Student Portfolios for Assessment and Self-Learning

Dr. Derek G. Williamson, University of Alabama

Dr. Williamson obtained his undergraduate degree in 1990 in Engineering and Public Policy from Washington University in St.Louis. He received his MS (1993) and Ph.D. (1998) degrees in environmental engineering at The University of Texas at Austin. Dr. Williamson joined the faculty of the the Department of Civil, Construction, and Environmental Engineering at The University of Alabama in 1999. He has enjoyed 15 years of a dynamic profession of teaching, research, and service. he now serves as the Director of Undergraduate Programs for his Department.

Dr. Kenneth J. Fridley, University of Alabama

Kenneth J. Fridley is the Senior Associate Dean for Administration at the University of Alabama. Prior to his current appointment, Fridley served as Head of the Department of Civil, Construction and Environmental Engineering at the University of Alabama for 12 years. Dr. Fridley has been recognized as a dedicated educator throughout his career and has received several awards for his teaching efforts, including the ExCEEd (Excellence in Civil Engineering Education) Leadership Award in 2010. At the University of Alabama, Fridley has led efforts to establish several new programs including new undergraduate degree programs in construction engineering, architectural engineering and environmental engineering, a departmental Scholars program allowing highly qualified students an accelerated program to earn their MSCE in addition to their BS degree, the interdisciplinary "Cube" promoting innovation in engineering, and the cross-disciplinary MSCE/MBA and MSCE/JD dual-degree programs. Fridley has advised 32 masters and doctoral students to completion. His former students have moved into leadership positions in industry, public service, and academia.

Dr. W. Edward Back, University of Alabama

Professor and Head, Dept. of Civil, Construction and Environmental Engineering Director, Center for Sustainable Infrastructure The University of Alabama

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Introduction

A well-conceived process for robust assessment has become an expected, if not required, component of academic programs in higher education. Most agree that a strong assessment program must include an evaluation of Student Learning Outcomes (SLOs). Since the advent of ABET2000, assessment of SLOs has become a critical component of program assessment in engineering, technology, and computer science programs. Moreover, regional accreditation bodies, e.g., Southern Association of Colleges and Schools (SACS) and Western Association of Schools and College (WASC), have continued and broadened the use of SLO-based assessments. Assessment is an altogether too familiar activity for many engineering faculty, with detailed course-to-outcome and even assignment-to-outcomes maps being created within programs. However, students are often individually disconnected or distanced from the process. Few students read their academic programs' learning outcomes, and even fewer can clearly articulate how their curriculum and daily academic activities relate to the learning outcomes required for their degree or desired by their future profession.

In the Department of Civil, Construction, and Environmental Engineering (CCEE) at the University of Alabama, a new approach has been created and employed for assessment. *This approach involves the student taking a more active role in demonstrating that they personally have achieved the degree program's SLOs through the completion of work as demonstrated in an individual student learning portfolio.* The student constructs their own portfolio as s/he progresses through the program relying, in large part, on evaluated/graded assignments carefully mapped to outcomes. The final, graduation-level portfolios are a mandatory requirement for degree completion. Portfolios have been used by the program for approximately ten years and for multiple ABET visits. Faculty and members of the department's external advisory board have traditionally evaluated the graduation portfolios. As the department's enrollment and degree production has grown significantly, portfolios have evolved to an electronic version that allows for easier assessment of SLOs by both faculty and outside evaluators such as practitioners or departmental board members. No longer confined to paper only demonstrations of competencies and outcomes, students have taken ownership of their portfolios and have used creativity and self-learning in preparing their portfolios.

Motivation

Since moving to "ABET2000 –style" learning outcomes, student awareness of program outcomes was very important to the faculty in this department. Over time, both ABET and department initiated changes were made to the program learning outcomes. As ASCE developed its Body of Knowledge (BOK) document as part of its raise the Bar strategy, the Department made changes in its outcomes to embrace the content and spirit of the BOK as much as possible. The BOK is a formal embodiment of what the U.S. Civil Engineering Profession values in its students and practitioners.

While ABET accreditation may be viewed by some as a compliance activity, at its heart is an assessment program to demonstrate continuous improvement in student learning. It is axiomatic that students learn better when they know the expectations or goals of the particular learning activity. In terms of performance, the program outcomes represent the faculty's learning expectations of the student. Since the department's student learning outcomes (SLOs) are constructed to reflect the ASCE BOK, they are also a representation of the profession's expectations of the students. Additionally, the department desired a strong role in the assessment process for practitioners (typically alumni and members of the departmental advisory board). Practitioners and alumni are often particularly effective assessors. *It is for these reasons that the faculty desired an assessment process that fully engaged the students in demonstrating their own personal achievement of the SLOs. We found such an assessment process in student portfolios.* While the use of student portfolios for assessment and accreditation is relatively uncommon in U.S. engineering programs, they have been used for such since 1998[1] and are widely used in other disciplines across higher education[2,3].

Starting a Portfolio Program

Overview
In 2006, the CCEE Department at The University of Alabama (UA) started using student portfolios in its assessment process. The use of portfolios started shortly after adopting a Body of Knowledge (BOK) informed set of student learning objectives in 2005[4]. The program learning objectives were developed using Bloom's Taxonomy to indicate the cognitive depth of the learning desired. The program-level outcomes were written at what we termed the graduation level (often called the summative level in the educational literature). This is the highest level of learning achieved in the program for that particular outcome. The term "Program Outcomes (POs)" refers to the formal set of "Student Learning Outcomes" at the graduation level that comprises the official ABET Program Outcomes. Faculty had previously identified which program learning outcomes were addressed in their classes and at what cognitive level (formative or summative) as part of the curricular mapping component of an ABET inspired continuous program improvement. Each outcome was only present at a single level in any given course. Individual outcomes progress from formative to summative as the students advance through the curriculum. The course outcomes at both formative and summative levels were mandatory component of the course syllabi handed to students. This use of outcomes in course syllabi was the first explicit activity within the department to routinely and repetitively convey program outcomes to students. *It was hoped that through repeated exposure to and discussion of course outcomes and portfolio preparation, that students would begin to identify with and ultimately take ownership of their Program Outcomes.*

Development
The use of portfolios started in 2006. The goal of this program was for each student to develop a graduation portfolio organized by outcome that demonstrated achievement of all of the ABET Program Outcomes at the graduation level. Such a system has been used by other engineering programs[5]. The students were free to pick any graded component of coursework that they believed demonstrated that outcome. In addition, the students were required to write a relatively

short statement indicating how each selected artifact demonstrated that particular outcome. These portfolios were collected as three ring binders in the senior capstone design course. Once collected, each outcome for each student was evaluated on a five point Likert scale, providing critical primary assessment data. When this process was first implemented, the graduation portfolios were assessed by two faculty members and two advisory board members each. The review effort was significant for both faculty and advisory board members; however, portfolio review data constituted a very large part of the department's data collection activity. In the 2006/2007 academic year 50 students graduated with a BS degree, meaning 20 students generated graduation portfolios in the fall and 30 in the spring. With sixteen faculty and a dozen board members in attendance, reviews of the graduation portfolio at the end of each semester were manageable.

Of course, producing a well-constructed graduation portfolio in 2006 with appropriately selected work and well-developed reflective statements was problematic for current seniors who had not been previously exposed to this process. In the case of these first generation portfolios, expectations for portfolio robustness were commensurate with a new process and curricular requirement. Faculty mentors spent extra time coaching graduating seniors on portfolio development during the senior design course. However, routine collection of appropriate course artifacts and generation of reflection statements would be needed throughout the curriculum in order to develop student culture and documentary practices to produce such a graduation portfolio. The answer was to require the development of class portfolios for all undergraduate classes in the department. Instructors collected these course portfolios at the end of the semester, reviewed the choice of artifacts and reflective statements, and provided feedback to the students regarding both their choice of artifacts for each outcome and the reflective statement. Initially, the class portfolios addressed all of the mapped program outcomes at both the graduation (summative) and formative levels for each course. The class portfolios were required in all departmental classes, but the use in grading or participation credit was left to the discretion of the individual faculty.

Several actions took place over the next couple of years to support the students in their portfolio creation and to develop an expectation for and appreciation of the graduation portfolio within the student culture. The most critical of these was the requirement of the class portfolio. This gave the students practice in selecting artifacts and writing reflective statements. The class portfolio requirement was also a very effective means of integrating the graduation portfolio building process throughout the program. Additional support included: (a) faculty led graduation portfolio preparation and review/feedback sessions in the capstone design class, (b) the development of a portfolio template to insure minimum expectations and standards were met for portfolio completeness, (c) student societies preparing and selling pre-labeled binders for portfolio building.

Evolving the Graduation Portfolio

In order to understand choices that were made in the evolution of the use of the portfolios within this department, it is very important to place them within the overall context of the department's history and growth.   In 2005, a ten year period of rapid growth started in the department's student population. The department doubled in number of undergraduate students in five years and increased another 30% from 2010-2015, as shown in Figure 1.   Additionally, a new degree program was added in 2007. However, the second degree plan was constructed with the same Program Educational Outcomes (PEO's) as the Civil Engineering degree. Moreover, the two degrees used an integrated set of Program Outcomes (citation to be added in final draft to support anonymity). This careful planning was intended to ensure that the second program did not have a significant impact (other than helping grow the number of students in the department) on the portfolio creation and assessment processes in the department.

Figure 1: CCEE Undergrauate Enrollment History
at The University of Alabama
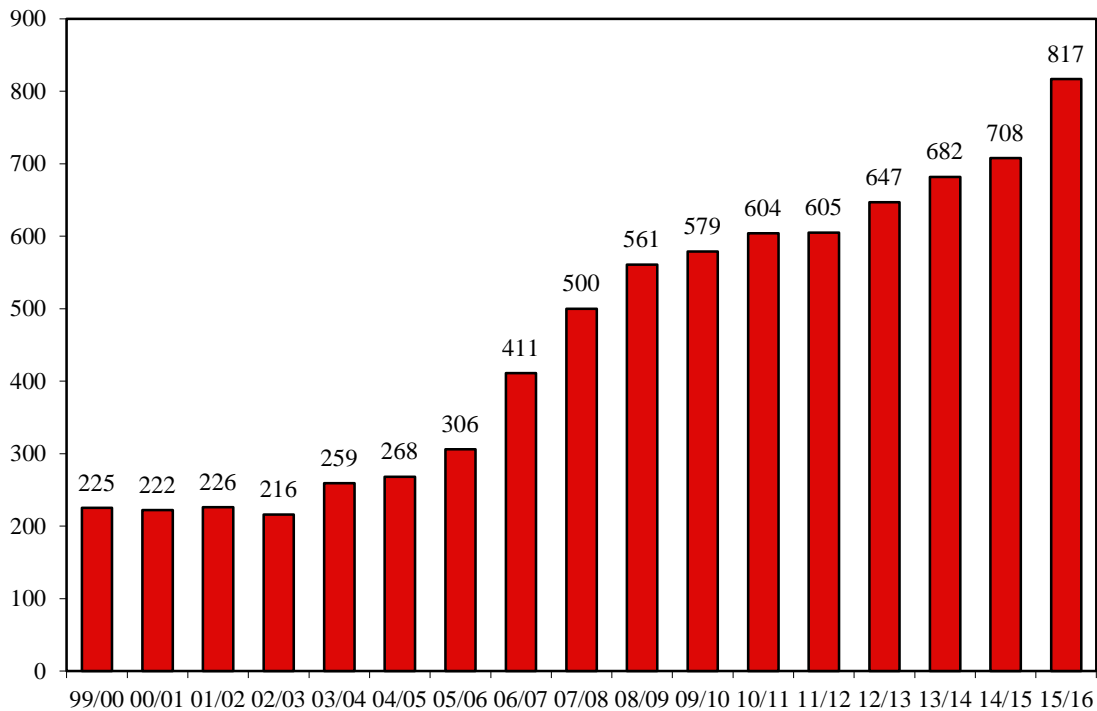
The assessment of paper-based graduation portfolios was a major part of the assessment process used in a period of time that covered four different ABET program assessments for the department: 2007/2008, (2009/2010 for the new program) and 2013/2014 for both programs. However, the growth in the department during this time put a large burden on the assessment process particularly on the departmental advisory board members. In addition, the shear bulk of 100 graduation portfolios per year made storage, sampling, transportation, and review overly cumbersome. While the Department did not want to make a significant change in the portfolio process while it was in its early stages and just before the two programs ABET visit in 2013, it

was obvious that changes were needed to accommodate the increased number of students. Two changes were made shortly after preparing for the 2013 ABET visit.

The first major change in the portfolios occurred in the 2012/2013 academic year and was a transition from paper to PDF class and graduation portfolios. This change made collection, review, and transmission of portfolios to external reviews all much easier. However, the creation of the portfolio itself was changed very little. The PDFs still used the same template and they were simple electronic documents without automated indices and searchable content. For all practical purposes the PDFs portfolios were scanned in digital versions of the traditional three-ring binder portfolio. The review was still accomplished using the same 1-5 Likert scale and using a combination of faculty and advisory board reviews. While structurally very similar to the paper process, the movement to PDFs had a number of practical benefits. The first benefit concerns student culture and saving work product from classes over the course of a 4-6 year college career. With (manually compiled) paper-based portfolios, each student needed to save individual work products from classes and store them over several years until they finally assembled and handed in their final graduation portfolios. Over the course of a college career, students move, participate in co-op and study abroad opportunities, take time off, and get called up on military deployments. Additionally, housing is often a very transitory state for students. All of these conditions meant that some students had a very difficult time producing strong graduation portfolios as many of their portfolio artifacts did not survive to be available for incorporation into the graduation portfolio. With the advent of very inexpensive portable memory storage, university accounts, and the cloud; saving and retrieving artifacts became easier. Storage was still the responsibility of the individual student and issues still arose, but easy electronic storage did help quality graduation portfolio production.

The 2013 ABET visit revealed another concern with our portfolio-based assessment process. Up until this point, the departmental policy was to ask each student to select artifacts appropriate for each of their SLO's and then to develop the supporting reflective statement. The advantage of this approach is that selecting work product from each course and aligning it to a Program Outcome is an intellectual contribution of the student to their own education. However, the risk is that without discipline, consistent feedback, and frequent mentoring, students may not select appropriate artifacts or may fail to properly correlate their work to the appropriate outcome. With exceptional growth in student populations and probable inconsistent feedback in course-level portfolios over a period of several years, inappropriate selection of artifacts occurred. This caused faculty to reexamine the policy of allowing students to self-select work products. In the fall of 2014, the department policy was revised to require each faculty to select explicit examples of work product for all of the summative (graduation level) outcomes in their respective courses. This resulted in more focused course-level portfolios and illustrated the connection of work product to outcomes to deepen student's understanding of their meaning of their program outcomes. Moreover, the assessed graduation level portfolios were now guaranteed of strong alignment between outcomes and work product demonstrations of outcomes.

An additional change occurred in the department context in 2014. The department added two new degree programs under the same set of unified Program Educational Objectives (PEOs) and an integrated set of Program Outcomes (citation held till final draft to preserve anonymity). While not impacted the process conceptually, the presence of several degree programs with differences in each programs particular educational outcomes, does represent some practical challenges in organizing and implementing unique program-specific portfolios. These challenges were addressed by moving to a more formal, commercial electronic portfolio system.

In the fall of 2014, a new technology was rolled out to streamline and improve the data collection, assessment and evaluation of portfolios. The technology selected is a commercially available assessment product called LiveText^{TM}. This technology was selected in large part because the College of Education at our university was already using it and the institutional knowledge and IT infrastructure to support its application in our department was therefore already in place. This was first required of graduating seniors and then in the spring of 2015, use of this technology was required of all departmental students. While there is a cost to students for this technology (~$100/5year subscription), a number of immediate benefits were immediately evident to both the students and to the department. These are enumerated in Table 1 below.

When the department switched from manually produced portfolios to the LiveText system, there was some student concern, mostly among graduating seniors. However, once they started using the system, many concerns diminished as the ease of using the structured software became apparent. Once frequent comment from graduating seniors using LiveText follows, "I am envious of the underclassmen. They will be building this throughout their classes and it will be very little work in their last semester." This comment reflects faculty observations that the students benefit greatly from being able to store their work materials as they are generated within a developing graduation portfolio. Students now purchase LiveText, receive instruction in class and start course portfolio and building their graduation portfolios in their sophomore year when they start taking civil engineering courses.

Observed Long-term Benefits from Using Electronic Portfolios

The active use of LiveText-based portfolios has been ongoing now for over a year. Student acceptance and faculty engagement has come quickly. Of course, the long-term use of paper and temporary use of PDF-based portfolios had prepared both stakeholders for this new system. The adoption of formal e-portfolios has occurred within the context of growth in: student and faculty numbers, facilities, number of degree programs, and in the intensity of graduate and research programs in the department. The use of electronic portfolios has required less faculty time and a bit more administrative time building and implementing the systems. Very little faculty effort is spent on course-level data collection encouraging student participation. The workload has been streamlined and centralized within the department administration. This allows faculty efforts to focus on assessment within the outcomes they are most familiar and on data evaluation and continuous improvement. Students have responded well to the flexibility and consistency of the

electronic system. The use of a formal, portfolio system allows the department to enhance is assessment programs, and ultimately student learning in several ways.

Table 1.0 Immediate Benefits of Moving to LiveText Based Portfolios

Item	LiveText Component	Benefit
Reaffirming Outcomes to Course Map	Course-Specific portfolio assignment template	Instant Alignment
Consistent application of course-level portfolio	Assignment template and linkage of LiveText to university registrar system	Auto population of LiveText course enrollment data and one-button indication to faculty of student assignment completion
Student storage of work products	File management and storage component with each student having a personal LiveText cloud storage account	Nearly complete retention of work products for use in Graduation portfolio
Students incorporating portfolio production into their culture	Electronic based system with very clear structure	Today's students respond much better to cloud-based processes than paper process…high level of acceptance
Assembly of graduation portfolio throughout curriculum	Portfolio templates developed for each degree	Student can immediately place graduation level artifacts and reflective statements in a working graduation portfolio as they progress through departmental courses on route to graduation
Ease of review and data storage	Assessment rubrics	Easy review and selection of performance metrics (1-5 Likert)
Ease of external reviews	Assignment of reviewer accounts	External assessors can assess portfolios and artifacts from any connected computer easily

Student Opinion Data
One might expect student resentment of implementing a formal requirement as involved as departmental-wide electronic portfolio system. However, early acceptance data indicates otherwise. Senior exit interviews of 61 students were conducted in the fall of 2015, after 1 full year of requiring the use of the LiveText system. Students were asked to identify areas of concern within the program/curriculum. Not one student identified Livetext. Several students commented that the electronic portfolio system was simple and easy and they wished it was in place when they entered the program.

Structural and Programmatic Benefits
This e-portfolio system allows very straightforward implementation of new assessment rubrics. At the start of this process the department used a 1-5 Likert scale for assessment. This has the advantages of simplicity and developing trend data in outcome performance and matched with the scoring system of other assessment rubrics such as student surveys and pre-graduation student interviews. Minor curriculum changes have been made using portfolio assessment data

in terms of moving some outcomes to new courses and in feeding back to faculty that certain outcomes need attention across the curriculum. However, further implementation of mechanisms for systematic changes within the curriculum has been waiting on two structural developments: finalization of the two new degree programs, and the development of the LiveText infrastructure to allow for the implementation of specific rubrics.   We are now positioned to implement more diagnostic assessment by constructing outcome-specific rubrics that will allow the department to focus on the particular aspects of each outcome that may need improvements. For example, we may construct a design rubric that specifically addresses the how effectively students develop design standards for new technology within their project in the absence of explicit building or design codes. This rubric can easily be incorporated into the LiveText system and aligned specific assignments that address this performance index for the design outcome.

As the department has grown, there is no longer the resources nor the need to assess every outcome for every student. We will be implementing a sampling protocol to obtain and adequate numbers for effective assessment. This will be very straightforward by having easy access to all of the electronic portfolios and outcomes. The LiveText environment was specifically made to support sampling and data mining. Such an effort would have been much more difficult with the previous cumbersome paper and PDF systems.

Given that all of the assessment data and even the raw data (student artifacts and reflective statements) is archived, establishing long-term trends for performance in each outcome (or even sub outcome) will be very straightforward. If issues arise in performance, the archives of student work in the graduation portfolios and also within every course will allow explicit diagnosis and development of focused and effective strategies to fix the issue early in the curriculum.

In today's world of transfer credit, on-line classes, study abroad, specialty honors courses, and other unique offerings, departments are often faced with evaluating whether a particular offering should be accepted as an elective. Such evaluations are not difficult; however, consistently doing so with an established process and baseline standards may be a bit more challenging By developing a culture of students recognition and understanding the importance of program outcomes through the integrated use of a portfolio system throughout the curriculum, a simple solution for evaluating such transfer credits can be established. The department first implemented such a process quite by accident. An honors student who had been studying abroad has developed a specialty course, and she utilized a standard petition form to request department credit. However, she used our department guide for preparing a graduation portfolio (that contained narrative explanations of each program outcome) and an understanding developed through discussions with classmates of how important portfolios had become to the department to craft a different strategy for supplementing the standard petition. She used the petition form to indicate that the course she took met a number of program outcomes for the department. She then utilized the list of department outcomes and narratives to select several outcomes that she believed her specialty course met. The student then constructed a logical document explaining why she selected these outcomes and provided very thoughtful statements of how her activities

in the course met these outcomes. It was a singular occurrence in many years of evaluating student petitions. Moreover, the department decided that this should become standard practice when a student requests credit for a novel course not transferring in as an existing course in the curricula. If the student can clearly demonstrate achievement of several program outcomes through this course, then it is self-evident that the course should be counted within the curriculum. Such a development simply would not have occurred without the culture shift in student understanding that was brought about over several years of using portfolios. We believe that the use of portfolios for these administrative decisions is a novel contribution to literature on this subject.

Student Creativity and Portfolio Flexibility
Once a student meets the minimum demonstration of an outcome using the pre-mapped outcomes, the digital nature of the LiveText graduation portfolio allows for creativity in demonstrating outcomes. For example, a video of conducting a laboratory process or giving an oral presentation could be used as direct evidence of meeting a student learning outcomes in the program. As the use of LiveText portfolios enters its second year, we are starting to see such non-traditional demonstration of outcomes supplementing the minimum demonstrations expected for the portfolio.

The LiveText system also lets the student share particular files/assignments with non-LiveText users. A student could share a writing sample with a potential employer or graduate school evaluator. More practically, the archive that each student has built up allows them work product samples to show if ever needed in terms of an application process or other evaluation. Finally students are starting to see the collection of their work and accomplishments as a source of pride. The "extra" or unique or over and above artifacts that some students chose to share in their graduation portfolios are an excellent way to increase the department, college, and university's awareness of the special gifts, accomplishments, and talents of their students.

In summary, we have found electronic portfolios an excellent mechanism to enhance and improve programmatic assessment and student learning. Portfolios have helped the department move an understanding and appreciation of program outcomes into the student culture. As we continue to evolve the use of this system, we expect to keep our assessment process efficient, vibrant, and effective.

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