Reflections on an E-Portfolio Assessment in a First-Year Physiology Course

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CHALLENGE STATEMENT

Traditional assessments such as closed-book written exams have several problems associated with them. Firstly, the format of the exam has little connection with the real world—¹ biomedical engineers do not, during their work-day, sit and write about biomedical engineering. Secondly, closed-book exams tend to only test memory and what the student can reproduce rather than what they can do.^{1–3} Thirdly, there is no opportunity for feedback and reflection during a written exam⁴ and unless feedback is received immediately after the exam, students have less interest in where they did well and where they lost marks.¹ Finally, time-constrained, closed-book written exams have accessibility issues including disadvantaging students who cannot express themselves through writing due to a disability, and disadvantaging those who have anxiety or attention issues that prevent focus.³

E-portfolio assessments are digital representations of students' work in addition to their reflections on learning.⁵ It is a social constructivist approach to learning where a student constructs knowledge by interacting in a learner-centered environment with learning materials and other people.⁶ They can address the problems of closed-book written exams in the following ways.

E-portfolios enable students to connect learning inside the class environment with experiences outside it. Anyon and Gambino describe the creation of an e-portfolio as an integrative learning process where connections are made between diverse experiences inside and outside the class.⁷

The integrative learning is enabled by the reflection, which is an essential part of an e-portfolio. It provides

opportunities for students to examine how they have learned and how they can improve. The reflection within an e-portfolio makes the learning process visible.⁷ The outcome of the reflection should result in an improved creative process for the next stage of the portfolio. This iterative procedure draws comparisons with the engineering design cycle, where the engineer addresses a question or problem; plans a design; creates the design; and reflects on the design to make an improved version. Student learning is further supported by regular feedback on e-portfolios.

Anyon and Gambino go on further to say that the integrative learning within an e-portfolio helps students to engage deeply with the course content.⁷ This deeper learning is supported by several case studies, which highlight increased student engagement through e-portfolio use.⁸ It has also been demonstrated that the deeper learning attained through completion of an e-portfolio assessment resulted in better final exam marks for a sophomore biology class⁹ and improved self-direction, communication, and leadership skills for students of an engineering program.¹⁰

E-portfolios address many of the accessibility issues of closed-book exams. Students can use a variety of formats and media to express their learning and are not subject to the same time constraints.

An assessment e-portfolio in a physiology course is presented. This is a required first-year course in the biomedical engineering program. The learning outcomes for the course are:

1. Describe and explain the function and regulation of the heart and circulatory system.
2. Outline and explain the structure, function, and regulation of the digestive system.
3. Describe and explain the function and regulation of the central and peripheral nervous system.

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4. Describe and explain the function and regulation of the connective, epithelial, and muscle tissue.

The major challenge in this work was to decrease dependency on the closed-book written exam and use an e-portfolio assessment instead. This was to achieve deeper learning in the subject, while also connecting the course content to students' personal experiences and increasing accessibility.

Implementing an e-portfolio assessment presented its own set of challenges to be overcome. They were:

1. Creating an engaging e-portfolio assessment that allows students to demonstrate their physiology knowledge in a personal way.
2. Enabling students to make connections between topics in physiology and biomedical engineering.
3. Allowing students to self-review and peer review their classmates to create a sense of community within the class. This is especially important when the class only meets online as is the case during the Covid 19 pandemic.
4. Using a platform for the e-portfolio that required little technical support: There currently is no dedicated e-portfolio platform within the institute where students can receive technical support. The class meets only for 1 h per week. This does not allow sufficient time for students to become familiar with dedicated e-portfolio platforms such as Mahara or PebblePad.

NOVEL INITIATIVE

E-Portfolio Assessment Structure

The assessment was worth 50% of the marks for the course. For context, the other components of the assessment schedule were 10% for completion of pre-class reading and pre-class quizzes, and 40% for four online tests (each worth 10%, 10%, 15%, and 5%, respectively).

The relatively large weighting for the e-portfolio assessment allowed the assignment of a rich variety of scaffolded tasks (Table 1). Initial tasks included students stating their goals in the physiology course and summarizing a topic covered in class. Later tasks required students to research biomedical engineering solutions to various diseases. Most tasks were additional work for students and did not correlate with other assignments but did provide deeper learning opportunities in the course learning outcomes. Tasks where students summarized a topic covered in class correlated with tests given during the year and provided opportunities for revision.

There were also some self-review and peer-review tasks. The self-review task required students to reflect on one of their earlier submissions and suggest improvements to it. They also indicated areas in the portfolio where they implemented feedback from the instructor. When peer-reviewing their classmates, they (a) reflected on what they liked about the portfolio, (b) made suggestions for improvement, and (c) indicated something they learned from it.

Students were provided with a basic template for each task but were allowed to deviate from it (Fig. 1).

A rubric was provided for each task, which detailed expectations in several areas, including content, reflection, and portfolio design (Table 2). Creative layout and use of multi-media within each e-portfolio task earned the student marks. The rewarding of creativity distinguishes the e-portfolio assessment from the traditional essay assignment.

Students usually had 2 weeks to complete each task. The instructor provided audio and written feedback to each student within 1 week of a completed task. The audio feedback was recorded on the e-portfolio page. Audio feedback has the potential to enhance the quality of advice with the tone of the lecturer's voice giving additional information to the student.¹¹ Students have previously reported audio feedback to be accessible, convenient, and personal.¹² Race¹ states the "the voice can be much more encouraging than mere printed or written words."

E-Portfolio Platform

Students developed their e-portfolios on Microsoft OneNote Class Notebook.¹³ While not a dedicated e-portfolio platform, OneNote allows students to do typical actions required in an e-portfolio. This includes embedding images and video, recording audio, uploading presentation files, inserting hyperlinks, and typing text. OneNote Class Notebook creates a section for each student enrolled in the course using their college computer account. Students can organize content into separate sub-sections, which are visible to the instructor. Written and audio feedback can be added to the sections. OneNote has the facility to record audio messages on the e-portfolio page, which the student can listen to.

Anonymous Survey

Students in this year's class were invited to complete an anonymous survey on their e-portfolio and OneNote experiences. There were thirteen questions, with a mixture of Likert scale, multiple-choice, and free text types. Ethical approval from the GMIT Research Ethics Committee was received for conducting the survey and gathering student e-portfolio samples.

Task 4: Overview of digestive system

Instructions for this task can be found on [Moodle](#). As with the other tasks, there are marks going for creative pages.

Overview

Provide a brief overview of what was covered in the digestive system.

Engineering and the digestive system

Provide a link to a resource or embed a video that links engineering to the digestive system. This could be a video talking about a device that helps improve the health of the digestive system or it could be a link to a biomedical laboratory that researches the digestive system.

Find something that was not already covered in the weekly on-line classes.

Reflect on the artefact you selected:

1. why did you choose it?
2. what are the key points you learned from it?

Reflection on learning

Reflect on what you learned in the weeks you spent studying the digestive system.

1. What did you enjoy most about the digestive system?
2. What were the challenges?
3. What you would like to learn next beyond what was covered in this module?

FIGURE 1. Sample template.

TABLE 1. Tasks assigned for the e-portfolio assessment.

Task No.	Task details
1	Student goal setting
2	Summarize and reflect on blood flow and blood pressure
3	Research gastroparesis and biomedical engineering treatments for the disease
4	Choose an artifact that links the digestive system and biomedical engineering
5	Research one of three topics related to the nervous system
6	Research one of three topics related to brain development to research
7	Self-review their work and peer review their classmates
8	Research any topic on biological tissues

REFLECTION

Student Engagement

There was good engagement with the e-portfolio assessment with 79% of the class completing at least seven of the eight assigned tasks.

The outputs created by students for the e-portfolio demonstrate the diversity present in the class. Students

used a variety of creative methods to display their portfolios, including Prezi, and Publisher (Fig. 2). Some students opted to scan and upload hand drawings. Several students produced audio to reflect on their outputs. Memes also proved a popular means of reflection and conveyed a sense of fun when creating the e-portfolio.

FIGURE 2. Sample of student e-portfolios (a) hand-drawn poster on blood pressure; (b) Prezi presentation on musical therapy for stroke survivors; (c) extract of a newsletter on stroke recovery.

TABLE 2. Sample grading rubric for an e-portfolio task on brain development.

	Not achieved	Acceptable	Proficient
Summary of topic	0 Topic not researched appropriately—information not relevant. Writing not in your own words.	2 Reasonable research of topic in your own words and style—not all questions fully answered; sources of information not always clear.	4 Excellent research of topic; sources of information clearly indicated.
Topic reflection	0 No reflection on the topic. No challenges or goals for continued learning listed.	1–2 Some reflective writing is present. No challenges or goals for continued learning listed.	3 Reflective writing is present and frequently includes more than description. Reflection explains growth and includes goals for continued learning.
Design and originality	0 Design choices are simplistic, inappropriate, or disorganised. No use of images, audio, or video.	1–2 Design choices are often appropriate; some audio, video, or images are used but not all relevant to the topic.	3 Design of page is well thought out and creative/attractive. Good use of audio, video, or images to communicate topic.

FIGURE 3. Survey responses indicating agreement level with statements related to the e-portfolio.

FIGURE 4. Survey responses to questions on OneNote use.

Deeper learning was evident in many of the student e-portfolios. Students chose to research topics on brain development, epilepsy, dreaming and sleep patterns, tickling, skin cancer, and soft tissue injuries. All these topics refer to material covered in the class but go more deeply into it. Student reflections revealed connections made between the learning environment and the outside world. For example, some students researched depression because they knew someone afflicted with the disease. Another student suffered from a traumatic brain injury and was motivated to research tissue engineering techniques for neuroregeneration. The research allowed him to go deeper and “get behind the buzzwords ... and look at it from a more scientific point of view”. Reflections allowed some students to identify pathways for growth. Researching music therapy for aphasia recovery highlighted for one student that “we have to be more than biomedical engi-

neers. We have to have a lot of tools in our tool kit because the key to discovering cures or solutions to a lot of our problems is being able to take multi-disciplinary approaches”.

Survey Responses

There were 24 responses to the survey out of a class of 39 students. For 75% of the responders, this was their first e-portfolio. 91% of students indicated that the e-portfolio tasks allowed them to research physiology topics that interested them (Fig. 3). 96% of students indicated that the tasks allowed them to be creative and it helped with revision for other assignments. All students agreed the tasks allowed them to demonstrate their knowledge, while 91% agreed that reflecting on the tasks furthered their learning. 9% of responders thought that the workload for the e-port-

folio was too much. 83% agreed that the feedback received from the instructor helped with subsequent tasks. 74% of respondents always listened to the audio feedback, while 17% sometimes did.

Students commented positively on being able to research interesting topics and communicate them in a way that was personal to them:

It really gave us a chance to show our own style of work and provide a sense of our personality, I honestly learned so much more from these portfolios than I have done so with other ways of learning I found them enjoyable as I got to research topics that interested me and I found it fun to do so.

Gave me a chance to research interesting topics

The freedom to do what you want.

The ability to go off and do research on topics within the unit that I found personally interesting or enjoyable.

Some students commented that the reflection components of the tasks were challenging. In the template, there were some prompts to get students started. For example, one prompt was “What were the challenges and how did you overcome them?”. See Fig. 1 for other examples. In future, providing more prompts and exemplars will provide more support to students when reflecting.

A common challenge for students was determining the reliability of online sources. To address this, time in class was dedicated to highlighting tools for students to check the reliability of information. One straightforward tool demonstrated was the CRAAP test, which gets students to answer questions on the currency, relevance, authority, accuracy, and purpose of a source.¹⁴ A one-page document on how to apply the CRAAP test is available online.¹⁵

Students also commented that displaying content creatively was challenging. In future, providing exemplars should give students ideas on how to creatively display content. Allowing students to be creative in higher education prepares them for solving complex problems in the real world.¹⁶ E-portfolios support the creative aspects of student learning.⁴ Encouraging students to be creative when presenting information in their portfolios will help them to be self-directed and motivated learners.¹⁷

OneNote as an E-Portfolio Platform

While 65% of the students had not used OneNote before, no one found it difficult to use and 96% indicated their OneNote proficiency improved throughout the year (Fig. 4). Students commented positively on the accessibility of their e-portfolio on OneNote. Editing

was straightforward and they did not have to worry about saving and uploading tasks. The only negative aspect for students was the occasionally slow syncing of their pages. As OneNote Class Notebook is used frequently in subsequent courses, students are well prepared to use it after completing the e-portfolio assessment.

From an instructor perspective, OneNote addressed most of the needs of an e-portfolio platform. Students required no significant technical support when creating their e-portfolios. Using a dedicated e-portfolio platform such as Mahara would most likely require training workshops.¹⁸ This course did not have the time available to do this. A significant challenge when using OneNote was enabling students to share pages for peer review. A workaround was developed where students copied selected pages into the collaboration space in the Class Notebook. Peer reviewing is an important component of e-portfolios.⁶ The easier it is to share pages for peer review, the more often it will occur.

CONCLUSIONS

The e-portfolio assessment was positively received by students. The challenges stated at the beginning were met:

1. Students demonstrated their knowledge in a creative and personal way using a range of media. In addition, students developed their computer literacy skills as they created their portfolios.
2. Students made connections to topics outside the course by researching treatments for diseases, and biomedical engineering technology. This research enabled deeper learning beyond what was covered in the classroom.
3. Students were able to peer review each other. The ability for students to highlight positive aspects of their peers' e-portfolios and also to provide constructive feedback helped to create a sense of community within the class. The actual extent to which students felt the e-portfolio activities developed a sense of community in the class needs to be ascertained. In future, the method of sharing pages needs to be easier to allow more peer reviews to take place.
4. OneNote was straightforward to use for students creating their e-portfolios. They required no significant technical support. The only issues were the mechanism for sharing pages, and the slow syncing of pages.

Future work would include evaluating whether the e-portfolio assessment did further student learning as much as the students reported. Analysis of performance in the other assignments in the course should determine this.

A further development of this e-portfolio assessment is to combine it with other courses across all years in the program. This will allow the students to make more meaningful connections between physiology and biomedical engineering and to reflect on their development as they progress through the program.

DECLARATIONS

CONFLICT OF INTEREST

The author has no conflicts of interest to declare that are relevant to the content of this article.

CONSENT TO PARTICIPATE

Informed consent was obtained from all individual participants included in the study.

CONSENT FOR PUBLICATION

The authors affirm that human research participants provided informed consent for publication of the images in Figs. 2.

ETHICAL APPROVAL

Approval was obtained from the research ethics committee of GMIT. The procedures used in this study adhere to the tenets of the Declaration of Helsinki.

AUTHOR CONTRIBUTIONS

The sole author conceived the study design, collected the data, and drafted the manuscript.

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DATA AVAILABILITY

E-portfolio templates available to share.

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