The Relative Effect of Team-Based Learning on Motivation and Learning: A Self-Determination Theory Perspective

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ABSTRACT

We investigate the effects of team-based learning (TBL) on motivation and learning in a quasi-experimental study. The study employs a self-determination theory perspective to investigate the motivational effects of implementing TBL in a physiotherapy course in higher education. We adopted a one-group pretest–posttest design. The results show that the students' intrinsic motivation, identified regulation, perceived competence, and perceived autonomy support significantly increased going from lectures to TBL. The results further show that students' engagement and perceived learning significantly increased. Finally, students' amotivation decreased from pretest to posttest; however, students reported higher external regulation as a function of TBL. Path analysis shows that increases in intrinsic motivation, perceived competence, and external regulation positively predict increases in engagement, which in turn predict increases in perceived learning. We argue that the characteristics of TBL, as opposed to lectures, are likely to engage students and facilitate feelings of competence. TBL is an active-learning approach, as opposed to more passive learning in lectures, which might explain the increase in students' perception of teachers as autonomy supportive. In contrast, the greater demands TBL puts on students might account for the increase in external regulation. Limitations and practical implications of the results are discussed.

INTRODUCTION

In their most traditional application, lectures impose on students a role as passive recipients, with lecturers being transmitters of information. In contrast, active learning requires students to actively interact with the learning material and has been shown to have a positive effect on retention, as well as reducing dropout and failure rates (Freeman *et al.*, 2014; Wieman, 2014). Similar results have been documented by Ryan and Reid (2015) using flipped-classroom techniques. Further, Singer *et al*. (2013) showed that interactive lecture demonstrations, in which students discuss, watch, and compare their predictions with actual results, improve students' conceptual understanding. Finally, Cavanagh and colleagues (2016) implemented active learning among higher education students and found that it was positively associated with students' self-regulated motivation, engagement, and achievement. There is, in other words, much to be gained by exchanging traditional lectures for more active-learning alternatives.

The purpose of the present research is twofold. First, we investigate how the empirically supported motivation theory of self-determination theory (SDT; Deci and Ryan, 1985; Ryan and Deci, 2017) explains the underlying psychological processes of different learning methods; that is, which psychological factors accounts for passive- and

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active-learning methods. Second, we investigate whether the implementation of a specific active-learning method, namely team-based learning (TBL; Michaelsen *et al*., 1982; Michaelsen, 1992), contributes to an increase in students' engagement and learning. In line with previous studies, active-learning methods are associated with increases in engagement and retention. To our knowledge, no studies have investigated TBL in a theoretical framework to understand its motivational mechanisms (Tucker and Brewster, 2015). The majority of the research on TBL has been atheoretical. The research has, in other words, lacked a meta-theoretical assumption when proposing hypotheses and interpreting the results. Thus, it is important to investigate what the motivational consequences of implementing TBL are in order to make changes in courses in higher education and motivate and engage students to participate in class.

TBL

TBL is characterized as a four-step process that facilitates student learning and participation before and during class. The four TBL stages are 1) student preparation, 2) readiness assurance, 3) application, and 4) peer assessment (Michaelsen and Sweet, 2008; McMahon, 2010). The first stage of TBL requires students, who have been allocated to specific teams, to prepare by reading specific parts of the literature or by watching a short lecture on the Internet. The readiness assurance process starts as all members of class meet to undertake a multiple-choice test—the individual readiness assurance test (iRAT). Second, the multiple-choice test is performed in teams (tRAT) applying the immediate-feedback assessment technique (IFAT). The teams must agree on their answers and are given immediate feedback. This stage is followed by a procedure in which the teams are set to work on specific cases, their task being to apply the knowledge and information they have obtained during the whole process. All teams are asked to work on the same significant cases, and they are asked to provide specific answers simultaneously.

Previous research has found support for TBL in different educational domains. For instance, Shankar and Roopa (2009) found that students who participate in TBL sessions are better at fulfilling learning objectives and that the TBL sessions enable better understanding and are more interesting compared with traditional teaching sessions. Vasan *et al*. (2011) found that medical students who took part in TBL-based preclinical anatomy courses achieved higher examination scores than students who took part in lecture-based courses. Further, Carmichael (2009) found that TBL students in a large-enrollment biology class performed better on tests and exams throughout the semester compared with students who took part in traditional lectures. Similar results have been found for students in undergraduate clinical neurology education (Tan *et al.*, 2011), architectural students (Epsey, 2008), and medical students (Koles *et al*., 2010). In a systematic review of 17 studies, Sisk (2011) found that TBL students overall are more satisfied and more engaged and perform better in exams than students who participate in traditional lecture-based courses.

In sum, the above-mentioned research suggests positive outcomes for student motivation, engagement, and learning when employing active-learning methods such as TBL. To further investigate this, we employ SDT, which is particularly useful for understanding how student outcomes in education occur due to its conceptualization of sociocontextual factors that promote student motivation and wellness (Figure 1). Furthermore, SDT has explicit assumptions of which type of motivation is hypothesized to promote learning and beneficial outcomes, providing an interesting framework to further understand the benefits of TBL.

SDT

SDT is a macro-theory of human motivation and personality. SDT views students as active organisms acting on the environment, as opposed to being passive recipients (Deci and Ryan, 1985). According to SDT, students have three universal psychological needs: the needs for autonomy, competence, and relatedness (Deci and Ryan, 1985; Ryan and Deci, 2000). Autonomy refers to being the causal agent and perceiving volition in one's behaviors. Competence is defined as feeling efficacious in the

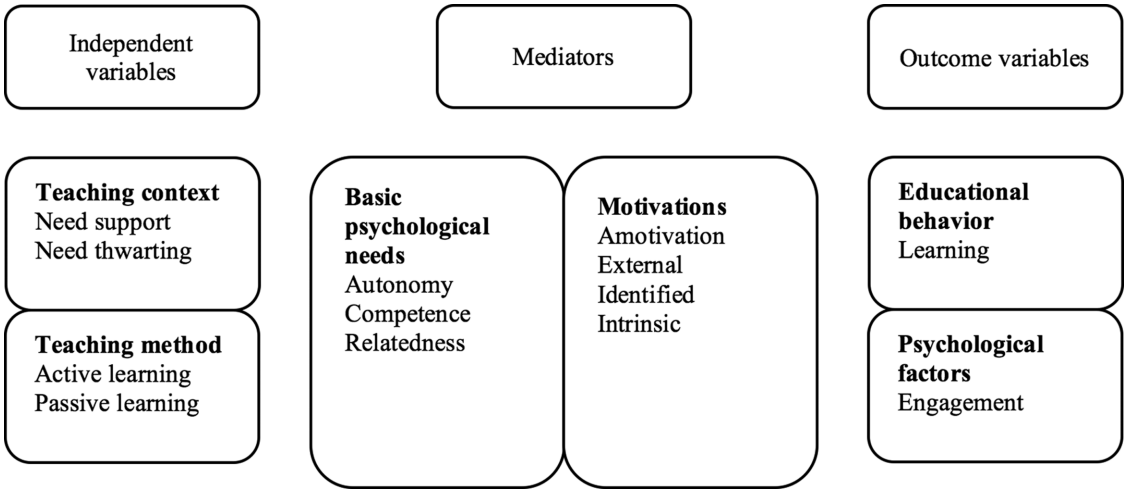

FIGURE 1. Basic model of SDT adapted from Deci *et al.* (2017). The model depicts antecedents of students' basic psychological needs and motivation. The motivations are ranged from least autonomous (amotivation) to fully autonomous (intrinsic motivation).

interaction with one's environment. Relatedness refers to feeling connected to, cared for, and belonging to a significant other or one's community. Further, according to SDT, there are two broad classes of motivation, intrinsic and extrinsic motivation. Intrinsic motivation are behaviors done out of interest and enjoyment, whereas extrinsic motivation are behaviors done because they lead to some separable outcome (Ryan and Deci, 2000).

Motivations

As opposed to other motivational theories, SDT differentiates between different types of extrinsic motivations, depending on their relative autonomy (Ryan and Deci, 2000, 2002). Amotivation is characterized by a state of lacking intentions to act. Students who are amotivated believe that they are unable to achieve an outcome, lack perceived competence, or do not value the activity. External regulation is the least autonomous type of motivation. Students who are externally regulated perform an activity to obtain a reward or avoid punishment. Identified regulation is the most autonomous type of motivation and is associated with valuing an activity. The students perform the activity volitionally, because it is personally important or relevant for them. Within SDT, it is postulated that satisfaction of the basic psychological needs for autonomy, competence, and relatedness promote autonomous types of motivation (i.e., identified regulation and intrinsic motivation), whereas thwarting these needs yields controlled types of motivation (i.e., amotivation and external regulation; Ryan and Deci, 2017). Studies have shown that autonomous types of motivation are associated with higher creativity (Liu *et al.*, 2013), more homework (Otis *et al.*, 2005), and higher persistence in school (Hardre and Reeve, 2003). Conversely, controlled types of motivation have been shown to be associated with less perceived learning (Jeno and Diseth, 2014; Taylor *et al.*, 2014), more negative coping strategies and anxiety (Ryan and Connell, 1989), and more surface-learning strategies (Yamauchi and Tanaka, 1998).

Social Context

SDT argues for the importance of a supportive interpersonal context. That is, students' social context within a learning situation could either support or impede students' psychological needs. For instance, teachers who take the students' perspective and try to understand the students' internal frame of reference, provide choices and opportunities, and nurture the students' inner motivational resources are assumed to support students' needs for autonomy, competence, and relatedness, which in turn promotes autonomous motivations (Reeve, 2009). In contrast, controlling teachers take their own perspective and pressure students to think, feel, and behave in a specific way. Controlling teachers are more likely to thwart the students' basic psychological needs and thus promote controlled motivations. Previous research shows that when teachers are autonomy supportive, the students have higher self-esteem (Deci *et al.*, 1981), higher engagement (Jang *et al.*, 2010), and perceive themselves as more competent (Diseth *et al.*, 2012).

A relatively unexplored research area within SDT has been on how different active-learning methods relate to students' autonomous motivation, perceived autonomy support, and needs satisfaction. However, Jeno (2015) argues that SDT could be employed to understand, test, and implement active-learning methods. Accordingly, Chang *et al.* (2017) argues that passive-learning environments are more susceptible to controlling teaching practices due to lack of responsibility on the part of students, lower interpersonal relations, and fewer possibilities for offering optimal challenges. Furthermore, Kusurkar *et al.* (2011) suggests that active-learning can enhance students' autonomous motivation because it provides opportunities for feedback (competence support), collaboration (relatedness support), and greater responsibility (autonomy support).

THE PRESENT STUDY

Research on TBL using a well-established motivational theory is still in its infancy, thus providing a novel and important research area. To address the lack of theoretical basis in TBL studies, we investigate the effects of TBL in an SDT perspective. Furthermore, Vallerand (1997) argues for the importance of investigating motivation not only at the global (individual) level and contextual level, but also at the situational (state) level. That is, the level of generality in the measurement of motivation can be differentiated on three levels (Vallerand and Ratelle, 2002). For instance, students' motivation could be considered to be an individual difference that applies across contexts (global level). Further, students' motivation could vary between contexts as well; for example, students can be more intrinsically motivated for sports and exhibit greater identified regulation for biology education (contextual level). Importantly, within a specific context, students' motivation can vary from situation to situation. That is, students could find a learning situation or subject within a course to be more autonomously motivating than others (situational context). Thus, we investigate the situational reasons students have for attending lectures or tutorials. This is especially important when differentiating between teaching methods within the same course, as we are doing in the present research.

In the present research, we adopt a quasi-experimental design (Shadish *et al.*, 2002) to investigate why students attend classes and to test whether active learning (i.e., TBL) promotes engagement and learning compared with passive learning (i.e., traditional lectures). See Figure 2 for the general flow of the present study. Quasi-experimental studies are especially useful when randomization is not feasible due to natural criteria, such as administrative selection of which class the students attend or students' self-selection (Shadish *et al.*, 2002; Crano *et al.*, 2015). We employed a one-group pretest–posttest design. This was chosen due to difficulties of finding equivalent control groups in quasi-experimental designs.

Owing to the explorative nature of the present investigation, and the lack of previous studies assessing TBL in a motivational perspective, we center our assumptions around the theoretical propositions of SDT. Specifically, we assume that the students will be more active in the TBL condition (intervention), as opposed to the lecture condition (baseline), and thus will experience more interest and engagement in tasks. This is due to the learner-centered framework of TBL, in which the student is engaged in meaningful learning tasks (Lambert and McCombs, 1998; Parmelee *et al.*, 2012). Thus, we assume that students will experience more autonomous motivations (i.e., intrinsic motivation and identified regulation). Some studies within the SDT framework support our line of reasoning. For example, Benware and Deci (1984) performed a study among university students and found that students in the active condition,

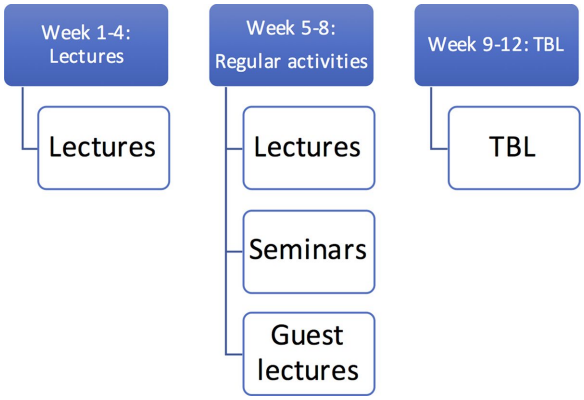

FIGURE 2. Flow and duration of the learning activities during the quasi-experiment. The pretest period (weeks 1–4) consisted of traditional lectures. A period followed during which the students had regular teaching activities (weeks 5–8). The posttest period (weeks 9–12) was the experimental intervention and consisted of TBL. The pre- and posttest measurements were done at the end of the lecture/TBL session, on the last day of the respective experimental week.

relative to students in the passive condition, were more intrinsically motivated and performed better at a heuristic task. Furthermore, Ryan *et al.* (1990) found that students with learning that is active and with a positive emotional set scored better on an unexpected test, compared with students with learning that is passive and with a negative emotional set. Conversely, because TBL requires more of the students (i.e., it provides students with structure) and affords students fewer choices, and therefore reduced autonomy around their learning, we suggest that a possible outcome of the intervention is an increase in external regulation for the students in the transition from the lecture condition to the TBL condition. A study by Jang *et al.* (2010) suggests the necessity of autonomy along with structure for an intervention to be autonomy supportive.

Furthermore, TBL classrooms are facilitated by both the teacher, who provides rationales for the learning assignments and offers structure and challenging tasks through the iRAT and tRAT, and the collaboration with peers. We thus expect TBL to afford students with competence support, autonomy support, and relatedness support. Specifically, with teacher-facilitated learning, as opposed to direct learning, students can internalize the value of the learning behavior and perform the activity volitionally and out of choice (Deci *et al.*, 1996). TBL teachers provide students with clear and meaningful learning goals, optimal challenges that are solved both individually and in teams, thus affording both competence and relatedness satisfaction, which in turn facilitate autonomous types of motivation, perceived competence, and engagement (Skinner and Belmont, 1993; Jang *et al.*, 2010; Chang *et al.*, 2017). A previous study has found that individual situational interest is accounted for by teachers' autonomy and competence support (Tsai *et al.*, 2008). In a study with biology students, Jeno *et al.*, (2017) found that active-learning methods enhanced intrinsic motivation and perceived competence, which in turn, predicted student learning. Finally, as TBL expects students to come to class prepared and work on both rote (iRAT/tRAT) and conceptual (application of significant case) learning, we assume that students will have higher learning gains as a function of the TBL intervention.

METHODS

Pilot Study

Pilot-Study Methods. Owing to the lack of previous studies employing TBL in a SDT perspective and the explorative nature of the present study, we conducted a pilot study. The participants in the study comprised a convenience sample consisting of biology students from a large university in Norway. Participants were enrolled in a biology course on evolution and ecology. The students in this study were second- and third-year bachelor's students and first-year master's students. The sample included 24 students; 11 were male (45.8%), and 13 were female (54.2%). The participants used a seven-point scale to respond on a range of items measuring intrinsic motivation, identified regulation, external regulation, amotivation, competence, needs satisfaction, autonomy support, engagement, and perceived learning. The participants were recruited at the end of a teaching session. The study was designed as a one-group pretest–posttest design (Shadish *et al.*, 2002). We collected the data 1 month after the semester had started in mid-January 2016. After a 2-week period of traditional lectures, at the end of the last lecture session, we provided the students with the pretest questionnaire. A 4-week period followed, during which the students attended regular teaching activities, after which a 2-week period with TBL teaching commenced. At the end of these 2 weeks, we asked the students to complete the same questionnaire.

Pilot-Study Results. The number of missing values was large, ranging from 8.3% to 41.7% on some of the items. There were 19 students at the pretest measurement and 15 students at the second, posttest measurement. Little's missing completely at random test revealed that the values missing from the data set were missing at random, $\chi^2(434) = 20.85$, $p = 1.00$. In other words, missing by design. Thus, we augmented the data by means of expectation-maximization imputation techniques, to increase the power of the data. We found five significant effects from pretest to posttest: intrinsic motivation, $t(23) = -2.42$, $p = 0.02$; amotivation, $t(21) = -2.59$, $p = 0.01$; perceived competence, $t(23) = -3.12$, $p = 0.005$; autonomy support, $t(23) = -2.40$, $p = 0.02$; and engagement, $t(23) = -1.82$, $p = 0.08$. Results from the pilot study indicated three main concerns; first, that missing by design could largely influence final sample size; second, that between-topic differences in intrinsic motivation and engagement could affect the mean differences between pretest and posttest; and third, that 2 weeks of TBL may be too short for the students to understand the benefits of TBL and get accustomed to the teams. Thus, as suggested by van Teijingen *et al.* (2001) and van Teijingen and Hundley (2001), modifications on the main study were done based on the results from the pilot study. Specifically, we conducted the main study in a course in which attendance was mandatory, thus removing missing by design; the topic was similar across the experimentation period, thus removing any between-interest effect; and the experimentation time could be extended.

Participants

The participants were a convenience sample consisting of second-year physiotherapy students at a large university college in

Norway. The participants ($n = 64$) consisted of 23 males and 41 females. Participant ages were sorted into 4-year intervals: below 20 (6.3%), 21–24 (82.8%), 25–29 (9.4%), and 30–34 (1.6%).

Procedure

Students were recruited from a mandatory course in physiological neurology. The pretest questionnaire was distributed to the students in late August 2016, after 4 weeks of traditional lecturing. This was done so that students would have received relevant information about the semester workload and would have become accustomed to the course syllabus and the teaching environment. The students filled out the questionnaire on the last day of traditional lecture. The students were told that we were interested in their general attitudes toward the previous 4 weeks of *lectures*. Furthermore, the students were told that we would collect data at several time points. This was done so the students would believe that we were interested in the development of their attitudes toward teaching activities and not the difference between two teaching activities. A 4-week period followed, during which the students attended regular teaching activities, after which a 4-week period with TBL followed (Figure 2). On the last day of the TBL session, the students responded to the posttest questionnaire. We asked the students to complete the same questionnaire, but this time with specific reference to *tutorials* for the previous 4 weeks. During both the traditional-lecture period and the TBL period, the students learned about physiology (e.g., neurophysiology, exercise physiology, pain, and how physiology influences rehabilitation). This was done to control for between-topic differences in students' engagement and intrinsic motivation.

The present study received ethical approval from the Norwegian Centre for Research Data to conduct the study. The participants were informed that participation was voluntary and that they could withdraw from the study at any time. Furthermore, the students were informed that any personal identifiable data would be treated confidentially and deleted after the completion of the study.

Measures

All scales were translated from English to Norwegian by L.M.J. and A.R. The scales were then back-translated from Norwegian to English by an English-speaking editor. In instances of discrepancy between the translations, a discussion was invoked to achieve correct, grammatical wording and capture the psychological meaning of the item. This procedure has previously been used in other Norwegian (Hole *et al.*, 2016) and international studies (Deci *et al.*, 2001) and is recommended when working with scales in other languages (Harkness and Schoua-Glusberg, 1998).

Motivation. To measure the students' situational motivation during a learning session, we employed the Situational Motivation Scale (SIMS; Guay *et al*., 2000). The SIMS measures the students' state of motivation during a learning task or situation. The SIMS consists of a general stem asking "Why are you currently engaged in this activity?," and four subscales measuring intrinsic motivation ("Because I think that this activity is interesting"), identified regulation ("Because I am doing it for my own good"), external regulation ("Because I am supposed to do it"), and amotivation ("There may be good reasons to do this activity, but personally I don't see any"). The students were asked to respond on a seven-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree). A previous study in the science education domain has documented the validity of the scale (Ntoumanis, 2003).

The scale has been validated and found reliable across three studies, with alphas ranging from 0.75 to 0.93 (Guay *et al.*, 2000). In the present study, the following Cronbach's alphas were obtained for the scales for intrinsic motivation (pretest: $\alpha = 0.78$; posttest: $\alpha = 0.81$), identified regulation (pretest: $\alpha = 0.88$; posttest: $\alpha = 0.79$), external regulation (pretest: $\alpha = 0.58$; posttest: $\alpha = 0.69$), and amotivation (pretest: $\alpha = 0.80$; posttest: $\alpha = 0.78$),

Perceived Competence. To measure the students' perceived competence, we employed the four-item Perceived Competence scale (PC; Williams and Deci, 1996). PC measures feelings of competence with respect to an activity ("I am competent enough to achieve the goals I have for the course"). The participants were asked to respond on a seven-point scale ranging from 1 (not at all true) to 7 (very true). Jeno and Diseth (2014) and Williams and Deci (1996) have previously reported satisfactory reliability scores of $\alpha = 0.86$ and $\alpha = 0.80$, respectively. The scale has been used in similar context with biology students (Jeno *et al.*, 2017). Reliability analysis showed high alpha levels for perceived competence (pretest: $\alpha = 0.93$; posttest: $\alpha = 0.93$).

Autonomy Support. To measure the students' perception of the teacher's autonomy support, we employed the short six-item Learning Climate Questionnaire (LCQ). The LCQ is answered on a seven-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree). An item example is "I feel understood by my teacher." The scale has proven to be highly reliable in previous studies. For instance, Black and Deci (2000) reported an alpha level of 0.93, while Williams and Deci (1996) reported an alpha level of 0.96. The scale has been proven valid among biology students in Norway (Jeno *et al.*, 2017). For the present study, autonomy support produced the following alpha levels: pretest, $\alpha = 0.75$; posttest: $\alpha = 0.90$.

Needs Satisfaction in General. The 21-item Basic Psychological Needs Scale (BPNS; Deci and Ryan, 2000; Gagné, 2003) was used to measure the students' needs satisfaction at the university. The BPNS has three subscales: seven items measuring autonomy ("At university I feel free to make my own decisions"); six items measuring competence ("Often I do not feel very competent" [reversed item]); and eight items measuring relatedness ("I really like the people I associate with at university"). Two items were omitted due to low reliability scores, measuring autonomy ("At university, I have little opportunity to decide how to do things" [reversed item]), and competence ("When I am at university I do not get the chance to show how competent I am" [reversed item]). The three subscales were combined to measure a general needs satisfaction scale. The students were asked to respond on a seven-point scale ranging from 1 (not at all true) to 7 (very true). Previous studies have found adequate Cronbach's alphas ranging from 0.66 to 0.86 for this scale (Ntoumanis, 2005; Jeno and Diseth, 2014). Previous validation has been done with a student sample learning

biopsychological values (Williams and Deci, 1996). Reliability analysis produced good alpha levels for needs satisfaction (pretest: $\alpha = 0.83$; posttest: $\alpha = 0.78$).

Engagement. The multidimensional 22-item scale measuring four aspects of engagement was employed to measure the students' in-class engagement (Reeve and Tseng, 2011). The engagement scale comprises four subscales: agentic engagement ("I ask questions during lectures"), behavioral engagement ("I listen carefully in class"), emotional engagement ("Lectures are fun"), and cognitive engagement ("When I study, I try to relate what I am learning with what I already know"). The students were asked to respond on a seven-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree). The subscales can be used separately or combined into a general engagement scale (Reeve and Tseng, 2011; Jang *et al.*, 2016b). Previous studies by Jang *et al.* (2016b) and Reeve and Tseng (2011) have reported satisfactory Cronbach's alphas ranging from $\alpha = 0.87$ to $\alpha = 0.97$. The engagement scale has previously been shown to predict achievement among science, technology, engineering, and mathematics (STEM) students (Reeve, 2013). In the present study, the subscales were combined and produced good Cronbach's alphas (pretest: $\alpha = 0.88$; posttest: $\alpha = 0.92$).

Perceived Learning. To measure the students' learning in class, we employed a four-item scale measuring perceived learning gains. The students were asked to respond on a seven-point Likert scale ranging from 1 (not at all true) to 7 (very true). An item example is "These last four weeks I have learned a lot." A previous study found validity support for a measure of perceived learning among a Norwegian sample, correlating positively with autonomous types of motivation, and unrelated with controlled types of motivation (Jeno and Diseth, 2014). The following Cronbach's alphas were obtained for perceived learning: pretest, $\alpha = 0.82$; posttest, $\alpha = 0.88$.

Analytical Strategy

All analyses were conducted using IBM SPSS version 23 and IBM AMOS version 23. To analyze the differences between the students' scores on pretest (lecture) and posttest (TBL), we conducted paired-sample *t* tests. Cohen's *d* was calculated to measure effect sizes for mean differences, which are considered small, medium, and large, at 0.2, 0.5, and 0.8 (Cohen, 1988), respectively. To test how well the theoretical model of SDT accounts for the changes in students' engagement and perceived learning, we conducted a path-analytical model. Specifically, to analyze change scores from pretest to posttest, we calculated the standardized residuals used in the model by regressing the posttest scores on the pretest score for all variables (Zimmerman and Williams, 1982; Allison, 1990). We employed conventional cutoff criteria for goodness of fit to assess model fit, as suggested by Hu and Bentler (1999). Accordingly, comparative fit index (CFI) values above 0.90, root mean square estimate of approximation (RMSEA) below 0.08, and a χ^2/df ratio below 2 are considered a good model fit. Path analysis was chosen due to the theory-driven and multivariate nature (Byrne, 2016) of the present study. That is, path analysis allowed us to test both how well the SDT constructs predict student engagement and perceived learning, directly and indirectly, and the interrelationship between the predictors. In our model, we specified that all motivational variables would predict engagement, which in turn would predict perceived learning, as suggested by the engagement model within SDT (Reeve, 2012).

TABLE 1. Descriptive statistics of the study variables for pretest and posttest along with means, SDs, skewness, and kurtosis

	M	SD	Skewness	Kurtosis
Intrinsic motivation: pretest	4.40	1.04	−0.11	−0.33
Intrinsic motivation: post	5.25	1.06	−0.08	−0.80
Identified regulation: pretest	5.24	1.30	−1.15	1.35
Identified regulation: posttest	5.87	0.96	−0.84	0.23
External regulation: pretest	4.96	1.19	−0.52	0.70
External regulation: posttest	5.49	1.09	−0.43	−0.70
Amotivation: pretest	2.72	1.21	1.42	2.43
Amotivation: posttest	2.01	0.97	1.10	1.09
Perceived competence: pretest	5.47	1.22	−0.92	0.26
Perceived competence: posttest	5.85	1.08	−0.81	−0.13
Engagement: pretest	4.36	0.74	−0.04	0.01
Engagement: posttest	5.04	0.89	0.44	−0.80
Autonomy support: pretest	4.22	0.87	−0.21	0.28
Autonomy support: posttest	6.09	1.04	−1.30	1.50
Needs satisfaction: pretest	5.03	0.57	−0.85	2.31
Needs satisfaction: posttest	5.55	0.50	0.04	0.05
Perceived learning: pretest	3.10	1.44	0.35	−0.61
Perceived learning: posttest	6.24	1.09	−1.89	2.93

RESULTS

Descriptive analyses of the study variables are presented in Table 1. All variables show signs of normal distribution at both the pretest and posttest measurements.

Main Effects

To test for changes in scores between the pretest and posttest, we conducted a range of repeated-sample *t* tests for the study variables. The results are presented in Figure 3. The results show that, on average, the students' intrinsic motivation, identified regulation, external regulation, perceived competence, engagement, autonomy support, needs satisfaction, and perceived learning, significantly increased from pretest to posttest. Further, students' amotivation significantly decreased from pretest to posttest. The effect sizes for the mean differences in change scores are all large in magnitude.

Indirect Effects

To test how well the SDT constructs fit together and to test for indirect effects, we conducted a path analysis. Model fit was excellent ($\chi^2(7) = 4.198$, $p = 0.757$, CFI = 1.0, χ^2/df ratio = 0.60, RMSEA = 0.000 [confidence interval, CI: 0.00 – 0.108]; see Figure 4). Specifically, increases in perceived competence predict increases in engagement. Increases in intrinsic motivation positively predict increases in engagement. Further, increases in external regulation positively predict increases in engagement. Finally, increases in engagement predict increases in perceived learning. The model as a whole accounts for 70% of the variance in engagement and 17% of the variance in perceived learning. Given our four

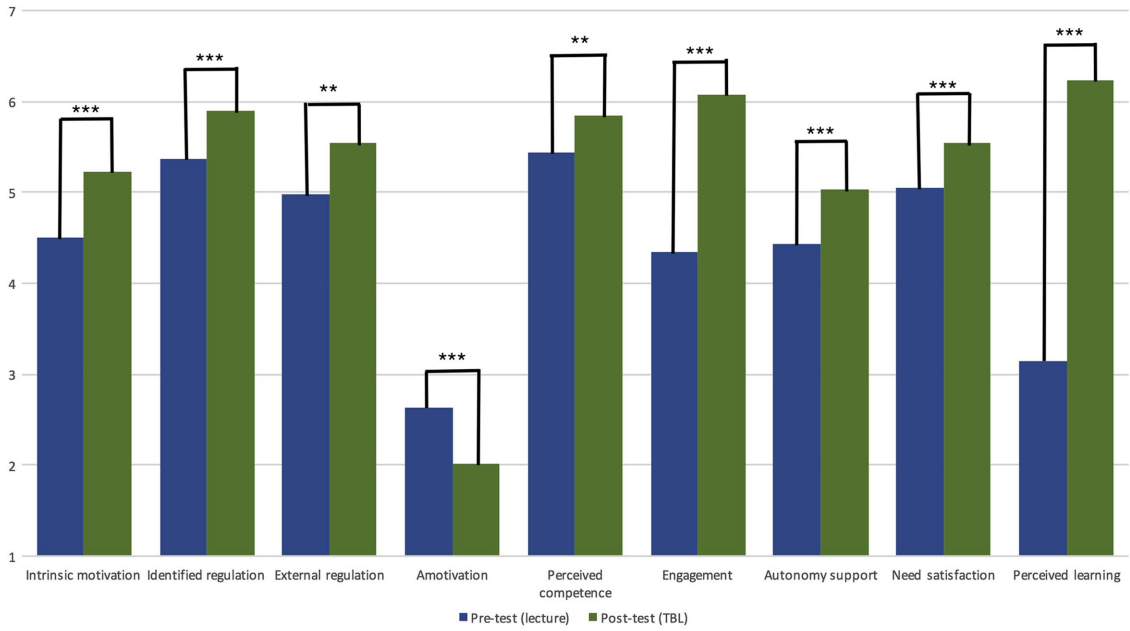

FIGURE 3. Changes in scores between the pretest and posttest. Pretest (lecture) reflects the baseline; posttest (TBL) reflects the intervention. Significance: **, $p < 0.01$; ***, $p < 0.001$. Effect sizes (Cohen's d) for differences between pretest and posttest: intrinsic motivation, $d = -0.66$; identified regulation, $d = -0.53$; external regulation, $d = -0.42$; amotivation, $d = 0.64$; perceived competence, $d = -0.35$; engagement, $d = -0.78$; autonomy support, $d = -1.56$; needs satisfaction, $d = -1.09$; and perceived learning, $d = -1.97$.

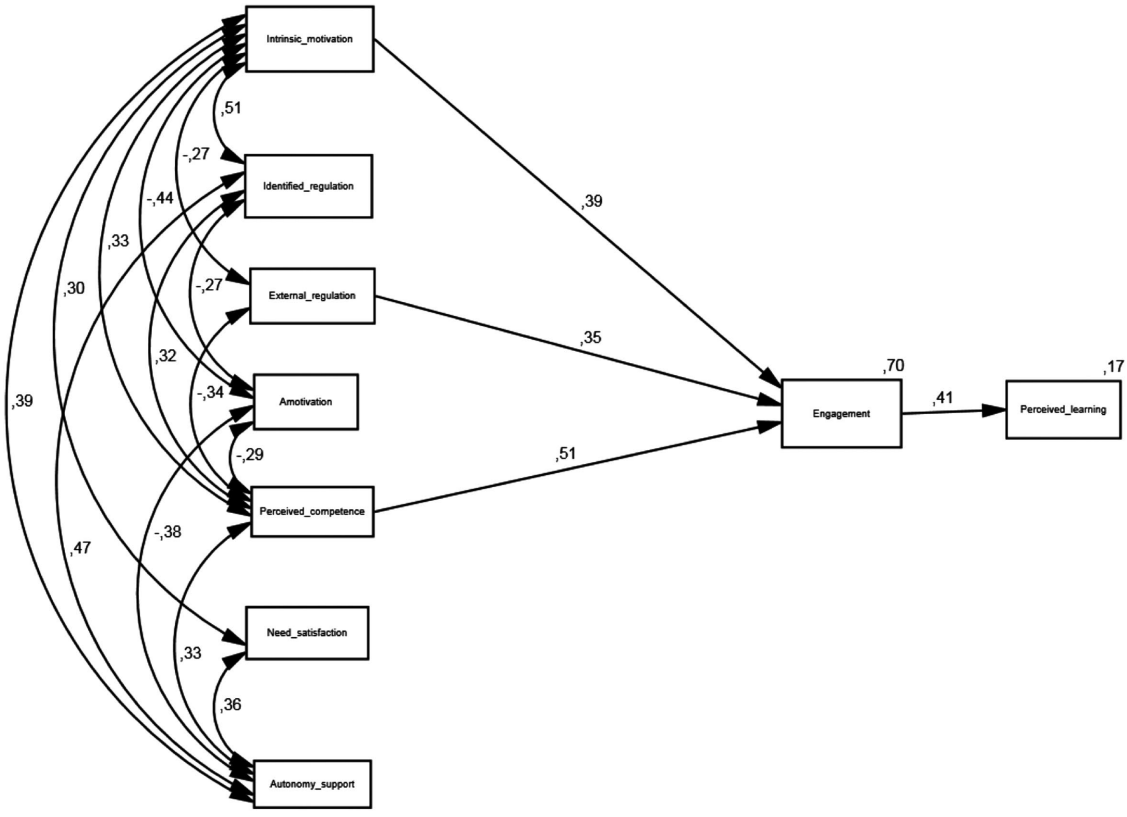

FIGURE 4. The model shows all the study variables predicting students' perceived learning indirectly through engagement. All variables are significant at $p < 0.05$, except amotivation ↔ identified regulation, amotivation ↔ perceived competence, external regulation ↔ intrinsic motivation, needs satisfaction ↔ intrinsic motivation, which are significant at $p < 0.10$. For clarity, only significant paths are shown.

significant paths, we conducted several Sobel tests (Sobel, 1982) to test for indirect effects. Specifically, we calculated the significant regression coefficients and SEs between predictor and mediator and between mediator and dependent variable (Baron and Kenny, 1986). Results showed that perceived competence predicted engagement, which in turn predicted perceived learning ($\beta = 0.209$, $z = 2.73$, $p < 0.01$). Further, external regulation significantly predicted engagement, which in turn predicted perceived learning ($\beta = 0.14$, $z = 2.48$, $p < 0.05$). Finally, intrinsic motivation predicted perceived learning, through the effect of engagement ($\beta = 0.16$, $z = 2.36$, $p < 0.05$).

DISCUSSION

The goal of the present research was to address the psychological processes attached to two teaching methods: traditional lectures and TBL. Through the lenses of SDT, we investigated whether the implementation of TBL, compared with lectures, influenced the students' different types of motivation, perceived competence, perception of the teacher as autonomy supportive, needs satisfaction, engagement, and perceived learning. In general, our assumptions were supported, although some interesting patterns emerged.

TBL, Autonomy, and Autonomous and Controlled Motivations

Results largely support our reasoning on the interest-enhancing effects of TBL. Specifically, we expected that students' intrinsic motivation and identified regulation would increase from pretest to posttest. There might be aspects within the TBL session that promote intrinsically motivated behaviors (Deci and Ryan, 2000). For instance, novelty has previously been associated with intrinsic motivation (Lepper, 1985; Hartnett, 2016). Scratching the immediate feedback cards during the team readiness assurance test to find out whether one's team has the correct answer adds novelty and curiosity to learning, and may, consequently, increase intrinsic motivation. A previous study has found similar results. A study by Gomez *et al.* (2010) assessed the impact of computer-supported TBL in a classroom. Using structural equation modeling, they found that the students' perception of teamwork uniquely predicted students' motivation and enjoyment, which in turn predicted students' perceived learning. Further, the increase in students' identified regulation are in line with theoretical assumptions of SDT. When a teaching method provides support for students' basic psychological needs for autonomy and competence, autonomous motivation is facilitated. Furthermore, in an autonomy-supportive context that provides students with meaningful rationales, affords engaging learning tasks, and communicate respect and warmth in a noncontrolling language (Reeve, 2006), students internalize the importance of the activity and thus promotes identified regulation.

It was hypothesized based on previous research and the controlling requirements of TBL that students' external regulation would increase form pretest to posttest. Results from the repeated *t* test supported our assumptions. Students reported higher mean levels of external regulation in the TBL-condition compared with the lecture-condition. This may be due to few choices in the learning process (i.e., learning activity, choosing teams, few choices in working with significant cases), whereby thwarting the basic need for autonomy (Ryan and Deci, 2002). Finally, results show that the students' amotivation decreased from pretest to posttest. This in line with assumptions of active learning. Active learning encompasses activity and engagement while conducting meaningful learning activities (Prince, 2004). Thus, lectures, due to its more passive nature are more likely to enhance feelings of amotivation, than TBL which require active students in the learning process. This is in accordance with SDT which suggests that feelings of amotivation emanate from a lack of perceived control, lack of intentionality and lack of value (Abramson *et al.*, 1978; Deci and Ryan, 1985).

TBL and Perceived Competence

According to SDT (Deci and Ryan, 1985), positive feedback and optimal challenges tend to facilitate a student's perception of competence. Thus, a learning environment that provides structure is highly associated with a student's increase in perceived competence (Guay *et al.*, 2008). Results from the present research support this line of reasoning. Specifically, perceived competence increased from pretest to posttest as a function of TBL. The result of the students' increase in competence after the introduction of TBL could be explained by small discussion groups, significant cases, immediate feedback from the readiness assurance tests, and the teachers' increased provision of structure and competence support in TBL (Michaelsen and Sweet, 2008).

TBL, Autonomy Support, and Relatedness

According to SDT, when students are in learning environments that provide choice, optimal challenges, and a sense of caring, the students' learning is characterized by autonomous motivation. That is, if the sociocontextual climate is nurturing and provides students with effectance relevant feedback in an autonomy-supportive context, the students' intrinsic motivation and autonomous motivation will increase (Niemiec and Ryan, 2009). Thus, to the extent that the teacher is sensitive to supporting the students' basic psychological needs for autonomy, competence, and relatedness, irrespective of the teaching environment, the students thrive.

Our results indicate that the students perceived the teacher to be more autonomy supportive during the TBL phase. This is important, because in traditional lecture-based courses, students are less active and are more prone to accept the role of passive recipient of information. Research has shown that students' attention tends to wander 15–20 minutes into a lecture (Wilson and Korn, 2007; Risko *et al.*, 2012). Because of this, and because there is little demand for personal involvement, the learning output for traditional lectures may be rather poor (Freeman *et al.*, 2014; Wieman, 2014). In contrast, TBL is a more active-learning approach, and the teacher takes on the role of facilitator, as opposed to being the provider of information or taken-for-granted facts. Teachers in TBL courses have to provide students with guidance, encourage them, and facilitate their growth potential and critical thinking (Lane, 2008). Results from the path analysis show support for the basic tenets of SDT. Specifically, the covariance of the predictors shows that autonomy support was highly related to needs satisfaction, perceived competence, identified regulation, and intrinsic motivation, whereas it was unrelated or negatively related to amotivation and external

regulation. This is in line with the SDT's proposition of autonomy support. For instance, Black and Deci (2000) found in a study among chemistry students that learning contexts that were more active and student centered increased the students' autonomous motivation over the semester. Grolnick *et al.* (2007) conducted an intervention study wherein students were divided into either an after-school program or a control group. Students in the after-school group were more active in their learning, and results revealed that the students in this group increased their intrinsic motivation and learning goals from pretest to posttest relative to the control group. Additionally, previous research shows that when teachers are autonomy supportive, the students have a better conceptual understanding of the learning material (Benware and Deci, 1984), higher perceived learning (Jeno and Diseth, 2014), and higher self-esteem (Deci *et al.*, 1981) and are more autonomously motivated (Vallerand *et al.*, 1997).

TBL, Engagement, and Perceived Learning

We found a significant increase in the students' engagement from pretest to posttest. Finding ways to engage students is important, because engagement is related to the quality of the students' learning and their involvement during the teaching session (Reeve, 2012). Previous studies have found engagement to be associated with learning (Archambault *et al.*, 2009; Reeve and Tseng, 2011) and positive emotions (Mageau and Vallerand, 2007), thus supporting the notion that engagement is important. Finally, we found a significant increase in students' perceived learning. Similar results were reported by Vasan *et al.* (2011) among students in a human anatomy course. In a comparison of class averages and results from a National Board of Medical Examiners subject exam, students who attended TBL classes achieved significantly better results on the exam than students who attended a traditional lecture-based course. Results from the path analysis show that increases in perceived competence, intrinsic motivation, and external regulation from pretest to posttest predicted increases in engagement, which in turn predicted increases in perceived learning. The model predicted a substantial amount of variance in engagement, but also a significant amount in perceived learning. An interesting finding was that external regulation indirectly predicted perceived learning. A possible interpretation might be that the controlling functions within TBL enable the students to participate in TBL activities, providing needs satisfaction and autonomy support, thus supporting control and structure within the context of autonomy. This line of reasoning has previously been found in laboratory studies and meta-analytically (Ryan *et al.*, 1983; Deci *et al.*, 1999).

Limitations and Practical Implications

Several limitations are worth mentioning when interpreting the results. First, the study was quasi-experimental, and thus no causal inferences could be made. Including a control group could have limited the confounding effects of maturity and history in the current one-group pretest–posttest design. Randomization of the participants to either of the conditions could have strengthened the conclusions of the study. However, according to Shadish *et al.* (2002), different constraints inhibit the possibility of randomization in quasi-experimental studies for ethical, funding, and/or administrative reasons. Furthermore, quasi-experiments also allow for a more context-sensitive investigation. Owing to the students' enrollment in courses, randomization was not possible. Although ruling out factors that could threaten the internal validity of the study increases the strength of the results (Baldwin and Berkeljon, 2012), we recommend future studies employ true experimental designs to further strengthen the validity of the results.

Second, the present study employs perceived learning, as opposed to actual achievement such as grades or achievement from a test. On the one hand, assessment of grades could have accounted for more variability. On the other hand, previous studies have shown that perceived learning is an adequate measure of actual learning (Kuncel *et al.*, 2005; Cole and Gonyea, 2010; Felder-Puig *et al.*, 2012) and related to needs satisfaction (Jang *et al.*, 2016a). Thus, the strategy employed for our design was adequate for the aims of our investigation.

Third, some of the scales employed had Cronbach's alphas that were below the recommended cutoff point of 0.70. Specifically, external regulation had low alphas at pretest and posttest. Some might argue that this is a concern. However, according to Cronbach (1951), scales with few items yield lower alpha levels, and the same scale with more items would have increased the alpha level proportionally with the increasing amount of items. Also, due to the explorative nature of the present investigation, we accepted a higher degree of measurement error (Crano *et al.*, 2015). Furthermore, smaller sample size has more variation, which may cause larger measurement error in the scales.

A final limitation was the short amount of time the students in the TBL condition had to become accustomed to the learning method. According to Michaelsen and Sweet (2011), TBL sessions require students to get to know their team members and stay together as a team throughout the semester. Thus, if the experimental period had lasted longer, the students could have gained more of the benefits that TBL provides (Slavin, 1991). Despite increasing the test period from the pilot test to the present study, the relative time the students had to get accustomed to the groups and the learning method was short. However, due to a shorter lecture semester in Fall (August–November) and the criteria of having a similar topic in both teaching methods, we were not able to extend the test period any further. On the one hand, continuous measurement of participants throughout the experimentation could have eliminated the engagement or autonomous motivation effect of the topic. On the other hand, several measurements could have produced pretest sensitization effect (Crano *et al.*, 2015), thereby either enhancing or reducing the effect of the intervention (i.e., TBL). Furthermore, a last follow-up measurement after the implementation of TBL, when students returned to traditional lectures, could have impacted their answers and their ability to detect the study hypotheses, especially when the experimentation time was as short as 4 weeks.

Several practical implications are put forth based on the results. We recommend teachers incorporate active-learning approaches, specifically TBL, into their teaching. Our results show that students perceive the teachers as more autonomy supportive under TBL conditions. Furthermore, TBL as a teaching method facilitates rote learning and conceptual learning, both of which are important for the future workforce to master (Ministry of Education and Research, 2015). In line with the

theoretical assumptions of SDT, we recommend teachers evaluate any teaching activities in light of motivational consequences and autonomy-supportive contexts. A strength of this study is the ability to investigate what the various motivational effects of TBL are, and why this might be the case. There might be some controlling aspects of TBL that enhance feelings of external regulation. We recommend teachers nurture students' psychological needs for autonomy, competence, and relatedness in an autonomy-supportive way to reduce feelings of external regulation (Cheon and Reeve, 2015) by providing choice, structure, and caring. Finally, based on our findings, we recommend teachers incorporate TBL in higher education due to the positive motivational effects of increased intrinsic motivation, perceived competence, and engagement.

CONCLUSION

In conclusion, our investigation has been a first step toward assessing the motivational implications of TBL in a higher education context, an area of investigation that has been understudied. Despite the limitations in our study, we have found some initial support for the motivational benefits that TBL can have on higher education students in physiotherapy. Specifically, implementing active-learning approaches, such as TBL, compared with passive-learning approaches, such traditional lectures, could improve students' autonomous motivation, competence, engagement, and learning over time.

Future studies should conduct randomized controlled trials of the effects of TBL and lectures from an SDT perspective. By conducting randomization, it is possible to remove within-group differences, a risk associated with quasi-experiments. Furthermore, more complex longitudinal designs over several semesters, in which the experimental treatments are counterbalanced with control groups, are recommended to rule out any training or novelty effects. Finally, we recommend future studies to assess students' psychological well-being in order to test how teaching methods (active vs. passive) interact with students' motivation (autonomous vs. controlled) in explaining psychological health and affect.

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