

Portfolios: An Effective Assessment Strategy for First Year Engineering Students

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Abstract

A portfolio is a purposeful collection of student work that tells the story of the student's efforts, progress and/or achievement in given areas. It can be used as a vehicle for demonstrating knowledge, understanding and performance, as a personal reflective tool, and as an assessment tool. Why use portfolios? They

- 1] Are conducive for assessing experiential learning
- 2] Provide opportunities for reflection
- 3] Encourage self-analysis
- 4] Provide broad and an in-depth portrayal of student thinking and behavior
- 5] Provide evidence of performance beyond factual knowledge
- 6] Provide developmental look at progress
- 7] Allow the student to share in the responsibility for assessment
- 8] Reflect life-long nature of learning

This article documents the preparation, documentation, and results of two sections of an Introduction to Engineering course's use of portfolios for reflection, self-evaluation, and demonstration of accomplishment. Formats for both a working portfolio and showcase portfolio are discussed. Student results and reactions are evaluated.

Introduction

Assessment of the graduate engineer's capabilities is part of gaining ABET accreditation for an engineering program. There are many means to do this including standardized tests such as the GRE or FE examination, interviews with students and/or employers, major research papers and projects, and locally developed essay tests [1]. Another method that the Messiah College Engineering Department has begun to explore is the use of portfolios.

Portfolios are commonly used tools in certain professions like art or photography, whereby artists or photographers seek to present collections representative of their best works to customers, clients or potential employers. Just as a photographer uses the portfolio to showcase his best work and a client can use that portfolio to assess that photographer's work, we believe the portfolio method can be a useful way to showcase and assess competencies required for an engineering graduate.

This article discusses our experience using portfolio as a reflection and assessment tool for the class, Introduction to Engineering (ENGR102).

Portfolio Defined

In order to emphasize the portfolio as a learning tool for this course, we combined elements of two portfolio definitions. Arter and Spandel's definition of portfolio states that a portfolio is "a purposeful collection of a learner's work assembled over time that documents one's efforts, progress and achievements"[2]. In addition, we also borrowed from Isaac and Jackson's definition of portfolio that "(portfolio) materials are accompanied by descriptive explanations and commentaries in which the learner describes, defines and reflects on the accomplishments represented in the portfolio" [3].

As the definition states, it is important that a portfolio be organized and arranged according to some purpose. It is not a haphazard collection of items that are randomly assembled with little rhyme nor reason. The purpose or intent of the portfolio must be clearly identified and articulated from the beginning. For the Introduction to Engineering course, the portfolio was to be a collection of every student's efforts and accomplishments relating to each of the five course objectives outlined in the syllabus.

Also as stated in the definition, a portfolio provides a documented history of a learner's progress and accomplishments over a specified period of time. We looked to the portfolio to serve as a record of each student's efforts and achievement. But more than that, we looked to the portfolio as an active learning tool. In the ongoing process of assembling a portfolio, the student interacts with items and materials that are part of his learning experience. As the student decides what to include or exclude from the portfolio, he is forced to interact with items repeatedly, reflecting upon those items' content and significance. We believe this serves to reinforce learning in powerful ways.

To insure that the portfolio was more than just a scrapbook of items and materials, we asked students to provide written commentaries to accompany the items that they selected for their portfolios. The written commentaries would portray how well the students had grasped concepts and content of various learning activities. We also wanted the commentaries to help students reflect upon and think through the personal impact and significance of their understanding about engineering as a potential profession.

Why Use Portfolios for this Course?

Portfolios can serve at least three purposes in an educational setting. They can be used to meet any or all the following purposes:

- 1.) As a personal reflective tool to the learner.
- 2.) As a tool for demonstrating knowledge, understanding or performance.
- 3.) As a tool for assessment.

All three of these goals were pertinent and desirable for this course.

Portfolio as a Reflection Tool. The portfolio, by its very nature as a tangible collection of the learner's own efforts and achievement, helps to stimulate personal reflection. As the learner interacts with the items in the portfolio, he must interpret and describe what the items are. He must consider and explain the significance of the item and why it is important enough to be included in his personal portfolio. He must consider the impact and implications of the item upon

his growth and development.

Portfolio as a Demonstration Tool. Secondly, the portfolio is a tool that provides direct evidence which portrays what the learner knows, understands and can do. It goes beyond claims to learning and offers verification of learning. The portfolio may include a variety of items at various stages of completion. Some items will simply demonstrate a learner's efforts to grasp and implement concepts. Other items may be works-in-progress that demonstrate the learner's progression or improvement. Other items may clearly show specific levels of achievement, competence, understanding or knowledge.

Portfolio as Assessment Tool. And finally, the portfolio can be used to gauge the degree of effort and/or the levels of accomplishment a learner has demonstrated or achieved. The portfolio is a tool that can be used for self-assessment by the learner as well as assessment of learning outcomes by the instructor. It can be a tool for both the learner and instructor to mutually discuss and celebrate learning accomplishments.

Characteristics and Procedures for Portfolios in the Course

Working Portfolio. Students were instructed early in the course to begin compiling a working portfolio. A working portfolio is characterized by its comprehensiveness and lack of selectivity. The metaphors, "suitcase" or "shoebox" portfolio, were used to explain that anything and everything relating to the course should be included in their working portfolio. This includes syllabus, class notes, assignments, project work, lab activities and notes, field trip notes, and out-of-class activities.

Students were advised to use a standard three-ring binder or file folder system and to organize sections around the five course objectives. Students were encouraged to maintain a log or journal as part of their working portfolios. They were also encouraged to think creatively about items and experiences to include which may go beyond normal class assignments and experiences. We recommended that they review their portfolios at least once a week.

Students Assume Active Role in Learning Process. One of the benefits of the portfolio is that students take a more active role in the learning enterprise. Although we provided a basic framework (by suggesting a format) and direction (by articulating the course goals) for the portfolios, we wanted students to determine what materials and experiences they would select to demonstrate and document their progress for the course. Therefore, students had to make decisions about what items to include that would best represent their progress in the course. They had to evaluate and assess what course assignments and activities had the most impact upon their own personal growth and development. They needed to give consideration to other out-of-class experiences and resources which would help them reach course objectives. To help prime students' thinking and imagination about items to include in their portfolios, a list of sample activities and resources for each course objective was included in the syllabus.

Reflective Commentaries. In addition to assembling materials as part of their portfolios, we wanted students to reflect upon the meaning and significance of the items they chose to include. Therefore, each item in the portfolio needed to be accompanied by written commentary

that would do three things: 1.) define and describe that item or experience; 2.) explain the personal significance and impact of that item or experience, and 3.) discuss the implications of that item or experience upon the student for the future.

Showcase Portfolio. At the end of the semester, students were to prepare and submit a showcase portfolio. Unlike the working portfolio, the showcase portfolio is characterized by its selectivity, focus, organization, and presentation. An excerpt from the syllabus describes the showcase portfolio assignment:

“...you will submit a showcase portfolio that demonstrates what you have come to learn and understand about yourself, the college experience and the engineering profession. From your working portfolio, you will select particular items representing the highlights of what you have learned and/or accomplished. The showcase portfolio will only represent the most meaningful and significant pieces to you from course activities. It should be a well-organized, well-written and professionally presented piece.”

The prescribed format for the showcase portfolio was: 1.) Title Page; 2.) Table of Contents; 3.) Introductory Statement; 4.) Documentation and Reflective Commentaries; and 5.) Closing Summary. The showcase portfolio was to be presented in a three-ring binder with section dividers. All written commentaries were to be word-processed. Materials and artifacts were to be clearly labeled.

Each student would personally submit his showcase portfolio to an instructor. A brief 5-7 minute conference would be held to review and interact on its contents. The showcase portfolio would be graded for completeness, clarity and presentation and would count as 25% of the final grade for the course.

Interventions during the Course

Course instructors established periodic times (interventions) to review working portfolio progress with each student.

The first intervention on the Introductory section proved very insightful since the students were asked to tell why they picked Messiah College and its engineering program. One student commented...

“ I came to Messiah College because I wanted to go to a Christian school with an accredited engineering program. I also think that Messiah has some of the most superior facilities of any school its size, and the dining services for the most part are excellent. I was looking for a school of about three thousand students, because if it gets any larger than that it then becomes impersonal. Less people know each other, it is not as friendly. The dorms are for the most part all redone, and very nicely set up, which was important to me because that is where I was going to be staying for my next four years. I also didn't want to be very close to home.”

Another student writes:

“ I ended up in the engineering program at Messiah College by a combination of chance, circumstance, and choice. The circumstance was that I wanted to attend a Christian college, but there are very few Christian colleges in the East which have an engineering program, especially a respectable 4 year program. The choice was the fact that Messiah had the best combination of a good engineering department, modern, up to date campus, good student body, and distance from home. All of these factors helped lead me to a place which I am now very happy to have chosen to attend.”

The second intervention on the Documentation and Reflective Commentary section

provided insights on the relevancy of the engineering topics, speakers, field trips, projects, team dynamics, etc. It was suggested by the instructors to divide this section into at least five divisions related to the objectives of the course: community building, personal development, professional development, academic success strategies, and orientation[4].

Community Building - The students make up a supportive learning community.

One student writes about the first project in the course. This project was a scale made with edible components such as lasagne noodles, candy, vegetables, etc.

“Although this lab did give me additional information about such principles as torque, the majority of my learning involved becoming familiar with the engineering process and toning my group work skills. We initially came up with an idea which seemed almost fail proof, and yet when we tried it, sure enough it was ineffective. My group had to continually adjust our thinking and our prototype as we tested and failed numerous times. Throughout this process, the three of us had to learn to work together. It was absolutely essential for all of us to respect one another and our ideas. There was a great deal of compromising and a great deal of criticism. However, this criticism had to be handled with care and tact. I found myself continually doubting their ideas and yet having to listen and give them the benefit of the doubt. I also had to give up my own ideas if they proved less effective and yet defend myself if my idea was the most effective. We grew as a group and learned how to deal with one another which eventually produced a fairly accurate edible engineering project.”

Personal Development - Students have a good understanding of and feel good about themselves and their educational experience. Students interact well with and respect others, engage in good health and wellness practices, and effectively manage the various aspects of their personal life.

One student writes about his working to improve his weaknesses:

“At the very beginning of the semester we did a self-evaluation, which is included in my portfolio. This self-evaluation really made me think about what type of person I am. It helped me to see what my weaknesses are and what my strengths are. The more I thought about who I was the more I realized that I’m not an optimistic person, I’m not a very good communicator, and that I’m not very sensitive to others. All of these things were things that I see as weaknesses in my life and things that I have tried to work on throughout the semester. Some things that I’ve found to be strengths in my life are; I have high morals, I have a good self-esteem, I’m always on time, and I’m usually very determined. These seem to be the things that help me in life, and that I don’t have to work at very much.”

Professional Development - Students are motivated by a clear understanding of engineering as a profession and conduct themselves ethically and in a professional manner at all times.

One student writes about an electronic kit she was building:

“Today I had my first soldering experience. I have no prior experience with this type of thing and I have had doubts about my ability and interest in such things. However, while making my Decision Maker I had a wonderful time. I was completely absorbed and preoccupied with what I was doing, and very pleased and proud with the end result. I showed all of my friends and they were equally excited. My Decision Maker now sits on my dresser, proudly displayed in view of anyone who may enter my room. I am so glad to know that I enjoy this kind of work. This only helps to support my choice of engineering as a major.”

Academic Success Strategies- Students know about and put into practice positive attitudes and productive behaviors that will result in academic success.

One student writes about collaborative learning:

“I have discovered that I really enjoy studying in groups. I also seem to learn more when I study in groups. I think that the reason I learn more is because in a group there are more ideas being passed around, and because in a group some of the time I end up teaching some of the lesson to the other people in the group. I have found that I

don't enjoy working by myself, because I like to mix a little socializing and fun with my studying. The only real problem with studying in a group is that sometimes the socializing takes up more time than the studying. Another real advantage that I've found to studying in groups is that in the work force you do a lot of things as groups, so studying as groups can also help give you more of a "real world" experience."

Another student writes about scheduling:

"The sections on scheduling time were probably the most beneficial in that there is so much to do in so little time that there is no time to waste on figuring out what you should be doing. Without a schedule it is so easy to waste time because you feel as if there is plenty of time. If you waste this half an hour, there will be time later to study, get projects done, or finish homework. The realization later when you are pressed for time causes a great strain when there is no need for it. At four in the morning and the paper, project, etc. is not done you begin to compromise your normal level of work. What you are suppose to be learning from the whole experience is no longer exciting or interesting, but rather an annoyance and a burden. I applied what I learned by making a detailed schedule of my day. In it, everything from eating, to devotions, to studying, to classes, to personal time, is figured in. No, the schedule is not written in blood. However, it does give me a foundation to work from and make changes as necessary."

Orientation - Students understand how the engineering department and the college work and how best to take advantage of the resources available to them.

A student writes about this visit to the machine shop:

"A major part of the orientation about Messiah came in the first couple weeks of college. During the first class in engineering we became oriented with most of the engineering aspects of the school. In the first class we were given the class syllabus and a calendar of events for the semester. Later that day in the first lab we took a tour of most of the engineering rooms and were able to see the different labs and some of the equipment that was available for our use. We met the technician in the machine shop who gave out an handout on the rules and policies of the shop. This handout was very informative because I know that the shop is something that I am going to use while I'm in college."

Conclusions

We are still discovering how using the portfolio in the Introduction to Engineering Course is impacting upon students. Some of these outcomes were anticipated and expected while others are still trends to observe and watch. Here are some of our observations and conclusions, thus far:

1. *Performance and Knowledge.* The use of the portfolio has helped us assess in a more balanced way not just what a student knows, but also what they can actually do. Whereas college courses often evaluate the conceptual knowledge a student obtains, the portfolio helps us determine if the student can apply that knowledge.

2. *Breadth and Depth.* The portfolio assisted in demonstrating both the broad and in-depth comprehension and competence of students relating to course objectives.

3. *Self-analysis.* The portfolio was a catalyst to students for assessing their own competencies, understanding and progress in the course. It also helped students reflect upon the significance and impact of course activities and concepts upon themselves in a more personally relevant way.

4. *Reflection.* The degree and substance of reflection demonstrated by students for this course improved over previous semesters when journaling was the sole reflective tool used. The portfolio helped us to identify and interact over some of the intangibles such as the students' thoughts and feelings about themselves, the college experience generally, the engineering department and engineering as a profession.

5. *Developmental Evidence.* The way students developed personally, academically and

professionally throughout the progress of the course was well demonstrated. Levels of growth in various areas were evident.

6. *Ownership and Engagement.* Generally, students took a more active role in the learning process. They seemed more engaged in experiences and items pertaining to course objectives. The portfolio helped connect the course agenda to their own goals and competencies.

7. *Affirmation and Confidence.* The assembling of portfolio materials demonstrated to the students what they were able to accomplish and what they learned. In most cases, this provided positive affirmation and instilled self-confidence.

Issues

There are a number of issues to consider when using portfolios and we encountered several of them as follows:

1. *Pacing of the Students Efforts.* Generally, a portfolio's progress and quality depend heavily upon the initiative and efforts of the individual student. And of course, students vary in the initiative and discipline needed to assemble a portfolio on a consistent pace throughout a course. Therefore, it is necessary to establish "checkpoints"(interventions) throughout the progress of the course to help hold students accountable in their portfolio progress. We required that the introductory section of the portfolio be due early in the semester. We also established a mid-semester review where each student met individually with an instructor to present and discuss his/her portfolio.

2. *Standardization versus Individuality.* When using portfolios, there is a tension between prescribing certain portfolio standards and allowing for a learner's individual creativity. Depending upon the purpose of the portfolio, an instructor must decide what is to be standardized across all student portfolios for the course and what is left up to the individual learner to determine. We tried to take a somewhat balanced approach in this course. As instructors, we determined five course objectives, but students were allowed to select which examples and how to best present them to demonstrate their progress in each objective. We also suggested a general format for organizing the portfolio, but students were free to be creative in the construction and presentation of their portfolios.

3. *Assessment Criteria and Standards.* Related to the point above is the issue of assessment. The less prescriptive an instructor is about portfolio standards, the more difficult it may become to establish evaluation criteria. Evaluating creative and different student portfolios can be like "comparing apples to oranges". For purposes of our course, measuring precise technical outcomes or competence was not as essential as promoting personal reflection, self-assessment, and an understanding about engineering as a profession. Therefore, we looked to the portfolio as a way to assess the student's personal interaction with and response to engineering at an introductory level. Our basic evaluation criteria included portfolio organization, presentation, progress in the five course objectives, level of personal reflection and writing ability, to name a few. Although we articulated these criteria in the course syllabus, an improvement would be to develop a flexible and economic assessment rubric to use in the future.

4. *Instructor Time and Resources.* Portfolio assessment may require more time than

standardized assessment tools. Scantron grading of an exam will take less time to grade than reviewing a student portfolio. That may be an issue in some circumstances, particularly in large class settings. However, the advantages of using the portfolio as it related to our course objectives outweighed this concern. In addition, since journaling had been part of this course's requirements in the past, the time needed to assess portfolios proved to be insignificant compared to assessing journaling. As instructors, we actually enjoyed this evaluation method over journaling.

Summary

Based on this first successful use of portfolios in the engineering curriculum as a personal reflective and assessment tool for demonstrating knowledge, understanding and performance, it is planned to utilize portfolios in several other engineering courses as well as recommending to the students to develop a showcase portfolio for potential employment interviews during the senior year.

References

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Biography

Carl Erikson is an Assistant Professor of Engineering. He obtained his BSEE from Rutgers University in 1969 and his MSEE from Purdue University in 1971.

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