Using 'approach goals' to increase student motivation for independent study: a randomised controlled field trial

Sam Sims[1], Laura A. Outhwaite[1], Sophie Bennett[2]

[1]Centre for Education Policy and Equalising Opportunity, UCL. [2]Up Learn.

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Motivation has an important influence on the extent to which students engage in study. Reported here is a large-scale randomised controlled trial comparing the effect of Mastery-Approach (MAp) goals, which focus on development of task mastery, and Performance-Approach (PAp) goals, which focus on demonstration of competence. The achievement goals were embedded within an online learning platform for students aged 16-18 years in England. In a sample of 1,791 students, intention to treat analysis showed students randomly allocated to receive the MAp goals (treatment group 1) engaged in more effortful learning activities on the platform, compared to students assigned to receive the PAp goals (treatment group 2) or no achievement goal messages (control group). The PAp messages had no significant impact on student effort. The research addresses a need for more ecologically valid causal evidence on achievement goal theory and has direct implications for educators managing remote learning.

1. Introduction

Motivation has an important influence on the extent to which students engage in study at school and at home (Trautwein et al., 2006; Trautwein & Lüdtke, 2009; Van Yperen et al., 2015; Xu, 2020). This in turn has important implications for student achievement. For example, greater motivation and effort is associated with higher test scores, even when conditioning on socio-economic status and prior achievement (Jerrim et al., 2020; Mo, 2019). Indeed, student motivation has been estimated to explain around one third of the variance in PISA test scores across participating OCED countries (Zamarro et al., 2019). It is perhaps to no surprise then that getting student to concentrate on their work has been characterised as one the five "persistent challenges" faced by all teachers (Kennedy, 2016, pp.14).

The importance of student motivation has recently become a pressing issue due to COVID-19, with 290 million students estimated to be out of school at one point early in the pandemic (UNESCO, 2020). This has led to a sharp increase in the use of online distance learning and creates new challenges in ensuring students remain engaged with their studies. In particular, teachers may be less able to monitor student activity and redirect their attention in the ways that they would in a typical class-based context. In line with this, a recent survey of parents in the UK found that 77% of parents cited "lack of motivation" as a reason that their child was struggling to complete school work during school closures, more than any other reason tested (Williams et al., 2020, pp. 11). There is hence a need to investigate how theory relating to pupil motivation can be put to work to support independent study, now and in the future.

1.1 Achievement goal theory

Motivation refers to the "initiation, direction, intensity and persistence of behaviour" (Brown, 2007, pp. vii) and has been the subject of study by psychologists for over a century (Perrin, 1923). During that time, several theoretical frameworks have been developed and tested (Ryan, 2012), though they tend to share an emphasis on the individual's perception of themselves within a social context (Perry et al., 2006). This paper utilises one such framework – achievement goal theory – which has been widely applied in education in order to understand individuals' drive to achieve

competence and performance, with a particular focus on what learners strive for when trying to enhance outcomes (Elliot, 2005; Lazowski & Hulleman, 2006).

Achievement goal theory distinguishes goals along two fundamental dimensions (Elliot & McGregor, 2001; Van Yperen et al., 2015). The first is between the valence of achievement goals: approach and avoidance. Approach goals involve aiming to get better at a task, skill, or ability, and are theorised to support student motivation, even in cases where the task is challenging. This is because approach goals focus on the possibility of success and help promote eagerness and excitement (Elliot & McGregor, 2001). In contrast, avoidance goals involve aiming not to fail. It has been argued that avoidance goals are unlikely to support student motivation, due to the focus on failure, which can evoke anxiety and vigilance (Elliot & McGregor, 2001). The second distinction is between the standards that students use to define their competence: mastery or performance. Mastery goals focus on developing self-referenced competence, whereas performance goals aim to demonstrate competence by comparison to an external benchmark (Shin et al., 2017).

Combining these two dimensions in a 2x2 model, achievement goals can be classified as Mastery-Approach (MAp), Performance-Approach (PAp), Mastery-Avoidance (MAv), and Performance-Avoidance (PAv; Elliot & McGregor, 2001; Van Yperen et al., 2015). This offers a useful framework within which to examine the impact of achievement goals on student motivation. For example, mastery approach goals (i.e., MAp) are theorised to be beneficial for student motivation due to their focus on the possibility of success and alignment with intrinsic motivation (Lazowski & Hulleman, 2016; Wigfield et al., 2015). In contrast, there is ongoing disagreement about whether performance-approach goals (i.e., PAp) are beneficial or maladaptive for student motivation (Senko et al., 2011).

1.1.1 Avoidance verses approach goals

There is consensus in the empirical literature that avoidance goals are maladaptive for student learning outcomes and experiences, prompting negative emotions, less effective learning strategies, and reduced willingness to seek help (Senko & Dawson, 2017). In contrast, approach goals have generally shown promising findings. For example, evidence suggests both MAp and PAp goals can be supportive

of later academic performance. While PAp goals were found to show a direct relationship with performance, MAp goals appear to be associated with performance via challenge seeking, which is protective against failure (Mouratidis et al., 2018). Furthermore, some research suggests there is a reciprocal positive relationship between MAp goals and mathematical attainment outcomes (Xu, 2020).

1.1.2 Mastery-approach goals

In a systematic review of motivation interventions in education, Lazowski and Hulleman (2016) identified four field-based intervention studies focused on achievement goal theory with an overall effect size of .38 (Cohen's *d*) in favour of overall achievement goals, compared to no achievement goals; this effect size did not differentiate between the impact of MAp and PAp goals. Included studies that did focus on MAp goals, such as, Bernacki et al. (2016) found a brief writing intervention that encouraged students in early adolescence to adopt a mastery approach to learning, showed significantly increased motivation and interest in science, compared to a business as usual control group. Similarly, Hoyert and O'Dell (2006) found a MAp goal intervention, implemented in-class or in an interactive computerised tutorial with undergraduate psychology students, significantly increased engagement as well as achievement outcomes, compared to no achievement goal intervention.

However, while this evidence suggests MAp goals can elicit deep-learning strategies and an interest-based study approach, this could be considered detrimental to academic achievement if the learner disproportionately prioritises personally interesting material over 'duller' content (Senko et al., 2013). This issue may be particularly pertinent in an online distance learning context, where teachers may be less able to monitor what students are spending their time on, compared to a class-based context. Nevertheless, the evidence largely concludes that MAp goals provide a wide range of benefits, including positive affect, interest, elaborative learning strategies, effective self-regulation, and help-seeking behaviours (Hulleman & Senko, 2010; Senko & Dawson, 2017), all of which can benefit student motivation and achievement outcomes.

1.1.3 Performance-approach goals

In comparison, evidence suggests PAp goals were aligned to a more vigilant approach to learning with students seeking cues on how to succeed and adjusting their study strategy accordingly (Senko et al., 2013). Overall studies examining PAp goals have produced inconsistent and sometimes contradictory evidence (Senko & Dawson, 2017). For example, while some studies have found PAp goals to be positively associated with success-related emotions (Pekrun et al., 2014) and academic achievement (Mouratidis et al., 2018), others have found negative consequences, particularly with achievement outcomes (Xu, 2020). Furthermore, correlational evidence, based on self-report data suggests PAp goals can elicit both positive and negative affect (Huang, 2011), low and high effort intensity (Midgley et al., 1996; Senko et al., 2013), and both rehearsal and elaborative learning strategies (Payne et al., 2007).

Meta-analysis of 243 correlational studies in achievement goals suggests these mixed results might be explained by the inconsistent way in which PAp goals have been operationalised across different studies (Hulleman et al., 2010). For example, when PAp goals align with normative references (e.g., wanting to exceed an absolute or relative benchmark) a positive correlation with performance outcomes is typically observed. By contrast, when PAp goals focus on appearances (e.g., wanting to demonstrate self-worth to an audience) or a majority evaluative component (e.g., wanting to outperform others) a negative correlation with performance outcomes is observed overall.

However, this pattern of findings is not always observed in the applied, experimental literature. For example, Lazowski and Hulleman's (2016) aforementioned review included a randomised field trial, which found undergraduate students who received PAp goal feedback in response to performance on an online weekly quiz had significantly higher achievement outcomes, compared to those who received MAp goal feedback, mixed MAp-PAp goal feedback, and no achievement goal feedback (Muis et al., 2013). In this study, the PAp goal feedback consisted of descriptions on how students had performed comparative to others in their class, including a percentile rank. This operationalisation of PAp goals aligned with a majority evaluative component (Hulleman et al., 2010). Taken together, this

mixed evidence warrants the further investigation of the impact of MAp and PAp goals in applied learning settings with robust, experimental methods.

1.2 Current study

The preceding review highlights three limitations of the existing literature. First, much of the research to date has focused on students' self-reported goals and their associations with achievement or learning-related outcomes. There are few experimental tests of achievement goal theory in real-world educational contexts (Lazowski & Hulleman, 2016; Wentzel & Wigfield, 2007). Second, to the authors' knowledge, very few studies have directly compared the impact of MAp and PAp goals to each other in the same field-based intervention study. Third, previous studies have focused on pupil achievement outcomes. While this approach has yielded valuable insights, it is also important to examine the other outcomes involved in achievement goal theory (Lazowski & Hulleman, 2016). The present study sought to address these limitations by examining the impact of MAp versus PAp goals on student motivation to complete effortful, real-world learning tasks on an online distance learning platform. The study addresses the research question: do students engage more with online distance study when they receive MAp (treatment group 1), or PAp goals (treatment group 2), or no achievement goals (control group)?

2. Method

A pupil-level randomised control trial (RCT) was conducted to examine the impact of MAp amd PAp goals induced through a messaging intervention embedded in the online learning platform, Up Learn (www.uplearn.co.uk). Up Learn is a commercially available education program, used by young people studying AS- and A-Levels, which are the typical university entrance examinations for students aged 16-18 years in England. The trial was implemented within an A-Level economics course on the online learning platform for 13 weeks between October 2019 and January 2020. Participants were randomly allocated to one of three parallel groups with a 1:1:1 ratio: MAp goals (treatment group 1), PAp goals (treatment group 2), or business as usual online platform with no achievement goals (control group). Ethical approval for the study was granted by the UCL Institute of Education Ethics Committee. Opt-in consent was obtained for all participants.

2.1 Participants

Table 1 summarises the flow of participants through each stage of the RCT following CONSORT guidelines (Moher et al., 2010). All new users of the online platform signing up for the A-Level economics course during the academic year 2019-2020 were eligible to participate. Existing research has reported effect sizes of .38 (Cohen's *d*) for achievement goals vs. control contrasts in experimental studies (Lazowski & Hulleman, 2016). A power calculation showed that a total of 226 participants would be sufficient to detect an effect of this size with 80% power (Raudenbush, 2011). Regardless, to maximise statistical power, recruitment of as many individuals as possible across the course of the academic year was planned. Ultimately, both recruitment and treatment were required to be halted on the 24th of January 2020, for reasons related to the commercial operation of the platform[i]. The research team were blind to the results at the point the trial ended. Eleven participants also withdrew from the study for reasons unspecified. The final sample consisted of 1,791 participants, resulting in a minimum detectable effect size of 0.13. Descriptive statistics summarising the final sample can be found in Table 2.

Table 1
CONSORT Table Summarising the Composition (Total N) of the Sample at each Stage of the RCT

Stage of RCT	Total	MAp Goals (Treatment Group 1)	PAp Goals (Treatment Group 2)	No Goals (Control Group)
Randomised to group	1802	601	601	600
Withdrew from study	11	4	7	0
Final sample	1,791	597	594	600
Received allocated intervention (%)	1,290 (72.0)	344 (57.7)	346 (58.3)	600 (100)
Did not receive allocated intervention (%)	501 (28.0)	253 (42.3)	248 (41.7)	0 (0%)

Note. MAp = Mastery Approach Goals; PAp = Performance Approach Goals. Participants received no messages if they never used the platform following sign-up.

Table 2
Descriptive Data Including Treatment Dosage (Mean [Standard Deviation], Minimum-Maximum), Free School Meal Eligibility (Total %), and Gender (Male %) for the Final Sample in the Trial

	Mean (SD), Min-Max			
	Total	**MAp Goals (Treatment Group 1)**	**PAp Goals (Treatment Group 2)**	**No Goals (Control Group)**
Days in trial	45.0 (19.9) 0-72	45.0 (20.0) 0-72	45.0 (20.0) 0-72	45.1 (19.9) 1-72
Messages received	5.2 (10.3) 0-75	8.3 (12.8) 0-72	7.5 (10.9) 0-75	0 (0) 0-0
Free school meals eligibility %	7.9	7.8	8.2	7.8
Gender* male %	67.4%	72.2%	65.8%	64.2%

Note. Up Learn do not collect data on gender for all participants but do infer it from participants name using an algorithm. This may explain the small post-randomisation imbalances observed on gender reported above.

2.2 Intervention

The achievement goal intervention was implemented in the Up Learn online learning platform within the Edexcel Economics course. This online course is designed to provide a complete set of instructional resources for students taking A-level Economics through the Edexcel exam board. Students can access the course through either a paid subscription or at zero cost via a scholarship available to disadvantaged students - as indicated by either eligibility for free school meals (FSM), registration at an IntoUniversity centre, or having Crowd Scholar candidate status.

The course is divided into four distinct modules that each cover one of the four themes on the Edexcel Economics specification: Introduction to Markets and Market Failure; The UK Economy-Performance and Policies; Business Behaviour and the Labour Market; A Global Perspective. Each module is further subdivided into a series of sections covering distinct topics and users are directed towards content by an algorithm that accounts for user progress, performance, and memory decay. However, users are also given the option to bypass the algorithm and self-select or skip content. The course content is delivered through a series of, 1) interactive videos, which incorporate quiz questions,

2) progress quizzes, which resemble exam practice paper questions, and 3) support from online tutors via a chat function.

For treatment group 1 (MAp goals) and treatment group 2 (PAp goals), a series of fifteen achievement goal messages were developed in line with the underlying theory of achievement goals (Barron & Harackiewicz, 2001; Kaplan & Maehr, 2007). For each of the fifteen messages, a similar sentence structure was used, while tweaking the wording to reflect either a MAp or PAp goal approach. Five messages were based on the direct provision of goals e.g., "Aim to master the economics in this module" (MAp) or "Aim to be the best in your class at economics" (PAp). Six messages were based on motivating persistence with the work e.g., "Stick at it in order to improve your skills as an economist" (MAp) or "Stick at it in order to demonstrate your skills in economics" (PAp). Finally, a further four messages were based on framing persistence e.g., "Your XP has gone up. You're on track to master this module" (MAp) or "Your XP has gone up. You're on track to get ahead of your peers" (PAp). Here, XP stands for 'Experience Points', which are points that users gain from completing learning activities on the online learning platform. Building on the findings from Hulleman et al. (2010), the PAp messages had a majority normative component. In line with the JARS standards (Appelbaum et al., 2018), the full list of messages is reported in the Appendix.

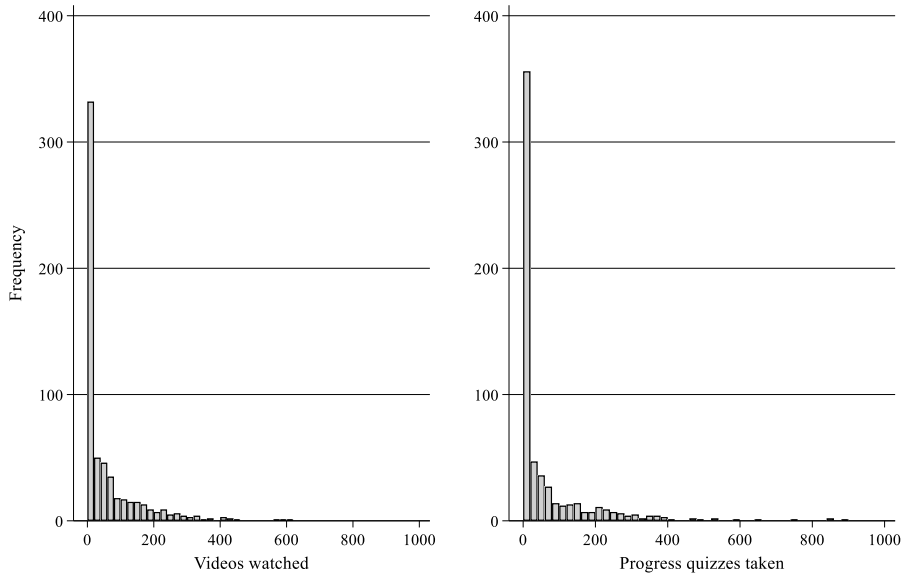
Participants allocated to treatment group 1 (MAp goals) and treatment group 2 (PAp goals) received an achievement goal message after fixed increments of time using the platform. For the first six messages, participants received one message after every 30 minutes of online usage, then one message after every hour of use for the subsequent nine messages. The messages were automatically delivered via the online chat function embedded in the online learning platform. Once participants had received all fifteen achievement goal messages, the presentation cycle repeated, with a new message delivered after every two hours of use. The order of delivery of the messages was fixed (see Appendix).

2.3 Outcome measures

The current study focused on student motivation, which was operationalised as engagement with effortful learning tasks on the platform: 1) the number of interactive video lessons watched, and

2) the number of progress quizzes[ii] taken. The interactive video lessons are short (3-4 minute) animated lessons containing two or three of embedded quiz questions. Answering the quiz questions embedded within the video lessons is necessary to progress to the end of the lesson. However, once the student has answered the question, the video continues whether or not the student answered correctly. The distribution of videos watched in the business-as-usual conditions can be found in the left-hand panel of Figure 1. The progress quizzes are distinct from the quizzes embedded in the videos and appear after every 4-5 video lessons. Each progress quiz consists of 5-7 quiz questions designed to consolidate learning and evaluate student progress. The questions contained within the progress quizzes are designed to be more challenging than the quiz questions embedded within video lessons and therefore tend to take longer to answer. Pupils receive their marks for each progress quiz attempt and can retake the progress quiz as many times as they like. The distribution of number of progress quizzes taken can be found in the right-hand panel of Figure 1. These data were automatically collected, and then extracted in anonymised form from the Up Learn platform by the research team.

Figure 1
Distribution of the Two Outcome Measures Under Business as Usual Conditions (in the Control Group, N=600)



2.4 Procedure

All individuals who signed up for the A-Level economics course on the Up Learn platform after October 23rd 2019 were invited to participate. Among those that agreed, sequential randomisation was used to allocate participants to one of the three trial arms, as and when they signed up for the course. This enabled the intervention to begin immediately for new users and avoided exposure to the learning materials prior to the intervention beginning. The sequence for the sequential randomisation was implemented using a random permuted blocks design, where each block contained three participants with exactly one allocated to each trial arm. The sequence was generated using the 'RALLOC' package in Stata (Ryan, 2018). This approach was chosen to ensure maximum balance in terms of the average length of time on the platform, and by extension the expected number of messages received, across the treatment arms. Generally speaking, small blocks of fixed size can increase the predictability of group allocation and thereby risk participants manipulating their allocation. Consequently, closed assignment to group, whereby the randomisation code automatically allocated participants to one of the three groups at enrolment was used. Furthermore, the risk of accidental bias across groups was minimal due to the large sample of 1,791 students and the researchers being blinded to participant group allocation, (Efrid, 2011).

Recruitment and treatment ended on the 24th of January 2020. After this period, participants had the opportunity to continue using the online platform under business-as-usual conditions, without the achievement goal messages. All students had the right to withdraw themselves and their data from the study at any time without giving reason and communication channels were established between users and Up Learn to facilitate this process if needed. Due to the COVID-19 pandemic, schools in England were closed, and A-Level exams cancelled on 23rd of March 2020. This was two months after the trial had ended.

2.5 Analytical approach

As can be seen in Table 1, 42% of participants in both treatment group 1 (MAp goals) and treatment group 2 (PAp goals) never received any of the messages that constitute the treatment in this experiment. In line with the procedure outlined above, this is because consent and therefore recruitment

to the trial had to occur when an individual signed up to the platform, whereas treatment can only begin once they started using it. Thus, around four in ten individuals in the two treatment groups were non-compliers: they were assigned to treatment but did not receive treatment.

Simply excluding non-compliers risks invalidating the trial by introducing selection bias (Ellenberg, 2005). Instead, the results of an intention-to-treat (ITT) analysis, in which all individuals are analysed as assigned, are reported. For example, the outcomes for untreated individuals in treatment group 2 (PAp goals) still contribute towards the average outcome in this treatment group. This analytical approach has the benefit of maintaining covariate balance across the trial arms in expectation, maintaining sample size and preserving the validity of certain statistical tests (Lee et al., 1991). It also answers the *policy-relevant* question: what was the effect of the intervention under study?

In our main analysis, the two outcome measures are regressed on treatment status (Table 3). Our outcome is a count variable that cannot go below zero (Figure 1), so we use negative binomial regression (Gardner et al., 1995) and report the results as incidence rate ratios, rather than standardised mean differences. Our data also has a large number of zeros, which reflects individuals who sign up to the platform but never use it. This highlights an important point about our data: the mechanisms determining why somebody displays a zero value for the outcome (never using the platform) is different to the mechanism determining why they display one or more of that outcome (intensity of use of the platform). We account for this using a zero-inflated negative binomial regression, which combines a logistic regression for whether an individual is a never-user and a negative binomial regression for the intensity of use among users (Huang & Cornell, 2012). Our model for whether an individual ever uses the platform relies on a single binary predictor for whether the individual paid for their account or received free access.

Random assignment balances all characteristics in the treatment and control groups in expectation, but any given trial has a finite sample size and will display some level of residual imbalance (Rosenbaum, 2017). Statistical inference is therefore necessary to understand the probability that any observed effect represents residual imbalance and is therefore compatible with the null hypothesis of no effect. Software packages typically calculate standard errors and *p* values using approximate

methods that rely on asymptotic properties in large samples (Heß, 2017). However, these are unlikely to apply in smaller datasets of the sort generated by randomised controlled trials (Leamer, 2010) and this results in pervasive inferential errors in trial analysis (Young, 2016). Moreover, these errors are likely to be particularly large in trials that employ many blocks/strata (Bruhn & McKenzie, 2009; Bugni et al., 2016). Due to the random permuted block approach to treatment allocation, this trial has 601 such strata. To ensure correct inference, exact *p* values (Fisher, 1935) are calculated that fully account for the blocked nature of the data. This is done using 250 permutations and a random number seed of 123456 to ensure replicability, implemented using the 'RITEST' command in the Stata software (Heß, 2017).

3. Results

Table 3 shows the results of regressing treatment allocation on the outcome measures using negative binomial regression, along with the (exact) *p* values. The coefficients are incident rate ratios (IRR), with the coefficient on videos in the MAp vs control contrast (1.17) indicating 17% more video being watched in the MAp group, for example. Participants in treatment group 2 (PAp goals) showed a similar level of effort to those in the control group ($p>0.05$), while those in treatment group 1 (MAp goals) showed higher levels of engagement, relative to both PAp and control groups. The number of videos watched is 17-19% higher in treatment group 1 (MAp goals) compared to the other two groups and the number of progress quizzes taken is 26-31% higher. The exact *p* values in Table 3 shows that the difference between MAp and control, and MAp and PAp arms are statistically significant ($p<0.05$), for both outcomes.

As shown in Table 1, the number of days in the trial, and consequently the number of messages received, varied widely within participants in the two treatment groups. This begs the question whether differences in exposure to the achievement goal treatment is related to the number of additional videos watched or quizzes taken. Figure 2 presents exploratory analysis exploring this dose-response relationship. Recall that spending more time on videos and quizzes directly causes delivery of further messages, which establishes a partly mechanistic relationship between the two variables. To get at the underlying effect of the marginal message, days in the trial (a proxy for dose which is not

mechanistically related to the response) was plotted against the two response variables. To distinguish the effect of additional days of exposure to the treatment from the effect of additional days of access to the platform, the predicted relationship between the two pairs of variables for both the MAp group and the control group were plotted. If the two lines are parallel, then the marginal day of exposure to the treatment has no effect over and above the marginal day of access to the course (with no achievement goal messages). If the MAp line rises faster than the control line, then this is indicative of a positive dose-response relationship. As can be seen from Figure 2, the latter pattern is observed for both videos watched, and quizzes taken. Confidence interval are not included on the chart because - to the best of our knowledge – no software currently exists capable of plotting predicted margins with confidence intervals derived from randomisation inference. While the results in Figure 2 are best thought of as exploratory in nature, they also suggest that the unexpected early end date of the trial is very unlikely to be driving our results.

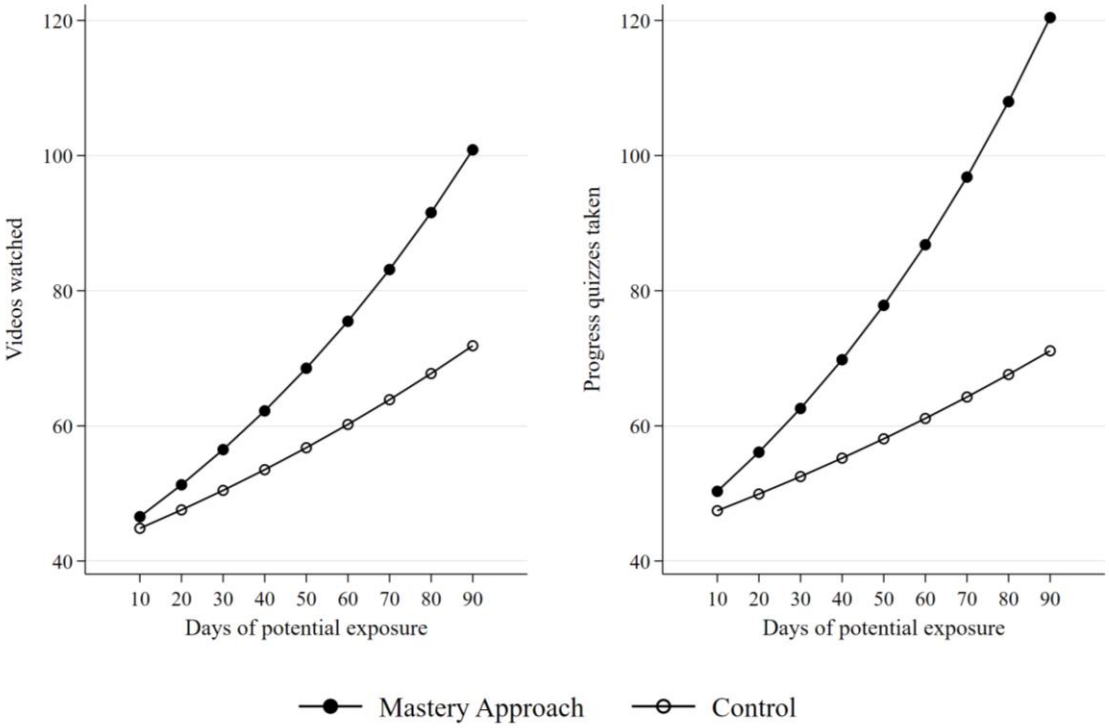
Table 3
Intention to Treat (ITT) Analysis

Contrast	**Outcome**	**IRR**	***p***	**N**
MAp vs. Control	Videos	1.171*	0.036	1,197
	Progress Quiz	1.260*	0.008	1,197
PAp vs. Control	Videos	0.988	0.884	1,194
	Progress Quiz	0.966	0.704	1,194
MAp vs. PAp	Videos	1.187*	0.036	1,191
	Progress Quiz	1.305*	0.008	1,191

Note. IRR = incidence rate ratio. *p* = exact p value. * = *p* <0.05. MAp = Mastery Approach. PAp = Performance Approach. Control = business as usual.

Figure 2

Predicted Values of Videos Watched and Progress Quizzes Taken Outcome Variables for Varying Values of Potential Exposure to the Treatment (Days in Trial) amongst those Assigned to Treatment Group 1 (MAp Goals) and Control Group (no goals)



Note. Predictions do not extend to zero in order to avoid meaningless projections of the regression line. *N*=1,139 in each of the two panels.

4. Discussion

This study reports a three-arm RCT examining achievement goal theory for improving student motivation in an online distance learning context. In a large sample of over 1000 students, the RCT directly examined the effect of MAp and PAp goals on measures of engagement with real-effort learning tasks, compared to no achievement goals. The study was designed and implemented in collaboration with Up Learn, an online learning platform for A-Level students aged 16-18. The current findings have implications for achievement goal theory, as well as practical implications for engaging students with online distance learning. This is particularly pertinent in the current COVID-19 pandemic, which has brought about a sharp increase in online distance learning.

Overall, the current results indicated that students who received MAp goal messages (treatment group 1) engaged significantly more with the online distance learning tasks, compared to students who

received PAp goal messages (treatment group 2) and students who received no achievement goal messages (control group). Specifically, the incidence rate ratios indicated that students in treatment group 1 (MAp goals) watched 19% more videos than those in treatment group 2 (PAp goals), and 17% more than those in the control group (no goals). Students in treatment group 1 (MAp goals) also completed 31% more progress quizzes than their peers in treatment group 2 (PAp goals), and 26% more than the control group (no goals). Students' level of engagement in response to the PAp messages (treatment group 2) were slightly lower than those receiving no achievement goals messages in the control group, but this difference was not statistically significant at conventional levels.

Additional analyses identified a positive relationship between the number of days of exposure to the messages and the increased level of engagement as measured by videos watched and progress quizzes taken. This additional engagement was above and beyond that shown by those with similar days of exposure to the platform in the groups that did not receive any achievement goal messages. This is indicative of a positive dose-response relationship and further supports the inference that the MAp goals (treatment group 1) had a positive effect on learners' engagement with real-effort learning tasks.

4.1 Implications for theory and practice

These results make two contributions to theory. As discussed in the introduction, previous research on the efficacy of PAp goals has reached conflicting conclusions (Senko & Dawson, 2017), perhaps due to variation in the way that PAp goals are operationalised across different studies (Hulleman et al., 2010). However, the results from this rigorous experimental test raises further questions about the impact of PAp goals on student motivation, at least in an online distance learning setting. In the current study, the PAp goals consisted of a majority normative component (i.e. demonstrating performance relative to absolute or relative benchmark), which based on Hulleman et al.'s (2010) meta-analysis of correlation studies would predict a positive impact on student outcomes. However, our results were contrary to this prediction: the PAp goals (treatment group 2) did not significantly increase student engagement, compared to the MAp goals (treatment group 1) or the no achievement goal control group. This suggests that association between PAp goals and motivation

observed in correlational research may not translate into causal effects in real-world, learning environments.

Alternatively, the divergence in our findings might be explained by the timing and intensity of the current PAp goal intervention. Namely, in the current study students received their allocated messages every 30-60 minutes, while using the online learning platform. As such, this approach could be characterised as relatively light-touch, continuous feedback. In contrast, in studies where PAp goals have demonstrated significant impacts, such as Muis et al. (2013), the implementation of the PAp goal intervention was much more explicit, in direct response to task performance and including percentile rank within the class. This may suggest the nature in which PAp goals are implemented in real-world contexts is an important influential factor and warrants further investigation.

A related but separate contribution of the current study is on the relative efficacy of MAp and PAp goals, which are theorised to be alternatives to each other in the 2x2 framework (Elliot & McGregor, 2001). While previous experimental research has tested the effects of MAp or PAp goals, very few studies have tested which has larger effects while holding the experimental setting fixed in an ecologically valid learning context (e.g. Muis et al., 2013). Such intervention research within achievement goal theory is at an early stage of development (Elliot & Hulleman, 2017) and the large sample size in the current study affords the necessary statistical power with which to make these comparisons – indicating clearly that, in this context, MAp goals were more powerful than PAp goals in motivating effort on the online learning platform.

These insights also have direct implications for practice, in particular around how best to motivate pupils. During COVID-19, large numbers of pupils are learning from home, due to nationwide school closures, regional lockdowns, or because they are individually highly vulnerable and have therefore been advised not to attend school (UNESCO, 2020). The results from the current study suggest that teachers should integrate MAp messaging into their email, telephone, or video call communications with students, in order to encourage them to engage with their studies while away from school. The fifteen MAp messages included in the Appendix of this paper provide examples of how this can be done, either through the direct provision of goals, “Set your sights on fully understanding the material

presented in this module", motivating persistence with a task, "Keep practicing the content in this module to make sure you fully master this part of the course", or by framing persistence, "Great work, you're on track to master this module". For pupils who are able to attend school, and for after the pandemic, teachers can also help foster MAp goals in pupils through their face-to-face verbal communication.

4.2 Limitations and future directions

The current study demonstrates the feasibility of embedding achievement goal theory into online learning environments (Green et al., 2019) with a large sample and long intervention exposure. As such, the observed positive impacts on engagement are ecologically valid and statistically precise. Moreover, the combination of random allocation, very low levels of attrition and ITT analysis to account for non-compliance in the control group provided strong internal validity. Nevertheless, there are three important limitations of the existing study to consider, which also point the way towards directions for future empirical research.

First, while the outcome measures (videos watched and progress quizzes completed) capture pupils' effort in a real-world learning tasks, they are in essence 'intermediate' variables in the learning process. Ultimately, interest resides in whether this increased effort translates into improved learning outcomes. The outcome variables are also specific to the Up Learn platform, which may partly explain why such substantively large effects of the intervention were observed (Cheung & Slavin, 2013). To further establish the causal impact of achievement goal theory within online learning contexts, future research should include other measures of achievement outcomes, including high-stakes examinations.

Second, although the current study setting allowed for a test of the key theoretical distinction between MAp and PAp goals, the extent to which more nuanced aspects of achievement goal theory could be addressed were limited. For example, the current study was unable to collect survey-based measures of participants self-regulatory or motivation processes (Hulleman & Senko, 2010; Senko & Dawson, 2017). Such information could help further evaluate the theoretical underpinnings of achievement goal theory by, for example, testing the hypothesis that MAp goals are effective due to their alignment with intrinsic forms of motivation. In addition, recent theoretical contributions have

emphasised that MAp goals can be subdivided into those which focus on task-referenced or self-referenced criteria for competence (Elliot et al., 2011). Building on the results of this study, an experimental test of this distinction would be valuable.

Third, the external validity of the study is questionable due to the way in which participants were self-selected. The current sample contains 0.5 female participants for every 1 male participant, which is very similar to the national ratio of 0.45 females for every 1 male studying economics in England[iii]. Likewise, the current sample contained 7.9% pupils eligible for free schools meals, which is similar to the national rate of 7.5% among 16-19 year olds[iv]. Nevertheless, it is likely that the sample contained individuals who were relatively highly motivated, since they were willing to sign up to an online A-Level learning platform between September and January – the first half of the academic year in England.

4.3 Conclusions

In conclusion, the current study has utilised a robust RCT design to evaluate achievement goal theory in the context of online distance learning. Results show student engagement with real-effort learning tasks can be enhanced through MAp goals but not by PAp goals. Overall, this demonstrates the applicability of psychological theory to the design of educational interventions for supporting students' education. The findings have direct implications for the messaging and language that teachers should use to keep students engaged in online distance learning during school closures; as well as having broader implications for the way in which teachers attempt to motivate students when they return to school after the pandemic.

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Appendix

Table 1
Complete list of messages sent to participants in the two control conditions

	Mastery Approach (MAp) messages	Performance Approach (PAp) messages
Direct provision of goals	1. Aim to master the economics in this module.	1. Aim to be the best in your class at economics.†
	2. Strive to understand the material as thoroughly as possible.	2. Strive to get the best grade in your class.†
	3. Aim to gain a deep understanding of the economics in this module.	3. Aim to show us how good you are at economics.
	4. Set your sights on fully understanding the material presented in this module.	4. Set your sights on achieving the best grade.†
	5. Aim to gain a deep understanding of the module content.	5. Aim to understand this module content to achieve your A – A* grade.†
Motivating persistence	6. Keep practising in order to become the best economist you can be.	6. Keep practising in order to get closer to your A-A* grade.†
	7. Stick at it in order to improve your skills as an economist.	7. Stick at in order to demonstrate your skills at economics.
	8. Keep studying and you will become a better economist.	8. Keep studying and you will get a better grade to show for it.
	9. Keep going and you will learn more about this module.	9. Keep going and you will get higher marks in this module.†
	10. Keep practicing the content in this module to make sure you fully master this part of the course.	10. Keep practicing the content in this module to make sure you get your A-A* grade.†
	11. You are making great progress through this module, keep striving to understand the content as thoroughly as possible.	11. You are making great progress through this module, keep striving towards your A-A* grade.†
Framing persistence	12. Your XP is increasing. You're on your way to improving your economics.	12. Your XP is increasing. You're on your way to a better grade.†
	13. Your XP has gone up. You're on track to master this module.	13. Your XP has gone up. You're on track to get ahead of your peers.†
	14. Your XP is rising. You will soon have mastered this material.	14. Your XP is rising. You will soon have better grades to show for it.†
	15. Your XP is going up. Keep going to improve your knowledge of economics.	15. Your XP is going up. Keep going to achieve your A- A* grade.†

Notes. XP stands for "experience points", which are points that users gain from completing learning activities on the online learning platform. † Indicates a PAp goal with a normative focus, as opposed to an appearance focus (see Hulleman et al. 2010).

[i] The current study depended on delivering messages to participants via a chat function embedded in the platform. In January, Up Learn decided that they needed to use this chat function to deliver messages regarding exam preparation to users. In order to avoid overloading users with messages, it was decided that the treatment – and thereby the study – should end at this point. The research team were blind to the results at the point the trial ended.
[ii] These are described on the platform as 'exam practice quizzes'.
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