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Examining the effectiveness of guidance and adaptive feedback

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Scaling goal-setting interventions in higher education using a conversational agent: Examining the effectiveness of guidance and adaptive feedback

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Abstract

Goal setting is the first and driving stage of the self-regulated learning cycle. Studies have shown that supporting goal setting is an effective means of improving academic performance among higher education students. However, doing so can be complex and resource intensive. In this study, a goal-setting conversational agent was designed and deployed to support higher education students in setting academic goals. Across 5-weeks, we tested the effects of goal-setting prompts (guided vs. unguided) and adaptive feedback (with vs. without) when delivered via a goal-setting conversational agent. We explored the effects of these supports (i.e., guidance and feedback) on students' 1) goal quality and 2) goal attainment. Findings showed that guidance and feedback combined had the largest positive effect on goal quality. They also revealed that guidance alone produced initially high-quality goals which decreased in quality overtime, whereas feedback had a delayed but cumulative effect on quality across multiple goal setting iterations. However, neither guidance nor feedback had significant effects on goal attainment, and there was no significant relationship between goal quality and attainment. This study provides insights into how a goal-setting conversational agent and adaptive feedback can be used to support the academic goal setting process for higher education students.

CCS Concepts

• **Applied computing** → Education; • **Human-centered computing** → Human computer interaction (HCI); Empirical studies in HCI.

Keywords

Self-Regulated Learning, Conversational Agents, Adaptive Support, Feedback

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1 Introduction

Studying in higher education can be demanding where students are expected to self-regulate their learning by engaging and steering multiple aspects of learning, including motivation, behaviour, cognition, and metacognition toward attaining personal goals [1]. The increasing use of technology in students' everyday study activities means that the demand for self-regulated learning (SRL) is even

higher since students have more autonomy over what, when, and how to study [2]. Unsurprisingly, goal setting is one of the first steps of SRL across various SRL models [3]. It is an important skill as it provides direction as students move through their learning activities, informing and providing a basis for the self-regulated behaviours which follow it.

While there is much research on using interventions to support student SRL skills [2], doing so has proven to be complex, especially on a large scale. Prior studies have shown that SRL interventions are more effective when they are interactive (carried out by an experimenter), than when they are non-interactive (filling in forms) [4]. This likely stems from the fact that non-interactive SRL interventions, rely on students to drive the process, and thus result in students with lower SRL, who are also those who are most in need of support, failing to engage fully with the interventions, and thus not deriving the intended benefits from them. Interactive interventions, which are driven by external parties, do not rely on students to drive the process forward, and can thus prompt deeper levels of engagement, especially from students who are normally less likely to engage with support tools.

Despite research outlining the fact that setting goals can be academically beneficial for students, several studies have also shown that most students set highly ineffective goals when they are not given any guidance [5]. Furthermore, not all goal-setting interventions are similarly effective in bringing about behavioural change and not all goals are as useful in driving effective SRL [6]. This seems to be largely related to a goals ability to transform cognitive and emotional wishes into concrete behavioural steps that can be undertaken [7]. This suggests that effective goal-setting interventions are those which are able to support students in setting goals which motivate the transition from the cognitive goal setting process, into the behavioural goal striving process.

While the increasingly digital educational landscape makes SRL skills more important than ever, it also offers tools which can be leveraged to help support and improve these skills. Conversational agents have emerged as one such tool and provide a promising avenue to support students in various aspects of their academic journey, including goal setting. Conversational agents are tools which individuals can interact with in the form of a dialogue, allowing pre-structured interactions to take the form of a conversation [8]. They allow for the creation of more adaptive, engaging, and scalable support tools, which can provide an interactive middle ground between the effectiveness of researcher led interventions, and the scalability of student-led versions. However, determining the most effective ways to implement technology driven SRL support tools remains an area that still requires further research. To fully leverage this kind of tool, exploring how to guide and support effective goal setting, and what effect this guidance and support has, is crucial. With this paper, we aim to explore how a conversational agent can support goal setting in higher education, and the role of feedback and guidance in enhancing the goal setting process.

1.1 Self-regulated learning and goal setting

Self-regulated learning (SRL) is a crucial aspect of academic success. It involves students taking responsibility for their own learning by

setting goals, monitoring their progress, and adjusting their strategies as needed [9]. Although there are many models suggested to explain self-regulated learning [3], perhaps the most prevalent one is that of Zimmerman. In Zimmerman's model of SRL, the process is cyclical containing three phases; the forethought phase involving goal setting and planning, the performance phase involving strategy use and monitoring, and the self-reflection phase involving self-evaluation and adaptation [9].

Studies have shown that students who are skilled in SRL are more likely to achieve higher academic outcomes [10]. However, research has also shown that many students have difficulty regulating their own learning or may self-regulate ineffectively during learning activities [11]. Goal setting forms the first and driving step in the SRL process, both in Zimmerman's model of SRL [1] as well as many other models [3]. When students set effective goals, they are more likely to direct their attention and efforts towards achieving them, with prior studies demonstrating a relationship between goal quality and achievement [12]. The importance of supporting goal setting is supported by studies showing that by targeting the goal setting process with interventions, students can be taught how to set more effective goals, which in turn can support and increase the occurrences of goal directed behaviours, resulting in a positive effect on the rest of the SRL cycle, as well as subsequent academic performance [5].

There is little consensus in the literature on exactly what constitutes an effective academic goal and how to best support students' efforts to set them, as goal setting is influenced by multiple different processes, and the exact needs of a student may rely on several different individual characteristics [6]. Earlier studies have shown that student characteristics such as SRL skills [10], self-efficacy [10], and perfectionism [13] can affect the goal setting process, and thus the kinds of supports which students need. However, prior literature supports the application of goal-setting interventions in general higher education settings, with a review of goal-setting interventions in higher education suggesting the importance of both guidance and feedback within the goal setting process [6].

1.1.1 Guidance. Unfortunately, many studies implementing goal-setting interventions do so without offering explicit guidance through the goal setting process [6]. Goal-setting guidance is instructional support provided to guide students through steps of setting effective goals. Asking students to set goals without giving any guidance as to the kinds of goals they should set, or the goal setting method they should follow, means there is a chance students set ineffective goals [14], resulting in very little behavioural change or improved academic performance. This is especially true for students with lower levels of SRL skills, who may not regularly participate in goal setting behaviours in their daily learning activities. Therefore, guidance is an especially important factor when creating goal-setting interventions, to ensure they encourage the setting of effective and useful goals which spur positive academic and self-regulatory behaviours.

1.1.2 Feedback. Feedback is defined as "information provided by an agent (e.g., teacher, peer, book, parent, self, experience) regarding aspects of one's performance or understanding" [15]. Feedback has also been suggested as a powerful tool during the goal setting process as it supports students in reflecting on prior SRL behaviours

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and improving on subsequent SRL cycles [16]. Furthermore, as SRL is a cycle students move through multiple times, feedback can help students continuously improve their goals over the long-term, building on top of the effects of guidance by helping students reflect on the content of their goals, and the extent to which they are effectively following the guidance offered. A meta-analysis of 16 studies, showed that feedback and goal setting support combined had significantly larger effects on performance than goal setting support alone, an effect which was even stronger in more complex tasks [17]. It is therefore important to test the effect of feedback on the goal setting process, and how this can be leveraged to help students set and achieve effective academic goals.

1.2 Conversational agents in education

The use of conversational agents in education is gaining popularity, and research has shown their effectiveness in enhancing student learning outcomes and as SRL support tools [18]. Prior research has shown that SRL interventions are more effective when delivered by an experimenter than when they are do-it-yourself interventions for students [4]. However, scaling interventions that require direct involvement from an experimenter, teacher, or counsellor is often challenging and inefficient. We therefore aim to use a conversational agent to deliver a goal-setting intervention, providing a middle ground between experimenter and student-led interventions. This approach seeks to leverage the benefits of more engaging and interactive interventions. Furthermore, conversational agents offer the possibility to collect large amounts of data about students SRL processes in the form of semi-structured dialogue. This in turn creates an opportunity to leverage learning analytics, by collecting and analysing the semi-structured dialogue to offer adaptive feedback to better support students. Some prior research has already explored the possibilities of processing this kind of dialogue for indicators of SRL behaviours [19], and there have been studies in which these data are processed with the intention of using it to create adaptive tools [18]. Adaptive SRL support tools have been shown in prior research to be a highly promising avenue of research, with studies showing them to be significantly more effective in improving performance than their generalized alternatives [20] but effectively identifying the needs of individuals can be challenging. In this study, we will use a conversational agent to carry out a goal-setting intervention, with the intention of using goals generated by students to inform adaptive feedback.

1.3 Research questions

For the purpose of this study, we developed a conversational agent-based goal-setting intervention to examine the effects of guidance and feedback on goal quality and attainment over a five-week study period. The study includes one within-subject factor, time, and four between-subject factors, conditions: guidance with feedback (G+FB), guidance only (G), feedback only (FB), and a control group with no guidance or feedback (CT). The main research questions (RQ) were: 1) *What is the effect of guidance and feedback on the quality of self-set academic goals over time?* and 2) *What is the effect of guidance and feedback on the attainment of self-set academic goals over time?*

The first set of hypotheses, which relate to RQ1, examine the effects of guidance and feedback on the quality of self-set academic goals over the five-week experimental period. Prior studies have shown the importance of guidance when students set academic goals, revealing that even students with high levels of SRL tend to set poor goals when not provided with clear instruction [14]. Guidance offers an immediate scaffold, helping students set well-structured goals [5, 21]. Feedback, on the other hand, prompts iterative refinement, with its benefits compounding over time [15]. This aligns with findings by Neubert [17], who demonstrated that feedback significantly amplifies the effects of goal-setting interventions in complex tasks. Together, these supports address both the initial and reflective phases of the SRL cycle [9], resulting in the highest and most sustained goal quality in the G+FB condition compared to other conditions. Therefore, we hypothesize a significant main effect of condition, with G+FB resulting in the highest goal quality, followed by G, then FB, and CT showing the lowest scores (H1a). Additionally, we hypothesize a significant interaction effect between time and condition. Specifically, we expect goal quality in the G+FB condition to start high, and the FB condition to start low, but both to increase in the later weeks of the experiment, while both the G and the CT groups remain stable over time (H1b)

The second set of hypotheses, which relate to RQ2, examine the effects of guidance and feedback on the attainment of self-set academic goals over the five-week experimental period. In this experiment, both guidance and feedback aim to increase engagement in the goal-setting process by helping them set clearer and more actionable goals, thereby improving their chances of attaining them. We expect that both guidance and feedback will lead to greater engagement with, and reflection on self-set goals, which in turn will increase goal driven behaviours between goal-setting cycles, resulting in higher levels of attainment [16, 17]. Furthermore, feedback aims to prompt students to reflect on their previous behaviours and offer suggestions for improvement in future goal setting cycles, a process that more directly targets goal attainment behaviours than guidance alone [17]. Therefore, we hypothesize a significant main effect of condition, with G+FB and FB achieving the highest average attainment, followed by G, and CT scoring the lowest (H2a). Furthermore, we hypothesize a significant interaction effect between condition and time, with goal attainment of G+FB and FB increasing over time, G also increasing but to a lesser extent, and CT showing no change over time (H2b).

To prevent confounding variables from impacting the main analyses, several additional variables will be tested for correlations with the outcome variables. If significant correlations are found, these variables will be included in the final analyses to control for their effects. Self-efficacy plays an important role in driving study behaviours, with prior studies finding that those with higher self-efficacy is related to SRL behaviours, and those with higher self-efficacy tend to perform better overall [10], thus highlighting the need to control for any possible effect on the outcome variables in this study, especially goal attainment. Another potentially confounding variable is SRL skills. Goal setting forms the first stage of the SRL cycle, and as such, effective goal setting skills contribute to overall SRL. However, SRL skills measure more than the ability to set effective goals, and prior studies on implementing SRL interventions have shown that initial differences in SRL skills may

account for differences in participants abilities to engage with, and benefit from, the interventions [10]. Finally, perfectionism has been identified as a potential factor in the goal setting process, with the tendency towards maladaptive perfectionism influencing the type and difficulty of academic goals which students set [13]. Given the complex role these variables play in the goal setting cycle, it is important to ensure they are controlled for, if necessary, when investigating how best to support SRL processes.

2 Method

2.1 Participants

Participants were 100 bachelor students from the department of social and behavioural sciences at a large Dutch university. They were recruited and completed the study between May 2022 and July 2022. Before beginning the study, ethical approval was requested and granted from the ethics committee of the institution where the study was carried out (ETH2122-0410). Participants voluntarily signed up to participate via the university's online research participant portal and received 3 research credit hours, which counted towards the 20 hours they were required to complete throughout the course of their degree. Of the initial sample of 100, 12 students signed up to participate but did not complete the informed consent and baseline questionnaire or respond to any further communication about their participation. A further four students requested to withdraw from the study midway through, and their data were consequently excluded. Finally, six students began the study, but only completed one or two of the five weekly activities, and thus were removed from the final analysis for having incomplete datasets. Thus, the final sample included 78 participants with weekly participation rates varying between $n = 66$ and $n = 78$ students in total across all conditions, with the number of students per condition differing between conditions and weeks from a minimum of $n = 16$, to $n = 21$.

The final sample consists of a majority of first-year students ($n = 68$, 87.2%), with nine (11.5%) in their second year, and 1 in their third year (1.3%). The sample was majority female ($n = 63$, 80.8%), reflecting the majority female student population of the social sciences department of the university. Independent sample t-tests showed no significant differences on any of the outcome measures based on gender or study year.

2.2 Materials

2.2.1 SRL skills. SRL skills were measured using the Online Self-regulated Learning Questionnaire (OSLQ), a 24-item scale developed by Barnard et al. [22]. Phrasing of the items was adjusted to fit the primarily face-to-face nature of student's education. The questionnaire consisted of six subscales measured on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree) including goal setting (5-items, $\alpha = .75$), environment structuring (4-items, $\alpha = .62$), task strategies (4-items, $\alpha = .76$), time management (3-items, $\alpha = .74$), help seeking (4-items, $\alpha = .66$), and self-evaluation (4-items, $\alpha = .72$).

2.2.2 Self-efficacy. Self-efficacy was measured using the short-form General Self-Efficacy Scale (GSE-6) [23]. This scale measures context-independent self-efficacy, using 6-items on a 5-point Likert

scale ranging from 1 (strongly disagree) to 5 (strongly agree). This scale has a Cronbach's alpha of .82.

2.2.3 Perfectionism. Perfectionism was measured using the Brief Frost Multidimensional Perfectionism Scale (FMPS-B) [24]. This scale measures general perfectionistic tendencies using 8-items across two sub-scales; evaluative concerns (4-items, $\alpha = .77$), and strivings (4-items, $\alpha = .90$). Each scale was measured on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).

2.2.4 Guidance for goal setting. All students were provided with a basic prompt "set an academic goal that you would like to achieve in the upcoming week". No further instructions were provided as to the type or characteristics of the goal for the two unguided conditions (i.e., FB and control). For the guided conditions (i.e., G+FB and G) additional information and prompts asking that they set specific, measurable, important, and planned (SMIP) goals. SMIP goals are a variation of SMART goals adapted from Lockspeiser et al. [25]. In all conditions, students were free to provide any response they chose.

2.2.5 Adaptive feedback. From the second week of the experiment, feedback was provided to the two feedback conditions before they were asked to set a new goal for the coming week. Only students in the two feedback conditions (G+FB and FB) were provided with adaptive feedback. The feedback was adapted based on the quality of the goals from the previous week as scored by two experimenters. Each goal was scored on the four characteristics of the goal (specificity, measurability, importance, and planning; see section 2.2.6 for more information on goal quality scoring). Participants were provided with pre-written feedback based on their lowest scoring characteristic. The feedback changed week-to-week, and student-to-student based on the quality of the previous goal. For example, students who scored the lowest on specificity received feedback on, 1) the fact that their goal specificity could be improved, 2) what goal specificity referred to, 3) the importance of this characteristic in setting goals, and 4) how a goal could be made more specific.

2.2.6 Goal quality. To measure the quality of student's goals, each goal was scored using a rubric adapted for the purpose of the study. The rubric was adapted from Lockspeiser et al. [25] by the authors in the pre-study phase in an iterative manner, to calibrate the rubric and ensure a high level of reliability. The rubric consists of four characteristics on which the goals were scored (specificity, measurability, importance, and multisource plan). Each characteristic was scored on a scale of 0-2, for a total goal quality score of 0-8. Scoring was done by the authors every week, and students' goal quality score was also used to select and provide feedback to students in the feedback conditions. Two researchers independent scored 10 participants goals, with scores then being compared for calibration purposes and any scoring differences were discussed and resolved. Week by week Cohen's Kappa measure of interrater reliability ranged from 0.813 to 0.960 for an average Cohen's Kappa of 0.886.

2.2.7 Goal attainment. Goal attainment was measured weekly from week two, during the follow-up activity carried out before the process of setting new goals. All participants were asked: "Last week you set the following goal: [prior goal]. To what extent do
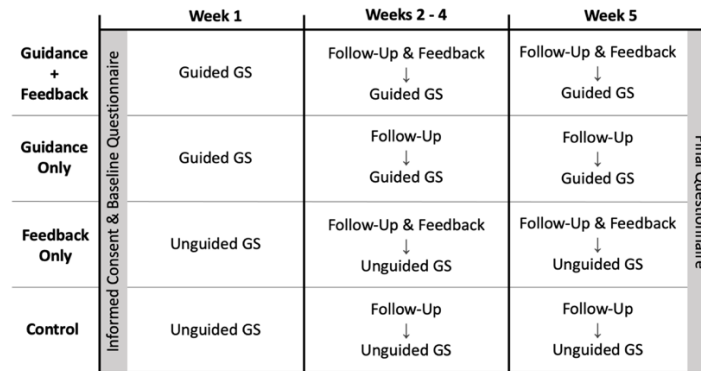
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		Week 1	Weeks 2 - 4	Week 5	
Guidance + Feedback	Informed Consent & Baseline Questionnaire	Guided GS	Follow-Up & Feedback ↓ Guided GS	Follow-Up & Feedback ↓ Guided GS	Final Questionnaire
Guidance Only		Guided GS	Follow-Up ↓ Guided GS	Follow-Up ↓ Guided GS	
Feedback Only		Unguided GS	Follow-Up & Feedback ↓ Unguided GS	Follow-Up & Feedback ↓ Unguided GS	
Control		Unguided GS	Follow-Up ↓ Unguided GS	Follow-Up ↓ Unguided GS	

Figure 1: An overview of the experimental setup for all conditions across the 5-week study.

you feel you have achieved this goal?". Participants were asked to answer on a 5-point Likert scale ranging from 1 (not achieved at all) to 5 (achieved it fully). Since goal attainment was measured the week after setting a goal, this measure only included 4 measurement occasions, with students rating their attainment for the goals they set during weeks 1-4, but not for the goal set in the final week of the experiment.

2.2.8 Goal striving. Goal striving was measured weekly from week two, during the same follow-up activity as goal attainment. Students were asked the extent to which they had worked on their goal the previous week on a 3-point Likert scale ranging from 1 (not a lot) – 3 (a lot). Similarly to goal attainment, this measure was only collected on 4 occasions, for goals 1-4, since it was measured the week after students set a goal, and the experiment period ended directly after the final goal-setting activity.

2.2.9 User experience measure. This contained a question asking students to rate the usefulness of the goal-setting activity on 5-point Likert scale from 1 (not at all useful) to 5 (very useful), and an open question asking for general experiences and feedback. The primary purpose of this measure was to gauge user experiences to inform the development of future versions of the goal-setting intervention.

2.3 Procedure

An extensive overview of the experimental procedure of this study, alongside additional information about the goal quality and feedback allocation workflows can be found at the attached OSF link (https://osf.io/gwxe5/?view_only=2c3cf672fff24d4581d983d38f4f8b87). Data collection for this experiment took place across a 5-week period coinciding with a single semester of the participants degree. They started at the beginning of the first week of the semester, and the final activity of the experiment took place at the beginning of their final study week. Since participants were recruited from multiple study years and degrees within the department, the course being carried out during the experiment period differed between students. All study materials were offered in English and could be completed via any browser at any time before the deadline for each activity. Activities were sent out every Monday morning at 09:00, and the deadline to complete the activity was in the same week on Wednesday by 23:59.

After signing up to participate in the experiment, participants received an email which included a link to the informed consent, T0 questionnaire, and the first conversational agent activity. After signing the informed consent, participants completed a T0 questionnaire which included measures of SRL skills, self-efficacy, and academic perfectionism. Participants were then randomly assigned to one of the four conditions (Guidance + Feedback, Guidance Only, Feedback Only, and Control) and could complete their first conversational agent interaction.

Participants interacted with the conversational agent once a week for five weeks. At the beginning of each week, participants received an email with a link to the conversational agent, which could be opened and interacted with in any browser. During the first week, participants only carried out the goal-setting activity assigned to their condition. From the second week, participants first completed the follow-up activity during which goal attainment and striving were measured, before moving onto setting a new goal for the week. The G+FB and FB conditions received feedback on the quality of their goals set in the previous week before setting a new goal for the week.

After completing the final goal-setting activity which took place in week 5, participants were asked to complete a user experience questionnaire to provide feedback on the conversational agent. This questionnaire was carried out within the conversational agent itself and constituted the last participant activity of the study. An overview of this experimental setup can be found in Figure 1.

2.4 Analyses

To answer the first research question, a mixed method Analysis of Variance (ANOVA) was run. For this analysis, there is one continuous outcome variable, which is goal quality, as well as two independent variables, a between-subjects factor consisting of the four treatment conditions, and a within-subjects factor which is time (5-measurement occasions).

To answer the second research question, a second mixed method ANOVA was run. For this analysis, there is one continuous outcome variable, which is goal attainment, as well as two independent variables, a between-subjects factor consisting of the four treatment conditions, and a within-subjects factor which is time (4-measurement occasions). For research questions one and two

Table 1: Descriptive Statistics for Outcome Measures Across the Five Weeks, Per Condition

Outcome Measure	Condition	Goal 1		Goal 2		Goal 3		Goal 4		Goal 5	
		M	SD	M	SD	M	SD	M	SD	M	SD
Goal Quality	Guidance + Feedback	4.53	2.37	3.81	1.99	4.22	2.26	4.19	1.81	3.74	1.85
	Guidance Only	3.19	2.37	3.76	1.82	3.24	1.60	2.82	1.55	2.94	1.92
	Feedback Only	0.82	0.73	1.90	1.51	1.90	1.64	2.29	1.76	2.58	2.17
	Control	0.87	1.36	1.16	1.21	0.78	0.73	1.05	0.78	0.95	0.78
Goal Attainment	Guidance + Feedback	3.12	1.11	3.28	0.83	3.24	1.34	3.16	1.34		
	Guidance Only	3.00	1.21	2.29	.99	3.65	1.06	3.88	1.05		
	Feedback Only	3.41	0.94	3.38	1.07	3.62	1.20	3.53	1.35		
	Control	2.56	1.21	3.22	1.00	3.79	0.71	3.47	1.43		

Table 2: Descriptive Statistics and Correlations of Included Variables

Variable	M	SD	1	2	3	4	5	6	7	8	9	10	11
1. Self-Efficacy	3.52	0.63	1										
2. FMPS-B Perfectionism	3.03	0.78	-.073	1									
3. OSLQ: Goal Setting	3.44	0.68	.309**	.375**	1								
4. OSLQ: Envir. Structuring[a]	4.07	0.50	.374**	.234*	.568**	1							
5. OSLQ: Task Strategies	3.01	0.83	.156	.186	.382**	.305**	1						
6. OSLQ: Time Management	3.00	0.91	.261*	.252*	.542**	.452**	.439**	1					
7. OSLQ: Help Seeking	3.45	0.65	.167	.007	.277*	.301**	.118	.305**	1				
8. OSLQ: Self-Evaluation	3.44	0.73	.214	.285*	.387**	.469**	.478**	.366**	.535**	1			
9. Goal Quality	2.53	1.70	.035	-.053	.169	.236	.057	.174	.116	.013	1		
10. Goal Attainment	3.28	0.78	.233*	.031	.350**	.197	.217	.288*	.144	.096	.076	1	
11. Goal Striving	1.36	0.43	.157	.115	.304**	.181	.233*	.252*	.039	.071	.118	.855**	1

[a] Environment Structuring, * correlation is significant at the 0.05 level, ** correlation is significant at the 0.01 level.

additional post-hoc tests were conducted to further explore significant findings, using Bonferroni corrections to compensate for multiple comparisons.

Before running the main analysis, all other measured variables (i.e., SRL skills, self-efficacy, and perfectionism) were tested as for correlations with the outcome measures to determine whether they needed to be controlled for in the analyses. Any scales with significant correlations to the outcome variables were included as covariates in the final analyses, and an Analysis of Covariance (ANCOVA) would be run in place of an ANOVA.

3 Results

3.1 Descriptive statistics

Table 1 shows the descriptive statistics calculated for the outcome measures across the five weeks per condition. Table 2 shows the means and standard deviations of each measured variable and correlations between variables. Significant correlations between potential confounding variables and outcome measures (i.e., goal quality and goal attainment) were identified to ensure relevant variables were included as controls in the main analyses. Goal quality was not correlated with any other variables, and as such no controls were used in the analysis carried out for RQ1. Goal attainment was significantly correlated with self-efficacy, the goal setting and time management subscales of the OSLQ measure, and goal striving. As a result, all four variables were included as covariates in the analysis carried out for RQ2.

3.2 Quality of self-set academic goals over time

Assumptions of a mixed method Analysis of Variance (ANOVA) were met, with the exception of the assumption of sphericity as
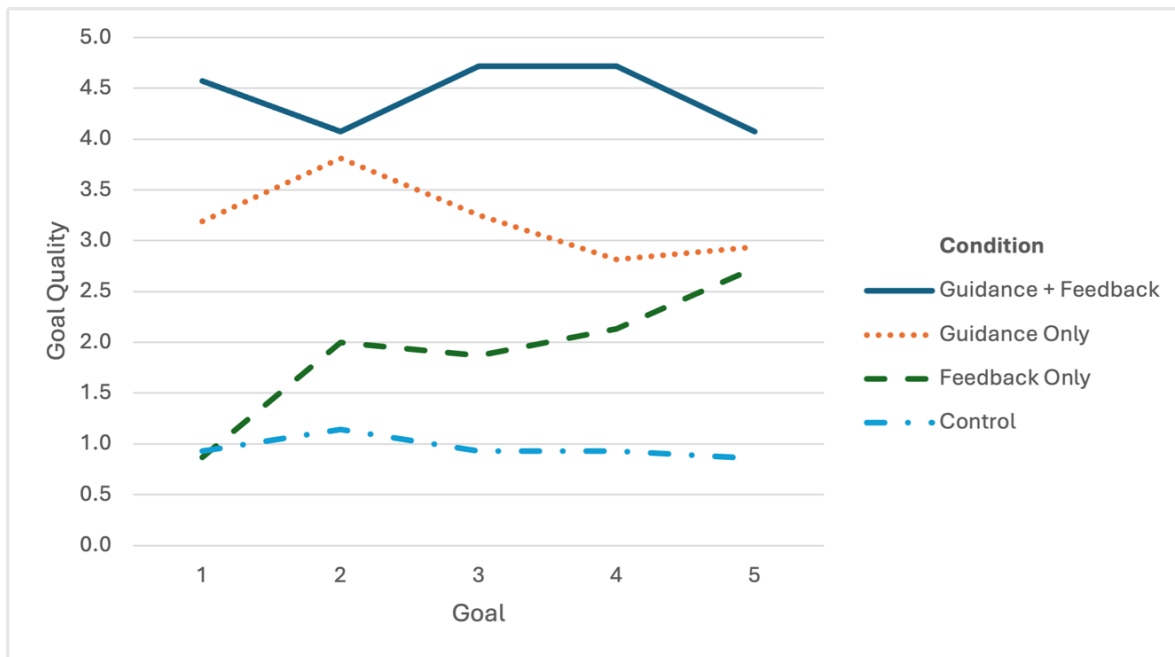
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Figure 2: A line chart showing the average goal quality across five weeks of the four study conditions.

Mauchly's test showed χ^2=36.92, p < 0.01. Following the guidelines proposed by Howell [26] and Field [27], Greenhouse-Geisser Epsilon was checked and equals .782, and thus the Huynh-Feldt correction were used during the analyses.

The results of the ANOVA showed that the main between-subjects effect of condition was significant, $F(3,55) = 18.616$, $p < .001$. The effect size reported as partial eta squared (η^2_p) was .504, indicating a large effect size. To further explore this effect, we carried out a Bonferroni corrected multiple comparisons analysis comparing conditions. There were significant differences between G+FB, and FB ($p < .001$), G+FB and control ($p < .001$), and G and control ($p < .001$) and no significant differences between G+FB and G ($p = .083$), G and FB ($p = .055$), and FB and control ($p = .328$). As these differences occur between conditions when comparing average goal quality across all five weeks, further analyses are needed.

Results show no significant main effect for the within-subjects factor of time, $F(3.520, 193.577) = 0.669$, $p = .595$. However, the results did show a significant interaction between time and condition, $F(10.559, 193.577) = 1.868$, $p = .048$, with an effect size of $\eta^2_p = .092$ indicating a moderate effect. This shows that changes over time in goal quality may differ significantly per group, and Figure 2 shows the change in goal quality over time, per condition also supporting the suggestion of a difference between conditions. Therefore, a pairwise comparison between groups with Bonferroni correction for each week was conducted and the results are presented in Table 3.

Overall, the results suggest that G+FB condition has the highest goal quality, and remains high and stable over time, while the CT condition has the lowest goal quality, which remains low over time. However, the two mixed conditions (G and FB), show changes over

time, suggesting that the effect of guidance alone wears off with repeated goal setting occasions, while the effect of feedback alone grows over time, two trends which are reflected in Figure 2.

3.3 Attainment of self-set academic goals over time

All assumptions for this analysis were met. A correlation analysis (full results can be found in Table 3 in section 3.1.1) to check for potentially confounding variables showed four potentially confounding variables correlated with goal attainment. These variables were included in the analysis as covariates and thus, a mixed method ANCOVA was run.

The results of the ANCOVA showed no significant main effect of the between-subjects factor condition, $F(3,52) = 1.069$, $p = .370$, and no significant main effect of the within-subjects factor time, $F(3,156) = 1.915$, $p = .129$. However, there was a significant interaction effect between time and condition, $F(9,156) = 1.971$, $p = .046$.

As a result, we carried out a Bonferroni corrected pairwise comparison between conditions for each week. The only significant differences occurred during week two, with the G condition being significantly different from all other conditions including G+FB ($p = .025$), FB ($p = .007$), and C ($p = .040$). There were no other significant differences in any other weeks, with only the goal attainment of the G condition dipped significantly for goal 2 before increasing to meet the same trend as the other conditions for goal 3.

Since the intervention was expected to affect goal attainment by increasing goal driven behaviours, we carried out one further analysis to add context to these findings. We examined the relationship between students reported goal striving, and their goal attainment. Table 2 showed a strong positive correlation between average goal

Table 3: Pairwise comparisons between conditions per week

		Guidance Only	Feedback Only	Control
Week 1	Guidance and Feedback	$p = .249$	$p = <.001^*$	$p = <.001^*$
	Guidance Only		$p = .003^*$	$p = .005^*$
	Feedback Only			$p = 1$
Week 2	Guidance and Feedback	$p = 1$	$p = .002^*$	$p = <.001^*$
	Guidance Only		$p = .006^*$	$p = <.001^*$
	Feedback Only			$p = .961$
Week 3	Guidance and Feedback	$p = .490$	$p = <.001^*$	$p = <.001^*$
	Guidance Only		$p = .096$	$p = <.001^*$
	Feedback Only			$p = .223$
Week 4	Guidance and Feedback	$p = .050^*$	$p = <.001^*$	$p = <.001^*$
	Guidance Only		$p = 1$	$p = .006^*$
	Feedback Only			$p = .084$
Week 5	Guidance and Feedback	$p = 1$	$p = .277$	$p = <.001^*$
	Guidance Only		$p = 1$	$p = .007^*$
	Feedback Only			$p = .033^*$

striving and goal attainment ($r = .855$, $p < .001$), however further correlation analysis of the week-by-week goal striving and goal attainment measures showed significant positive correlations for between the two measures for goal 1 ($r = .732$, $p < .001$), goal 2 ($r = .838$, $p < .001$), goal 3 ($r = .657$, $p < .001$), and goal 4 ($r = .838$, $p < .001$). Furthermore, a one-way ANOVA examining the differences in goal striving per condition found no significant differences between groups, $F(3, 77) = 0.230$, $p = .875$. This suggests that the lack of effect of the intervention on goal attainment could be due to its failure to increase goal related behaviours in between goal setting sessions, despite its overall positive effect on the quality of the goals set during the sessions.

3.4 Analysis: User experience & feedback

An additional analysis was run using the collected user experience and feedback measures, to investigate how participants had experienced the conversation agent and intervention, and their feedback on what could be added to the intervention to improve it.

Overall participants mean usefulness score of the intervention on a 1–5-point scale was $M = 3.69$ ($SD = .84$), suggesting that on average students indicated that they found the intervention quite useful. We then split the population into two equally sized groups based on total SRL score and compared usefulness scores between the two groups. Prior studies have suggested that those with moderate to high levels of SRL may be better equipped to make use of SRL interventions [10]. While the measures of SRL had no significant correlations with goal quality, and only two subscales were correlated with goal attainment, we wanted to investigate whether there was a difference in how useful students perceived the intervention to be, based on their prior SRL skills. An independent sample t-test found there was a significant difference in usefulness between the low SRL group ($M = 3.35$, $SD = 0.83$), and the high SRL group ($M = 4.03$, $SD = 0.726$). This significant difference in the perceived usefulness of the tool could have impacted the way students interacted with it, and thus the extent to which it was

able to induce changes in goal directed behaviours in-between goal setting sessions.

Overall, 68 (87.2%) of participants gave some form of feedback in the open response feedback question provided at the end of the study. A thematic analysis was done on these answers to group them into overarching feedback points provided by participants. 16 participants indicated that the intervention had been helpful or positive in some way but provided no additional feedback of comment. Of the remaining 52 participants, the conversational agent format of the intervention was mentioned as a positive 12 times, and it was mentioned 4 times that the participants found that the intervention increased their motivation to work on their weekly goals, with one participant stating:

> "I think setting goals here and looking back at them made me more responsible. After I couldn't achieve my first week goal, I got motivated and did even more during the second week. Therefore, I think it was really helpful."

Participants also mentioned several ways in which they felt the intervention could be improved upon to be more helpful. Main improvement points which emerged were: provide even more guidance when setting goals ($n = 9$), make the feedback more personalized, or provide additional concrete examples of what to change ($n = 8$), include the option for reminders or check-ins between goal setting sessions ($n = 8$), and add the option for more reflection on the past goal before setting a new one, especially if the goal was not achieved ($n = 6$).

Overall, the feedback was positive, and there was a lot of overlap in the comments by participants. Utilizing the conversational agent to deliver the intervention seemed to be a main point of praise amongst participants, and most points of improvement focused on either expanding the guidance and feedback as provided in the intervention, or to extend the intervention to add additional monitoring and reflection activities.

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4 Discussion

Goal setting forms an important element in students' self-regulated learning (SRL) process, driving goal directed behaviours that contribute to their academic success [1]. Supporting effective goal setting can therefore be a powerful method of enhancing SRL, and thus academic performance. In this study, we implemented a goal-setting intervention using a conversational agent, to examine the effects of guidance and adaptive feedback on goal quality and attainment. Our primary research question was: What is the effect of guidance and feedback on the quality and attainment of self-set academic goals over time? Overall, we found that the intervention had a significant effect on goal quality. The combination of guidance and feedback produced the highest quality goals. However, the effect of guidance alone diminished over time, whereas feedback showed delayed effect, improving goal quality only in the second half of the study. The intervention had no significant effects on goal attainment, and further analyses showed that this could be due to a lack of effect on goal-directed behaviours between goal-setting sessions.

The results examining the effects of guidance and feedback combined and separate on goal quality, showed significant positive effects. These results confirm earlier findings on the importance of both guidance [6, 14] and feedback [16, 17] in the goal setting process. Hypothesis H1a was partially supported, with results indicating that, on average, G+FB had the highest quality goals, with CT having the lowest. However, there was no significant difference between the G and FB conditions. Hypothesis H1b was also partially supported. As expected, the CT group started with low goal quality, and remained stable throughout the intervention. The FB condition started with low-quality goals but increased in the latter half of the five-week period, supporting the notion of feedback having delayed positive effects, compounding over time to improve goal quality. Conversely, G+FB started with high quality goals, but did not increase overtime as had been expected, rather remaining stable across the five-weeks, potentially also limited by the ceiling effect of the goal quality measure. Additionally, G started with high quality goals, but by week 4, the effect seemed to be starting to fade. The results seem to suggest that guidance provides an immediate positive effect on goal quality, but that this effect fades over repeated cycles of goal setting, while feedback has a delayed effect, but that the effect grows over time. Furthermore, the consistently low quality of goals set by the CT group supports prior studies indicating that students struggle to set high quality, effective goals when they are not provided with any supports [5, 14]. While guidance may have helped students to set higher quality goals leading to the initial positive effects, our results suggest that feedback is also critical for goal setting. One reason could be that feedback helps students to reflect on their goals [16]. Overall, these findings support the notion that guidance and feedback combined result in the highest quality goals, an effect which is maintained overtime. This supports findings from prior literature, highlighting the importance of both guidance and feedback in the goal setting process [6], in which guidance provides a basis on which students can build effective goals, while feedback on student goals prompts self-reflection and continuous improvement to their quality.

The analyses testing the second set of hypotheses, examined the effect of guidance and feedback, combined and separate, on goal attainment. Results showed there was no main effect of condition, and thus H2a was not supported. This is in contrast to prior studies showing the positive effects of guidance and feedback on goal attainment [6, 16, 17]. These findings may be due to a disconnect between the process of setting goals, and the behavioural steps to work on those goals. Some prior studies have found that goal setting support alone did not improve subsequent performance, largely due to a lack of goal striving undertaken after the intervention [28], while other studies have found goal setting only had a positive effect on performance when combined with support for the other phases of the SRL cycle like monitoring, or reflection [29]. Hypothesis H2b was also not met, as there was a significant interaction effect, but further post-hoc analysis showed that the only significant difference between conditions occurred in goal 2, when the goal attainment of condition G dropped significantly from goal 1, before rising again for goal 3, when there were no significant differences from the other conditions. One possible reason for this difference in goal 2 could be due to an overcorrection by condition G following goal 1 with no feedback to inform this correction. Since condition G only received guidance, they may have attempted to improve their goals after goal 1, in line with the guidance provided, but lacking the feedback, they did not have concrete ideas of what to improve and thus overshot and created overly complex or difficult goals which were more difficult to attain. This would be in line with the feedback statement offered by one participant stating: "After I couldn't achieve my first week goal, I got motivated and did even more during the second week.".

The lack of significant correlation between goal quality and goal attainment suggests that students were not more likely to attain better quality goals. Furthermore, additional analyses uncovered strong correlations between goal striving and goal attainment, as well as no differences in goal striving between groups. This suggests that the intervention was successful at changing immediate behaviour, by improving the quality of the goals that students set during the activities, but did not change student behaviour in-between sessions, and increase goal driven behaviours to result in better goal attainment. Future studies may need to focus on closing the gap between goal quality and attainment, by offering additional monitoring and reflection support to encourage the transition between goal setting and goal striving. Furthermore, the conversational agent format of this intervention offers the opportunity to collect additional data points which could serve as feedback and help learners track progress, opening the possibility of providing additional adaptive supports to improve performance. The focus on goal quality and attainment as the outcomes allow for the examination of SRL behaviours at a weekly level, aiming to capture the impact of guidance and feedback on cognitive and behavioural self-regulated learning processes. However, in view of the potential impact on performance, future research should focus on expanding this examination to consider the effect on academic performance.

Finally, an additional exploratory analysis was carried out to understand user experiences with the conversational agent, and intervention. These findings showed that overall users were positive, especially about the conversational agent itself, reportedly finding the activity useful in their daily study behaviours. However, main

feedback points suggested increasing the amount and personalization of the guidance and feedback provided, as well as adding in additional monitoring and reflection activities. Given prior studies finding that adaptive or personalized tools tend to be more effective [20], this provides a promising avenue for future research.

Overall, the results from this study have several practical implications. Firstly, they support the idea of a conversational agent as an effective means of delivering adaptive goal setting support, with positive effect of the intervention on goal quality and positive user feedback. The conversational agent provided a user friendly, scalable delivery method, allowing for easy adaptation, and supporting the idea that it may form a good middle ground between participant and researcher-led interventions. This supports prior research showing the benefits of adaptive SRL supports [20] and the potential of adaptive feedback for effective SRL [30]. More specifically, this study also shows the importance of both guidance and feedback when creating a goal-setting intervention, in order to ensure effects which do not wear off after repeated SRL cycles. However, findings relating to goal attainment also suggest that there is a gap between improving goal quality and goal attainment, as such additional activities may be needed to provide supports during goal striving, in-between goal setting cycles, to ensure students are able to move effectively from the goal setting (i.e., forethought) phase of the SRL cycle, smoothly through the other phases. This was supported by the feedback provided by students, in which two emerging themes were the wish for monitoring and reflection activities to provide further reminders and support during the week, as well as previous studies, in which goal-setting activities have been found to be more effective when implemented alongside monitoring or reflection activities [6, 29]. However, further research is needed to fully understand how to best implement these additional monitoring and reflection activities. One potential avenue of research is to analyse the dialogue collected from a conversational agent to inform adaptive feedback. While this study offers only an initial look into how dialogue and textual data collected in this format could be used for adaptive supports, future research could build on this, to better understand what other indicators of SRL behaviours could be extracted from conversational agent interactions, and infostructure improvements could allow for the provision of more complex, and real-time adaptive supports.

This study does have some limitations. The sample was drawn from the general population of a social sciences department, meaning participants came from various study programs and years of study, and were taking many different courses at the time of participation. While this diversity allows for more generalizable results and enables us to examine the goal-setting process without tailoring the procedure to specific course content, it also limits our ability to assess the effect of goal-task fit and to provide feedback specific to that fit. Furthermore, since the sample being primarily consisted of social sciences students, the generalizability of the findings to other contexts is limited. Further research is needed to better understand whether the goal-setting process functions similarly for populations from other fields, and whether they would benefit from the same kinds of support structures. Additionally, participation in this study was voluntary, with students receiving compensation in the form of research credits. This may have resulted in some participation bias, and have implications for possible generalizability to other settings, as this 'motivated participation' setup adds additional factors influencing individuals' choice to participate in specific studies, and how to engage with them. Future research should focus on a naturalistic setting, exploring the effect of conversational goal setting supports when embedded within classroom settings to better understand how these technologies could be implemented in general educational settings.

To conclude, this study is the first step in an iterative design process to develop a goal-setting support tool, tailored to the needs of individual students. This study confirmed the benefits of guidance and feedback to support effective goal setting and highlights the existing gap between goal quality and goal attainment. This information provides a solid foundation on which we can base the design and implementation of future goal setting activities to further explore this process, and hopefully expand the positive effects of the support to include goal attainment and academic performance.

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