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Teaching Capstone Students to Reflect and Illustrate Design Skills and Experience through ePortfolios

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Electronic portfolios (ePortfolios) provide a way for capstone students to reflect upon and visually demonstrate their academic and professional experiences as they prepare to transition to engineering workplaces. This project builds upon work from a previous project integrating ePortfolios across multiple levels of undergraduate classes within the Mechanical Engineering curriculum at New Mexico Tech. While the initial project confirmed that integration of ePortfolios within the undergraduate Mechanical Engineering curriculum at New Mexico Tech was of value, this project integrates lessons learned and more thoroughly develops ePortfolio instruction, particularly for students taking capstone design courses.

Keywords: *Electronic portfolios, self reflection, workplace preparedness*

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Introduction

In the foreword to *Creative Ways of Knowing Engineering*, Radcliffe argues "Success as an engineer depends vitally upon being self aware"[1] (p. v). While self awareness is not easily taught, through electronic portfolios (ePortfolios) we can provide opportunities for capstone design students to reflect upon and assess their educational experiences and resulting skills and interests.

In selecting the artifacts and annotations to include within their ePortfolios, students engage in self assessment and realize the opportunity to identify both knowledge gained as well as areas where they have gaps. The personal narrative component of ePortfolios provides the means by which students can make connections between their prior learning activities and their future goals.

For most students, their capstone design project experience will play a prominent role in the ePortfolio. To maximize the potential of the ePortfolio as a tool students can use in the job search process, capstone students benefit from targeted ePortfolio instruction. Such instruction should guide students in self-reflection activities as well as provide them with communication instruction so that they can most effectively demonstrate engineering skills and interests through both visual artifacts as well as accompanying annotations and a personal narrative to provide context.

Background

While many programs integrate portfolios into their curriculum, often such emphasis on portfolios is motivated by programmatic assessment and focused on displaying student outcomes[2,3]. We recognize the value in that body of work, yet our scope is limited to professional preparedness portfolios as a vehicle for student reflection, self assessment, and as a professional internship and job search tool. Multiple prior studies led by researchers at the University of Washington support the value in integrating preparedness electronic portfolios within undergraduate engineering curricula[4,5,6,7,8,9]

In our previous project, we introduced ePortfolios within multiple design courses[10]. Students were required to create and submit annotated visual artifacts demonstrating engineering skills. Analysis of these artifacts guided development of an ePortfolio studio course to be offered in Spring 2025.

Through student surveys, the initial project demonstrated that participants received valuable takeaways from the ePortfolio instruction and

assignment. Among the total 130 participants (across first-year, junior, and senior design courses) who completed the survey, the majority of them considered ePortfolios as potentially valuable or valuable, as shown in Figures 1-3.

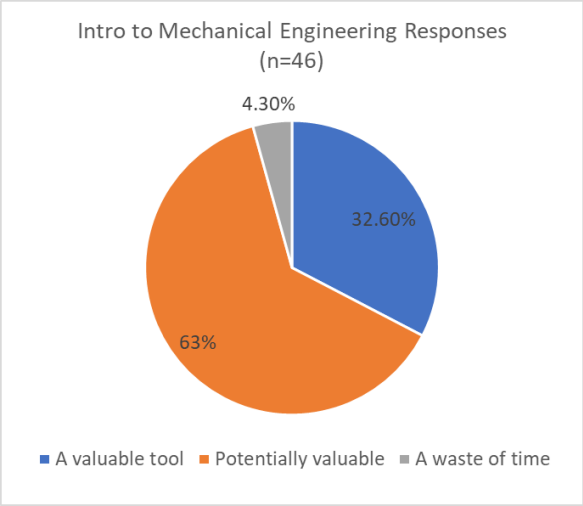

Figure 1: Introduction to Mechanical Engineering responses to the usefulness of ePortfolios

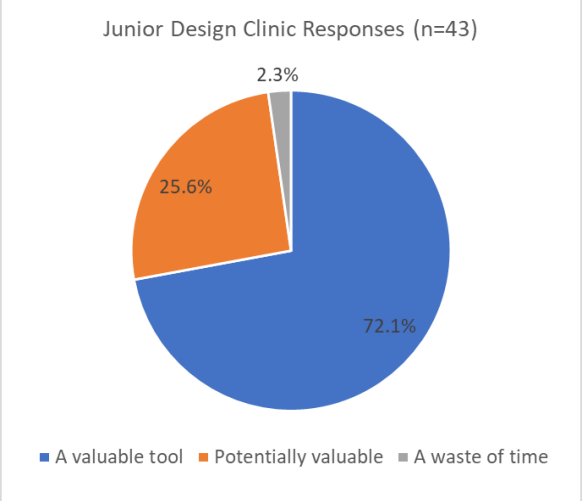

Figure 2: Junior Design Clinic responses to the usefulness of ePortfolios

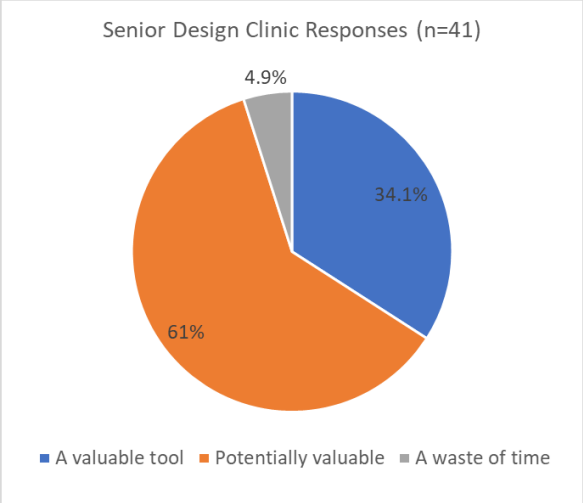

Figure 3: Senior Design Clinic responses to the usefulness of ePortfolios

Open-ended survey responses from participants helped us better understand the ways students viewed the ePortfolio as useful.

- *"ePortfolios serve as not only a valuable resource for searching for jobs and internships, but also as excellent practice in assessing one's accomplishments realistically and professionally."*
- *"I chose two artifacts that I felt were my most significant contributions to my design team last year. They also displayed multiple engineering skills which I thought would be best."*
- *"I decided to choose my capstone project as it seems to showcase the most engineering design work and applied learning, which should hopefully be attractive to employers."*
- *"This helped me put a past summer internship project into concise words, which I found was very difficult… my main takeaway was being able to concisely recollect my past work."*

While the initial project confirmed the value of integrating ePortfolios within the undergraduate Mechanical Engineering curriculum at New Mexico Tech, through lessons learned we are currently developing more thorough ePortfolio instruction, particularly for capstone students.

Integration of lessons learned

Below we share lessons learned as well as strategies for capitalizing on these lessons within the ePortfolio studio course when we pilot it in Spring 2025.

Students need additional instruction on writing style

By the time students are in their final year, nearly all of them will have taken a technical communication course. However, clear writing style, a key component of any technical communication course, was not evident in many of the annotated artifacts submitted by senior students.

We saw examples of students including lengthy and irrelevant prose. Some submissions included passive voice, an unfortunate style choice that made it difficult to understand what individual work the student performed or what specific skills they were highlighting in the provided artifacts. Other submissions contained vague phrasing or irrelevant information, issues that both affected clear understanding of the significance of the included artifact.

Within the ePortfolio studio course, we plan to include emphasis on effective style. This emphasis will include style exercises focusing on sentence length and structure, verb choice, and individual word choice.

Capstone students need more instruction about how to establish context and cater content to specific audiences

In the submissions we reviewed, we noticed students did not always prioritize accommodating information appropriately for their audience. Some artifact annotations more closely resembled students writing an assignment to be read by their course professor versus an external audience. For instance, projects might be referred to be undefined acronyms. Within the annotations, details might be lacking regarding the overall purpose of a project (and, by association, the role the particular artifact played in said project).

While the ePortfolios students create in the future course will have a "real" audience beyond the course (whereas the prior project did not), emphasis on audience awareness is one of the most important communication lessons we can integrate into the portfolio studio course. Students will benefit from class exercises focused on accommodating information to different audiences. Further, our plan to involve industry professionals as reviewers of students' ePortfolio drafts will remind students of their target audience and allow students to benefit from direct feedback from this audience.

Capstone students need to be explicitly taught how to communicate their individual contributions to collaborative design projects

Capstone projects should play a prominent role in students' ePortfolios. Often, these projects best represent the culmination of multiple fundamental engineering skills. In addition, capstone projects result in tangible outcomes that may best serve as recent and applied examples. It did not surprise us that students in our initial study most commonly chose to include artifacts from their work on collaborative design projects.

We noticed that often students failed to clearly present what their individual contributions were on the design project artifacts they included. In some cases, an artifact might include a diagram of the complete design used within a project, yet no mention would be made of individual components the student worked on, nor of the role the student played in developing the design. Students seemed to prioritize including a visual highlighting overall team outcomes versus an image narrowly focused on their individual skills.

While the chosen artifacts should be as visually appealing as possible and represent depth of skills, students need to be reminded that the goal of their ePortfolio is to highlight their individual skills.

When providing further instruction to capstone students, we plan to introduce them to the argument model used by Turns et al.[6] The argument model teaches students to create their personal narrative as a professional statement that centers on an argument for their level of preparation. In choosing annotated artifacts that support this argument, students can better understand how to focus on their individual contributions within collaborative projects.

Students need in-depth instruction on writing the personal narrative

Most consequentially, whereas the initial project did not include substantial instruction on the personal narrative due to time limitations as well as the fact that the range of students (first-year to senior) was too vast, the planned course involves targeted personal narrative instruction and analysis for students in their final year of undergraduate study. Part of that instruction involves guiding students in self-reflection activities so that their personal narrative presents a clear argument of their skills and interests evidenced by their ePortfolio artifacts. Further, with a smaller group of students limited to those in their final year preparing to enter the job market, the planned course has the means to include more individualized instruction regarding not just effective artifact selection and annotation, but with emphasis on the personal narrative.

Implementation

This ePortfolio studio course will be first delivered as a pilot in Spring 2025 as an extension to New Mexico

Tech's existing Senior Design courses. Students in their final year of undergraduate study within the Mechanical Engineering major at New Mexico Tech who are planning to enter engineering workplaces upon graduation will have the opportunity to receive in-depth ePortfolio instruction and feedback.

This senior-level communication course is designed to help students assess and reflect upon their skills and experience as they prepare to transition to professional engineering environments. Through readings, discussions, activities, and assignments, students will deepen their understanding of their chosen discipline and their own preparedness to enter it. Students will also have the opportunity to receive feedback from professionals. Successful completion of the course will include an electronic portfolio demonstrating each student's professional interests and value to potential employers.

Course topics will include self reflection, self assessment, goal setting, argumentative writing, visual communication, non-verbal communication (body language), and oral communication (elevator speeches and interviewing, and presentations). Students will participate in in-class brainstorming, writing prompts and journaling, as well as assigned readings and class discussions, and peer review. Students will also have opportunities to receive feedback from industry professionals on drafts of their ePortfolio contents.

Course assignments will include required readings and discussions, a journal, a preparedness statement, five annotated artifacts, an updated resume reflecting their most recent experiences and skills, and presentation of the ePortfolio.

In closing, we see the ePortfolio studio course as a way to help students both reflect on the way their undergraduate education has prepared them to begin professional careers within engineering as well as successfully demonstrate this preparation for future employers

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