USING PORTFOLIOS IN THE CLASSROOM

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Abstract. *This paper presents a review of the literature (including World Wide Web sources) and discussion of using student portfolios in the college classroom. Topics discussed are the definition of portfolios, contents, uses, evaluation methods, effectiveness, and suggested sources for further research. Specifics from various college courses, including engineering, writing, mathematics, and science courses, illustrate concepts. Three engineering courses are showcased to give an overview of differences in portfolio types, contents, and evaluation.*

In response to a desire for more information about portfolios expressed by engineering educators at the 1996 Frontiers in Education Conference, this paper presents a review of the literature on the theory and practice of using student portfolios in the college classroom. Throughout the paper, details from various college classes (such as engineering, writing, mathematics, and science) illustrate concepts. A separate section, however, focuses on a more complete overview of the ways three engineering classes use portfolios.

My purpose in writing this paper is to inform interested professors to help them decide for themselves about using portfolios. I try to answer these questions:

1. What are portfolios?
2. How are portfolios used in the classroom?
3. How are portfolios evaluated?
4. What are some examples of engineering classes using portfolios?
5. How effective are portfolios?
6. What conclusions can be drawn from the research cited in this paper?
7. What sources provide further research on this topic?

Therefore, the paper contains the following sections:

1. the definition and contents of portfolios
2. uses of portfolios for assessment and instruction
3. methods of evaluating portfolios
4. examples of engineering courses using portfolios
5. effectiveness of portfolios (drawbacks and benefits)
6. conclusions drawn from this literature survey
7. suggested sources for educators planning to do further research

Before researching this topic, I had used portfolios in three ways in my own classes as the need arose to accomplish a particular purpose. In my technical communication course, I had used portfolios in two ways. First and currently, at the end of the semester students turn in a folder of all graded work. When I assess course grades, a portfolio showing progress or excellent writing examples could raise a student's grade if the student is between grades. According to at least one source, this is not an example of a portfolio, but merely a folder of papers [1].

Secondly, I have in the past required students to turn in twice during the semester a folder of ungraded exercises and practice papers, somewhat like a collection of practice sets in engineering classes. I holistically assigned points for excellent, good, adequate, and poor work. The purpose was for students to learn from practice without being excessively penalized. While the students may have learned from this practice work, I did not consider my method of adding extra assignments very successful. To assess, even in a cursory manner, the volume and detail of these portfolio assignments was too overwhelming to give adequate feedback in a writing course already requiring eight graded papers plus other assignments.

The third method and my favorite, one I used in a former composition class at another college, is an individual conference method. It is adapted from the Garrison approach [2] of evaluating numerous rough drafts before grading selected finished papers. After discussing with the student as many drafts as necessary to meet a minimum criteria, I marked a paper as acceptable. The student then placed it in a portfolio folder and moved on to the next paper. After two or three papers were acceptable, the student chose one to revise for a grade. The portfolio itself was required but not graded. I liked this system very much, not for the portfolios, which I considered incidental, but for the individual conferences and revisions of each assignment. The assignment emphasized the student's writing process and learning by one-on-one instructor intervention and also self-assessment. The literature validates my experience. Portfolios work best when designed to include (but not necessarily be restricted to) student involvement and learning-centered (formative) evaluation.

My review of the literature on portfolios confirmed my belief that using portfolios should result from what one intends to accomplish. In addition, the literature confirmed that there is no one best way to use portfolios in a course [3,4]. Various effective ways exist and are still evolving [5].

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Definition and Contents of Portfolios

Definition

The term *portfolio* derives from the Latin verb *portare*, meaning *to carry* and the Latin noun *foglio*, meaning *sheets* or *leaves of paper*. Portfolios are the cases containing artwork, papers, and musical scores of students and professionals [1]. Indeed, the concept of portfolios comes from the artist's portfolio. The idea caught on in elementary and secondary schools and has recently spread to higher education [5].

A portfolio is a collection of student work that can be further defined by how the portfolio is used. One definition states: "A portfolio is a purposeful collection of student work that tells the story of student achievement or growth" [4]. Some sources are quite adamant that portfolios are much more than a mere collection. One proponent states that all portfolios have in common the fact that students must "collect, select, and reflect" [6] on their assignments. Portfolios in writing classes and indeed all portfolios, says Kathleen Yancey, have three common characteristics. "They are, first, longitudinal in nature; second, diverse in content; and third, almost always collaborative in ownership and composition" [7].

Kay Butler-Nalin's writing class at the University of Northern Iowa is a good example showing most aspects of this definition. Students submit three portfolios and select three exhibits for each portfolio: a showcase exhibit indicating best work, a growth exhibit of two drafts of a paper, and a response exhibit showing the student's feedback to peers. Students arrange the papers in the order they want to present to their instructor. A label for each exhibit defines selection criteria and reasons for the choice. Thus, the labels show that students have reflected on how their work meets the criteria [8].

Another good example is Gavin LaRose's systematic model for a course portfolio in his math classes at Nebraska Wesleyan University. The portfolio consists of weekly journal entries, solutions to student-selected homework problems explained in writing, and a synthesis entry relating the current weekly topic to previous topics and/or to other math principles previously studied. At the end of the semester, students select three portfolio entries representing their best work, worst work, and best illustration of learning. They include a paragraph explaining their choices [9].

Types and Contents of Portfolios

The purpose of the portfolio determines what goes in it. Portfolios may contain a variety of items (called artifacts): rough drafts, graded assignments, papers, showcase pieces, critiques or summaries of reading, self reflection pieces, homework assignments, journal entries, peer responses, graphics, spreadsheets, and even online discussions. The portfolio can take many forms. Some of these include: a folder of papers, a three-ring notebook, a box containing multimedia, a diskette, and a totally online portfolio. A guide is useful for understanding the arrangement and context of the portfolio, such as a table of contents, student comments or narrative (either oral or written), or a self-reflection paper.

Elizabeth Chiseri-Strater's college sophomore writing class provides a good example of content diversity. Students produce three categories of literacy portfolios: writing portfolios, learning portfolios, and self-reflective portfolios. All three portfolios allow for self-exploration. The writing portfolio emphasizes writing as a craft and contains such items as drafts of a paper, writing done in other disciplines, essays about literature, in-class writing exercises, and essays about the writing process as self-exploration. The learning portfolio emphasizes writing as a method of learning and making new meaning. It contains such items as journal entries, reader-response papers, multimedia entries (videos, music, artwork), collaborative projects, and essays about the learning process as self-exploration. The self-reflective portfolio focuses on self-development and personal identity. The small number of students writing these in the particular class Chiseri-Strater describes were all victims of abuse. They described who they were and how they were affected by their experiences [1].

Selection of Portfolio Contents

The student, professor, school system, or combination of any of these may select the portfolio contents. Professors can require selected assignments showing certain skills. Some proponents strongly recommend that contents must be student selected. Chiseri-Strater states that her classes' portfolios were not merely folders of their best written work but a way to think of new possibilities of literacy portfolios [1]. She agrees with Graves [10] that the content of the portfolio should show "range, depth, and growth." She describes the instructor's method of assigning portfolio content as the Chinese dinner menu approach:

> Take two [items] from column A, one from column B, and possibly a special appetizer or dessert, and voila! A portfolio that combines all the styles and genres of writing undertaken by the student writer (range) with all the revisions of one piece of writing (depth). Then stir in the reflective essay or letter written to describe the student's overall development as shown through the portfolio (growth) [1].

She states that although this approach is not wrong, it emphasizes the teacher and puts the student in a passive role. Her assignments have evolved into more open portfolios where students set the goals and choose the pieces. Students include a portfolio letter to her describing the items and their

reflections.

Uses of Portfolios

The student classroom portfolio has many uses. Some of these include a document of progress or risk-taking, a conference with the instructor, a record of performance, a tool for self-assessment and reflection, a job interview, and a reference for future professors to see the students' experience/training. One source mentions the term "passportfolio," indicating that the portfolio is sometimes used to certify competence to move to the next level. As these examples indicate, most portfolio uses fall into two main categories: assessment and instruction [4].

Assessment

In a recent *PRISM* article, Beth Panitz [5] states that the primary purpose for portfolios is assessment. Portfolios can be assessed by the class professor, a team of professors, the student, and/or peers. Sometimes an administrative or accrediting group, such as the Accreditation Board for Engineering and Technology (ABET), may look at a few to assess the program and the professors. Many sources stress the importance of student self-assessment. For example, student narratives about each portfolio item, much like artists' narratives, contribute greatly to the students' learning and to the audience's understanding of the context. The student-led conference provides an effective means of student self-assessment and reflection [11]. Two words kept cropping up in the literature: progress and growth. The professor and the individual student use the portfolio as a means to assess the student's progress in the course. The collection of work from the beginning of the course until the end charts the student's individual growth.

Assessment can be formative or summative [9]. With formative assessment, the instructor intervenes in the creative process, reviews drafts, and makes recommendations for revision. The purpose of formative assessment is to develop the students' skills. With summative assessment, the instructor evaluates a finished product for a grade. The purpose of summative assessment is to evaluate and rate quality. Practices differ for summative assessments. Some instructors grade the entire portfolio holistically and some grade individual pieces and total or average the scores. Some instructors assess in groups [12,13], sometimes with two instructors scoring anonymous student work and a third scoring to settle any disputes [7].

Instruction

Assessment was the original intent of the portfolio movement; however, Donald Graves states that "portfolios are simply too good an idea to be limited to an evaluation instrument." He and others recommend that portfolios should also be a "medium of instruction" [14]. The primary instruction method seems to be guiding the student's assessment of the portfolio -- that is, guiding the student's reflection, self-evaluation, and narrative describing the portfolio artifacts. Emphasizing that portfolios show the students' range, depth, and growth, Graves advocates "nudging" students to evaluate their portfolios by answering open-ended questions. For example, in his writing class, to help students recognize their range of values, he asks them to select and label the following artifacts: pieces they like, pieces that were difficult to write, pieces that surprised them in some way, and pieces that they did not want to stop writing when time was up [10].

Hill, Kamber, and Norwick also suggest questions to encourage students to reflect and learn from their work. Although used in an elementary classroom, these questions can easily be applied to the college level and adapted in various disciplines, for example, in an engineering design course. The questions include the following: "What is the process I went through while creating this piece?" "Who or what first influenced me to create this piece?" "What risks did I take?" "What new knowledge did I gain?" "Why was this piece an experiment for me?" "What did I learn?" "Why did I choose this piece for my portfolio?" "Do I have questions about this piece?" "If I were going to redo this piece, what would I do differently?" Another instructional tool that Hill, Kamber, and Norwick recommend is structuring regular instructor and peer portfolio reviews throughout the term [15].

Methods of Evaluating Student Portfolios

While professors' schedules for evaluating their students' portfolios may vary, most review them at least once (usually at the end of the term), sometimes in a conference. Others review them also at midterm while some evaluate selected items throughout the semester. Some simply give an holistic evaluation based on whatever criteria they have set. Others use some evaluation tool for the professor's evaluation, peer evaluation, or self evaluation. Some examples of evaluation tools include competency matrices, scoring guides, and student reflective essays.

A competency matrix for students to evaluate their learning achievement is used by Professor Lynn Bellamy and Professor Barry McNeill in an engineering design course at Arizona State University (ASU). It is described in a recent *PRISM* article [5] and also is available on the World Wide Web [16]. Bellamy and McNeill developed their format from one used in an Alaskan high school. It is a detailed matrix listing learning outcomes and competencies achieved for each assignment. Examples of learning outcomes are teaming skills and creative problem solving skills. In addition to learning outcomes, the matrix categorizes learning objectives

into two types: affective objectives (from Krathwohl's Taxonomy: receiving, responding, valuing) and cognitive objectives (from Bloom's Taxonomy: knowledge, comprehension, application, analysis, synthesis, evaluation). Listing page numbers of assignments, this grid also serves as an index to the portfolio.

A scoring guide (assessment sheet) for the entire portfolio is used in Professor Gene Takle's online environmental studies course at Iowa State University. This scoring guide lists items submitted, dates submitted, dates reviewed, points possible for each assignment, and points earned. Also, for each assignment, the guide describes standards for acceptable and unacceptable work [17]. Although called an assessment sheet, it also serves as a table of contents. The individual assignments are graded, but the portfolio itself is not [18].

For writing instructors, three examples of scoring guides are worth considering. All three have explanations of criteria with the latter two examples being the most detailed. The first scoring guide, from the Vermont Portfolio Program, although used in elementary school, can apply to any portfolio paper or can be adapted for the entire portfolio. Called a writing portfolio rating, it lists five categories: purpose, organization, details, voice/tone, and grammar/usage/mechanics (GUM). The evaluator, whether teacher, student, or peer, can rate each category on a scale of 1 to 4. The form also contains explanations for each rating [19]. Another scoring guide for individual papers is the holistic scoring guide created by committees in the California State University English departments. Each paper is rated on a scale of 1 to 6. The specific categories are (1) incompetent, (2) inadequate, (3) weak, (4) competent, (5) strong, and (6) superior. A holistic scoring guide for the entire portfolio was developed by Donald Daiker and the Miami University of Ohio English department. It also has a scale from 1 to 6 and the categories are (1) poor, (2) below average, (3) fair, (4) good, (5) very good, and (6) excellent [20].

A student essay reflecting on the portfolio and progress toward learning goals is an excellent tool. One example of a reflective essay assignment is from a critical thinking class at Indiana University at Purdue University Indianapolis (IUPUI) [21]. The assignment requires students to reflect on strengths and weaknesses in their learning, considering individual learning style and life circumstances. The students must explain ways to use this knowledge in future learning situations. Also, they must describe four useful concepts or skills and select examples from their work to illustrate either concept knowledge or skill mastery.

Another student reflective assignment that could be used as a guide is the previously mentioned questionnaire recommended by Hill, Kamber, and Norwick to teach students how to examine their work. Used as a written assignment, it can also form the basis of a student/instructor conference. Students answer questions about the process of creating the artifact, the risks taken, new knowledge gained, and reasons for selecting the piece. They also include still-unanswered questions about the work, and students' ideas about redoing the piece differently [15].

Engineering Classes Using Portfolios

The previous discussion has included selected details about various courses to illustrate certain points. The following examples provide an overview of three engineering courses using portfolios. These three courses illustrate the diversity in types of portfolios, in portfolio contents, and in evaluation techniques.

Informatics Engineering Course at Vanderbilt University

Professor John Bourne in his paperless, Web-based, electrical engineering/management of technology course at Vanderbilt Engineering School requires an online portfolio from his students. The course promotes asynchronous learning, meaning that students access the weekly assignment and needed materials, work on the assignment, and turn it in at any hour during the week until the deadline. For this course, called Informatics Engineering, students submit assignments electronically to the online portfolio. It contains all assignments done during the semester, including Web pages, Powerpoint slides, postings in online private conferences and discussion groups, papers, a final exam, and answers to questions on the reading. A midterm progress evaluation of the portfolio counts 10 percent of the total grade (5 percent for written materials and 5 percent for Web page presentation). Professor Bourne grades the individual assignments all at once at the end of the semester. He grades the portfolios holistically with a rating of excellent, good, fair, poor, or missing. The individual assignment grades, midterm evaluation, portfolio grade (which counts 10 percent of the total course grade) and final progress evaluation determine each student's final grade. The final progress evaluation at the end of the course counts 5 percent and includes conferences with the students [22,23].

Engineering Design Course at Arizona State University

As previously mentioned, chemical engineering professor Lynn Bellamy and mechanical engineering professor Barry McNeill at Arizona State University use portfolios in their freshman course called Introduction to Engineering Design. Students may submit either a printed or electronic portfolio. The electronic portfolio can either be sent in electronic mail or turned in on diskette [24]. In this large course, four-member design teams keep a team portfolio in the lab segment of the course. This team portfolio contains all work done on the projects, including problem definition work, idea generation, decision analysis, planning, assessment of

process, and team meeting materials. The grade for the lab portion is based solely on the portfolio. The professor checks the work for completeness and gives feedback. Portfolios are evaluated eight times during the semester, mostly by peers with the professor evaluating at least three times. Professors Bellamy and McNeill have developed an assessment method using checklists for each assignment. The checklists allow for self, peer, and faculty evaluation. Assessing with the checklist entails, rather than assigning grades, determining if the portfolio assignments fit one of three categories: Meets Expectations, Exceeds Expectations, or Needs Improvement. Grades are given at the term's end based on an explicitly stated system of possible ways to meet the grading criteria. The students assess their learning gains from each assignment with the detailed competency matrix explained earlier, analyzing competencies achieved and affective and cognitive objectives met. The matrix becomes the index of the portfolio and includes page numbers. This thorough analysis of learning outcomes takes considerable time; therefore, the professors have decreased homework assignments to counterbalance the students' workload [17,25,26].

Civil Engineering Course at the University of Colorado

Anthony Songer, a professor in the civil, environmental, and architectural engineering department at the University of Colorado, requires that students in his construction management course, a graduate course, keep all class materials and assignments in portfolios. Students submit some weekly assignments electronically, such as article summaries, and peers give feedback. Currently, the student's portfolio consists of a folder of papers, projects, weekly journal, class exercises, article summaries, and printed copies of online work. Professor Songer grades each assignment systematically with his own weighted scale, assessing such aspects as rationale, format, and content. He grades these assignments when they are submitted throughout the semester. He grades the portfolios, however, at the end of the term. When grading the research papers, he tells students what range of grades their work falls in and suggests improvements. Students may revise assignments and, if so, must include the original, the revision in the portfolio, and a memo detailing the changes made. This method is modelled after the review system used by refereed publications, one that Professor Songer feels contributes much to learning about good writing. The portfolio counts 10-15 percent of the grade, with the individual assignments counting 85-90 percent. Students may choose certain items to include and may omit others. Students also must include a justification paper telling what assignments should count toward the grade and why, suggesting how much each category of assignments should count within certain limits. For example, they must choose three of six article summaries and weight this category from 5 to 15 percent [27,28,5].

Effectiveness of Portfolios

As one would expect, a large majority of the sources consulted present more benefits than drawbacks. However, the drawbacks deserve serious consideration. Portfolios are not a panacea for all educational problems and using them does create some difficulties.

Drawbacks of Portfolios

Portfolio proponents mention some drawbacks. Several sources cite an increased workload. One states that research shows increased demands on students, teachers, administrators, and financial resources [6]. For large classes, the grading may be too much, says Anthony Songer [5]. (However, at least one person, a writing teacher, stated that portfolios lightened her workload [29].) Another drawback is that some students resist this new form of assessment [5]. They may also fall behind in keeping the portfolio [30] or may not turn it in, especially if it is not counted toward a final grade. Other drawbacks are storage problems [31] and scarcity of hard evidence to support the logical arguments and anecdotal claims of enthusiastic proponents [4].

One survey of 150 educators and educational contacts by the University of California's Center for the Study of Writing indicates that even though respondents claimed portfolio assessment was important, none gave a clear account of how achievement should be evaluated. This source states that the portfolio guidebooks cited did not advise about evaluating portfolios. The Stanford professor conducting this study speculates that the elementary and middle school teachers using portfolios were rebelling against external control and standardized tests. He also surmises that the portfolio movement encourages anarchy because articles and newsletters sometimes encourage an "anything goes" approach to portfolios. He states that without a more "solid conceptual foundation" portfolios may just be a passing fad [32].

Benefits of Portfolios

The sources consulted indicate that portfolios offer the following benefits:

- "They are readily adaptable to any grade, ability, or motivational level" [31].
- "They document student growth, change, and risk taking" [31].
- They support dialogs between teachers and students [32].
- They can be fully integrated into the curriculum as records of classroom performance [6].
- They, unlike tests, "supplement rather than take

time away from instruction" [6].

- Their instructional benefits include "close examination of work, comparison over time, identification of strengths and weaknesses through good criteria that define quality, [and] goal setting. . ." [4].
- They provide a convenient way to showcase work [4].
- They allow the instructor to be more of a coach [31].
- They provide a ". . . collection of multiple samples of student work over time . . .[enabling] us to (a) get a broader, more in-depth look at what students know and can do; (b) base assessment on more 'authentic' work (c) have a supplement or alternative to report cards and standardized tests; and (d) have a better way to communicate student progress to parents" [4].
- They can, some proponents claim, cause students to increase critical thinking, self reflection, knowledge, participation, and responsibility for learning [4].

Conclusions

My review of the literature on classroom portfolios indicates the following conclusions:

- Portfolios are a byproduct of an educational goal and should not be used as an end in themselves.
- Portfolios are and should be used in various ways in the classroom.
- Student assessment and student narratives are the most important element to reach learning goals in the classroom portfolio.
- Instructors planning to use portfolios can expect to spend time goal setting and formulating how the portfolios will be used.
- Instructors can expect portfolio use to be a continually evolving process.

Suggested Sources for Further Research on Classroom Portfolios

For engineering educators interested in researching this topic further, I recommend starting with the following sources to provide a good overview of the topic and of the wealth of information available. All but three sources are available on the World Wide Web.

Good Overview Sources

For those wishing to get an overview of the subject, four articles provide a good knowledge of portfolios used in the classroom. For a quick overview and examples of how portfolios are used in engineering education, Beth Panitz's PRISM article is a must [5]. Gary Wagenheim's paper presented at the ASEE 1995 conference defines portfolios, describes his classroom portfolio, offers suggestions for increasing student involvement, and describes the drawbacks and benefits of portfolios [32]. David Sweet's article entitled "Student Portfolios: Classroom Uses" defines portfolios, discusses factors affecting classroom use, and lists some current researchers in this area [6]. An excellent article summarizing research and consensus on this topic is Arter, Spandel, and Culham's "Portfolios for Assessment and Instruction," published by the Northwest Regional Educational Laboratory [4].

Bibliographies

Two comprehensive bibliographies show the plethora of information available on portfolios. *Portfolio Resources Bibliography* by test center staff at the Northwest Regional Educational Laboratory is quite helpful [33]. Another bibliography, on portfolios and portfolio assessment in higher education, is available from the ERIC Clearinghouse on Assessment and Evaluation and from the Web [34].

A unique and most helpful bibliography available online is Dr. Helen Barrett's favorite links on alternative assessment and electronic portfolios [35]. Barrett, a professor at the University of Alaska Anchorage, has listed four pages of direct links to online articles, bibliographies, and groups such as the Coalition of Essential Schools at Brown University.

Sources on Portfolios and Technology

For information about combining technology with portfolios, three articles may be helpful. David Niguidula's "The Digital Portfolio: A Richer Picture of Student Performance" describes a prototype of a digital multimedia portfolio [33]. Helen Barrett in her article entitled "Technology-Supported Portfolio Assessment" evaluates software, primarily for the MacIntosh computer, which supports student multimedia portfolios in the elementary and secondary schools [36]. Her descriptions and recommendations give an overview of the process. A brief, clearly written description of one online portfolio course is found in Taber, Takle, and Fils' article, "Use of the Internet for Student Self-Managed Learning" [37].

A Final Recommendation

For those interested in getting the most for the least time spent, I recommend reading the Panitz article [5], the Arter, Spandel, and Culham article [4], and the Northwest Laboratory bibliography [35].

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