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Reflective Practice In STEM Degrees To Support Adaptability And Lifelong Learning

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REFLECTIVE PRACTICE IN STEM DEGREES TO SUPPORT ADAPTABILITY AND LIFELONG LEARNING

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ABSTRACT

The benefits and importance of reflective learning is widely recognized for the development of STEM students. However, the implementation of reflective practices in the curriculum remains a significant challenge for educators. The main purpose of this paper is to help educators overcome this challenge: to better support students to develop their approaches to reflective learning, to better develop ownership of their own learning processes and to foster skills to support lifelong learning. First, we describe the results of a recent survey among engineering academics to look at the

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issue of reflective learning and the extent to which it is deployed in practice. This was then followed up with a linked workshop designed for STEM educators to exchange experiences on their reflective learning practices at SEFI 2023 conference at TU Dublin in September 2023. The outcomes of both survey and workshop showed a genuine positivity and consciousness of the need and benefits towards the implementation of student reflective practice with a range of approaches used to guide to the students in this. Despite the numerous identified hurdles of implementation, we propose interesting practices to make the implementation easier.

1. INTRODUCTION

Reflective practice in which students look back on their learning on a continual basis as a way of developing more robust and comprehensive understanding tailored to the individual is a key part of a number of cyclic learning models including those of Rolfe et al. (2001), Schön (1991), Gibbs (1988) and Kolb (1984). Such habits may also be considered to be important in helping with the lifelong learning processes of an individual once beyond formal education. It was therefore considered useful to investigate the extent to which reflective practice is used in engineering degrees, how it is supported and to look at the drivers and hurdles associated with its implementation. This was achieved via a review of prior work, via a survey and via a workshop.

2. BACKGROUND AND RATIONALE

2.1 The interpretation of Reflective Practice

In the academic literature, we can find a wide range of definitions for the reflective practice applying multiple approaches and interpretations to describe this concept. However, there is no consensus on the definition (Mann et al. 2009) and we consider it as a part of the process of lifelong learning allowing to individual learner to develop continuously their understanding. We define reflective learning as "*practice which involves the development of learning and understanding through self-review to help determine progress against goals and future learning needs*" and this can be argued is an important competence for both current students to help maximise their learning and as a competence for future professionals to take into their working life to ensure continued growth. Furthermore, there are different interpretations concerning the conception of reflective practice by educators including the development of students' (1) professional practice and (2) professional identity, (3) as well as their critical view on the course content (4) and their critical consciousness (Bailie et al. 2021). These interpretations of reflective practice from a professional and critical perspectives show the relevance of it not only in the educational but also in the professional context.

In Engineering Education, reflective practice has been identified as an important and emerging aspect of education in particular with regard to the personal, interpersonal and professional competences needed alongside technical competences (Sepp et al. 2015) for enhancing students' professional development. Similarly, Berglund's (2018) empirical study provided evidence of engineering students' professional identity development in their personal effectiveness (personal management), social and interpersonal competence (teamwork and communication), and the engineering professional role (engineering roles) through reflective practice. This work highlighted the potential benefits of reflective practices on engineering students' professional development laying the foundations to help graduates habitually identify and work toward development needs while progressing through their careers. However, we can observe that reflective practices in engineering education are

mostly applied from a professional perspectives and there is a room of improvement for broadening the application of critical perspectives.

2.2 Implementation of reflective practice

Even if reflective practice is traditionally not included in engineering curriculum (Sepp et al. 2015), there is no doubt today about the relevance and usefulness of his integration and the concept of reflective practice is widely considered as a part of engineering education. The implementation of reflective practices improves significantly engineering students' academic performance as well as their social engagement through a more active participation in their team activities (Menekse et al. 2022). As a part of the lifelong learning process, engineering students' recognized the importance of reflective practice for their future professional career preparation as confirmed the empirical evidences of Eshuis et al. (2022). However, they were often not always satisfied with the tools or assessments used in their study program. Reflective reports were often regarded as the least meaningful in the eyes of the students. Reflective conversations with tutors were preferred by some indicating the important supportive role of teachers in this process. Similarly, Morgan et al. (2021:13) observed, despite an acknowledgement of the value of reflective practice, engineering students' showed reluctance and a generally low level of true reflection beyond simple reporting of facts. However, we should highlight that forcing students for practicing reflexive learning could be inappropriate and counterproductive (Finlay 2008). Therefore, teachers play an important role not only for giving clear assignment and guidance by supporting students' all along of their reflective practice in a persistent way (Cosgrove et al. 2014, Wallin et al. 2016) but also motivating and engaging them.

2.3 Survey outcomes

Prior to the workshop and to gain an overall feel for the use of reflective practice on engineering programmes, a survey was prepared. This looked at the perceived value of and the extent to which reflective practice featured in engineering programmes. It also explored barriers to implementation together with tools and approaches used by academics. Participants were academics or support staff associated with the delivery of engineering degrees and were drawn primarily from the SEFI and CDIO communities of educators. Full details on the methodology and results are reported elsewhere (Thomson & Kövesi 2023).

The survey showed that many practitioners were keen to embed reflective practice within their own degrees but they perceived greater hesitancy among colleagues and students. Barriers existed to implementation, most notable among these were pressures on time within the syllabus together with students not always being receptive to the approach. A range of approaches were used by the participants and their colleagues with presentations and end of term reports being among the most common. Free text responses highlighted some common issues around a difficulty in getting students engage and to reflect on and not simply report activities – "Students failed to properly engage and treated it as a last-minute afterthought". Successes

were generally centred on providing students with consistent and regular guidance - "The structured nature helps students learn to reflect and enhance that skill" and "Reflection with a more obvious, immediate purpose improved engagement".

3. WORKSHOP DESIGN

3.1 Workshop Introduction

To help disseminate and expand on these results, a workshop was held at the SEFI Annual Conference held at Dublin Institute of Technology in September 2023 (Fig 1).

Fig. 1. Workshop at the SEFI Annual Conference in Technological University of Dublin, September 2023

The workshop was open for all conference delegates according to their interest in reflective practice without requiring any prerequisite or experience. In addition to the two authors, 15 workshop participants took part in the activity.

3.2 Workshop Format

The participants in the workshop were first introduced to the topic and were given a brief summary of the results of the survey. They were then placed in self-selected groups of 4-6 and given worksheets to help stimulate discussion on:

- WHY – Why is it important to encourage students to engage in reflective practice?
- TOOLS – How can this be achieved?
- HURDLES – What hurdles are there in implementing reflective practice?
- TIPS – What tips can be used to make implementation easier?

The worksheets were then populated with thoughts, ideas and experiences of the participants using sticky notes. Groups were encouraged to expand on and link to the postings of others.

4. WORKSHOP RESULTS

Following each group's discussions around the prompts on the sheet, all participants were invited to come forward and share "key takeaways" with the wider group. See Fig 2. for a completed set of worksheets.
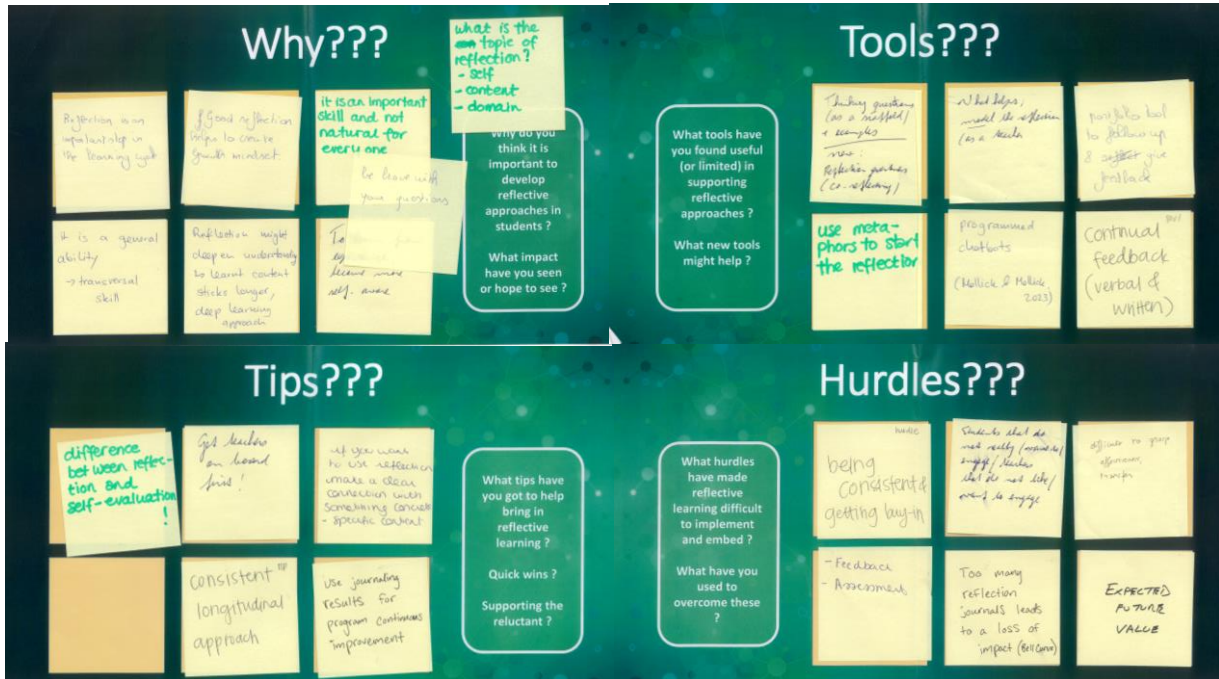

Fig 2. Typical worksheet sets from a group of participants at the workshop

Post-workshop transcription of ideas was carried out to preserve some of the key takeaway points.

Table 1. Summary of takeaway points

WHY	TOOLS
- Is key transversal learning skill - Helps students learn to learn - Develop lifelong learning into work - Strengthen & deepen understanding - Recognise progress & gaps	- Programmed chatbots - Thinking questions as scaffold - Co-reflections - Portfolios – maybe? - Showcases / metaphors / examples?
TIPS	**HURDLES**
- Provide good, regular feedback - Make it regular, continuous - Start small - Show it is not self-evaluation - Get staff on board	- Finding space in curricula - Getting staff & Student buy-n - Difficult to assess - No perceived immediate benefit - Not engineering, uncomfortable skill

5.   DISCUSSION AND CONCLUSIONS

Both the results of the preliminary survey and the workshop showed a high degree of consensus on most of the key issues. The potential benefits of reflective practice are clearly identified and recognized as useful for engineering degrees especially for improving engineering students' professional development (Sepp et al. 2015, Berglund 2018). However, we have to point out that these benefits are predominantly interpreted from a professional perspectives emphasizing the importance of the development of (1) professional competences in the educational context and (2) students' capacity for lifelong learning in their future professional context. Even if the relevance of reflective practices' interpretation from critical perspectives is entirely acknowledged, our results showed that it is less prevalent in engineering education context.

Hurdles identified in both investigations highlighted the difficulty in finding space in the curricula to properly support reflective approaches and the difficulty in getting students to engage given the lack of immediate impact on marks or approach. For this reason, we would like to underline the key role of teachers and educators for motivating and engaging students in reflective practices. Similarly both identified clear scaffolding and support on a consistent basis being a necessity if reflective practice is to be embedded.

The workshop also brought in new perspectives with the application of emerging technology, for example the potential for AI chatbots to act as a neutral third party to help draw out reflections was considered. Also, it could be an interesting support for teachers and educators and could be considered as an excellent opportunity to facilitate the not only the co-creation but also the assessment of reflective practice that perceived as one of the major difficulties of implementation. In accord with the empirical finding of Cosgrove et al. (2014), our findings showed that persistence and continuity/regularity are important elements of the implementation of reflective practice.

On the basis of the findings presented in this paper, in the future we would like to continue our investigations on the topic of reflective practice's role and implementation in engineering degrees by adding students' perspectives. We consider that further research is needed to have a better understanding how to enhance students' motivation and engagement in reflective practice.

6.   ACKNOWLEDGEMENTS

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