McMaster University

Validation of Reflection

Faculty of Engineering, McMaster University

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1. Motivation

The Faculty of Engineering at McMaster University, in conjunction with the University’s Forward with Integrity initiative, has expressed the need for enriching the student experience. The University-wide working group on learning portfolios has identified the purpose of the learning portfolio as a means to capture and enhance the learning journey of students at McMaster. The learning portfolio ties directly into this notion by enhancing the student experience and promoting self-directed learning.

One essential component of the learning portfolio is the idea of reflection. Reflection is one of the four main phases in Kolb’s Experiential learning theory (1984), and with the new Engineering Centre for Experiential Learning (ExCEL) focused on increasing the experiential learning opportunities within the Faculty of Engineering, reflection is an essential piece to the puzzle.

The Faculty of Engineering has a unique situation with regard to how reflection and learning portfolios could be integrated into the curriculum as each program will have to evaluate twelve graduate attributes as defined by the Canadian Engineering Accreditation Board (CEAB). Evaluating the graduate attributes outlined by the CEAB is a challenge that every engineering program across the country will be facing in the near future. The concept of reflection and the learning portfolio will enable the Faculty of Engineering to uniquely evaluate the attributes against students’ course work and provide adequate samples of how each attribute was effectively taught.

When considering theses concepts and how they would be integrated into the engineering curriculum, there are many potential stakeholders. Stakeholders that would be able to make use of and promote the learning portfolio and reflection to students include the McMaster Faculty of Engineering Experiential Learning Task Force, the McMaster Engineering Society, SELECT Student Leadership Program, Engineering clubs and teams and Engineering Co-op and Career Services.

2. Background

2.1. Learning Portfolio

The learning portfolio is a flexible, evidence-based process that combines reflection and documentation to enhance student learning and promote the development of professional skills. It engages students in the ongoing, reflective and collaborative analysis of their learning, both inside and outside of the classroom. It focuses on purposeful, selective outcomes for both improving and assessing learning (Zubizarreta, 2009). The main idea behind using a learning portfolio is to keep students focused on the outcomes of their education, rather than on individual projects or products – learning portfolios are a part of the learning process, not a product of it (Gulbahar & Tinmaz, 2006).

The two key elements when creating a learning portfolio are reflection and selection of work. Selection must be purposeful and systematic, taking examples of students’ own work. Furthermore, selection needs to be done by the student. The creation of a learning portfolio requires the students’ active involvement when organizing, synthesizing, and describing their achievements (Heinrich, Bhattacharya, & Rayudu, 2007).
The concept of developing learning portfolios is based on the fact that the reflective practice of creating portfolios enables students to document and track their learning, develop an integrated, coherent picture of their learning experiences, and enhance their self-understanding (Bhattacharya & Hartnett, 2009). Portfolios are generally used for learning, showcasing skills, and assessment.

The learning portfolio model offers numerous benefits to both the Faculty and students of McMaster Engineering. The benefits that the Faculty will reap from introducing learning portfolios into curricula include: being able to accurately measure the twelve graduate attributes, enhancing student understanding, and supporting the learning process. Additionally, the learning portfolio will enhancing student learning opportunities, develop their life-long learning and reflection skills, and better prepare students for interviews.

The learning portfolio enables professors to collect examples that represent the different levels of understanding students have of the twelve graduate attributes. Some of the attributes are difficult to measure using traditional summative assessment, but by encouraging students to include certain items and accompanying reflections in their learning portfolios, these artifacts could be used as evidence supporting various attributes. These reflections would be beneficial to demonstrate competencies in attributes such as communication, ethics and equity, professionalism, and life-long learning.

Learning portfolios are primarily used to support the learning process. The use of learning portfolios encourages students to think beyond simply attaining a grade in a course, and to think about how to clearly articulate what they have learned, identifying areas for improvement or further learning (Tosh, Light, Fleming, & Haywood, 2005). It encourages students to explore the learning process and to make connections between what they learn in the classroom to other learning experiences. The use of learning portfolios will enable students to see the connection between their courses and facilitate the retention of knowledge from course to course.

Written reflection is often considered to be a required component of learning portfolios and is what sets them apart from a scrapbook, photo album or webpage (Chen, et al., 2005). The best students are constantly reflecting on their learning. They are the students who set goals for themselves, take notes, write in journals, and generally self-assess throughout their education (Williams, 2002). Learning portfolios and the associated activities and exercises encourage students to engage in reflection and increase their understanding of course takeaways through those activities. Additionally, by teaching and promoting reflection in courses, students will grow to appreciate the benefits of reflection and develop the essential skills required for life-long learning.

A student who has worked on a portfolio is not only able to showcase their skills better, but they are better prepared for an interview situation, and to deal with the challenges of working in a collaborative but competitive working environment (Heinrich, Bhattacharya, & Rayudu, 2007). In a study done at Massey University in New Zealand, potential employers were questioned regarding their thoughts on the learning portfolio concept. Employers are looking for initiative and interest in the subject area and for commitment; they want to see students who go beyond their study requirements (Heinrich, Bhattacharya, & Rayudu, 2007). The learning portfolio provides students with the opportunity to collect
and showcase their learning achievements and experiences as well as demonstrate why they are the best candidate for the position. Using the learning portfolio may also be an asset in highlighting skills such as communication and organization, in addition to giving the employer a look at the person behind the resume.

2.2. Reflection

Knowledge construction has four main phases according to Kolb’s experiential learning theory (1984), including simulation, reflection, abstraction, and experimentation. Reflection is a form of mental processing that we use to fulfill a purpose or to achieve some anticipated outcome. It is applied to gain a better understanding of relatively complicated or unstructured ideas and is largely based on the reprocessing of knowledge, understanding and emotions that we already posses (Moon, 2005).

2.2.1. DEAL Model for Critical Reflection

When reflection is well-designed, it promotes significant learning including problem solving skills, higher order reasoning, integrative thinking, goal clarification, openness to new ideas, ability to adopt new perspectives, and systemic thinking (Ash & Clayton, 2009). The DEAL Model for Critical Reflection consists of three sequential steps: Description, Examination, and Articulation of Learning (Ash & Clayton, 2009). The DEAL Model is designed to move students away from simply summarizing their experiences, and into meaning-making. The way in which student should move through the DEAL Model is depicted in Figure 1.

![FIGURE 1: SCHEMATIC OVERVIEW OF THE DEAL MODEL FOR CRITICAL REFLECTION (ASH & CLAYTON, 2009)](image-url)
2.2.1.1. **Description**

The purpose of the *Description* phase is to encourage students to provide an objective, detailed description of an experience which in turn provides a strong foundation for meaning-making in the critical reflection process. It is a way to make the experience present and to ensure that students have access to all relevant aspects of it as they engage in reflection. Reflection prompts (questions, hints etc) associated with the *Describe* step ask students to address such issues as when and where the experience took place, who was present, and what they did and did not do, what they heard etc. (Ash & Clayton, 2009).

2.2.1.2. **Examination**

In the second step of the DEAL Model, prompts that help students *Examine* how their experiences are linked to the desired learning outcomes or objectives. The intent of this step is to stimulate questions or surface issues for further discussion rather than to evaluate students’ reasoning. For example asking questions such as ‘What was I trying to accomplish?’ and ‘who benefitted and who was harmed?’ (Ash & Clayton, 2009).

2.2.1.3. **Articulation of Learning**

The third step of the DEAL model supports students in the *Articulation of Learning* that the two previous steps have begun to generate, while providing further guidance in continuing to expand and deepen that learning. This step helps students capture their learning in such a way to be able to act on it and thereby improve the quality of their learning and their future actions. This section usually consists of four prompts: (a) What did I learn?; (b) How did I learn it?; (c) Why does it matter?; and (d) What will I do in light of it? (Ash & Clayton, 2009).

2.2.1.4. **DEAL Conclusion**

The DEAL Model for Reflective and Critical Thinking is a recommendation as to how students, Faculty and staff can structure reflective activities to optimize the learning that results from an experience. It follows a simple methodology and is open to modification at any step to further enrich the learning process. The DEAL model offers students the opportunity to use writing or speaking as vehicles for learning rather than as expressions of learning after it has already occurred.

2.2.2. **Occasions for Reflection**

While reflection is conventionally thought of as taking place after something has happened, such a view can tend to construct learners as passive respondents to events, and result in reflection pieces being a retelling of the event. There are three occasions of reflection: in anticipation of events, during them and afterwards (Boud, 2001). A reflective activity can include one or a combination of reflective occasions to optimize the learning that results for the experience.

2.2.2.1. **Before Events**

Reflection in anticipation of events emphasizes what we can do to make the most of future events. It is important that during this type of reflection that the focus is on the learner, asking questions such as: What intent and specific goals do you bring to the event? The purpose is to write about what the learner brings to the situation, what they want to get out of it, and what they must be mindful of that may distract them from their intentions. Usually most features of an event are given and cannot be
altered. It is important for the learner to focus on all aspects of the context, especially for reflection before events. This helps clarify questions that need to be addressed about the situation, and to determine what is needed for the learner to have a productive event (Boud, 2001). It may help to think of this stage as goal setting for the event.

### 2.2.2.2. During Events

Reflection during events is achieved through noticing, intervening, and reflection-in-action, which can help steer through events in accordance with what our intentions are and what will help us through the process (Boud, 2001). Noticing is about recognizing what is happening in and around us. It is directed at both the external world of what is happening around us and the internal world of thoughts and feelings. Intervening is about taking action to change the situation in which you find yourself. This step may not be noticeable to others in the situation. The conscious decisions not to speak, or to focus activities on thoughts and feelings rather than external activities, are forms of intervention (Boud, 2001).

Reflection-in-action describes the process of noticing and intervening to interpret events and the effects of one’s interventions. For the majority of the time, these factors are invisible and unconscious. While there are few opportunities to write in the heat of the moment when events are rapidly changing, enough needs to be recorded to prompt fuller exploration when there is time to do so (Boud, 2001).

### 2.2.2.3. After Events

Reflection after events consists of three elements: return to experience, attending to feelings and re-evaluation of experience. These are features of reflection at all stages and can be applied to the other times for reflection as well.

Returning to experiences and recapturing it in context, with its full impact, allows for further reflection. Usually too little emphasis is placed on what has happened and how it was experienced at the time. If judgements are made prematurely, then possibilities for future learning can be shut out forever. By mentally revisiting and vividly portraying the experience in writing can be an important first step.

An important part of returning to the experience is attending to ones feelings that were present during the experience. These feelings can enhance the possibilities for further reflection and learning. Stating the feeling and thinking about what aspects of the experience made you feel that way is an important step in the reflective process.

Reacquainting with the event and attending to and expressing the thoughts and feelings associated with it, can prepare the ground for freer evaluation of experience than is often possible at the time. The process of re-evaluation includes, relating new information to that which is already known; seeking relationships between new and old ideas; determining the authenticity for ourselves of the ideas and feelings which have resulted; and making the resulting knowledge one’s own, a part of one’s normal ways of operating.

From the more diligent writing of return to experience, and the expressive modes of attending to feelings, re-evaluation is about finding shape, pattern and meaning in what has been produced. It
involves revisiting previous reflections, of looking again at what has been recorded, of adding new ideas and extensions of those partially formed. It addresses questions: what sense can I make of this and where does it lead me? It involves trying out new ideas and asking the ‘what if’ questions mentioned earlier. Re-evaluation is the end of one cycle and the beginning of another reflection as new situations are imagined and explored.

3. Graduate Attributes

The Canadian Engineering Accreditation Board (CEAB) has identified twelve Graduate Attributes that every student must be competent in, upon graduation from an accredited institution. The Faculty of Engineering at McMaster University has identified an additional graduate attribute that each graduate of McMaster must be competent in upon graduation; this attribute is sustainability.

Introducing reflection into engineering education provides the Faculty and student population with the opportunity to see what learning is occurring. By constructing reflective activities appropriately, Faculty members will be able to use reflection to identify which graduate attributes were completed in their course and could encourage students to further identify which activities specifically helped them increase their graduate attribute competencies. Additionally, reflective activities can be used to showcase these competencies to the Accreditation Board.

In terms of measuring the graduate attributes, this is where the reflective tools will come into play; by having students’ reflect on various aspects of their engineering education, Faculty members will be able to extract pieces that demonstrate a sound understanding of certain graduate attributes that can be showcased. For example, a student could be asked to reflect on various components of their education such as communication skills, professionalism and knowledge of sustainability.

Reflection encourages the growth of skills such as: problem solving skills, higher order reasoning, integrative thinking, goal clarification, openness to new ideas, ability to adopt new perspectives, and systemic thinking (Ash & Clayton, 2009). These skills are reflected within the graduate attributes, and directly relate to problem analysis and lifelong learning specifically, but could be expanded to incorporate more of the attributes.

Lifelong learning is the attribute that is most difficult to quantify and demonstrate an understanding of, and how it contributes to life as a working professional. Consequently, it is the attribute that students have the most to gain from, as it a skill that will help them as the world evolves. By introducing reflective mediums into the curriculum, the notion of lifelong learning is quantified, with direct evidence to demonstrate that competency to the Accreditation Board. Encouraging students to dive deeper into their education and examine how they can gather more information and guide them to be better learners, will strengthen the concept of lifelong learning.

The learning portfolio is an excellent tool to bring together student work and reflection as well as reinforcing the importance of the graduate attributes. Encouraging students to confront their successes and failures and reflect on what can be done to enhance their learning journey will increase their comprehension of the graduate attributes, especially their understanding of lifelong learning.
4. Implementation

Reflection and the learning portfolio are directly related, as one supports the other; within the Faculty of Engineering there are a few key stakeholders that would be able to bring these concepts to fruition. The stakeholders that are seen as the most likely champions for this initiative are extracurricular opportunities ranging from student clubs and teams to the SELECT program, the Engineering Co-op and Career Services office, Faculty members, more specifically members of the Experiential Learning Task Force. Each stakeholder brings a different opportunity to utilize the learning portfolio and reflection in a diverse capacity while striving towards the same end goal of encouraging students to develop goals and use the tools provided to develop a comprehensive image of their learning experiences and achievements.

The learning portfolio is hosted online through Avenue to Learn and all students have access to this tool for the duration of their time at McMaster University. The unique thing about the online interface is that presentations can be shared and pushed to other Avenue users. Sharing a presentation with another user allows them to view the presentation and provided comments on the various components. Pushing a presentation to other users allows them to take ownership of the presentation and modify it as they see fit. The original user would still be able to make alterations to their presentation but the user that the presentation was pushed to would not be able to view the alterations.

4.1. Extracurricular Opportunities

4.1.1. Student-led Clubs, Groups and Teams

Learning portfolios and reflection can be implemented by student clubs, groups and teams as a means of enhancing their clubs functionality, assisting in the transitional process and tracking the development of the club/group/team as the years go by.

The transitional process for extracurricular groups can be supported by the learning portfolio platform by taking advantage of the unique features that Avenue has to offer. Using the push option explained previously and compiling all of the resources and documents used throughout the term, students with high-level involvement in various clubs and activities can create a portfolio to ensure that materials are given to students taking on high-level roles and developed further in subsequent years. In a transitional learning portfolio students would upload documents, reports and reflections on the various events and activities that they were responsible for facilitating throughout their term.

Creating a shared learning portfolio that high-level members have access to has the potential to increase the clubs functionality; the learning portfolio could be used as an internal website or an advertising mechanism for students interested in the club to view prior to joining. Students would put images and important documents in the portfolio and make it similar to a pamphlet so students would have an idea of what kind of benefits and challenges the various clubs face on a yearly basis prior to getting involved. Additionally, it has the potential to increase functionality by making club information easily accessible to each member on Avenue to Learn.
4.1.2. SELECT Program

The concept of reflection is already heavily embedded in the SELECT program, with a large component made up of encouraging student to reflect on the various modules and activities that they participate in. The learning portfolio will support these reflective activities by providing students with a centralised space to store their reflections. Additionally, the students who wish to solicit feedback on reflections from their peers, mentors and facilitators would be able to share their learning portfolio to gain that feedback.

There are two formats that could be used by the program to introduce the learning portfolio and reflection. The first format would have students create professional goals that they wish to accomplish throughout their time in the program. Students would then reflect on those goals after each module, documenting their successes and challenges that face with regard to their goals. The second format would have students write reflective pieces after each module, highlighting what they learned, how that learning can be expanded as well as answering some critical questions specifically tailored to each module. For both formats, once all the modules have been completed the participants would be encouraged to create a presentation in their learning portfolio on Avenue that showcases all of their reflective pieces, an overall reflection on the program, as well as outline some professional goals of skills they would like to develop now that the program is over.

4.2. Engineering Co-op and Career Services

The Engineering Co-op and Career Services (ECCS) office is the ideal venue to support the learning portfolio and the accompanying reflection initiatives. As engineering is a very technical program and employers generally comment that engineering graduates are lacking communication skills, the co-op office is a great place for students to get support and feedback on their learning portfolio and reflective pieces to further develop communication and professional skills. Additionally, reflection and the learning portfolio are unique tools that could be used to assist with job searches, increase employability and interviewing skills, and set McMaster Engineering students apart in the competitive job market.

The ECCS office should introduce the learning portfolio to students enrolled in ENG 1EE0. Introducing the importance of the learning portfolio and highlighting how reflection can enhance success while job searching will encourage students to develop their own learning portfolio. Resources such as reflective questions, sample learning portfolios and a guide on how to write your own learning and professional development goals would be available to students through the co-op office.

Alongside the final assignment of submitting a tailored cover letter and resume, the students enrolled in 1EE0 would be required to share with the instructor a copy of their learning portfolio presentation for the course. This would be a mandatory component that would introduce students to the software as well as to the idea of reflection and how it can be incorporated to enhance everyday activities. The instructor would provide feedback on the students learning portfolio and encourage them to keep reflecting and adding artifacts to their portfolio to benefit them and quantify their learning experiences in the future.
Throughout the co-op course the instructor(s) should encourage the students to experience the learning portfolio and highlight different ways that using the learning portfolio (and reflection) can benefit the job search. Some of the ways that reflection can benefit the job search is that when you practice reflection and think about the experiences and emotions that you have had during various events, it will make it easier for you to answer challenging behavioural questions, for example when the interviewer asks you to identify a time where you have failed. The learning portfolio can be used in the job search to help you think about your strengths and weaknesses and how they can be applied to various job postings. In the hiring process, students could put a link to their portfolio on their resume or LinkedIn profile for employers and hiring managers to see tangible examples of the skills and accomplishments that they claim to have on their resume and cover letter.

Exposing students to the possibilities and uses of the learning portfolio in the co-op course and having the ECCS office act as the ‘hub’ for reflective activities and the support centre for the learning portfolio is a smart move for the Faculty of Engineering. The individual Department offices won’t have the resources available to support these activities, and it seems natural that the learning portfolio and reflection be utilized primarily for career and professional development, at least within the engineering faculty. By hosting resources and support in the ECCS office ensures that there is one central point of contact for the vast majority of resources and feedback is available to all students equally.

4.3. Curricular Opportunities

There is an array of opportunities to introduce the learning portfolio and reflection into the curriculum, ranging from design and capstone projects to laboratory experiments, midterms and assignments. Reflection encourages the growth of skills such as: problem solving skills, higher order reasoning, integrative thinking, goal clarification, openness to new ideas, ability to adopt new perspectives, and systemic thinking (Ash & Clayton, 2009). These skills are essential for engineers to have and will increase student’s capacity for lifelong learning and problem analysis.

When students participate in design and capstone projects, reflection and the learning portfolio can replace some of the more outdated methods. Typical design and capstone projects are done in groups or teams of students. An opportunity to show students how important teamwork is, is to encourage the students to reflect on how their group interacted, how tasks were delegated and if they could start over what they would change. These reflections could be added to their final design notebook submission or even as an appendix in their individual reports. It would be an excellent way to gain insight on who completed a large amount of the work and might be able to highlight students who didn’t work well or contribute as much compared to the other group members. Collecting students’ reflections for these types of projects would provide student accounts of the teamwork skills that they acquired while at McMaster University and could be used in the accreditation process to showcase the individual and teamwork attribute.

Laboratory reports are technical in nature, and students often find it difficult to connect the experimental content to other aspects of the course and, more importantly, real world applications. Professors should add additional questions to report guidelines that encourage students to identify how they see the material fitting into their career as well as how it connects with real world events and
discoveries. This would help students in drawing stronger connections as to why it is important to learn course material and how different aspects of the course connects to their life as an engineer. This concept can be expanded to include assignments as well; but be mindful of the frequency of reflection as asking students to reflect on the same concepts or too often will result in reflections of lesser quality.

One of the major priorities of the learning portfolio is to encourage students to create learning outcomes, or goals, to better direct their learning opportunities and experiences towards those goals. Having students in a course create learning outcomes will provide students with the opportunity to reflect on their progress throughout the course. Many courses already have learning outcomes outlines in the course calendar and having students create their own will encourage students to take ownership of their learning and motivate them to perform better on course deliverables.

4.4. Experiential Learning Task Force

The resources, rubrics and reports that have been developed throughout this summer should be communicated to the Experiential Learning Task Force. A presentation should be made to the group on methods and mediums necessary for reflection to occur as well as how the learning portfolio can be incorporated into the curriculum. As reflection is an integral part of the experiential learning cycle, and the faculty members that are a part of this task force are champions for promoting experiential learning within their departments, hopefully they will champion the learning portfolio and reflection in their departments as well. The resources and methods are available for implementation and hopefully they will encourage others to utilize reflective exercises and the learning portfolio within their courses as well.

5. Available Resources

There are many resources available for professors and staffs to aid in implementing reflective activities and assist students in the development of their learning portfolio. There is an excellent introductory video that Desire to Learn has created to describe what the learning portfolio and how it can be used. This video can be found on YouTube by searching ePortfolio Introduction or accessed by the following link http://www.youtube.com/watch?v=TFb0u6dl3u4.

Contact Dr. Lynn Stewart, at stewarl@mcmaster.ca for additional reports and rubrics that were developed such as rubrics for various purposes as well as a comprehensive list of reflective/critical questions that can be used to precede or secede any event or experience.
6. References


