The evaluation of an integrated Growth & Goals Module to better equip students with learning skills in postsecondary courses: systematic, scalable, and explicit

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Abstract

Objective: Most students spend years in formal education settings without being explicitly taught how to learn effectively. Our objective was to evaluate an innovative intervention designed to effectively equipping all students with learning skills, called the Growth & Goals Module, which is an adaptable open education resource available in English and French.

Methods: We evaluated the module using a Practical Participatory Evaluation approach and the 4-level Kirkpatrick Evaluation model. To investigate ten research questions aligned with the model, we collected data from 1845 students and five educators from nine undergraduate courses in science, engineering, and mathematics through questionnaires, focus groups, course assessments, and institutional data.

Results: Students and educators reported high satisfaction (Level 1, Learning). The training was new to most students and most completion rates were over 75% when educators provided an incentive. Students in some demographics used the module less than others. In Level 2 (Learning), students' metacognitive skills increased. They could identify SMART goals and differentiate growth/fixed mindset statements. At Level 3 (Behaviour), students reported intending to use the module in the future. Most educators created learning outcomes for the first time. The module required little time of students and educators; however, greater support, incentives, and rewards are needed for project sustainability. Educators have used the module in courses in many disciplines and levels (Level 4, Results).

Conclusions: The Growth & Goals module explicitly teaches core learning skills for students in science, engineering, and mathematics courses and has the potential to scale to other disciplines and levels.

Key words: Learning skills, metacognition, goal-setting, growth mindset, mindfulness, postsecondary, STEM education, module, scalable, systematic, consistent, open education resource, evaluation, Practical Participatory Evaluation, Kirkpatrick Evaluation

1. Introduction

In this dynamic and rapidly changing world, students need to be able to continually learn and adapt throughout their lives as well as well beyond the time they spend in formal education (World Economic Forum, 2020). However, most students spend years in formal education settings without being explicitly taught how to learn effectively. The recent pivot to remote education caused by the pandemic revealed existing deficiencies in the postsecondary education system clearly. Without having the essential learning skills to adapt, including well-defined learning strategies (World Economic Forum, 2020), students resort to working harder rather than more strategically, resulting in increased stress and significant mental health and academic impacts (COVID-19 Social Science Lab, 2020; Dennon, 2020; Mahdy, 2020). Moreover, equity gaps widen as those fortunate students living with support continue to thrive, while others fall further behind in their studies or drop out altogether (Dennon, 2020; Kuhfeld et al., 2020; National Student Clearinghouse Research Center, 2020).

Some existing approaches to explicitly teach learning skills show beneficial impacts for students, including reducing equity gaps (Aronson, Fried, & Good, 2002; Baliram & Ellis, 2019; Bergey, Parrila, Laroche, & Deacon, 2019; Bol, Campbell, Perez, & Yen, 2016; Fink, Cahill, McDaniel, Hoffman, & Frey, 2018; Good, Aronson, & Inzlicht, 2003; Hofer & Yu, 2003; Paunesku et al., 2015; Wagener, 2016; Zimmerman, Moylan, Hudesman, White, & Flugman, 2011). However, there is a significant barrier to making these approaches systematic, scalable, and consistent for all students. For example, interventions may reach some students in some programs (e.g., first year seminar courses) or those in serious need (e.g., remedial programs through academic services). Courses and workshops on learning skills offered separately from the courses within students' programs may seem remote, not applicable, or as yet another thing to add to an already full schedule. These interventions require the educator to have expertise in the constructs being addressed (e.g., metacognition, goal-setting, mindfulness), including how to teach these constructs. However, most educators are experts in their own discipline and not in making these constructs explicit (Cooke, 1999; Cullen & Bryman, 1988).

Our overarching goal was to develop an approach that can effectively equip all students with learning skills, particularly those of metacognition, goal-setting, growth mindset, and mindfulness. To accomplish this goal, we sought an approach that was: integrated in courses, scalable, independent of educator expertise to incorporate, transferable to any discipline and year of study, and created with an inclusive design for learning (AODA, 2014; CAST, 2021). We also aimed for an approach that would explicitly and consistently teach and assess learning skills, be adaptable, and be linked to the disciplinary context—the course's intended learning outcomes (ILOs are the knowledge, skills, and values that students should demonstrate by the end of a learning period—e.g., course or program). We therefore developed the **Growth & Goals Module** for postsecondary students as an Open Education Resource that educators and students can use almost as is—requiring only incorporation of the course's intended learning outcomes (Flynn, 2021; Flynn et al., 2020c, 2020a; O'Connor, Roy, & Flynn, 2021). Students can complete the module throughout a given postsecondary course. Available in French and English, the module contains a combination of theory and practice, including phases of reflection, goal-setting, planning, and acting (i.e., self-regulated learning).

The goal of the present study was to evaluate the module. With so many competing demands on students' and educators' time and priorities, evaluating the module was critical to justifying its use and understand under what conditions it benefit the users (Kirkpatrick & Kirkpatrick, 2016). Moreover, the present evaluation explored the perceived impacts of the module for different types of students and thus, addressed issues of equity and inclusion in learning environments. We piloted the module as well as the evaluation of it in science, mathematics, and engineering courses, representing challenging courses in which failure and withdrawal rates are high (Laverty et al., 2016; Mahaffy, 2015), despite the importance of STEM disciplines (Brandon Miller & Jay Croft, 2018; Craven, 2017; Intergovernmental Panel on Climate Change, 2018; Saner, 2010; Steffen et al., 2015; United Nations, 2018). We then used the results of the pilot and evaluation to iteratively improve the module, inform ongoing evaluation activities, and identify future areas of study, ultimately to improve students' learning abilities.

2. Methods

2.1 Evaluation design

Our evaluation design used a Practical-Participatory Evaluation approach (Cousins & Chouinard, 2012; Cousins & Whitmore, 1998; Cousins, Whitmore, & Shulha, 2012) and included the 4-level Kirkpatrick evaluation model (Kirkpatrick & Kirkpatrick, 2016; Praslova, 2010). With that design, we addressed ten evaluation questions (Table 1). We collected data from four main sources: the institution's Institutional Research Office, the activities in the module, course assessments, focus groups, and educator questionnaires. The evaluation received an exemption by uOttawa's Research Ethics Board, in accordance with Canada's Tri-Council Policy Statement: Ethical Conduct of Research Involving Humans, Section 2.5 (Canadian Institutes of Health Research, Natural Sciences and Engineering Research Council of Canada, & Social Sciences and Humanities Research Council, 2018).

Table 1. Evaluation questions.

Level	Evaluation question (EQ)
1: Reaction	1: What are the module's completion rates, based on students' demographics and course incentives? 2: How do students perceive the module? 3: How do educators perceive the module?
2: Learning	4: To what extent do students achieve the module's intended learning outcomes (ILOs), specifically those related to metacognitive skills, goal-setting, and mindsets? 5: To what extent do students perceive that they will actually apply the learned knowledge/skills?
3: Behaviour	6: What resources does the module require? 7: To what extent do processes reinforce, monitor, encourage, and reward learning to apply the learned knowledge/skills?
4: Results	8: What are the effects of the module on educators' teaching? 9: What elements of the module are transferable across academic disciplines? 10: What impacts does the module have on the institution's goals?

2.2 Study setting and sample

Participants included undergraduate students and professors from a single, research intensive institution in Canada, enrolled in or teaching science, mathematics, and engineering courses, in English or French, at the first through fourth year levels (N = 1845). We referred to these as Course 1 – Course 9. The activities in the module (questionnaires) were a core source of data, including student satisfaction and specific responses to metacognitive, goal-setting, and growth mindset questions. We collected data from 1845 students; however, not all data sets include the responses from all students for two main reasons: (i) students did not always answer all questions and (ii) some educators had altered the module (appropriately for their context), which made analyzing some results difficult (e.g., if a question had been modified) or impossible (e.g., if a question had been removed) to compare in some courses.

2.3 Study protocol and data analyses

Activities (questionnaires) – students

To evaluate student completion rates, we considered the module "completed" by a student if they had completed at least 70% of the module's activities (Kirkpatrick Level 1, EQ1). We removed data for students who dropped the course with the module or received an "incomplete" in the course. We analyzed students' responses to identify their perceptions about the module (Level 1, EQ2).

We analyzed questionnaires to evaluate students' learning, we focus on their metacognition, goal setting, and mindsets (Level 2, EQ4). Specifically, we investigated students' knowledge in the areas of metacognition, goal-setting, and mindsets:

Metacognition: We evaluated students' metacognitive skills in one context by comparing their ability ratings (questionnaire responses) with their actual results (midterm or exam responses). Self-ratings of knowledge identify one key aspect of metacognition (identifying what you know); students' accuracy on those ratings identify students' metacognitive skill in that area. For a single course (Course 5), we identified students who had provided a rating for all of the intended learning outcomes in a module activity before a major assessment and who completed the associated major assessment (midterm 1, n = 133; midterm 2, n = 119; final exam, n = 102). We summed the ratings to produce students' overall ILO scores, which we approximated as interval data, then compared each student's intended learning outcome score to their grade percentage on the associated major course assessment using a bivariate (Pearson's r) correlation analysis. We report bias corrected and accelerated bootstrap 95% confidence intervals in square brackets in the results section.

Goal-setting: We used the score on a response to an activity's question to measure students' skills at identifying SMART goals (Specific, Measurable, Accountable, Reachable, and Time-specific); that question asked students to identify the SMART goal(s) in a set of four statements. To identify the quality of students' written goals, we analyzed a subset of responses to an in-module goal-setting question in depth from Course 5, in which each student wrote three goals (n = 150). We analyzed each goal for whether it met each of the SMART goal criteria; we did not evaluate the goals for the nature or topic quality. We used students' highest score in the analysis to determine the average quality of students' goals and to investigate the correlation between the quality of the goal and students' final exam scores.

Mindsets: We analyzed students' abilities to differentiate between a series of growth and fixed mindsets in five courses (*n* = 600) (Dweck, 2006; Yeager et al., 2019). For Course 5, we analyzed the students' reported specific mindsets for that course's subject. At four times during the semester, students had been asked to rate to what extent they agreed or disagreed with ten mindset statements on a five-point Likert scale. We analyzed the responses from the students who completed all four activities (*n* = 101). For analysis, we converted the survey responses to a numeric value as follows: strongly disagree=1, disagree=2, neutral=3, agree=4, strongly agree=5. Since the students' responses did not span the entire five-point range of the Likert scale, we used non-parametric tests to analyze the data (Friedman's analysis of variance). We conducted *post hoc* analyses using the Wilcoxon signed-rank test between students' agreement to mindset statements reported at the beginning of the course and those reported before the final exam.

We analyzed data from Courses 2 and 5 in depth to identify the ways in which students reported planning to use their knowledge and skills from the module (i.e., transfer, Kirkpatrick Level 2 - Learning). We also conducted a survey in a subsequent course that asked students who had previously used the module which of module's constructs they were using or planned to use, if any (*n* = 43). That subsequent course did not use the Growth & Goals module.

Finally, we analyzed responses to the last activity in the module to identify how students articulate their new knowledge and skills and how they intend to use them in the future.

Course assessments

We analyzed the correlation between responses on course assessments (midterm and final exams) and the achieved learning outcomes from the module (Level 2, EQ4)

Focus groups – students

We recruited focus group participants from courses in which the module had been used used. Participants (n = 42) took part in a 1-hour focus group (Level 1, EQ2). Each student received a $20 Amazon gift card. The question guide can be found in the Supporting Information (SI). Focus groups were audio-recorded and transcribed verbatim for thematic analysis (Patton, 2014).

Questionnaire and focus groups – educators

Educators completed a questionnaire before and after using the module. Most also participated in a 1-hour focus group. These tools explored educators' perceptions (Level 1, EQ3), behaviour (Level 3, EQ6 and EQ7), and effects on their teaching (Level 4, EQ8). The focus group question guide can be found in the SI. Focus groups were audio-recorded and transcribed verbatim for thematic analysis (Patton, 2014).

Institutional data

The university's Institutional Research Office provided anonymized demographic data, which included students' region of residence, first-generation status, program of study, and sex (self-reported at the time of registration, with the options: female, male, other). First generation students are those whose parents have never attended a college, CEGEP (Collège d'enseignement général et professionnel – equivalent to a community college), or university

(SASS - Student Academic Success Service, n.d.). Region of residence (home location) was the region where students reported living during the semester of studies.

We compared the completion rates with the course incentive (if any) and demographic data (Reaction, EQ1). We analyzed the data using ANOVA tests and post-hoc *t*-tests with Bonferroni corrections.

The nature of courses that incorporated the module provided insight into the transferability of the modules across academic disciplines (Level 4, EQ9). The module's alignment with the institution's mission and provincial degree level outcomes provided information about the module's potential impacts on the University's goals (EQ10).

3. Results

Level 1: Reaction

Completion rates varied by course incentives and students' demographics (EQ1)

When educators provided a grade incentive as low as 1% either as part of the course grade or as a bonus, 76% of students completed the module (*N* = 1845) (Figure 4). Participation rates were lower in courses with no associated mark (17%) or when educators introduced the module late in the course (33%).

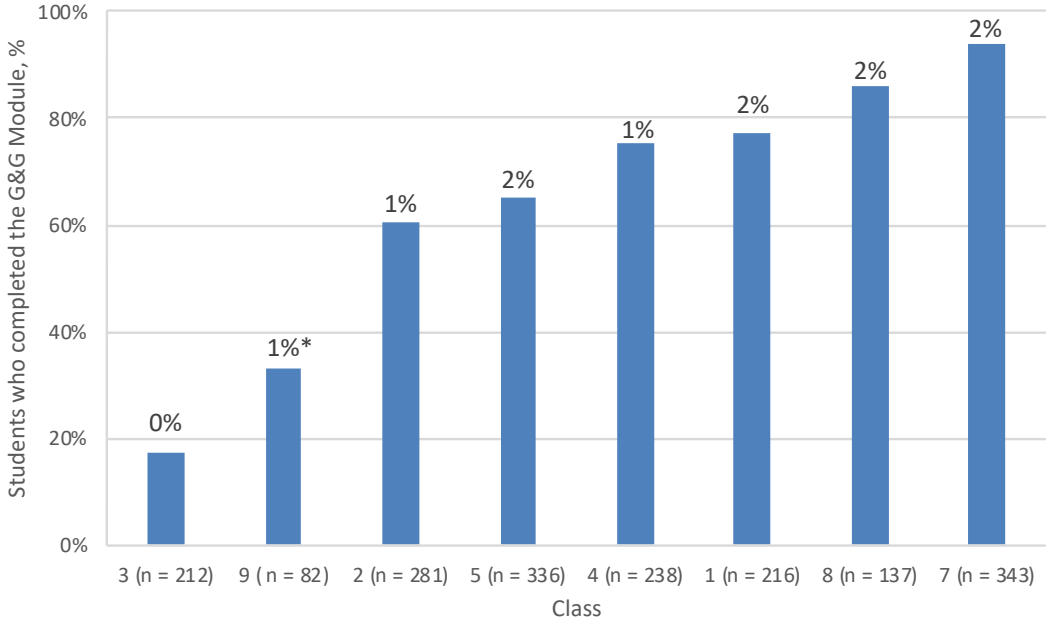

Figure 1. Percentage of students using Growth & Goals module for each course in the study. Course names/codes were anonymized using arbitrary codes. Grade/Mark incentives (in %) for the module's completion are indicated above each bar (* = module was introduced late in the course). G&G = Growth & Goals.

Students living in the Ottawa-Gatineau region were most likely to complete the module; the greater the distance from the university, the lesser the likelihood of completing the module; $F(2, 166.6) = 5.412$, $p = 0.001$ (Figure 5).

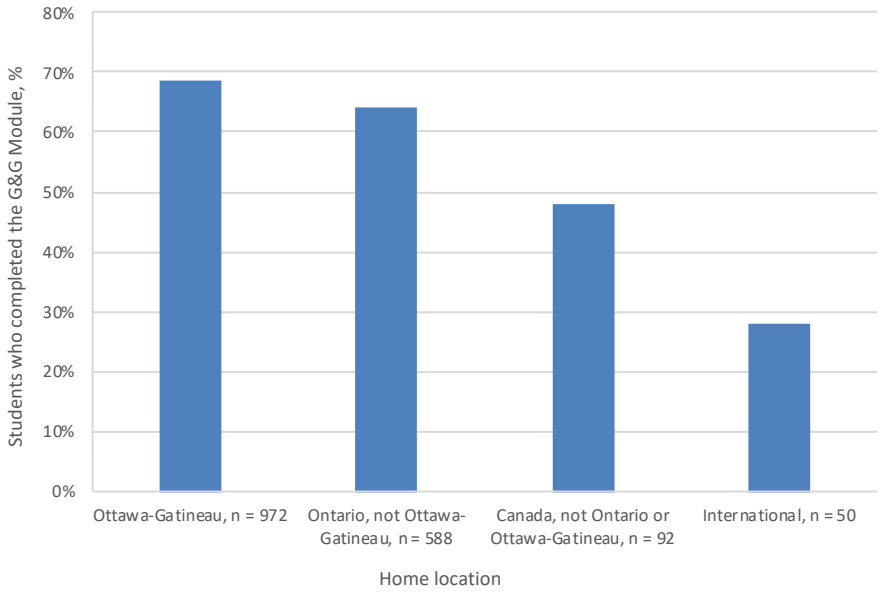

Figure 5. Percentage of students completing the Growth and Goals module based on the students' home location (region of residence). *n* = 1702.

Students in engineering and science programs had the highest completion rates, with the exceptions of chemistry and "other engineering" programs (Figure 6). Students in human kinetics and psychology programs were the least likely to complete the module.

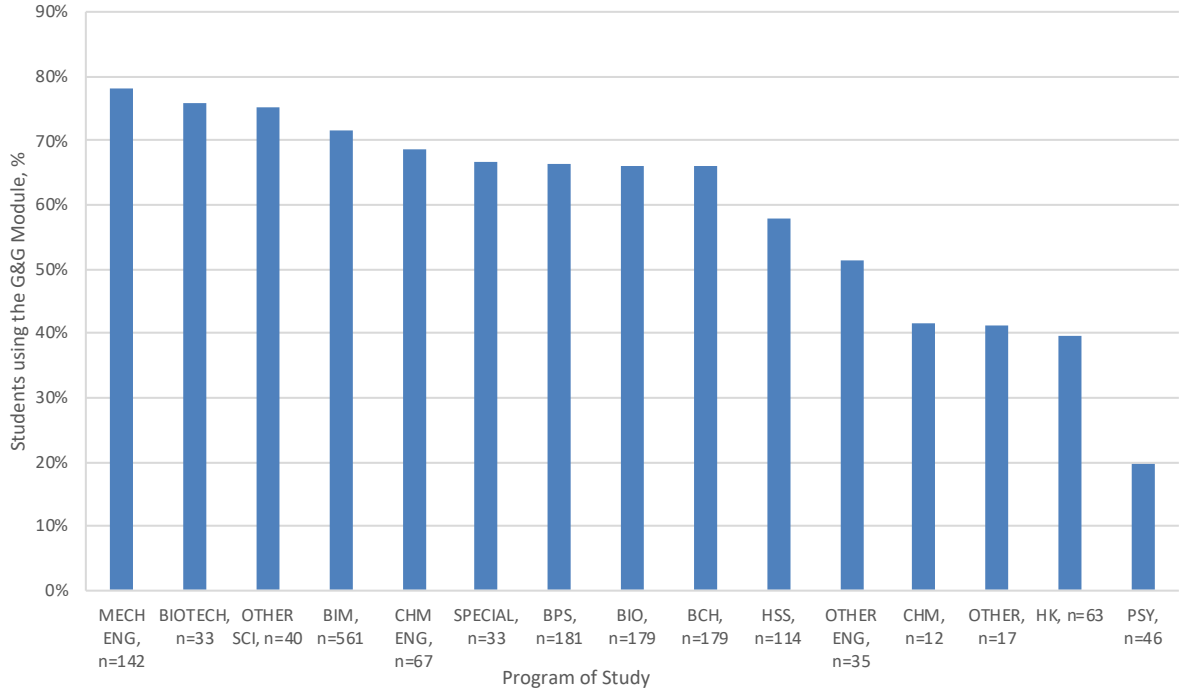

Figure 6. Percentage of students using the Growth and Goals module based on the students' programs of study. *n* = 1702. BIOTECH=biotechnology, HSS=health sciences, MECH ENG=mechanical engineering, PSY=psychology,

OTHER ENG=other engineering program, BIM=biomedical sciences, CHM=chemistry, BPS=biopharmaceutical sciences, OTHER=other program outside of the Faculty of Science, HK=human kinetics, OTHER SCI=other program in the Faculty of Science, BIO=biology, BCH=biochemistry, SPECIAL=special registration.

Students whose parents have a post-secondary education (PSE) were far more likely to complete the module (69%) than students who parents do not have a PSE (27%) or students who are unsure if their parents have a PSE (57%) (Figure 7).

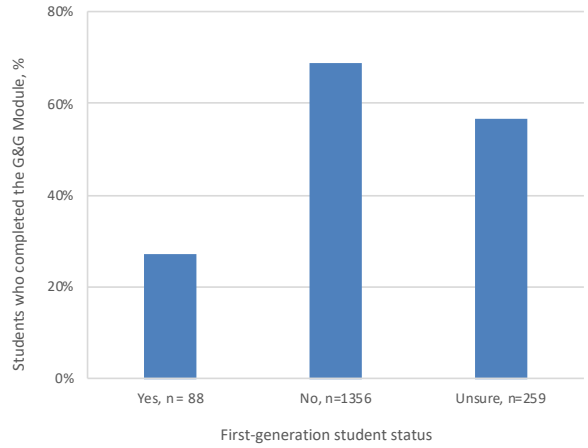

Figure 7. Percentage of students using the Growth and Goals module based on students' first-generation status. *n* = 1703.

There was a significant effect of the student's sex on module completion, $F(2, 1697) = 12.03$, $p < 0.001$ (Figure 8). Females completed the module more than males with a small effect size ($p < 0.001$, $r = 0.12$) although there was no significant difference between females or males and those who indicated "other" for sex ($p = 0.45$, $p = 1.00$).

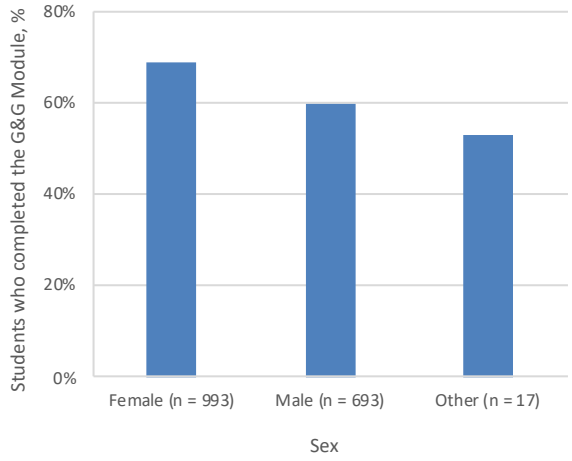

Figure 8. Percentage of students using the Growth & Goals module based on sex. *n* = 1703.

Students' perceptions of the module were positive (EQ2)

Students reported that the module was **the first time most students had done explicit training** in the learning skills addressed in the module (88%, *n* = 1120). Moreover, students' perceptions of the module were positive. For example, 59% believed the module would improve their *learning* (n = 983) and 65% believed the module would improve their *awareness of their own knowledge* (n = 996).

Students' comments showed that they appreciated the module's constructs, such as going through their goals and breaking them down, reflecting on their mindsets, and rating their abilities on the learning outcomes. Students also mentioned that they appreciated being able to rate their abilities on the learning outcomes that they should have when entering the course (i.e., prior knowledge expectations). A number of students mentioned that this rating helped them identify course material to catch up on if they had forgotten aspects or had never learned them in a different institution. Students' comments included: "I like that a growth mindset makes you realize that it's okay to make a mistake and fix it later on.", "I think it kept you on top of things – oh man I really need to review that. I think it was the learning outcomes that made it really clear.", "It showed me resources I didn't really know about, like [academic support services]", "It was hard to write down things I wasn't good at. I'm glad I did, though, because later in the module I made a plan to improve those things.", and "When I put a zero for a learning outcome rating, that really made me think and work on that thing." (Figure 9). A minority of students reported not enjoying completing the module or that the time doing it detracted from their study time.

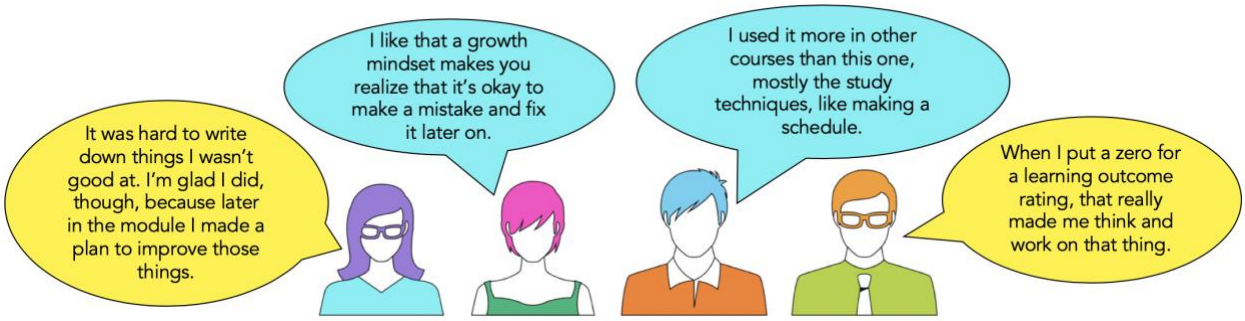

Figure 2. Selection of quotes from students who used the module and attended a focus group.

On the questionnaire and in focus group students suggested incorporating the module more into the course itself, adding more videos about concepts, providing an overview of other students' answers (e.g., most common study methods), making the module even more course specific, and simplifying the number of learning outcomes in the course (there were a few dozen in some courses). They recommended sharing evidence about the evaluation of the module, so that students were also made aware of the evidence associated with its use. They also recommended that the module's concepts be included on exams "so that we care about it more" and "are more likely to answer in depth versus just getting it done"—that recommendation is consistent with principles of constructive alignment: designing assessments that are aligned with the course's intended learning outcomes (ILOs) and values (J. Biggs, n.d.; J. B. Biggs & Tang, 2007; Collis & Biggs, 1986). Finally, they recommended that the module be

expanded into levels, so that someone taking it could build on their learning skills as they gained expertise. Moreover, students recommended that we incorporate career strategy aspects into the module, especially when it is used in senior years. They indicated that such an approach would also minimize repetition for those who were exposed to the module in more than one course or year.

Educators' perceptions of the module (EQ3)

The majority of educators who have incorporated the module into their courses have continued to use it in subsequent years, an indication that the module has been favourably received in their courses. Most educators had used the module to create learning outcomes in their courses for the first time and appreciated the opportunity to do so. They also expressed the importance of the module being plug-and-play for educators who don't have experience teaching the module's constructs. The educators had similar comments to the students about wanting to incorporate the module into classes/lectures more and wanting to be able to show students how other students were studying; past data are now available for this purpose for professors who are using the module for the first time. Educators expressed the beliefs that the module has been positive for at least some and not detrimental to any.

Level 2: Learning

This level examines students' measured learning as it related to the module, and their beliefs that they will apply that learning in future contexts.

On average, students who completed the module had a higher final grade (M = 6.20, SD = 2.8) than those who did not complete the module (M = 5.17, SD = 3.1), $t(1698) = (–6.76)$, $p < 0.001$ with a medium effect size, r = 0.20 (Figure 10). There was also a large correlation between module completion and students' final grades (r = 0.80).

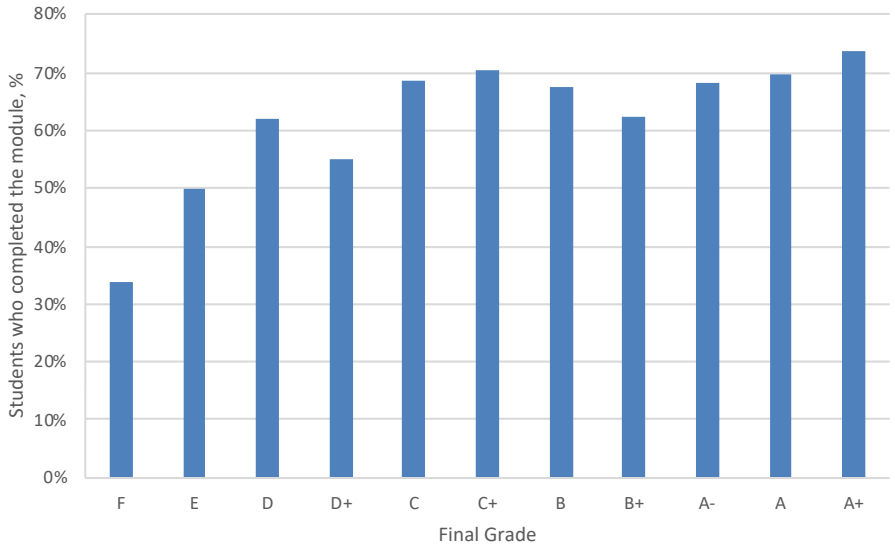

Figure 10. Percentage of students using the Growth & Goals module, by final grade. n = 1700.

The students achieved most of the module's intended learning outcomes (EQ4)

The module's learning outcomes are listed in detail in the Intended Learning Outcomes section of the module (Flynn et al., 2020c); in this analysis, we focused on students' abilities related to three main constructs in the module: (i) metacognition, (ii) SMART goals, and (iii) growth mindset. We analyzed students' responses in the module's activities across courses. Using data from one course, we furthered the analysis related to metacognition and goal-setting.

(i) Improvement in metacognitive ability as the course progressed; Dunning-Krueger effect detected

Students' metacognitive ability was low early in the semester but improved as the course progressed. Specifically, students' scores on Midterm 1 showed a significant correlation with their ability rating before that assessment, with a small to medium effect size, $r = 0.255$ [0.077, 0.410], $p = 0.003$, $n = 133$ (Figure 11a); Midterm 2 showed a significant correlation with their ability rating before that assessment, with a medium effect size, $r = 0.308$ [0.119, 0.483], $p = 0.001$, $n = 119$ (Figure 11b); and the final exam showed a significant correlation with their ability rating before that assessment, with a medium to large effect size $r = 0.460$ [0.316, 0.593], $p < 0.001$, $n = 102$ (Figure 11c).

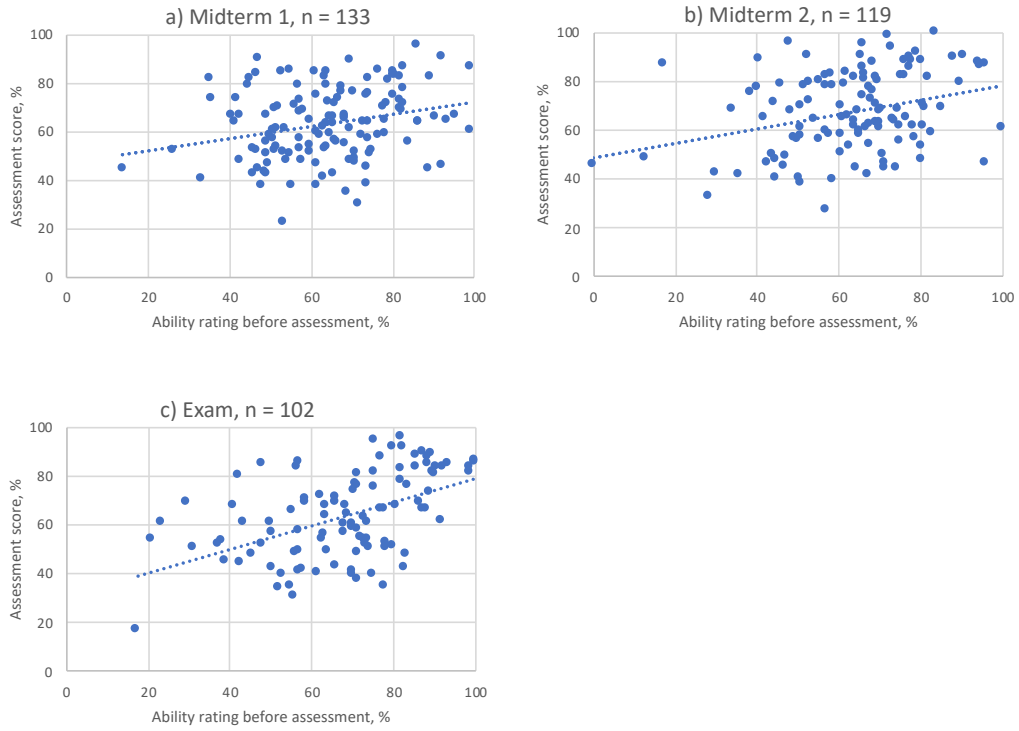

Figure 3. Comparison between course assessment scores and students' ability rating before each assessment. a) Midterm 1, $n = 133$ ($r = 0.255$), b) Midterm 2, $n = 119$ ($r = 0.308$), c) Exam, $n = 102$ ($r = 0.460$)**.** Data from Course 5.

For Midterms 1 and 2, the self-ability ratings of the lowest-performing students was higher than their actual scores, representing over-estimation of their knowledge (Figure 12a and Figure 12b). Conversely, the self-ability ratings of the highest-performing students were lower than their actual scores, representing under-estimation of their knowledge. For the final exam, the

ability ratings of low to highest-achieving students became accurate when compared to their actual scores (Figure 12c). The ability ratings of the lowest-performing students (i.e., those who achieved 1–25% on the exam) remained higher than their actual scores.

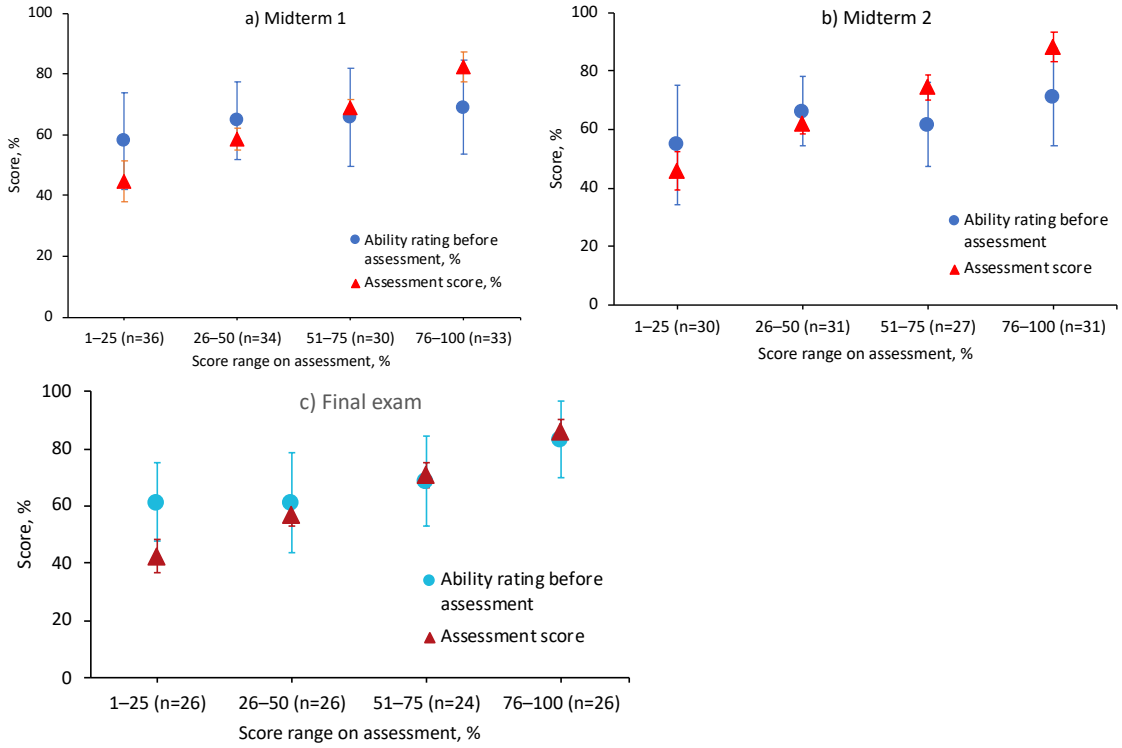

Figure 4. Students' ability ratings and actual scores for: a) Midterm 1 (n = 133), b) Midterm 2 (n = 119), and c) Final exam (n = 102) in Course 5. Error bars represent +/– 1 standard deviation of the mean and the n-value below each bin represents the number of students in that score range.

(ii) Small improvements in self-assessment methods

We analyzed the methods that students reported using to gauge their own knowledge. Early in the semester and across courses, the top three ranked methods to assess their own knowledge were: reading over the section/chapter/slides, self-testing with previously seen questions, and using intuition/feeling (Figure 13). The lowest three ranked methods were: self-testing with never-before seen questions, explaining ideas to someone else and checking their understanding, and working with classmates to test each other.

Late in the semester, there was a slight shift in reported methods to self-assess knowledge, with "testing myself with problems I've never seen before" moving into the top 3, and "intuition/feeling" ranking 4th. Explaining ideas to someone else and working with classmates to test each other remained the lowest ranked methods. These findings were consistent across

the five courses for which these data were available.

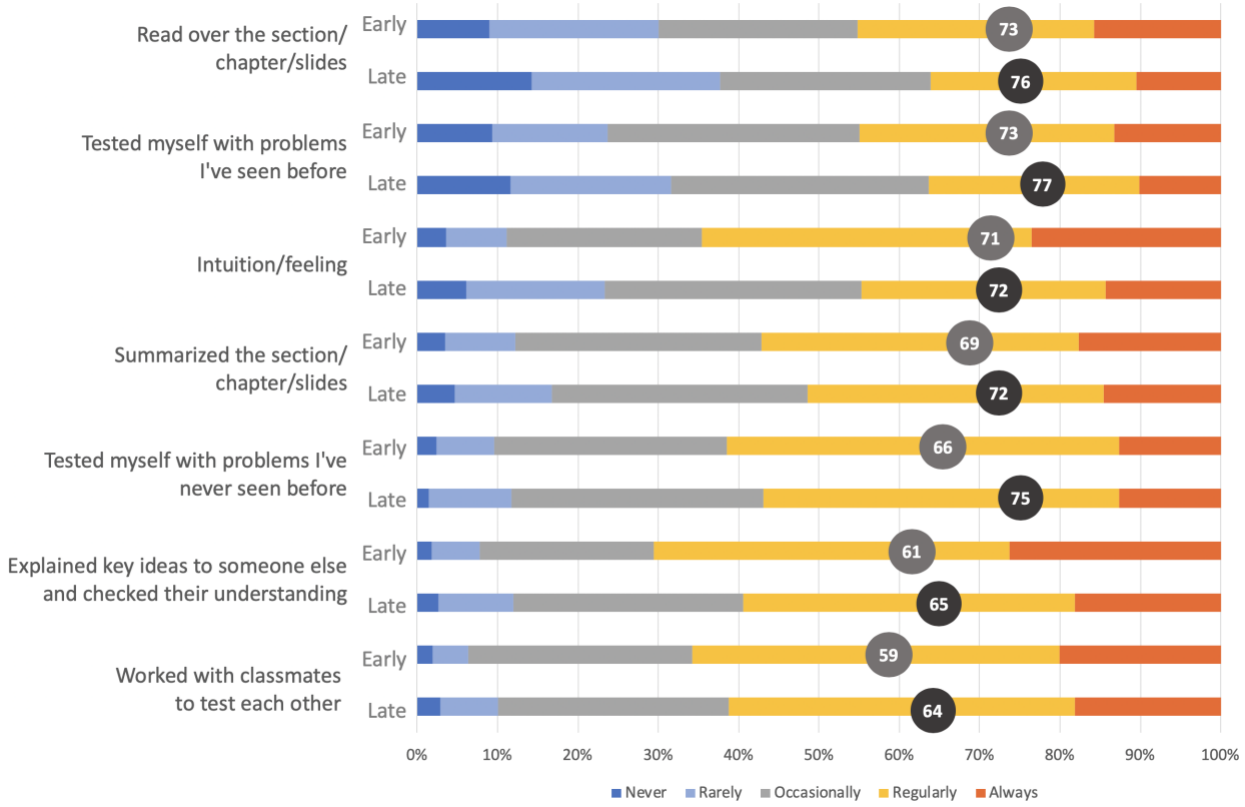

Figure 5. Methods that students used to self-assess their knowledge, early and late in the semester. Data from the 5 courses for which these data were available. Early semester, n = 704; Late semester, n = 630. Circled values represent weighted averages (light grey = early semester, dark grey = late semester); these are approximations since these data are categorical.

(iii) Students could identify SMART goals but wrote more vague goals

Students demonstrated a high ability to identify a SMART goal, based on in-module responses (*M* = 88%, *SD* = 19%, *n* = 701). For one course, we analyzed the quality and content of the goals in depth. Quality was determined by deciding whether each of the SMART goal criteria were met in the student's written goal (5 points possible in total); the average was 49% (*SD* = 26%, *n* = 150). The topics of the goals spanned a range, with most being fairly large and distant (e.g., post-graduation and career), rather than finer-grained goals that would be achievable in a shorter time frame (Figure 14).

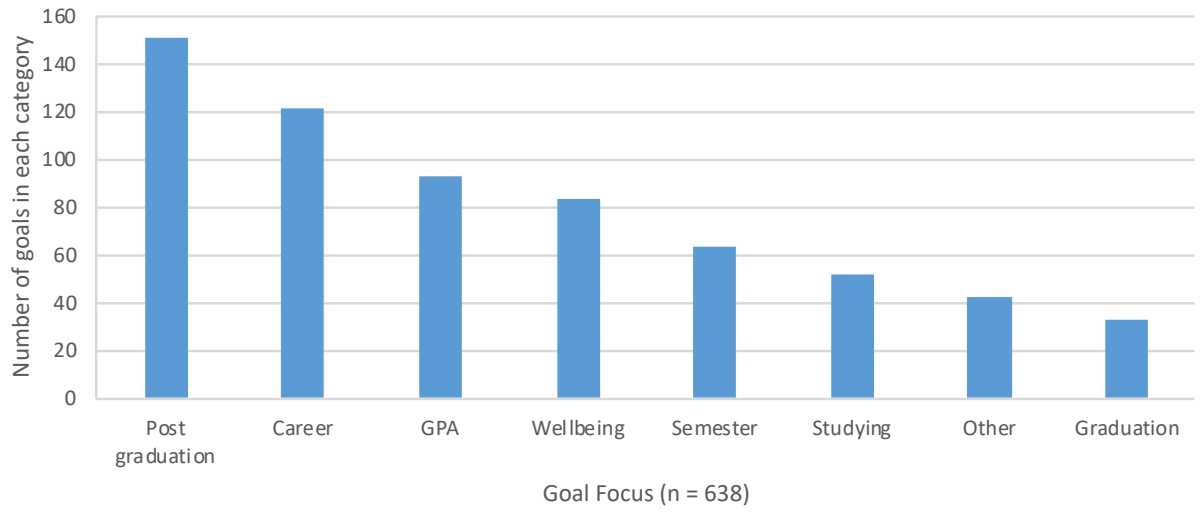

Figure 6. Main area of goals set by students in one course (Course 5). In that course, 638 goals were identified (in the goal-setting activities, students could set up to 3 goals).

Students who created SMART goals had a significantly higher pass rate than students who did not create any SMART goals, $t(48) = 8.31$, $p < 0.001$, $r = 0.2$ (Figure 15). There was only a low correlation between the quality of the goal and the student's grade. Only 10% of students who created SMART goals failed the course (<50%) compared with 59% of students who failed and course and did not create SMART goals (Figure 15).

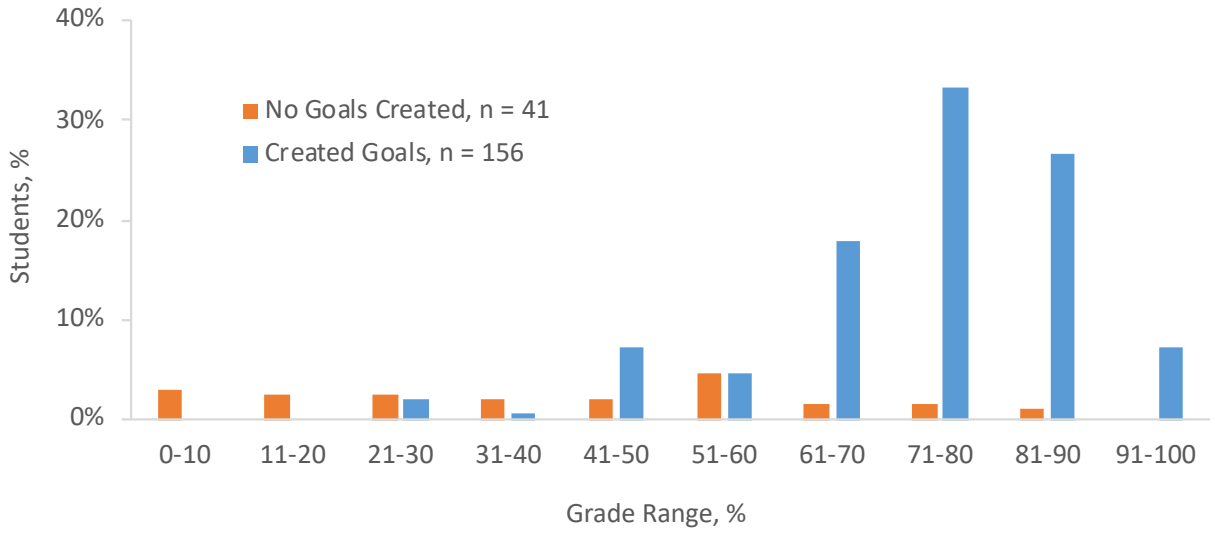

Figure 7. Percentage of students in each grade range, compared with whether they set goals in the module. Data are from Course 5 (n = 197). There was no correlation between the quality of the goal and the course grade (data not shown).

(iii) High abilities in differentiating between growth and fixed mindset statements

Over 92% of students gave correct responses to a question that asked them to differentiate between a series of growth and fixed mindsets (n = 600). When we analyzed students' responses to mindset statements specific to the course's subject, we found that students had shifted towards a growth mindset for six of the ten mindset statements, with no change in the other four statements. This finding suggests that overall, students shifted toward a growth mindset by the end of the semester with respect to that course. For example, in mindset statement 5: "I get help when I get stuck on a problem", students shifted towards a growth mindset by the end of the course (Figure 16). There was a significant change in the students' mindset during the semester, $X^2(3) = 14.74$, $p = 0.002$, $n = 98$. *Post hoc* analysis revealed students reported a statistically significant increase in agreement values before the final exam (Mdn = 4, IQR = 4–4) than at the beginning of the course (*Mdn* = 4, IQR = 3–4) with a small to medium effect size, $z = -3.203$, $p < 0.001$, $r = -0.2288$.

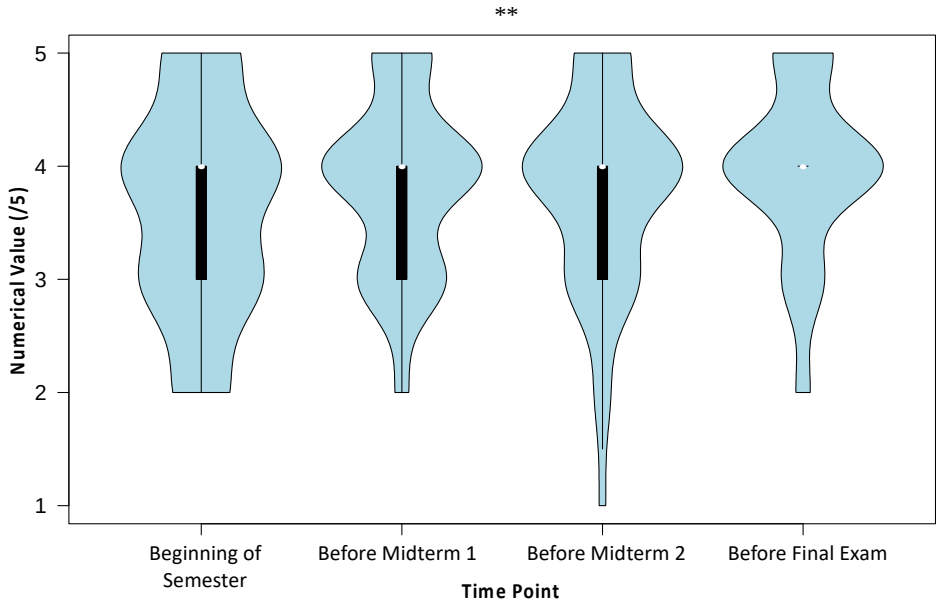

Figure 8. Students' agreement to mindset statement 5: "I get help when I get stuck on a problem" rated at four time points during the Fall 2017 semester. Students' responses were converted to numbers as follows: strongly disagree=1, disagree=2, neutral=3, agree=4, strongly agree. In the violin plot, the white circle indicates the median, the thick vertical line represents the interquartile range, and the width of each plot at each value is proportional to the number of responses of that value. ** indicates a significant difference with $p < 0.001$.

Most students believed they would apply the module's concepts (EQ5)

Most students believed they would continue to use the module's concepts after completing the course (68%, n = 987) (Figure 17). At the end of the course, the module asked students to describe how they would use the knowledge and skills gained in the module in the future. We analyzed data from two of the courses to identify how students intended to use the knowledge attained (Course 5 and Course 8, n = 380). The most common response was that they would use the skills in other courses or their career in a general sense (22%). Common answers also

included: setting SMART goals (13%), making a schedule (11%), and using specific study strategies (9%). Only 5% of students identified that they would apply the metacognition skills, a result that surprised us as metacognition forms the foundation of other skills (e.g., self-regulated learning, goal-setting). Approximately 10% of students indicated that they would not use concepts from the module at all.

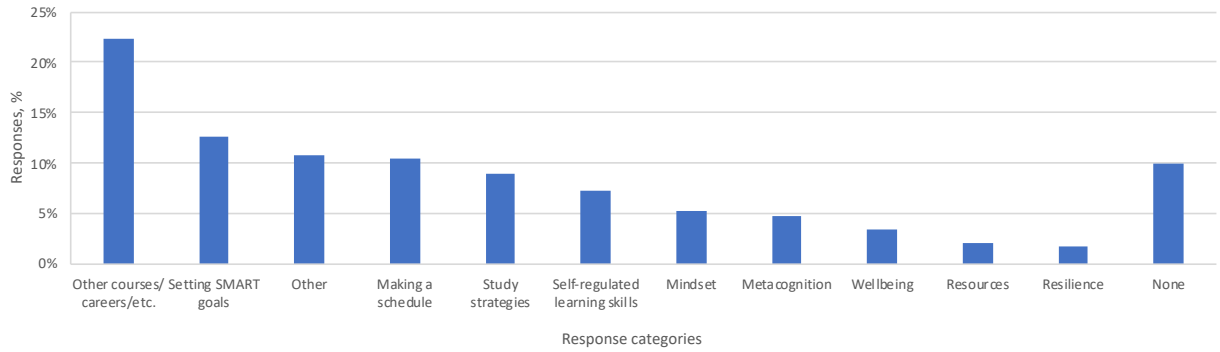

Figure 9. Predominance of responses to the end-of-course module question: "How will you use the knowledge or skills gained in the Growth & Goals Module in the future?". Data analyzed from two courses (Courses 5 and 8, n = 380).

We also began to explore how students were actually using the module in future courses, even if those courses did not incorporate the module. The questionnaire results indicated that 97% of students were still using or planning to use the module's constructs (*n* = 43). While preliminary, these findings are encouraging.

Level 3: Behaviour

Resources required to use the module (EQ6)

Incorporating the module in the course requires relatively little time on the part of the educator—one to four hours to adapt a template—and no knowledge in the module's constructs (Figure 18). Ideally, the educator will develop and incorporate the course's intended learning outcomes into the module, as these provide an important foundation for students to develop and refine their metacognitive skills, set goals, and plan strategies. Students and educators who have used the module recommend spending a few minutes in class periodically discussing the module. Otherwise, no major course changes are required. As an Open Education Resource that uses a Creative Commons license (CC-BY-NC-SA), the module is free and completely adaptable; it is available in French and English and can be used in its default browser format or in other exportable formats such as PDF, Kobo, or Word (Flynn et al., 2020c, 2020a). Instructions and support are available to educators, including periodic workshops and presentations (Flynn, 2021). The module's activities are available by default as Google Forms (also adaptable to other formats), which export to spreadsheets that can be used to connect with a learning management system. Moreover, the module can be reused in future years without requiring additional modification.

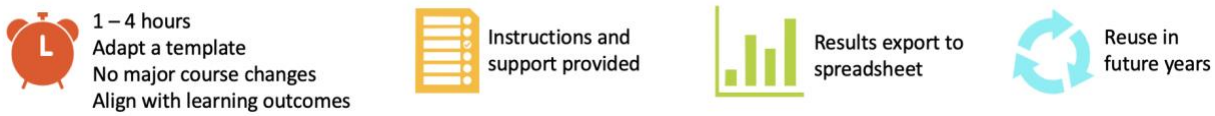

Figure 10. Key resources needed to incorporate the module in a course.

The module is similarly free for students to use, reducing barriers to use. Time is the major resource needed from students.

Level 4: Results

Effects of the module on educators' teaching (EQ8)

We detected two major impacts: (i) many educators created learning outcomes for the first time—incorporating the module seemed to act as both a motivator and a method to be supported in creating the learning outcomes; (ii) educators wanted to better support students' learning and the module provided a way for them to do so.

The module is transferable across academic disciplines (EQ9)

To date, educators have used the module in courses in a number of disciplines, including the sciences, engineering, mathematics, education, and psychology (course-level data not yet available for the latter two course types). Educators report no issues with integration in those disciplines.

Impacts does the module have on the institution's goals (EQ10)

In the province of Ontario, the Ontario Council of Academic Vice presidents (OCAV) outlined a set of six degree level expectations (DLEs) for undergraduate and graduate students (Ontario Universities Council on Quality Assurance, 2019). Two of the DLEs are critical in helping students learn to learn and manage their responsibilities but are rarely explicitly taught: "Awareness of the limits of knowledge" and "Autonomy and professional capacity". The Growth & Goals module directly addressed both, the first through explicit instruction and practice in metacognition skills, the second through skills development throughout the module (e.g., goal-setting, reflecting, planning, acting, mindfulness, growth mindset). Moreover, the University's mission includes transformative learning and agility; students who master learning skills will be better positioned to learn and adapt quickly to rapidly changing situations, such as the 2020–2021 pandemic. The module positively aligns with this mission, as it helps to equip students with these essential learning skills.

4. Discussion

Overall, we found a number of differences in completion rates based on various demographic factors. A grade incentive had a clear connection with participation rates. Further studies could explore why participation rates vary among different groups. For example, the high proportion of special registration students who completed the module could be because they are a particularly motivated group with specific career goals and knowing they have particular circumstances that may present barriers to their success at university. Possibly, the elite nature of some engineering and science programs (e.g., biotechnology, biomedical sciences) means that students in those programs are already more motivated to succeed and therefore more

likely to make use of the module to support their success. These programs may also be among the most challenging, in which students are motivated for grade supports (e.g., bonus marks). The lower participation rates among first generation students was concerning as these students often face challenges that include understanding how university works, meeting expectations, and juggling academic, career, and personal responsibilities (SASS - Student Academic Success Service, n.d.). Possibly, international students do not understand the reasons for developing learning skills in the context of a science course, if they are used to traditional approaches to learning sciences.

Overall, students' responses were very positive. We believe that a balance is needed between time to complete the module and study time. We do not think that the module will be useful for every student and some students may already be skilled learners; however, we do hope that developing explicit learning skills will help the majority of students become more proficient learners, even if they do not immediately see the benefit. As with learning anything new, time and effort are needed. Students' suggestions were specific and will be useful in future iterations to make the module even more beneficial.

We have already been able to address many of the educators' suggestions from the first version of the module, such as reducing the number of activities (reduced from 20 to 8–10), making the module easier to adapt (the Pressbooks version is much like working in a Word document), making the outputs easier (using Google Drive forms rather than the original version of the module's activities has made that easier). Some educators were not comfortable with students sharing their personal information with them, such as their values and thus, each of these questions can be readily adapted in the module, such as instructing students to write their answers in a personal notebook rather than in the activity.

Educators indicated concern about the bottom quartile of their course being less likely to participate—a concern that is born out in the data across courses (Figure 5). Here we also wish to explore methods to encourage students to engage in the module and are partnering with our University's academic success services to do so. Ultimately, however, it is students' decision whether to engage or not. Like students, educators expressed a desire to minimize repetition and incorporate skill-building/refining options for students who see the module in more than one course or year. They also suggested making the module into a program-level initiative, an idea that we are actively pursuing.

The discrepancies between ability ratings and assessment results are consistent with the Dunning Krueger effect (Kruger & Dunning, 1999) and research in exam predictions. Each situation is undesirable, as students who overestimate their ability may prematurely stop studying in an area where they should be working, and students who underestimate their ability may spend too much time studying in a particular area. These metacognitive issues are problematic in a strategic sense: assuming each student is working hard, inaccurate self-knowledge ratings result in working hard in the wrong areas, rather than targeting the areas where they actually need work.

The improvements in metacognitive skills for higher achieving students converges with prior research that found that higher-performing students' accuracy improved with explicit instruction (Callender, Franco-Watkins, & Roberts, 2016). Research has found that incentives

and tailored feedback can help lower-performing students improve their metacognitive skills, becoming better calibrated as to their abilities (Callender et al., 2016). While we remain concerned that students with the very lowest course scores remained quite inaccurate, we are pleased to see the high prediction accuracy of students who achieve 26 – 100% on the assessment by the final exam.

In the early semester results, we were concerned that the prevalent study methods were the more passive ones, or using familiar questions. These methods most-used by students are not aligned with literature findings on successful self-assessment methods, which indicate that the first three methods are the least effective although they may feel the easiest and most comfortable; the latter three methods are the most effective (Brown, Roediger, & McDaniel, 2014). We were reassured somewhat to see an increase in self-testing with unfamiliar questions at the end of the semester, but remain concerned at the relatively high prevalence of passive reading and using "intuition/feeling" methods as ways of testing knowledge, as these are the least objective among the list. Moreover, peer learning could be much better leveraged to further self-knowledge assessment and, ultimately, learning (Brown et al., 2014).

The low stakes environment of the module could have led to lower effort in writing goals (lower extrinsic motivation) and that students may have written more specific goals in a higher stakes exam environment (higher extrinsic motivation). The findings related to goal-setting could indicate that creating SMART goals helped students to succeed in their learning environment and accomplish more, and as a result, students obtained higher grades and passing rates. Alternatively, these findings could suggest that students who did not create any SMART goals were less motivated, and thus were already more likely to receive a low grade or fail the course due to their lack of motivation.

While we were pleased to see mindsets shifting toward growth throughout the course, we interpret these results cautiously. Growth/fixed mindsets are not inherently good or bad and relate to a specific area (e.g., academic, athletic, artistic) and not to ourselves as a person. For example, we may have a growth mindset about one aspect of our lives (e.g., learning math) and a fixed mindset about another (e.g., painting). Having a growth mindset about everything would make it nearly impossible to get anything done/learned. Analogously, having a fixed mindset about everything would hinder or prevent learning. The greatest benefits stand to come if we can be strategic about our mindsets, aligning them with our goals and priorities. Since we cannot place value judgements on students' goals (e.g., whether or not they should want to master a course in chemistry), we similarly cannot judge whether their mindsets are appropriate or not.

As most students indicated that they would continue to use some aspect of the module, future work will investigate how those skills are used. Students may have identified that skill implicitly or not realize the important role metacognition plays in setting related strategies. Similarly, they mentioned the application of self-regulated learning skills, mindset, and resources less often, perhaps for similar reasons or because other concepts were more important to them. Further exploration would be beneficial to understand why some students do not believe they will use the module's skills, since it is hard to imagine learning not involving any of these concepts.

From the perspective of the project team, expanding the module's use and effectiveness requires time, people, and funding. The team gave more than two presentations at local, national, and international events. At most events, the team also held workshops for educators who chose to incorporate the module into their courses. To expand awareness of the module, team members have also been interviewed for media pieces, created infographics, produced videos, and written manuscript; these valuable contributions have only been possible through resources such as time, people, and funding, as well as in-kind contributions of production and research laboratories. **Time**: The development and knowledge mobilization team needs time to increase awareness of the module, support educators who incorporate the module, and provide technical support. The evaluation team also needs time to collect and analyze the data, meet to identify key research questions, data sources, and indicators. The project lead also needs time to connect with future potential project collaborators, to increase the module's quality, uptake, and scope (e.g., a program-level version). **People**: The project teams depend on strong team members, including students (Carle et al., 2020; Flynn, 2020), professors, academic support service experts, pedagogical experts (e.g., instructional designers), administrators, and other collaborators. **Funding**: Finally, the project needs funding, particularly to support student salaries (42% of original budget) and knowledge mobilization activities (32%), with other funding needs including production costs for the module (19%), research (5%, gift cards for participants, software subscriptions), and translation costs (2%).

By integrating the module with a course that the students are taking (i.e., meeting students where they are), the goal is to increase relevance and applicability of the module. A course incentive promotes high completion rates (Figure 4); discussing the module in class and including assessment questions related to the module (none personal) improve students' perceptions of the module's value.

We find there is a lack of other kinds of motivation and rewards to truly master these skills, i.e., to change habits and behaviours. Incentives for correct and accurate answers may prove helpful (Callender et al., 2016), as could integrating the module within a program to build skills over time. Moreover, the main motivator for professors is the desire to better support student learning. There is not external motivation or incentive, and they need to take time to incorporate it, even if that time is low.

We will continue to explore educators' recommendations, beliefs, and approaches as the module's use expands. Future work will explore the transferability to a greater range of disciplines and contexts.

5. Limitations

We analyzed real course data in this study, which brings advantages of ecological validity but drawbacks of variations in questionnaire formats, changes over time, and lack of a control group (Abowitz & Toole, 2010; Brewer & Crano, 2014). However, we believe the trade-off is essential in this case, to understand how the module is integrated and adapted in real course settings. With this information, we can best support students' learning. Moreover, the simplicity of integrating the module in courses affords an opportunity to investigate, in multiple settings, how the module is enacted, experienced, and its effect.

Students' may not have accurately reported their learning outcome ability ratings and agreement to mindset statements for a variety of reasons. First, there was no incentive for students to complete the activities accurately. Students received the grade incentive for completing the module regardless of whether they completed the activities accurately. Second, students had to rate their abilities for many learning outcomes, up to fifty in a few courses. Providing ratings for many learning outcomes can be a time-consuming task. Many students reported during the student focus group that the activities before the major course assessments were too long. Some students reported going through the activities as fast as they could, so that they could get back to studying for the major course assessment. Thus, students may have quickly inputted responses to the activities and may have not taken the time to assess whether or not their learning outcomes ability ratings were justified. Based on the presence of statistically significant correlations between learning outcomes ability scores and course assessment grades, we believe that, in general, students reported reasonable ability ratings in the course's intended learning outcomes, according to their metacognitive skill. We also believe that students' reports of agreement to the mindset statements were quite accurate because of the presence of a statistically significant correlation between mindset score and assessment performance, a relationship that is supported by the literature (Kennett & Keefer, 2006). Yet, the possibility that some students did not accurately report responses for various reasons exists in the data set. Providing incentives for accuracy may improve the results.

Although we found a number of correlations in the analysis of the module's use, these do not prove a causal link. For example, the statistically significant correlations between mindset score and academic performance does not necessarily mean having a growth mindset leads to academic success. There is always the possibility that academic success leads to a growth mindset (reverse causality). Or, another variable could be at play that is the casual factor (the third variable problem). For example, having high motivation could lead to having a growth mindset and also leads to academic success; in this case, high motivation would be the third variable. Reverse causality and the presence of a third variable are also potential explanations for the relationship between the correlation of ILO ability score and academic performance.

This evaluation is not longitudinal and so it provides information only about perceived behaviour change and preliminary results.

6. Conclusions

In this study, we evaluated the effectiveness of a new Growth & Goals Module, a course-integrated module that teaches critical learning skills, including: metacognition, goal-setting, growth mindset, and mindfulness (Flynn, 2021; Flynn et al., 2020c, 2020a). Mastering such learning skills are essential for students to be able to continually learn and adapt in our complex, dynamic world (World Economic Forum, 2020).

Using a Practical Participatory Evaluation approach and the Kirkpatrick Evaluation model, we investigated ten research questions aligned with Kirkpatrick's four levels (reaction, learning, behaviour, and results). We collected data from nine undergraduate courses in science, engineering, and mathematics (N = 1845).

In Level 1 (Reaction), students and educators reported high satisfaction and that this was the first time most students had done such training. Completion rates were high in courses that gave at least a one percent mark for using the module. However, students in some demographics used the module less than others (small to medium effect sizes), including: lower-achieving students, from outside the Ottawa-Gatineau area, male, in certain programs, and first-generation university students.

In Level 2 (Learning), we found that students started with quite low metacognitive skills, but these increased over a single semester. The Dunning-Krueger effect was observed early in the semester on exam predictions, in which lower performing students over-estimated their ability, and higher performing students under-estimated their ability. By the end of the semester, most groups were extremely accurate except the students with the very lowest exam grades (<25%). Incentives for accuracy could be helpful to motivate students to make more accurate predictions (Callender et al., 2016; Miller & Geraci, 2011). Early in the semester, students reported using passive methods to self-assess their knowledge (e.g., intuition) but moved to more active methods by late in the semester (e.g., self-testing with unfamiliar questions). Relatively few students used social methods to self-assess their knowledge (e.g., explaining to a friend), despite that being a research-supported strategy (Brown et al., 2014). Most students could identify a SMART goal from a list (88%), but demonstrated a lower ability to write one (49%), with more than half of goals being broader and longer term (e.g., career related) than desirable for a SMART goal. Students who created SMART goals had a significantly higher pass rate than students who did not create any SMART goals. Finally, over 90% of students in all courses successfully differentiated between growth and fixed mindset statements, and we observed an overall shift in mindset toward growth (one course analyzed).

In Level 3 (Behaviour), we identified that relatively few resources are required of educators; the module is free, adaptable, requires low technical knowledge, and takes between one and four hours to incorporate in a course, depending on educators' desired level of tailoring. The major resources required of students are time (a few hours) and low technical knowledge; the module is free and uses common technologies (web browser and online survey tools). Research and development require sustained support. Future research evaluation efforts will require substantially more resources (e.g., time, personnel, funding). By integrating the module with a course that the students are taking, the module meets the students where they are rather than being a separate entity (e.g., workshop); the goal in doing so is to increase module's relevance, applicability, and number of students reached.

In Level 4 (Results), we found that (i) most educators created learning outcomes for the first time—incorporating the module seemed to act as both a motivator and a method to be supported in creating the learning outcomes and (ii) educators had wanted to better support students' learning and the module provided a way for them to do so. All evidence to date indicates that the module can be readily used in any discipline; no specific course format is required. The module addressed two provincial degree level expectations that are critical in helping students learn to learn and manage their responsibilities but are rarely explicitly taught: "Awareness of the limits of knowledge" and "Autonomy and professional capacity". Moreover, empowering students with learning skills addresses institutional goals of transformative

learning and agility by equipping them to monitor their own knowledge and skills, ready to strategize and adapt as needed.

We conclude that the module teaches core learning skills in a way that is systematic, scalable, and explicit; moreover, as an adaptable Open Education Resource, the module can readily be adapted to any discipline at any level of postsecondary study. The module has now been used by over 5000 students at 10 institutions.

We are currently exploring options to expand the module to non-academic contexts using a recently-published course-independent version of the module [citations], including athletic and artistic settings. We are also investigating two new aspects to incorporate in the module: Indigenous Knowledge and resilience, through collaborations with experts in each area. In the next phases of this work, we are seeking to increase uptake of the module by using a combination of change theories (Reinholz & Andrews, 2020), guidance from knowledge mobilization frameworks (Cooper, 2013; Henderson et al., 2016), and financial support, as educational innovations require specialized approaches in order to spread past the innovators themselves (Lane et al., 2020).

7. Data availability

The module itself is available for analysis; there are course-integrated versions available in English and French (Flynn et al., 2020c, 2020a), and course-independent versions available in English and French (Flynn et al., 2020d, 2020b). Student data are not available for reasons of privacy.

8. Acknowledgements

This material is based upon work supported by uOttawa's Chair in University Teaching Program (2016–2019). We thank Jean-Luc Daoust for assistance with data gathering and statistical analysis, Glen Loppnow for preliminary data analysis and helpful discussions, Adam Shuhendler for assistance collecting data, educators for integrating the module in their courses, educators and students for participating in the evaluation, and evaluation team members for providing guidance in developing the research questions and setting evaluation priorities.

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