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Abstract: We extend Goal Setting theory to the Educational field. A Bayesian longitudinal moderated mediational model was used to demonstrate the effect of students' daily/proximal self-set goals on a final course grade through daily study performance. Thirty-six daily diaries were completed twice a day by 147 sophomore students. Study goals were self-set in the morning and daily performance was self-assessed in the evening. Two independent coders, blind to the hypotheses, evaluated goal specificity and difficulty. The relationship between the goals and final grade was mediated by daily performance, and occurred only in the case of goals high in specificity and of moderate difficulty.

Cover Letter (confirming paper not published elsewhere)

P Cirino, Ph.D.
Editor, *Learning and Individual Differences*
University of Houston, USA

Rome, March 13th, 2019

Dear Prof. P. Cirino,

I am enclosing herewith a manuscript entitled "Self-set Goals Improve Academic Performance Through Nonlinear Effects on Daily Study Performance" coauthored with Drs. Gary P. Latham, Laura Borgogni, Gianluca Cepale, Annalisa Theodorou, and Evelina De Longis for consideration of publication.

This manuscript extend the core assumptions of the Goal setting theory, namely that the effect of goal specificity and difficulty improve performance, to the academic setting. The Goal setting theory (Locke & Latham, 2018) has acquired great relevance in management and I/O psychology, but we demonstrate that it can be very useful also in the University setting. We believe that our results are innovative and could lead to a new flow of studies examining the optimal level of academic goal specificity difficulty in the University.

The manuscript has a length of 35 pages (9499 words).

All co-authors agree with all the contents of the manuscript and there is no financial interest to report. We certify that the submission is original work and is not under review at any other publication. Furthermore we attest that participants were treated in accordance with ethical standards of APA.

We hope that our findings could be of interest to the readers of *Learning and Individual Differences*.
We appreciate the contribution that your Journal offers to the scientific community.

Yours sincerely,

Prof. Guido Alessandri

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Self-set Goals Improve Academic Performance Through Nonlinear Effects on Daily Study Performance

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Self-set Goals Improve Academic Performance Through Nonlinear Effects on Daily Study Performance.

Abstract

We extend the Goal Setting theory to the University setting. A Bayesian longitudinal moderated mediational model was used to demonstrate the effect of students' daily/proximal self-set goals on a final course grade through daily study performance. Thirty-six daily diaries were completed twice a day by 147 sophomore students. Study goals were self-set in the morning and daily performance was self-assessed in the evening. Two independent coders, blind to the hypotheses, evaluated goal specificity and difficulty. The relationship between the goals and final grade was mediated by daily performance, and occurred only in the case of goals high in specificity and of moderate difficulty.

Keywords: self-set goals; academic achievement; daily study; non-linear mediation; multilevel modeling.

Since the 1950s, studies have pointed to the students' second year in university as among the most challenging, leading some scholars to refer to it as the "forgotten year" (see Freedman, 1956; Hunter et al., 2010; Tobolowsky, 2008). The existence of a "sophomore slump", namely a sudden decrease in motivation, engagement, and performance affecting university students in their second year has been documented in Australian (Quinlivan, 2010), European (Webb & Cotton, 2018), and US (Furr & Gannaway, 1982; Gahagan & Hunter, 2006; Pattengale & Schreiner, 2000) universities.

Several approaches have been proposed to help students improve their second-year academic performance. Among the more successful recent approaches are those that focus on improving student's ability to self-manage the academic load by self-setting study goals (e.g., Morisano, Hirsh, Peterson, Pihl, & Shore, 2010). Self-set study goals appear to be important because undergraduate students usually do not receive frequent performance feedback as they once did in high-school. Rather, they are expected to study independently in the relative absence of feedback as to whether it is necessary to change their strategy for obtaining a high grade (McCardle, Webster, Haffey, & Hadwin, 2017). Setting proximal study goals may help students in monitoring their progresses toward their desired grade (i.e., distal goal), and thus may represent a source of feedback on the effectiveness of their study plans.

Improving Students Chances of Success

Using goal setting theory (GST, Latham & Locke, 2007; Locke & Latham, 1990) as a theoretical framework, we examined the effect of self-setting study goals on academic success during the sophomore year. Although the internal and external validity of goal setting theory is widely recognized, most of the supporting evidence has been obtained in laboratory and field experiments that did not involve self-set goals in a university setting (Locke & Latham, 2013). A few studies have shown that goal setting improves undergraduate students' GPA (e.g., Acee, Cho, Kim, & Weinstein, 2012; Morisano, 2013). However, few if any studies have examined the effect of goal setting on study sessions, let alone distinguish between *distal study goals* (e.g., passing the exam with a *specifically* desired mark), and *proximal* or "daily" study goals (i.e., studying chapter 3 by the end of the morning) (Covington, 2000; McCardle et al., 2017). Moreover, almost no study in the educational domain has explicitly examined the effect of self-set goal specificity and difficulty. This latter two are emphasized in GST (Latham & Locke, 2007).

Students may be prone to self-set general life goals (e.g., obtain a meaningful education) that lack specificity hence the difficulty level cannot be ascertained. To address these issues, we asked undergraduate sophomore students to report on a daily basis their study goals and performance during the month that preceded a final course exam. We hypothesized that students who self-set proximal study goals would obtain a higher course grade than students who did not do so. In accordance with GST, our model assumes that goal specificity and difficulty are important moderators of goal efficacy with respect to both daily proximal study performance goals and final course grade. Specificity and difficulty level of a goal were examined as possible moderators because students might vary widely in their tendency to set rather general as opposed to specific goals, and easy rather than difficult goals. We conducted a longitudinal study to test a dynamic model of the relationships among daily goals, study performance, and the final course grade.

Goal Setting Theory (GST)

Goal setting is a cognitive theory of motivation (Latham & Locke, 2018). A goal is what the individual is trying to accomplish, the object or aim of an action. It is similar in meaning to the concepts of purpose and intent (Locke & Latham, 1990). Importantly, GST states that the effect of a goal on performance is dependent on its specificity and difficulty level as opposed to an easy or general goal such as “to do my best” (Latham & Seijts, 2016).

The importance of goal specificity and difficulty for improving performance cannot be overstated. Locke et al. (1981) defined goal specificity as "the degree of quantitative precision with which the aim [goal] is specified" (p. 126). The problem with vague goals is that they can be interpreted in too many different ways. Increasing the specificity of a goal decreases the “wriggle room” about the interpretation of goal attainment (Locke & Latham, 1990). Moreover, specific goals increase task focus (Beehr & Love, 1983; Frost & Mahoney, 1976), the use of an appropriate strategy for goal attainment (Beehr & Love, 1983; Frost & Mahoney, 1976), and they facilitate self-monitoring (Campion & Lord, 1982; Frayne & Latham, 1987).

Locke et al. (1981, p. 5) argued that: "the term goal difficulty specifies a certain level of task proficiency, measured against a standard". Consequently, a goal can be classified as hard, moderately difficult, or easy. Hard or challenging goals imply a need to overcome obstacles, experiencing varying levels of frustration, and investing effort and persistence. Goal specificity and difficulty have independent effects on performance, and thus both are necessary for increasing performance (Klein et al., 1990).

A goal can be assigned, self or participatively set (Latham & Seijts, 2016). They can be *distal* or *proximal* (Bandura & Simon, 1977; Latham & Seijts, 1999; Zimmerman, 2008). The value of proximal goals is two-fold. First, when facing uncertainty, proximal goals improve error management (Frese & Zapf, 1994) as errors provide or prompt seeking feedback about the congruency between the individuals' representation of reality and progress toward goal attainment. They also promote the discovery of strategies to reduce a goal-performance discrepancy. Such feedback is often missing when only a distal goal is set. Second, proximal goals represent on-going markers of progress. Their attainment are tantamount to "small wins" that in turn increase self-efficacy for distal goal attainment (Latham & Brown, 2006).

A Theoretical Model of the Indirect Relationship Between Daily Study Performance and Final Course Grade

Following Roe (1999, p. 234), daily study performance was conceptualized as the process of setting and attaining daily proximal goals. Empirical research has consistently shown that performance is higher when both distal and proximal goals are set for a complex task rather than when only a distal goal is set (Seijts & Latham, 2001). A distal goal, such as obtaining a specific high course grade, can be conceptualized as the "end result" of the desired performance to be achieved. A proximal goal, such as studying daily the material required to pass the exam, are the steps leading to attaining the distal goal. Thus, Bandura (1997, chp. 4) suggested that the combination of proximal and distal goals leads to higher performance on tasks that are complex for people than only setting a distal goal because (a) when proximal goals are set procrastination is reduced. This is because individuals must attain them in a shorter time-period than the distal goal. Thus a sense of urgency is created. (b) The attainment of proximal goals represents on-going markers of progress. This in turn fosters motivation. (c) Their attainment also increases perceived efficacy that the distal goal is attainable. Hence, effort and persistence toward the distal goal is maintained if not increased. (d) Proximal goal attainment stimulates and raises intrinsic interest in the tasks to be performed by creating a sense of mastery and causal agency that in turn increases an individuals' perceived control of the environment (e.g., academic context). (e) Proximal goal attainment provides an individual feedback as to whether to adjust or calibrate a strategy for distal goal attainment.

In this study we used a longitudinal design in order to investigate (1) the dynamic prediction of the attainment of specific/difficult proximal goals, and (2) the indirect relationship between goal specificity and difficulty with final course grade, through increases in proximal goal attainment. Previous work has shown the beneficial effect of specific, difficult goals in promoting academic achievement (see Morisano, 2013 for a review). However, to our knowledge, no research has examined longitudinally the effect of specific, difficult goals on a students' final course grade.

Most goal setting studies have employed between-person cross-sectional designs (see Sitzmann & Ely, 2011). Although cross-sectional investigations are informative, longitudinal studies are necessary to avoid biases in testing mediation, and for exhaustive testing of alternative models (Cole & Maxwell, 2007). Furthermore, no study to date has investigated proximal goals as mediators of such relationships, despite evidence suggesting their value (Latham & Brown, 2006). Likewise, very few studies have been conducted on behavior in an academic setting comparing the performance of students' self-set goals with that of students who did not set goals (McCardle, et al., 2016). Finally, many previous studies in this domain are based on a small sample size or a few repeated observations. Thus, those studies lacked the statistical power necessary for reliably testing the effect of goal setting on academic performance (see Morisano 2013 for a review).

As stated earlier, we hypothesized that students who set specific, difficult proximal goals, in addition to a distal goal attain a higher final course grade. Consistent with GST, we hypothesized that the relationship between specific, difficult proximal goals is linear with daily study performance.

These arguments led to the following hypotheses:

H1. Specificity of a goal moderates the relation between self-set goals and daily proximal goal attainment.

H2. Difficulty of a goa moderates the relation between self-set goals and daily proximal goal attainment.

However, the ability to determine what is both specific and difficult when setting a goal may vary randomly across individuals depending on their self-regulatory ability (Zimmerman, 1990). That is, not all students may be able to recognize what a high level of specificity and difficulty is in relation to the nature of the material to be studied. Similar arguments have been raised to explain the results of the meta-analyses on goal-setting conducted in the sport and exercise field (Kyllo & Anders, 1995, see also Burton, Naylor, & Holliday, 2000), where non-linear effects of specific, difficult goals on performance have been ascertained. This hypothesis will be explored investigated exploratively.

However, we hypothesized that students engage more in their daily study as the date of the final course examination approaches. Thus, an increasing linear trend was expected for proximal (daily) goal attainment (i.e., daily study perforamance).

H3. Proximal goal attainment increases linearly over time.

In sum, proximal goal setting increases the ability to focus attention on proximal goal attainment and self-monitor thus enabling students to evaluate their plan to improve their performance (Cleary & Chen, 2009). This process of setting and attaining daily goals should lead to a higher final course grade.

H4. Increases in daily/proximal goal attainment predict final course grade

This reasoning led us to further hypothesize that proximal goals act as the mediator of the relationship between self-set goals and the final course grade. Indeed, *H1* and *H2* make this a longitudinal moderated mediational model, where the relationship between self-set goals and final course grade is expected to be moderated by their specificity and difficulty levels, and mediated by increases in daily goal attainment.

H5. Increases in daily goal attainment mediate the longitudinal relationship between self-set goal specificity, and final course grade.

H6. Increases in daily goal attainment mediate the longitudinal relationship between self-set goal difficulty and the final course grade.

We tested our model, shown in Figure 1, by controlling for covariates that have been repeatedly associated with academic achievement, namely previous GPA, sex, and conscientiousness (Lindberg, Hyde, Petersen, & Linn, 2010; Poropat, 2009). We did not formulate a hypothesis regarding the relationship between the number of daily self-set goals with the final course grade.

Method

Participants

The participants were 180 sophomore students (60 % females) enrolled in an introductory psychology class. Their average age was 21.25 years (*SD* = 3.42). They received partial course credit for participating in this study. Note that this study has been approved by the IRB of [blinded] (prot. 2/9/2017).

Procedure

Conscientiousness, GPA, and sociodemographic characteristics were collected a week before conducting this study. The students completed a daily diary each morning for 36 days before the beginning of the study day, and again in the evening at the conclusion of the study day. Each student was told that only two days of absence from the study was allowed. Participants who accumulated four absences, two mornings and two evenings, were excluded from the study. Hence, the sample size was reduced from 180 to 176.

In the morning diary, the students reported 3-10 study goals chosen for that day. In the evening diary, the students reported their performance with regard to goal attainment. Students responded in the morning between 8.30 am to 10.30 am, and in the evening between 8.30 pm to 10.30 pm. To enhance study participation, the students received an e-mail at 8.30 am every morning, and at 8.30 pm every evening with a link to a website to complete their diary. This approach prevented participants from completing more than a single diary in a day.

Attrition analysis

Of the initial pool of 176 students, 110 (63%) responded to all questionnaires. The average number of students who participated each day was approximately 147 (i.e., 88% of the original sample). Attrition was unrelated to age, sex, conscientiousness, GPA, final grade, or missing data. M-Box tests suggested that the participants who did not complete the study did not differ significantly from their counterparts.

Measures

Self-set goals

The online diary allowed up to 10 entries. Examples of study goals included: “summarizing chapter 3 by the end of the morning”, “summarizing and repeating aloud 20 pages”, “studying for at least 3 hours during the afternoon”.

Proximal goals

Students rated their proximal goal attainment at the end of every day by answering from “1” (*not at all*) to “5” (*totally*) four questions (e.g., “I attained my study goals”); two were reverse scored (i.e., “I'm not satisfied with my study”). The coefficient alphas ranged from .79 (day 12) to .90 (day 26), with a mean of .85 and a standard deviation of .02.

Grade Point Average (GPA)

GPA was based on (1) mean academic achievement, (2) total number of exams passed, and (3) university credits gained. At the beginning of this study, the mean academic achievement was 26.3 (on a scale ranging from 0 to 30) (*SD* = 2.95). The average number of exams passed was 7.6 (*SD* = 2.06) and the mean number of academic credits was 58.40 (*SD* = 16.80). The academic credit system is used by European universities to measure the requisite student workload. One academic credit typically corresponds to 25 hours of active student engagement in studying or attending class.

To derive GPA, we performed a confirmatory factor model, using the WLSMV as the method of estimation (Muthén & Muthén, 2018). The WLSMV is a weighted least squares parameter estimate that uses a diagonal weight matrix with robust standard errors and mean and variance adjusted chi-square test statistics (Muthén & Muthén, 2018). This estimator is particularly suited for dealing with non-normal or categorical data (Muthén & Muthén, 2018). GPA was defined as a latent factor loaded by average academic achievement, number of exams passed, and number of university credits at the beginning of the study. After establishing the unidimensionality of this indicator (54% of the variance was explained by the first factor alone), we estimated the factor score of GPA by using a regression method.

Conscientiousness

Conscientiousness was assessed by responses to 12 items from a reduced version of the Big Five Questionnaire (BFQ; Caprara, Barbaranelli, & Borgogni, 1996). The response scale varied from “1” (*very false for me*) to “5” (*very true for me*). Cronbach’s alpha was .82.

Final course grade

Final course grade was measured by 30 multiple choice questions concerning the subject matter addressed during the course. Each question had five choices of which only one was correct. Right answers were coded as “1”, wrong and missing answers were coded as “0”. Hence, a student’s final course grade could vary from “0” to “30”. Students were allowed 45 minutes to complete the examination.

Goals coding

Two graduate students acting as research assistants, who were blind to this study's hypotheses, independently read the 10 entries in each student's daily diary. They assigned a value of "0" to any entry coded as a "non-goal" (i.e., entries coded as tasks, such as "reading the first chapter", or coded as purposes, such as "reading"), and a value of "1" to entries where a goal was set (e.g., "repeating aloud chapters 4 and 5 within two hours"). The assistants were provided a one-page write-up containing the operational definition of a goal. The coding criteria are presented in Figure 2. Each entry could be coded zero or one for a self-set goal, up to a maximum of 10 self-set goals per day. Before starting the process, the two assistants conducted initial coding on 10 diaries, discussed any discrepancies between them, and then developed explicit coding rules to reconcile disagreements before proceeding with the remaining transcripts.

The final median Cohen's Kappa, observed across the 36 days by the two judges was approximately .70, which is in line with Landis and Koch's (1977) recommendation for satisfactory interrater reliability. At this point, the first two authors reviewed and resolved any discrepancies with the two judges. At the end of this the process, 1567 self-set goals were ascertained out of 4581 diaries coded (i.e., 34%). Of the diaries containing self-set goals, 1321 reported one goal (84%), 184 two goals (12%), 49 three goals (3%), 12 four goals (1%) and 1 diary contained 5 goals.

Each goal was then independently rated by the same two graduate assistants for specificity and difficulty, using a scale ranging from "0" (when a goal was not set) to "5". Figure 2 shows the different labels and definitions associated with each step of this scale. The degree of agreement observed between the two graduate assistants was high (specificity, r = .82; difficulty, r = .65; specificity, min = .62; specificity, max = .97; difficulty, min = .25; difficulty, max = .86; specificity, DS = .09, difficulty, DS = .17). These ratings were averaged in order to have a single "specificity" and "difficulty" score for each self-set goal. The average specificity and difficulty observed for the 1567 self-set goals were, respectively 1.74 (SD = .56) and 1.64 (SD = .73).

Data Aggregation

Given our interest in the average predictive value of the number of goals set, as well as their specificity and difficulty, we aggregated the day-level observations. In doing so, we examined the values of the Type I and II intraclass correlation coefficients, namely ICC(1), ICC(2), and of the $r_{wg(j)}$ statistics (see Le Breton & Senter, 2008) by using the R-Package "Multilevel" (Bliese, 2016).

The ICC(1) represents a measure of group homogeneity (i.e. the average correlation among variables reported by individuals of the same group). This captured the proportion of variance among groups or the variance explained by the grouping structure in multilevel data. In our data, the ICC(1) of the variables was .25 (goal number), .35 (goal specificity), and .27 (goal difficulty), with an average of .29 (*SD* = .05). This value suggests a moderately high grouping effect (Le Breton & Senter, 2008).

The ICC(2) is an estimate of the reliability of the individual means (Le Breton & Senter, 2008). It indicates the consistency between coders' ratings of goal number, specificity, and difficulty across days. An ICC(2) level of .70 or above is considered sufficient to justify aggregation (Le Breton & Senter, 2008). In our data, ICC(2) values were .92 (goal number), .95 (goal specificity), and .92 (goal difficulty) with a mean of .93 (*SD* = .02).

Finally, the $r_{wg(j)}$ coefficient (the within-individual inter-day agreement) was computed for each student separately, and then averaged by using a uniform null-distribution (Bliese, 2016). This coefficient indicates whether the level of agreement observed for each student across the 36-study days was sufficient to assert that the goal number, the observed level of goal specificity and difficulty as well as study performance were sufficiently interchangeable across days to justify aggregation. According to Lebreton and Senter's (2008) revised standards, a mean $r_{wg(j)}$ value of .70 or greater justifies aggregation. In our study the $r_{wg(j)}$ levels were .89 (goal number), .82 (goal specificity), and .80 (goal difficulty), with a mean of .84 (*SD* = .05). In sum, ICC(1), ICC(2), and $r_{wg(j)}$ values suggest that aggregating goal number, difficulty, and specificity as well as daily study performance was justified.

Preliminary analyses

After aggregation, the average number of goals set had a mean of 9.75 (SD = 9.00) a skewness of -1.00, and a kurtosis of 0.52. In general, over the 36 days, 25 individuals (17%) reported “no-goal”, 17 individuals (12%) had one goal, 34 individuals set between two and five goals (23%), 18 (12%) individuals set between six and 10 goals, 17 (12%) individuals set between 11 and 15 goals, 16 (11%) individuals set between 16 and 20 goals, 10 (7%) individuals set between 21 and 25 goals, 10 individuals (7%) set more than 25 goals. The students who did not set any goal during the 36-day period introduced structural zeros in the data. Structural zeros refer to zero responses that are different from random (or sampling) zeros (He et al., 2014, p. 439). Students who did not report a goal during this study formed a subgroup, namely the “no goal setters”.

Given our theoretical interest on the predictive value of goal presence/absence, and goal number, we used the approach suggested by He et al. (2014) by including for each individual an indicator of structural zeros in the model along with the count variable representing the average individual’s number of goals. This indicator, “no goal”, was a Level-2 indicator because it indexed for each student the presence or absence of goals. It was allowed to have a value of “1” for those who reported no goals during the study day period (i.e., 36 days), and a value of “0” otherwise. The “no-goal” indicator did not correlated significantly with any of the outcomes. Average number of goals showed a moderate correlation with sex (.18, $p < .05$: on average males reported more goals), and daily study performance (.19, $p < .05$), a higher correlation with GPA (.35, $p < .01$) and final course grade (.31, $p < .01$).

Average goal specificity and difficulty had means of 1.31 (SD = 0.12) and 1.24 (SD = .17), respectively with skewness of 0.99 and 0.80, and kurtosis of 0.48 and -0.20, respectively. Both goal specificity and difficulty showed moderately highly correlations with GPA (.34, $p <.01$ and .28) and final course grade (both .27, $p < .01$), and moderate correlations with daily performance (.18, $p < .05$) and (.20, $p < .05$), respectively. Moreover, goal specificity was moderately correlated with gender (.19, $p < .05$), with males setting more specific goals. Goal difficulty correlated positively with conscientiousness (.18, $p < .05$), with more conscientious individuals setting more difficult goals.

Modeling Strategies

Modeling change in daily study performance. We tested our theoretical model using Growth Curve models using a Multilevel Structural Equation framework (ML-GCM; Preacher, Wichman, MacCallum, & Briggs, 2008) in two steps.

Step 1. Multilevel growth modeling. In the first step, we examined if daily study performance (i.e., proximal goal attainment) showed a significant change over time, a premise of our model. We started with a linear model positing a linear pattern of intra-individual change over time:

Level-1

$$(1)\ \textit{daily study performance} = \eta_{0i} + \eta_{1i} * \mathrm{Time}_1 + \varepsilon_{ti},$$

Level-2

$$(2)\ \eta_{0i} = \alpha_{00} + \zeta_{0i},$$

$$(3)\ \eta_{1i} = \alpha_{10} + \zeta_{1i}.$$

In this model, daily study performance is posited as a linear function of time (*Time*) with the origin or intercept values for the different participants (η_{0i}) established at the first day of assessment. The factor η_{1i}, or the slope, captures the individual growth rates. Both η_{0i} and η_{1i} are defined by a fixed term α_0 and α_1, representing the average intercept and the average growth rate, and by the random terms $\zeta_{0i,}$ ζ_{1i}. representing the individual-level residuals, or average departure by the intercept or the slope. Time-specific deviations are represented by the independent and identically standard normally distributed ε_{ti}.

We compared this model with a series of alternative models. Model 1 (strict stability, no growth model) includes only the intercept. The mean and variance of the slope are zero. This model assumes that no change occurred over the 36 time points (i.e., the level of the construct is stable over time, except for a random error component at each point of assessment). Model 2 posits a quadratic pattern of intra-individual change over time, and includes a linear slope in addition to a quadratic slope.

Step 2. Building the Mediational model. After we established the best fitting growth model, we tested our substantive hypotheses by adding predictors and outcomes to the previous model. We specified a direct prediction of the slope factor by (1) no-goal, (2) goal number, (2) specificity, and (3) difficulty. Non-linear effects of specificity and difficulty were tested by including two additional terms representing squared specificity (i.e., specificity^2) and difficulty (i.e., difficulty^2) scores. The above predictions were also set, in an exploratory manner, for the model intercept. Thus, the above model became:

Level-1

(4) daily study performance$_{i1}$ = η_{0i} + η_{1i}*Time$_1$ + ε_{ti},

Level-2

(5) $\eta_{0i} = \alpha_{00} + \sum_{j=1}^{v}(\gamma_{0i} * v_j^x) + \zeta_{0i,}$

(6) $\eta_{1i} = \alpha_{10} + \sum_{j=1}^{v}(\gamma_{1i} * v_j^x) + \zeta_{1i},$

The new i = 1, …, 9, terms in the equation are the γ_{0i} and γ_{1i} coefficient linking each of the j linear (^{x} =1) or quadratic (^{x} = 2) predictors and covariates (i.e., v) respectively to the slope and the intercept. Although we were in fact interested in the interaction effect of having a goal X specificity/difficulty of that goal, it was not necessary to explicitly include any interaction term in the model. Indeed, when "no-goal" = 0 (i.e., in case of students with at least one goal over the 36-day period) this term and any interaction involved naturally drop-out of the model because:

(7) η_{0i} = α_{00}+ γ_{01}*("no goals" = 0) + γ_{02}*(goal number) + γ_{03}* (goal number*no goal = 0) + γ_{04}*(difficulty) + γ_{05}*(difficulty*"no goal = 0) + γ_{06}* (difficulty^2) + γ_{07}* (difficulty^2*"no goal = 0)+…….+ ζ_{0i},

simplifies to:

(8) η_{0i} = α_{00}+ γ_{01} * ("no goals" = 0) + γ_{02}*(goal number) + γ_{04}*(difficulty^2) + ζ_{0i}.

When the "no-goal" is equal to "1", as in the case of the students with structural zeros, all the other terms are equal to "0", because that goal specificity and difficulty are purely goal properties (Locke & Latham, 1990, 2013). Thus all first order linear, quadratic, and interaction terms naturally drop out from the model (except the "no-goal" indicator). In light of this, all the linear and quadratic effects of goal number, specificity and difficulty included in our model can be interpreted as the effects of goal number, specificity, and difficulty for those individuals who reported at least one goal during the study period (He et al., 2014).

Along with these effects, we also specified the final course grade as predicted by the slope factor. To control for possible omitted paths, we investigated if the hypothesized mediation was full or partial. Thus, we included all direct paths from no-goal, goal number, specificity, specificity^2, difficulty, and difficulty^2 to the final course grade variable. In order to adjust for the interaction between initial levels of study daily performance with its subsequent change, we regressed the slope of each construct on its respective intercept (see Curran & Muthén, 1999). The effects of the covariates were specified on all the criterion variables (i.e., daily study performance intercept, slope, and final course grade). Finally, although not hypothesized, we investigated the prediction of the daily study performance intercept by no-goal, goal number, specificity, specificity^2, difficulty, and difficulty^2. The inclusion of these effects expands the above model with this additional Level-2 equation:

Level-2

$$(9)\ \mathit{Final\ course\ grade}_1 = \alpha_{20} + \gamma_{20}\eta_{0i} + \gamma_{21}\eta_{1i} + \sum_{j=1}^{v}\gamma_{2i}w_i^n + \varepsilon_i.$$

The interpretation of the linear and quadratic effects of goal number, specificity and difficulty is the same as before.

Statistical Analyses

The above model was estimated by using Bayesian Structural Equation Modeling (BSEM) as implemented in Mplus 8 (Muthén & Muthén, 2018). The Markov Chain Monte Carlo (MCMC) algorithm with the Gibbs sampler method was used to achieve the posterior distribution of Bayesian estimates. The MCMC "uses the conditional distribution of one set of parameters given other sets to make random draws of parameter values, ultimately resulting in an approximation of the joint distribution of all parameters" (Muthén & Asparouhov, 2012, p. 334). In the present study, two MCMC chains involving 50,000 iterations with different starting values, and different random seeds were used. This procedure that makes it possible to assess convergence. The default convergence criterion is a Proportional Scale Reduction (PSRF) factor (Gelman, Carlin, Stern, & Rubin, 2004). A PSRF value of 1.1 or smaller is evidence of convergence. To ensure that the number of iterations was sufficiently large, the PSR values were checked for convergence before the first half (i.e., 25,000) of the iterations.

Alternative models were compared by using the deviance information criterion (DIC). This criterion, a Bayesian analogous to the Akaike Information Criterion, balances the largeness of the likelihood and adds a penalty for model complexity based on the effective number of parameters referred as p_D (see Gelman et al., 2004; Spiegelhalter, Best, Carlin, & Van Der Linde, 2002). Models with smaller values of DIC are preferred.

Mplus default non-informative prior distributions were used for all parameters included in the model: normal distributions with a prior mean of zero, an infinitely large prior variance for means and regression coefficients, and inverse Gamma distributions with a mean of -1 and a variance of .00 for variances, covariances, and residuals, that is, low precision. The significance of estimated parameters was examined by looking at the 95% credibility interval. Bayesian credibility intervals are based on the percentiles computed on the whole distribution of the posterior estimates. Importantly, the derivation of these intervals does not rely on large-sample theory, and does not make the usual normality assumptions. All coefficients with an associated confidence that did not include zero were considered statistically significant ($p < .05$).

Mediated effects were computed by using the method of the instantaneous indirect effect ($\theta_{wi,}$) developed by Hayes and Preacher (2010). This entails taking the product of the first partial derivative of the mediator, with respect to the predictor, with the partial derivative of the outcome, with respect to the mediator variable. To investigate the statistical significance of mediated effects, we followed the credible interval method recommended by Yuan and MacKinnon (2009). This method accommodates the skewness in the distribution of an indirect effect.

Results

Multilevel Growth Modeling of Daily Study Performance

All the growth models converged properly with PSR values below 1.1 from the 400th iteration on for the no-growth model, from the 300th on for the linear model, and from the 600th iteration on for the quadratic model. Consistent with GST, we selected the linear model as the best fitting one. This model resulted in a significant unstandardized intercept (α_0 = 2.94, C.I. = 2.85, 3.04), slope (α_{00} = .019 C.I. = 0.014, 0.023), and means and variances ($\zeta_{0i,}$ = 0.023, C.I.= .18, .34; ζ_{1i}, = .001, C.I. = .0001, .001). The slope and the intercept were significatively correlated negatively (-0.24, C.I.= -0.52, -0.15). The Level-1 unstandardized residual term was also significant (ε_{ti} = 0.62, C.I. = 0.60, 0.65).

As shown in Figure 3, this model reproduced a growth trajectory that closely resembled the one that was estimated. In general, the students tended to linearly increase their study performance as the day of the final course examination approached. However, those students who started with higher study performance showed less linear change over time due to a ceiling effect.

The linear model (DIC = 11191.79) fared better than the no-growth model (7835.66), but not as well as the quadratic model (11078.95). In this latter model, only the means and the variances of the linear term were significant (and close in values to that of the linear model), whereas the mean of the quadratic slope and all covariances between growth parameters were nonsignificant. The trajectory reproduced by this latter model was not significantly different from that reproduced by the linear model. Thus we concluded that the complexity associated with this model was not justified. Indeed, it is well known that the DIC index tends to select over-fitted models (van der Linde, 2012). Hence to be conservative, we retained the more parsimonious linear model. All in all, these results supported *H3*, namely that proximal goal attainment increased linearly over time.

Full Longitudinal Moderated Mediational Model

After establishing the best fitting growth curve model for daily study performance, we tested the full mediation model. This model converged with PSR values below 1.1 from the 600th iteration on. After the inclusion of the predictors, the unstandardized intercept (α_0 = 2.90, C.I. = 2.76, 3.05), and slope (α_{00} = .047 C.I. = 0.015, 0.077), intercept terms remained significant as well as their residual variances ($\zeta_{0i,}$ = 0.21, C.I. = .14, .29; ζ_{1i}, = .001, C.I. = .0001, .0001). The unstandardized level-1 residual term was also significant (ε_{ti} = 0.64, C.I. = 0.69, 0.67). Moreover, the model was efficient, as attested by the high proportion of explained variance in the outcomes of interest, with R^2 coefficients being .72 (*C.I.* = 0.30, 0.93) and .83 (C.I. = 0.50, 0.96) for the intercept and the slope of daily study performance, and 0.39 (*C.I.* = 0.15, 0.71) for final course grade.

Prediction of daily study performance by goal presence and number. We found no evidence that the setting of a goal, or having a higher number of goals was associated with the daily study performance intercept, slope or with the final course grade itself (see Table 1).

H1: Specificity moderates the relation between self-set goals and daily proximal goal attainment. We started by testing the relationship between goal specificity with students' initial daily job performance. As shown in Table 1, the intercept of daily study performance was positively predicted by squared specificity, but not negatively predicted by linear goal specificity. As shown in Figure 4, Panel A, predicted initial level of daily study performance was higher (*B* = 3.57, CI95% = 2.91, 4.21) when goal specificity was low (-1 *SD*), decreased when goal specificity was average (*B* = 2.81, CI95% = 2.60, 3.01), and decreased (*B* = 2.56, CI95% = 1.95, 3.18) when goal specificity was high (+ 1 *SD*), reaching its minimum at a value of 0.90 *SD* above the mean. That is, the relationship between goal specificity and change in daily performance was "U-Shaped".

In support of *H1*, the change in daily study performance, as assessed by the slope, was positively predicted by linear goal specificity, but negatively predicted by squared specificity. This outcome was the result of individuals setting daily proximal goals. Figure 4, Panel D, shows that the linear change in daily study performance was not significant (*B* = 0.02, CI95% = -0.021, 0.082) when goal specificity was low (-1 *SD*), became significant when specificity was average (*B* = 0.052, CI95% = 0.021, 0.082), and became even stronger (*B* = 0.068, CI95% = 0.033, 0.10) when goal specificity was high (+ 1 *SD*) It reached its maximum when specificity was equal to 1.07 *SD* above the mean. Again, the relationship was curvilinear.

Figure 4, Panel C, also shows the latent trajectories estimated for individuals who reported low, average, and high goal specificity. Students who set more specific goals started their trajectory with a slightly lower level of daily study performance than those who set less specific goals. However, they then showed steeper increases than those whose goals were average or low in specificity.

***H2.* Goal difficulty moderated the relationship between self-set goals and daily proximal goal attainment.** As shown in Table 1, the intercept of daily study performance was negatively predicted by squared goal difficulty, but it was not predicted by linear goal difficulty. As shown in Figure 4, Panel B, the predicted starting level of daily study performance was high (*B* = 3.22, CI95% = 2.77, 3.65) when goal difficulty was high (+1 *SD*), decreased at the average goal difficulty level (*B* = 3.00, CI95% = 2.83, 3.16), and was minimal (*B* = 2.38, CI95% = 1.82, 2.95) when the goal difficulty level was low (- 1 *SD*). The highest level of initial daily performance levels were observed at a value of goal difficulty equal to 0.92 *SD* above the mean. Thus, the relationship between goal difficulty and change in daily performance was curvilinear.

The slope of daily study performance was significantly negatively predicted by linear goal difficulty, but positively predicted by squared difficulty. This means that the relationship between goal difficulty and change in daily performance was curvilinear. As shown in Figure 4, Panel E, the predicted linear change in daily study performance was significant (*B* = 0.069, CI95% = 0.034, 0.10) at low goal difficulty levels (-1 *SD*), decreased at the mean goal difficulty level (*B* = 0.043, CI95% = 0.011, 0.074), and was non-significant at high (+1 *SD*) goal difficulty levels (*B* = 0.033, CI95% = -0.004, 0.071). In this case, the minimum of the function was located at a value of goal difficulty equal to 0.90 *SD*, attesting to the adverse effect of goal difficulty on daily study performance. The relationship too was curvilinear.

Figure 4, Panel F, further shows the latent trajectories estimated for students who reported low, mean, and high goal difficulty. Students who set more difficult goals started with higher levels of daily study performance and maintained them over the study period until 10 days before the final exam. But, those who set lower goals started with lower daily performance study levels. They showed steeper increases than students who set mean or low goal difficulty levels. They reached a higher level of daily study performance during the last 10 days before the exam.

H4. Direct prediction of final course grade. As shown in Table 1, final course grade was predicted only by the slope of daily study performance. This result supports *H4*. There was also a significant indirect effect of both study goal specificity and difficulty level.

H5 and H6. Indirect prediction of final course grade. Support was found for *H5*, namely that the instantaneous indirect effect of goal specificity through daily performance at a standard deviation below the mean, the mean, and one standard deviation above the mean are:: $\theta_{spec_{high}}=$ 0.09 (C.I. = -0.08, 0.36), $\theta_{spec_{mean}}=$ 0.38 (C.I. = .02, 1.01), $\theta_{spec_{low}}=$ 0.66 (C.I. = .06, 1.07). An increase in goal specificity among students who set moderate or low difficulty goals led to an increase in the final course grade because of an increase in daily study performance. However, there was a diminishing return. Increasing goal specificity by students who set highly specific goals improved the final course grade through the effect of the increase in specificity on changes in their daily study performance.

In support of *H6*, there was an instantaneous indirect effect of goal difficulty through daily performance at a standard deviation below the mean, the mean, and one standard deviation above the mean are: $\theta_{diff_{low}}=$ -0.22 (C.I. = -0.24, 0.12), $\theta_{diff_{mean}}=$ -0.27 (C.I. = -0.75, -0.004), $\theta_{diff_{high}}=$ -0.03 (CI95% = -0.55, -0.021). Increases in goal difficulty by students who initially set easy goals or goals of medium difficulty reduced their final course grade through the negative relationship between the increase in difficulty and changes in their daily study performance.

However, increasing goal difficulty by those students who initially set difficult goals had no indirect effect on the final course grade via changes in daily study performance. In sum, there is a diminishing cost of increasing goal difficulty. Indeed, increasing goals difficulty implies a higher cost for students who initially set easy goals than for those who initially set difficult goals.

Covariates

There were significant relationships between conscientiousness and daily study performance on the first study day, GPA, and final course grade (Table 2).

Number of goals

The relationship between number of goals and course grade was not significant.

Discussion

This study disentangled the indirect effects of proximal goal specificity and difficulty on final course grade through their relationship with students' daily study performance. As predicted, daily study performance involving proximal self-set goals was moderated by goal specificity and difficulty. Of importance, these predictions were of opposite sign.

With regard to goal specificity, contrary to GST, there was a non-linear U-shaped relationship with initial daily performance, and an inverted U-shaped relationship with the observed change. That is, those who self-set specific goals tended to have an initial lower level of daily study performance. However, they tended to show a steeper linear increase over time than those who had self-set less specific goals. The reverse occurred for goal difficulty. There was a curvilinear relationship between goal difficulty level and initial daily performance, as well as a curvilinear relationship with the observed change. That is, students who set difficult goals tended to show higher initial study performance, but less positive change over time than those students who initially set less difficult goals.

Goal specificity and difficulty had a differential effect on proximal goal attainment in the different phases of this study. The daily goal attainment trajectory was higher for individuals who set low- and average-specific goals up to the 9^{th} day of this study. After the 10^{th} study day, students whose self-set goals were higher in specificity showed a steeper increase in study performance than students whose self-set goals were low in specificity.

With regard to goal difficulty, individuals who set more difficult goals showed, on average, higher daily study performance levels across the study period, except for the last few study days (i.e., starting from the 15^{th} day on). Those whose goals were relatively easy increased their daily study performance across the entire study period. These results suggest that different mechanism are affecting behavior when people set easy versus challenging goals. In the first case, people may have gained an initial advantage in terms of proximal goal attainment and maintained that advantage throughout the study. This strategy seems advantageous from a self-regulation perspective. These students appear to set proximal goals they could attain from the very beginning to the very end of this study. Thus, they didn't need to change their level of daily study performance. In the second case, the other students appear to have started from an initial disadvantaged position, and then tried to catch-up. They appeared to be unable to set appropriately difficult goals. The observed increase in goal attainment likely reflected their attempt to catch-up with a level of preparation requested to attain their desired grade at the exam. This second strategy seems clearly to have been less efficient than the former.

The present results are consistent with studies on athletes where non-linear effects of goal specificity and difficulty on performance were found (Burton & Naylor, 2000; Kyllo and Anders, 1995). This is likely because many students may prefer moderately specific difficult goals (see Kyllo and Anders, 1995). Consequently interventions aimed to teach students how to set specific, difficult goals appear to be needed.

Practical Implications

The practical significance of these findings is that they suggest that it is not sufficient to urge students to self-set proximal study goals. In addition, students should be made aware of the importance of goal specificity and difficulty. The optimal level of these two goal characteristics is likely determined by the nature of the academic course, by the structure of the study materials they must learn, and the moderators in GST (i.e., students' ability, resources, feedback, and commitment). When GST moderators are ignored in the goal setting process, dysfunctional behavior is likely to occur (Mawritz, Folger, & Latham, 2013).

Finally, an important implication of our results is that, consistent with GST, they show that goal specificity and difficulty have independent effects on students' academic performance. Thus, the importance of advising students on the necessity of taking both (i.e., goal specificity and difficulty) into account for increasing their academic performance. The non-linear indirect effect of goal specificity on final course grade followed a diminishing return pattern. Accordingly, interventions designed to increase students' grades through goal setting may show their highest effectiveness for those who self-set low or moderately specific goals. Helping these students to make their short-term goals more specific would lead to an increase in their final course grade by increasing the effectiveness of their daily study performance. The non-linear relationship of goal difficulty with final course grade suggests that the greatest effect may occur for those students who are predisposed to set easy goals.

Another noteworthy aspect of this study is that the findings are consistent with previous research. Students high in conscientiousness tended to be industrious and attain high academic performance levels (Poropat, 2009). Moreover, the high predictive validity of previous GPA on subsequent GPS suggests that our results are robust. The strength of the self-set goal- academic performance relationship in this study over and above conscientiousness, previous GPA and sex shows that goal specificity and difficulty are important determinants of academic success over and above well-known predictors of academic performance (e.g., GPA).

Limitations

A limitation of this study is that the results are based on a single sample of students who were studying for a single exam. Future research should test the generalizability of our findings across different populations of students studying for exams in different disciplines of varying difficulty (e.g., engineering, mathematics, physics) in different cultural contexts.

Conclusion

In this study we examined the value of goal setting theory postulates for helping students to regulate their study and improve their performance on a university exam. Our results clearly show the benefits of self-set proximal study goals. The curvilinear findings suggest the need to (1) individuate the boundary conditions of goal specificity and difficulty for students' study habits, and (2) to clarify the mechanism linking goal specificity and difficulty to higher course grades.

This study provides a contribution to the literature on the value of self-set goals in the academic domain by illustrating the potential mechanisms through which they operate. If future research corroborates these results, universities could benefit from the application of GST to their students especially for those attending the second year.

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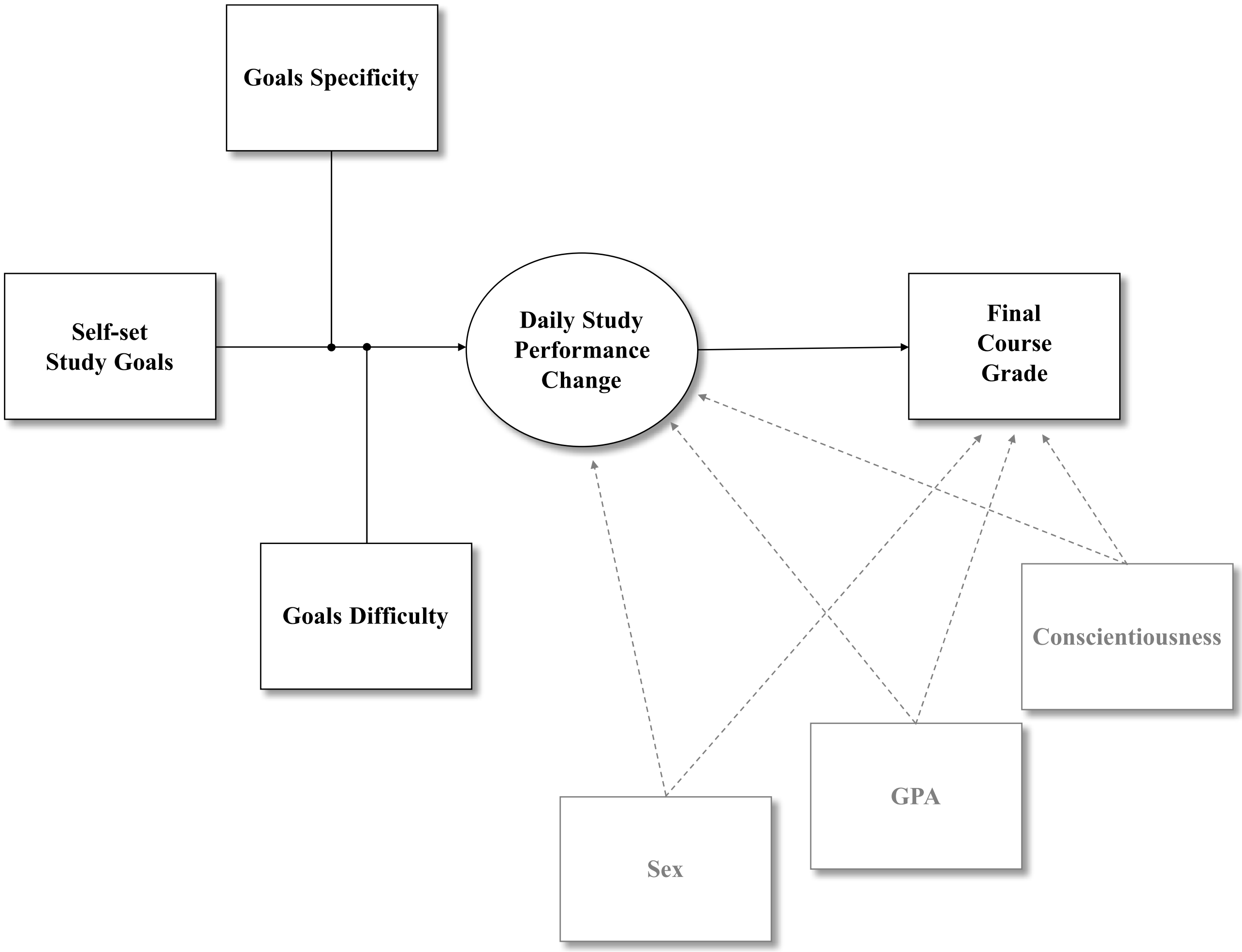
Figure 1. The Hypothesized Multilevel Moderated Mediational Model



Note. Covariates are in gray.

Figure 2. Diagrammatical Representation of the Coding Process

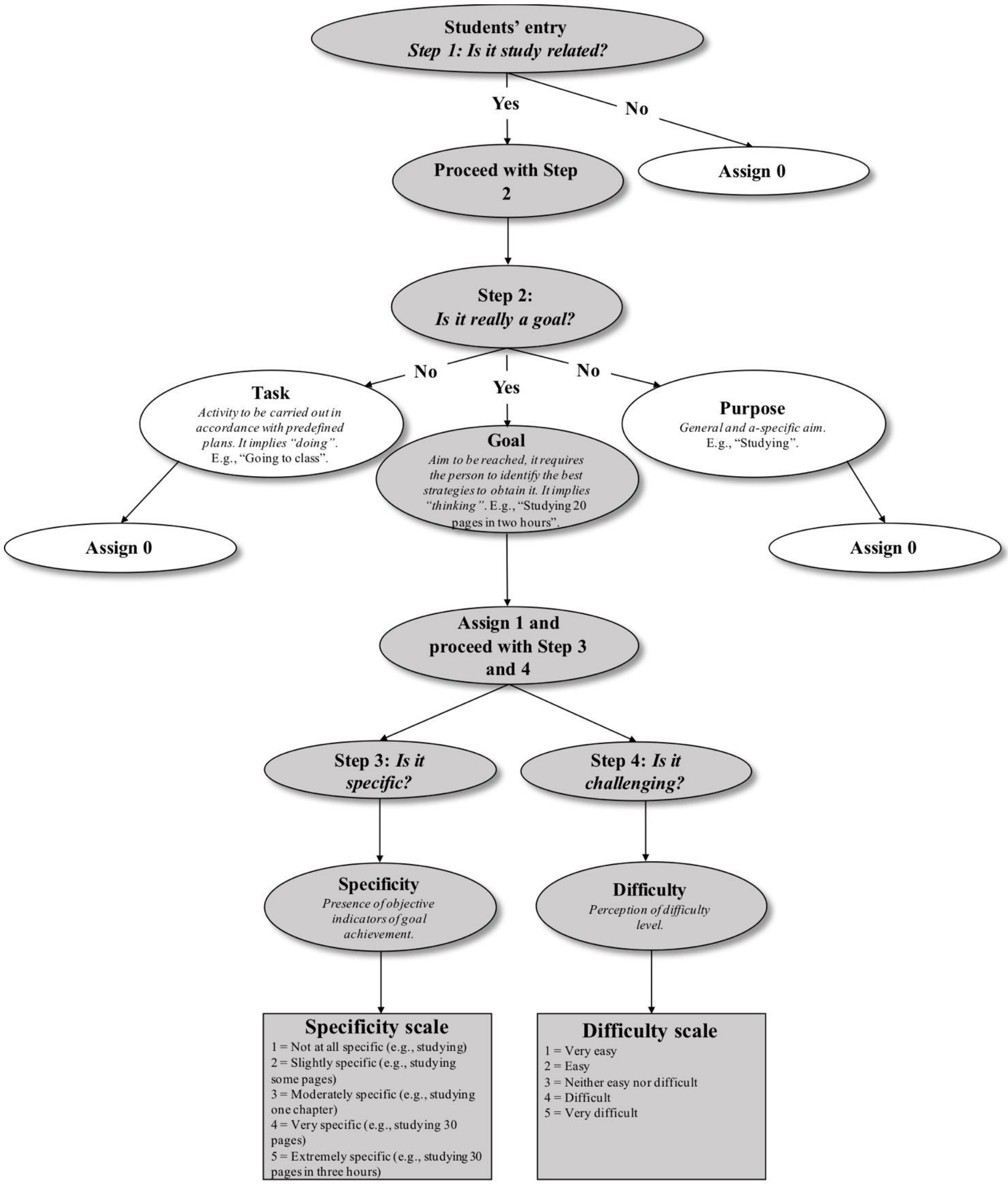


Figure 3. Observed and Reproduced Trajectory of Daily Study Performance Across the 36 Days

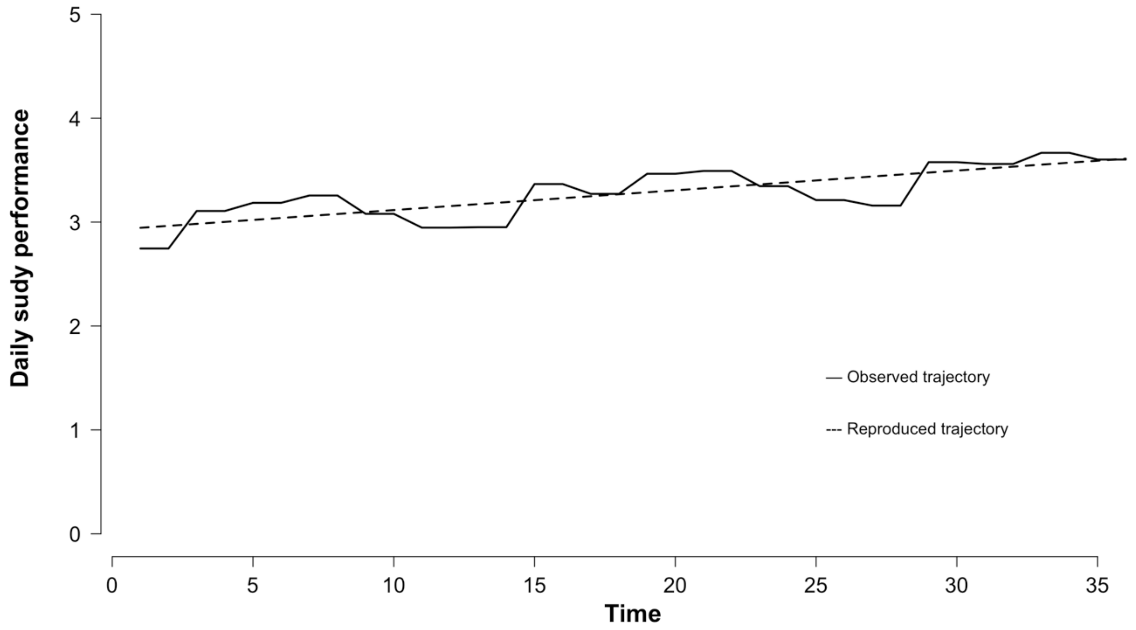


Figure 4. Observed relationship of goals specificity and difficulty with daily study performance.

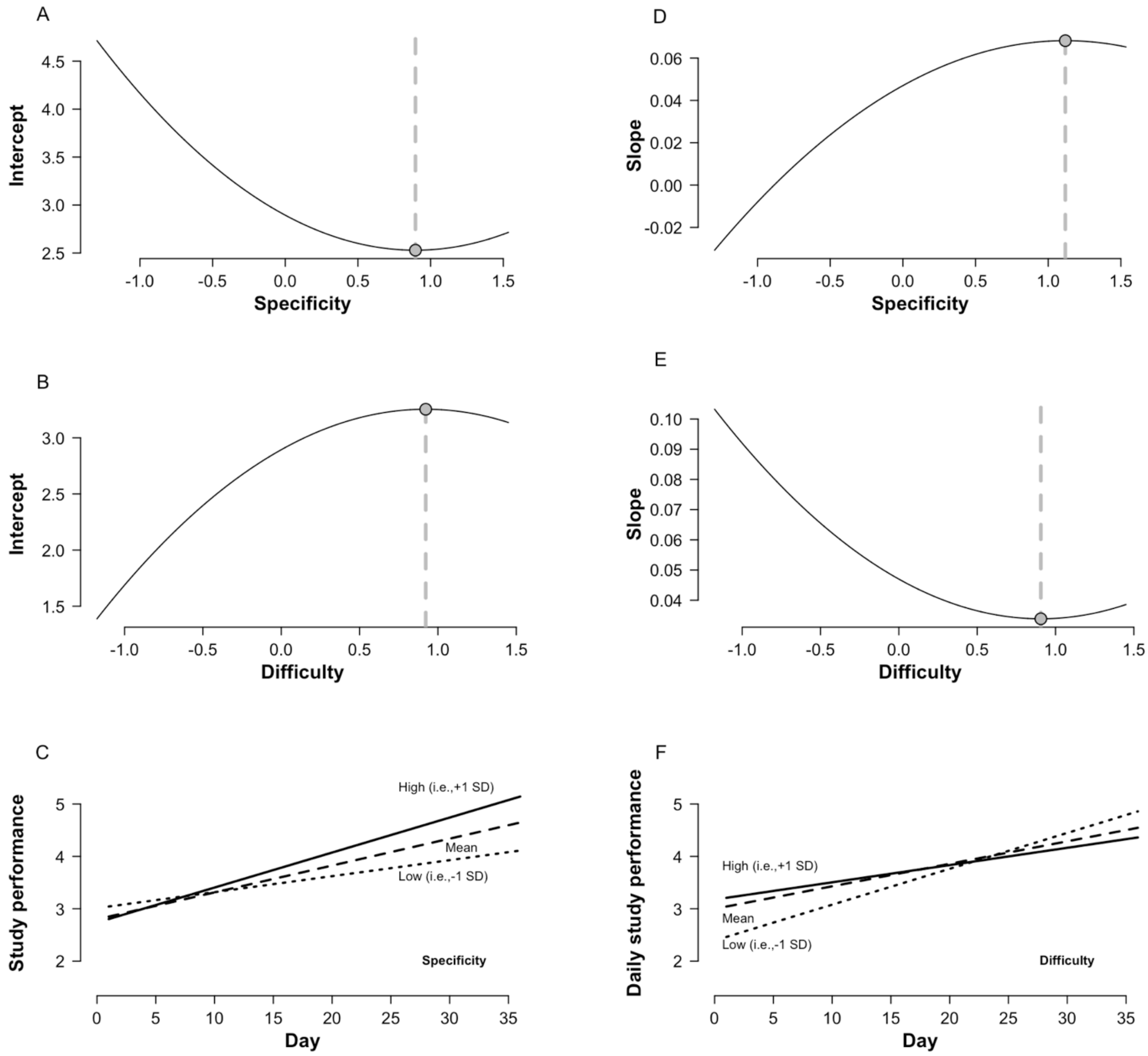


Table 1. Posterior Estimates Obtained for the Multivariate Mediational Multilevel Growth Model

	Daily Study Performance								
	Intercept			Slope			Final Course Grade		
	Estimate	*S.D.*	*C.I. 95%*	*Estimate*	*S.D.*	*C.I. 95%*	*Estimate*	*S.D.*	*C.I. 95%*
1. No-goal	0.60	0.40	-0.18, 1.40	-0.01	0.02	-0.04, 0.02	-0.01	0.61	-1.21, 1.19
2. Goal number	0.23	0.47	-0.71, 1.15	-0.01	0.02	-0.05, 0.03	-0.13	0.19	-0.50, 0.25
3. Specificity	-0.84	0.48	-1.77, 0.10	**0.04**	**0.02**	**0.01, 0.08**	-0.74	0.77	-2.24, 0.81
4. Specifcity^2	**0.51**	**0.20**	**0.13, 0.90**	**-0.02**	**0.01**	**-0.04, -0.04**	0.33	0.33	-0.32, 0.99
5. Difficulty	0.76	0.42	-0.05, 1.60	**-0.03**	**0.02**	**-0.07, -0.01**	0.55	0.67	-0.73, 1.91
6. Difficulty^2	**-0.46**	**0.22**	**-0.88, -0.02**	**0.02**	**0.01**	**0.01, 0.04**	-0.50	0.36	-1.23, 0.16
7. Intercept	-	-	-	-0.18	0.13	-0.47, 0.05	-0.11	0.18	-0.49, 0.23
8. Slope	-	-	-	-	-	-	**0.45**	**0.28**	**-0.01, 1.07**
9. GPA	0.06	0.05	-0.02, 0.17	-0.07	0.04	-0.16, 0.01	**0.22**	**0.07**	**0.10, 0.36**

10. Conscientiousness	**0.17**	**0.08**	**0.03, 0.35**	0.05	0.07	-0.08, 0.18	0.02	0.09	-0.16, 0.20
11. Gender	-0.05	0.07	-0.19, 0.09	0.02	0.06	-0.09, 0.14	-0.03	0.08	-0.20, 0.13

Note. “Estimates” are posterior parameters modes, “S.D.” are posterior standard deviation for the parameter estimate, and “C.I. 95%” are 95% credibility intervals for the estimated parameter. Estimates for “No-goal”, Goals number, specificity, specificity^2, difficulty and difficulty^2, are unstandardized, in order to have more meaningful interpretations (see Aiken & West, 1991). All other parameters are in completely standardized form.

Highlights

- We extend Goal Setting theory to the University setting
- We tested the effect of students' daily/proximal self-set goals on a final course grade
- This effect resulted moderated by goals specificity and difficulty
- Goals high in specificity and of moderate difficulty resulted the more predictive
- The relationship between the goals and final grade was mediated by daily performance