USING PREFLECTION PROMPTS IN THE TRANSITION TO TERTIARY MATHEMATICS FOR IDENTIFYING AND ADDRESSING NEGATIVE EMOTIONS

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ABSTRACT

In higher education, empowering students to become self-directed and motivated learners is an ongoing challenge. This paper explores the transformative potential of preflection prompts, strategically employed at the start of a course, to enhance self-efficacy and motivation among first-year undergraduate maths students. Drawing on empirical data, we identify four primary themes encapsulating students' learning barriers: (1) resuming mathematical studies after a hiatus, (2) the enduring impact of past academic setbacks, (3) anticipated hurdles in motivation and organisation, and (4) concerns regarding teaching methods and digital learning platforms. These themes provide insights for educators and institutions seeking to support and elevate the learning experiences of diverse student populations. By addressing these barriers early on and promoting self-reflection, we aim to guide students toward a path of enhanced self-efficacy, intrinsic motivation, and more successful academic journeys. This research offers a roadmap to cultivate a conducive learning environment that nurtures students' self-directed learning skills and fosters their overall well-being.

INTRODUCTION

First-year undergraduate students begin their educational journey with a unique set of experiences, expectations, and aspirations. As they step into their classrooms, they bring a diverse range of skills, learning styles, and levels of self-confidence. Yet, they share the desire to succeed academically.

The evidence suggests that integrating reflection into the initial phases of a course can instigate a cascade of positive effects. Insights from recent studies indicate that reflective practices can spark a heightened drive for in-depth learning. In essence, reflection serves as the compass guiding learners toward their educational goals (Zhai et al., 2023). These observations acknowledge the individualistic nature of learning, where factors like mood can sway decision-making and learning outcomes (Lehmann et al., 2014). In fact, reflective practices not only sharpen cognitive and metacognitive strategies but also set the stage for self-regulated learning (SRL). SRL is an essential lifelong learning skill (Boud & Soler, 2016) that fosters self-efficacy (Schunk & DiBenedetto 2014; Code 2020). SRL is an active, constructive process in which students set goals for their learning, and monitor and regulate their thinking, behaviours and motivation while engaging with their environment, to finally evaluate their learning against their initial goals (Zimmerman & Schunk 2011; Code 2020). The concept of SRL forms the backbone of this exploration. SRL encompasses a blend of metacognitive, motivational, and behavioural processes aimed at achieving specific educational objectives within a given context (Lehmann et al., 2014). The metacognitive dimension serves as the conductor orchestrating cognitive, motivational, and behavioural processes (Ifenthaler, 2012); and the motivational dimension encapsulates the processes that ignite, guide, and sustain goal-driven actions (Lehmann et al., 2014). Each dimension is intricately woven into the fabric of effective learning, and they are all influenced by instructional interventions, such as prompts (Lehmann et al., 2014).

Prompts, as pivotal instructional tools, assume centre stage in our narrative by connecting reflection with SRL. Preflection is a term used to refer to a reflective session that is held before the learning experience (Falk, 1995). The central objective of this paper is to illuminate the impact of what we term “preflection prompts” on first-year undergraduate students. These prompts, administered before the learning journey commences, raise students’ awareness of potential hurdles, with the aim of empowering them to activate their motivational strategies. Furthermore, we use these insights to proactively address the identified learning barriers, thus influencing student motivation and nurturing goal-oriented behaviours. In the following sections, we will present the students’ self-identified learning barriers and discuss strategies we can implement to support them in overcoming these. In essence, this paper integrates the insights of reflection with SRL providing a roadmap for enhancing students’ self-efficacy and motivation.

CONTEXT

Our study is based in an Australian university where secondary school mathematics, specifically VCE Mathematical Methods units 3-4 (VCAA 2022) serves as a prerequisite for various academic disciplines including engineering, health sciences, education, IT, business studies, and law. Mathematical Methods is a fundamental component of the Australian Victorian Certificate of Education curriculum, encompassing subjects such as algebra, basic functions, differentiation, integration, and statistics. The mathematics course in this study is for students who have not completed VCE Mathematical Methods 3-4 (or equivalent) providing pre-requisite knowledge for these courses and spans a duration of 12 weeks.

Our student body represents a diverse mix of cultural backgrounds, educational backgrounds, and demographic characteristics. It comprises students with strong mathematical foundations, a genuine enthusiasm for mathematics, and an appetite for academic challenges. However, it also includes individuals who either lack prior exposure to Mathematical Methods units 3-4 or have not engaged with mathematics for an extended period. This diversity in mathematical readiness can significantly influence their self-confidence in the subject.

A total of twenty-six students voluntarily participated in our study. It’s important to note that this sample may lean towards more motivated students and may not fully represent the entire cohort. For example, only one member of the participant group failed the course, and over 50% obtained a grade of 80 or more, which is much higher than the overall cohort. We conducted our research with strict adherence to ethical guidelines and refrained from collecting detailed demographic data. Our data collection centred around the initial task within students’ portfolios, known as the “goal-setting task.” As part of this initial assessment task within the course, students were prompted to articulate their goals and to identify both their strengths and personal barriers to learning or potential obstacles they anticipated facing. These potential obstacles were symbolised as “dragons” within our framework. This unique approach created a safe and constructive environment for students to openly discuss their challenges within the context of these “dragons.”

As part of the feedback process, academic staff engaged in conversations with students addressing the concerns they identified. Anecdotally, students were more open to discussing their challenges with both staff and other students in this context. Such discussions facilitated early intervention and proactive measures to address these challenges throughout the trimester, ultimately fostering a more open and collaborative learning atmosphere.

METHODOLOGY

The data used in this research was collected from the first assessment task submitted by undergraduate students in their portfolio for this first-year mathematics course. An example of part of this task is given in Figure 1. There were 26 students who participated in this study. As part of the assessment, students were asked to identify a potential `dragon’ that might prevent them achieving their goals and identify ways to defeat it Twenty-one of the 26 students gave responses related to negative self-efficacy beliefs. We then used inductive analysis on this collection of student comments to identify themes arising (Braun & Clarke, 2006) by categorising these comments into the factors associated with these negative self-beliefs. Initial analysis was performed separately by each of the authors. They then compared the themes identified and refined them into four main themes, with only

two students' responses falling into two themes, the rest fell into a single category. The responses and associated themes are presented in Table 1.

Figure 1: Example instructions for preflection task

Reflect on your 'dragons', the fears, weaknesses and potential obstacles that might prevent you from achieving your goals for this course. Here are some suggestions:

- I need to achieve high marks to achieve my goal.
- I am concerned about losing marks by not understanding the requirements correctly.
- I don't know how to multiply fractions.
- I can do the maths but I don't know how to present the solution correctly.
- I am not good as good as other people in my band (team).
- I have nothing to contribute to my band.
- I was never good at maths.

(1) Identify your goal.
(2) Identify a strength and explain how it will help you or others in your band complete the quest.
(3) Identify a dragon, or a potential obstacle, that you feel might prevent you achieving your goals for this course and explain ways that you have identified to defeat it.

Table 11: Themes identified: Not studied maths for a long time (L), Past experience of failure (F), Expected challenges with motivation and organisation (C), and Teaching methods and platforms (T).

Comment	Theme
'I have not studied maths since 2012 so I need to keep referring to additional resources and old textbooks and practice a lot.'	L
'I haven't dabbled in this type of math for some time. I finished school over 12 years ago. Being able to re-establish an adequate level of understanding is key.'	L
'Not making the assumption that it will be easy to re-gain the maths skills I have previously held.'	L
'My biggest dragon preventing me from achieving my goals is the fact that I not only haven't studied at Uni before, but I haven't studied at all for 15 years. '	L
'I have not been exposed to mathematics for a long time, and this course is a big challenge for me. Therefore, the dragon I want to defeat is that I have to solve math problems through correct presentation and contribute to my band, although I am not as good as others.'	L
'It has been 23 Years since I was at school and studied maths, and sometimes I am not sure if I am up to the challenge'	L
'Lack of knowledge as I haven't studied maths in over 26 years and my inner perfectionism, in the work that I do. If I don't get something right or am not fully understanding a concept, I can become fixated on it and that's all I can focus on until this is rectified.'	L
'I have not studied maths for four years. When I was in high school, I once chose further math as one of my elective courses, but I was failed in the final exam then I barely touched math since that time because of it, it leads me lack of self-confidence for my mathematic ability and that is my dragon (my weakness).'	L, F
'Some fears, weaknesses and potential obstacles that might prevent me from achieving my goals for the unit are that I might appear incompetent to my peers or to tutors/teachers which prevents me from asking as many question I would of liked and also rushing things to as I found that when I was doing questions,'	F
'Sometimes, it takes me quite a time on even simple problems to solve them, moreover, I do silly mistakes in calculations.'	F

‘I have never been good at math.’	F
‘I have only ever completed year 10 foundational maths.’	F
‘Believe it or not, I did Mathematical Methods Units 1-4 through VCE ... and advanced maths in year 10. I am not mathematically strong though. I know that as over the years I struggled a lot! I had teachers who doubted me and told me not to continue, who advised me to give up methods, who told me (right before a sac) that no matter what I do I won’t have a chance to do well in methods. It was very upsetting, receiving my test scores back and not passing the test on almost every occasion but I didn’t give up.’	F
‘However, in terms of my mathematics abilities, at times I can lack confidence and currently feel as though I still need to develop a few core skills before I truly realise my potential in maths,’	F, C
‘A personal dragon for me would be my motivation skills. Generally, I have been slack in the past with getting on top of work quickly and usually leave it to the last minute.’	C
‘The main dragon I had for this unit was me not being able to do my best in this subject as I was not very fond of it from a young age’	C
‘My biggest dragon is definitely making sure I keep up to date and on top of my work, throughout my schooling and during last trimester I often tend to fall behind so from this week onwards I will be doing my best to ensure I stay up to date with all coursework to give me the best chance of succeeding’	C
‘Can I Dedicate the time that I need to achieve my desired outcome with a young family and working full time? Will this help me in my career progression or am I too late to make a change? A bit nervous about being at a bit more mature age (38) for university than most of my peers, will they respect me, will I get on with them.’	C
‘The language of studying, the structure, the platforms and programs and the content are all new to me’	T
‘I don't really like Maths, because I always focus on the marks that I've got instead of the knowledge or skills that I lea[r]nt from solving problems.’	T
‘A potential obstacle for my learning this trimester is that it is taking place online, I struggle to properly learn new information in an online format which will hinder my results.’	T

FINDINGS

From our students’ identified learning barriers, or ‘dragons’, we identified four main themes: (1) not having studied maths for a long time, (2) experiencing failure in maths, (3) expecting challenges with motivation and organisation, and (4) concerns with the teaching methods and/or platforms.

NOT HAVING STUDIED MATHEMATICS FOR A LONG TIME

Students returning to mathematics after a hiatus, whether short (≤ 4 years) or long (decades), often experience anxiety. This apprehension can affect their self-worth, as they grapple with challenges like solving math problems correctly and feeling less proficient compared to peers: ‘*I have not been exposed to mathematics for a long time, and this course is a big challenge for me. Therefore, the dragon I want to defeat is that I have to solve math problems through correct presentation and contribute to my “band”, although I am not as good as others*.’

EXPERIENCE OF FAILURE

The impact of past failure on a student’s self-efficacy can be significant. One student expressed this very clearly, *‘I once chose further math as one of my elective courses, but I failed in the final exam then I barely touched math since that time because of it, it leads me to lack of self-confidence for my mathematic ability and that is my dragon (my weakness).*’ Some students fear appearing inadequate in the eyes of their peers or teachers as one of our students stated: ‘*Some fears, weaknesses and potential obstacles that might prevent me from achieving my goals for the unit are that I might appear incompetent to my peers or to tutors/teachers which prevents me from asking as many questions.*’ Many students believe that they ‘*have never been good at math*’ or that they have insufficient math for further study e.g. *‘I have only ever completed year 10 foundational mathematics*’.

EXPECTED CHALLENGES WITH MOTIVATION AND ORGANISATION

Many students in this unit view mathematics as an obstacle that may prevent them from achieving their goals rather than an enabler towards achieving their goal. ‘The main dragon I had for this unit was me not being able to do my best in this subject as I was not very fond of it from a young age’. Lack of motivation can result in students avoiding engaging with content ‘A personal dragon for me would be my motivation skills. Generally, I have been slack in the past with getting on top of work quickly and usually leave it to the last minute’ and ‘My biggest dragon is definitely making sure I keep up to date and on top of my work, throughout my schooling and during last trimester I often tend to fall behind so from this week onwards I will be doing my best to ensure I stay up to date with all coursework to give me the best chance of succeeding’. Challenges for mature students in this area also arise from a lack of belonging and pressure balancing work-study-life, this is clearly stated in a comment by one of our students who wrote ‘*Can I dedicate the time that I need to achieve my desired outcome with a young family and working full time? Will this help me in my career progression or am I too late to make a change? A bit nervous about being at a bit more mature age (38) for university than most of my peers, will they respect me, will I get on with them.*’

TEACHING METHODS AND PLATFORMS

Students raised concerns about how they will study mathematics e.g. ‘The language of studying, the structure, the platforms and the content are all new to me’ and ‘I don’t really like Maths, because I always focus on the marks that I’ve got instead of the knowledge or skills that I lea[r]nt from solving problems’. Furthermore, this study occurred during a long covid-shutdown, introducing additional pressures ‘A potential obstacle for my learning this trimester is that it is taking place online, I struggle to properly learn new information in an online format which will hinder my results.’

RECOMMENDATIONS

The findings from our study provided us with an opportunity to engage in meaningful discussions with students about how to integrate support mechanisms within the course to tackle the common “dragons” that they face. The students’ dragons are part of their self-efficacy beliefs. Self-efficacy beliefs are formed through engagement with information sources such as performance accomplishments, social persuasion, vicarious experiences, and emotional indexes, such as feeling less anxious (Schunk & DiBenedetto, 2020). To improve students’ self-efficacy beliefs, we present a set of strategies and opportunities that can be incorporated.

ASK QUESTIONS AND ASK EARLY

Encouraging students to ask questions and seek clarification early in the learning process is pivotal. Creating a classroom environment where students feel comfortable expressing their uncertainties can mitigate the anxiety associated with returning to mathematical studies after a break. Instructors should actively promote a culture of inquiry and make themselves readily available for queries, either during class or through accessible online platforms.

SUPPORT YOUR PEERS

Fostering peer support and collaborative learning can be instrumental in overcoming obstacles related to self-confidence and past academic setbacks. Encouraging students to work together, share their experiences, and help each other can build a sense of camaraderie and promote a positive learning atmosphere. Peer-assisted study groups, discussion forums, and group assignments not associated with grades can facilitate this collaborative approach.

ACKNOWLEDGE YOUR LEARNING PROCESS

To enable students to gain insight into their learning process, identify areas of improvement, learning resources, and strategies that work for them, it is important to embed reflective practices and scaffold metacognitive strategies, such as self-monitoring, planning, and self-regulation. These skills enable students to better understand how they learn and how to adapt their learning strategies for optimal results.

ENGAGE IN ACTIVE FEEDBACK DIALOGUE

Encourage a two-way dialogue about feedback. Providing students with the opportunity to receive and incorporate feedback effectively can significantly contribute to their self-efficacy and motivation in mathematics. Students should also be prompted to respond to feedback, ask questions, and seek clarification when needed. This fosters a sense of ownership in students over their learning. In addition, linking feedback to their individual objectives allows students to better appreciate the

relevance of the input and how it contributes to their learning journey. In fact, it is important to provide feedback that focuses not only on the final outcomes but also on the process of problem-solving and learning. This approach emphasises the importance of effort, strategies, and perseverance in achieving mathematical success.

ACKNOWLEDGE YOUR LEARNING PROGRESS
Recognising and celebrating small victories and progress in learning mathematics is essential for promoting students' confidence. Instructors should acknowledge and praise students for their efforts, improvements, and achievements. Providing regular feedback and emphasising the value of incremental learning can motivate students to persevere through challenges.

CHALLENGES

Incorporating preflection follow up discussions and feedback dialogue at scale for large cohorts at tertiary level can be challenging, requiring upskilling of both academic and sessional staff. One thing that our study highlights is that many students face similar challenges so dialogue can be shared with large sections of the cohort.

CONCLUSIONS

Through the use of preflection prompts in a first-year mathematics units, our study uncovered four primary areas encapsulating student learning barriers in transitioning to tertiary mathematics, namely, (1) resuming mathematical studies after a hiatus, (2) the impact of past academic setbacks on student's self-efficacy, (3) anticipated obstacles in motivation and organisation and (4) concerns about teaching methods and digital learning platforms. In response we present a set of strategies to address these.

Preflection prompts allow us to acknowledge the diversity of mathematical readiness within our student cohort, normalise these differences, promote a growth mindset, and foster an environment where our students can feel safe to express their concerns, seek help, and actively engage in their learning. This has the potential to have positive effects on students' mental health and overall well-being. Furthermore, incorporating preflection prompts has enabled us to recognise our students' unique backgrounds and learning profiles. Early understanding of factors affecting students' self-efficacy in mathematics can inform early interventions and proactive strategies to mitigate the impact of past academic setbacks. For example, responses from our cohort highlighted challenges faced by mature students in tertiary education, which as described by Leder and Forgasz (2004), include achieving work-study-life balance, social isolation, and the impact of prolonged breaks from studying mathematics. Equipped with this information, we can address these challenges to create an environment supportive of these students.

The preflection approach used in our study offers a promising avenue for identifying and supporting students facing challenges in various subjects and aspects of their academic journey. Consequently, the implications extend beyond this specific study and can influence various facets of education and student development. At tertiary level, students are expected to become independent learners (Stenalt & Lassesen, 2022). Explicitly incorporating preflection and reflection on the learning process and progress, nurtures and develops this within the course, empowering students to take charge of their own learning. Developing these strategies in first year lays the foundation of success in the university life as they are transferrable across disciplines. Educators can use these insights to create more inclusive and effective learning environments and to foster resilience and a positive attitude, therefore influencing how students approach challenges in their education and later in their careers.

ETHICS APPROVAL

Ethics approval obtained: Deakin University SEBE-2020-31.

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