, negatively predict dropout. Relatedness positively predicts dropout through perceived competence ($\beta = -0.03$, $p < .05$) and autonomous motivation ($\beta = -0.05$, $p < .05$). Lastly, intrinsic aspiration negatively predicts dropout through autonomous motivation ($\beta = -0.08$, $p < .001$), while extrinsic aspiration positively predicts dropout through controlled motivation ($\beta = 0.04$, $p < .05$).

Discussion

The main goal of the present study was to test a comprehensive SDT-based model on students' dropout intentions and prospective academic achievement among a higher education sample. Results from our model suggest that need-support and relatedness are positively related to perceived competence and autonomous motivation, as expected. Both perceived competence and autonomous motivation in turn positively predict academic achievement and negatively predict dropout intentions. Intrinsic aspiration is a positive predictor of autonomous motivation, but not related to perceived competence. Extrinsic aspiration is a positive predictor of controlled motivation and a negative predictor of academic achievement. Controlled motivation is unrelated to academic achievement and a positive predictor of dropout intentions.

Student competence and motivation on dropout and academic achievement

According to SDT, students who act out of volition, self-endorsement, and choice (autonomous motivation), and who perceive that their tasks and challenges at university are at an optimal level (perceived competence), exhibit more engagement, higher quality learning, and persistence (Ryan & Deci, 2000, Ryan & Deci, 2017). Despite research showing that students may be motivated by both internal and external motives (Brahm et al., 2016), our model finds that controlled motivation is not associated with academic achievement, but instead is a positive predictor of dropout intentions. However, autonomous motivation and perceived competence are positive predictors of academic achievement and negative predictors of dropout, as suggested by SDT. The results are of relevance to teachers who wonder whether external contingencies (e.g. rewards or threats) should be employed to motivate students. It suggests that when students are motivated by external contingencies such as rewards, the behaviour will not increase prospective academic achievement, but rather alienate the students from school. These results generally concur with previous studies on dropout and academic achievement (Guay & Vallerand, 1997; Hardre & Reeve, 2003; Lavigne et al., 2007; Ntoumanis, 2005; Sarrazin, Vallerand, Guillet, Pelletier, & Cury, 2002).

Underlying effects on dropout and academic achievement

The second goal of this investigation was to test different underlying motivational predictors of student academic achievement and dropout. The indirect effect analyses suggest that need-supportive teachers and relatedness have a positive indirect effect on academic achievement, mediated via autonomous motivation and perceived competence. Teachers are the proximal motivators in the classroom (Hattie, 2009), and thus important in facilitating autonomous motivation and perceived competence. The need for relatedness is important for motivation and internalisation (Baumeister & Leary, 1995; Ryan & Deci, 2017). When students are in an environment that is nurturing, sensitive to their feelings, and perceive that they belong, they will internalise the importance of studying and make it part of their value-system (Deci et al., 1996). In contrast, controlling teachers and a lack of relatedness are associated with higher alienation, and thus, higher likelihood of dropping out (Black & Deci, 2000; Hascher & Hagenauer, 2010). This notion is supported by the negative indirect effect of need-supportive teachers and relatedness on dropout intentions.

Students' extrinsic aspirations are positively related to dropout intentions through the effect of controlled motivations, as hypothesised. As suggested by SDT, extrinsic aspirations may cause a narrow focus and shortcuts to wealth leading to controlled motivation, which in turn, negatively relates to achievement. Furthermore, the model shows that extrinsic aspiration has a negative direct effect on achievement. SDT suggests that aspiring goals for extrinsic reasons detract from true need-satisfaction and inhibit integration and wellness (Ryan & Deci, 2017). This is partly supported by the positive association between relatedness, intrinsic aspiration, and need-support, and the non-significant association between extrinsic aspiration, relatedness, and need-support. Focusing on materialistic reasons for studying, shifts the locus of causality from internal to external and thus contributes to more performance-related goals and

superficial learning (Kasser, 2016). It is difficult for institutions to control for, or especially to change students' extrinsic goals when entering higher education. However, teachers can moderate the negative effect of extrinsic aspiration on academic achievement by supporting the students' psychological needs. For instance, Vansteenkiste et al. (2004) found across three experimental studies that students with both intrinsic and extrinsic aspirations benefited from a need-supportive context, as opposed to a controlling context, which in turn translated to higher levels of deep processing, performance, autonomous motivation, and persistence.

Regarding the level-differences in the model, the results suggest that there exist different motivational dynamics for bachelor and master students. For instance, the relation between need-support and perceived competence, and perceived competence and academic achievement show difference in strength, indicating that need-support is more important for bachelor than master students. The relation between relatedness and autonomous motivation was only significant for master students, and the relation between autonomous motivation and academic achievement was only significant for bachelor students. Although the results are in the expected direction and in accordance with SDT, the results may suggest that some motivational resource (i.e. autonomous motivation, relatedness) may be more important at different stages of the education. This has important implications for initiatives undertaken by the institutions. Future studies should address these issues to further understand these motivational differences and dynamics.

Limitations

Some limitations in interpreting the results of our study should be noted. First, the study is a cross-sectional study, thus no causal-inferences could be made. A longitudinal design would have helped to explain students' motivational development during the school year. The bioCEED survey 2015 (Hole et al., 2016) is a baseline study and further data collection was, consequently, not possible. A strength of the study, however, is the collection of prospective academic achievement, as opposed to perceived academic achievement.

Second, dropout was measured as *intentionality* and not *actual* dropout. Thus, no causal inferences can be made based on the students' intentions. However, a meta-analysis on the reliability of using intentions found that there is a strong correlation between intentions and actual behaviour (Armitage & Conner, 2001). Furthermore, assessing students' intentionality could be considered more important from a precautionary perspective than assessing which students actually dropped out, which is often statistically more difficult (O'Connell & Freeney, 2011). Moreover, it could be argued that there are problems in measuring dropout due to issues of what constitutes dropout (ending higher education). For instance, students may 'stop-out' and pause their educational path and still be considered dropouts (Aamodt & Hovdhaugen, 2011). Furthermore, students who leave their educational programme and take up studies elsewhere may be assessed as dropouts in that programme, even if they move to another programme within the same institution. Thus, due to the controversy of measuring dropout, the strategy was considered appropriate for the purpose of this study.

Third, some of the latent variables have two indicators in the measurement model. Inclusion of more items could have strengthened the validity and the reliability of the proposed SDT-model. Furthermore, dropout intention has a Cronbachs alpha that is just below the recommended cut-off point of 0.70. This may be due to the low number of items in this scale. According to Cortina (1993) and Cronbach (1951), the Cronbach's alpha increases as the number of items in the scale increases. Moreover, smaller alpha levels than the conventional cut-off point in latent models that are theory driven are acceptable given large enough samples (Kline, 2011; Little, Lindenberger, & Nesselroade, 1999). The dropout intention scale is derived from previous studies and theoretical assumptions and was tested using latent SEM-techniques, hence the decision to retain the scale was deemed appropriate.

Fourth, only 41% ($n = 309$) of the respondents provided us with the necessary information to collect their prospective achievement. Results from a MANOVA reveal a non-significant multivariate test and only one main effect (dropout) with low effect size and power. Although the decision to retain academic achievement in the SEM-model is appropriate for the purpose of the study, we do recommend caution when interpreting the results from this variable.

Lastly, the motivational model is based solely on a SDT-perspective. Further assessment of mediators such as intelligence and socio-economic status could have contributed to explain more of the variance in academic achievement and dropout intentions, which are often discussed as antecedents by others (Tinto, 1975).

Conclusions

Despite the limitations of the study, the findings point to some key antecedents of higher education students' dropout intentions and academic achievement. The results of this study are representative for biology students in Norway. However, the robustness of our model and comparable studies presented indicate that these results may have ecological validity in other STEM samples such as engineering and mathematics.

Implications and directions for future research

Based on the results, some practical recommendations are put forth. The strongest predictor of dropout intentions and academic achievement is perceived competence: we therefore recommend teachers and institutions to provide students with effectance-relevant feedback, optimal challenges, and positive feedback in an informational way (Hattie & Timperley, 2007). In accordance with SDT, it is important to consider the 'why' of behaviour as well. As our results show, students benefit from environments that facilitate autonomous motivation, and not controlled motivation. Providing students with opportunities of choice and options (e.g. with regard to decision-making such as type of work and assignments), and provide them with meaningful rationales is important in order for students to internalise the regulation of the behaviour.

A strength of this study was the ability to test a multifaceted motivational model of dropout and academic achievement. A previous study by Fryer et al. (2014), for instance, has shown that intrinsic aspiration is related to high quality learning and

achievement. We extend this line of research by showing how goal aspirations are related to dropout intentions. Our findings have both theoretical and practical implications because teachers and institutions have not only to take the students' motives (autonomous vs. controlled motivation) into account when finding ways to motivate students, but also the content of the goal aspirations (intrinsic vs. extrinsic) students have when entering higher education.

Future studies should expand on our study by using other student samples (e.g. social sciences) and further investigate why and how students achieve and dropout in a longitudinal or controlled research design. Lastly, we recommend future studies to assess the different types of motivations suggested by SDT (e.g. external, introjected, identified regulation) separately, to assess how the students' goal aspirations relate to them, and what are their effects on academic achievement and dropout.

Disclosure statement

No potential conflict of interest was reported by the authors.

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