Raze the Silos: Using Digital Portfolios to Increase Integrative Thinking

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Wende Garrison got her bachelor's and master's from Portland State University in Film & Television and Rhetoric & Composition. She taught at Portland State University for over eight years in their award-winning general education program. While she was there, she oversaw Portland State's use of the Open Source Portfolio (OSP) and the university wide conversion to OSP. Active in the OSP community, Garrison helped many universities adopt digital portfolios. Garrison then joined the Association of American Colleges and Universities where she ran the VALUE Initiative. Through that FIPSE grant, she recruited and led over 100 faculty volunteers from universities around the country in the development of 15 national rubrics that have been downloaded more than 15,000 times. Garrison currently is the the Director of Assessment, Curriculum, and Communication for the Portfolio to Professoriate NSF grant at Virginia Tech. There she has written and taught a digital portfolio curriculum to students on four campuses, bringing professional portfolios to graduate students in STEM disciplines. Garrison also consults and gives keynotes at a variety of institutions on digital portfolios, assessment, rubrics, and curriculum mapping.

Raze the Silos: Digital Portfolios and Integrative Thinking

I. Preparing Future Faculty through Integrative Thinking

This project has been developed to address the issue of preparing future faculty, an issue acutely faced by graduate students and faculty in STEM disciplines, where faculty are expected to not only keep up with rapid progress in their fields, but also to create and implement innovative strategies for teaching students to navigate the complex intersections of scientific and technological advances and society. The problem, however, spans disciplines, and is two-fold: first, we need to ensure that some of our best students pursue careers in academia, and second, we need to prepare these future faculty with the skills and institutional support to excel in these academic careers. Research studies have found that many Ph.D. programs are preparing students for research careers at universities, even though there are a limited number of research positions available; and, even when these students do attain university positions, they are not well-prepared for the demands of those careers[1, p. 5]. Since 1993, the Council of Graduate Schools and the American Association of Colleges & Universities has engaged in the Preparing Future Faculty (PFF) initiative designed to "transform the way aspiring faculty members are prepared for their careers"[2]. Furthermore, in a recent publication focused on faculty in science and mathematics, the PFF program "identifies teaching, research, and service as the three expectations for faculty at most institutions of higher learning and asserts that graduate students planning to join the faculty should begin learning about each of these elements of the academic profession"[3, p. v].

This problem has also been noted in engineering education: many graduate programs focus on specializing in a research area, often at the expense of training future educators for teaching. As Jamieson and Lohmann assert in their 2009 ASEE report, *Creating a Culture for Scholarly and Systematic Innovation in Engineering Education,* "we must strengthen career-long professional development in teaching and learning, starting with the doctoral programs that produce most engineering faculty"[4, p. 1]. Even graduate students who plan for industry, government or non-profit careers should possess the skills of "knowing how to explain difficult concepts; what misconceptions, preconceived notions, and biases people bring to learning; how to work with diverse groups; [and] how to use learning and collaboration technologies" [4, p. 11]. However, many students do not have the opportunity to teach during their graduate career, and many teaching assistantship programs do not provide pedagogical training. Also, within prevailing academic cultures in engineering, teaching assistantships are often not as highly valued as research assistantships.

Our project addresses this issue through an approach that promotes integrative thinking through digital portfolio construction. Our portfolio curriculum guides students through the process of collecting and posting evidence of their work in teaching, research, service and lifelong learning. Each artifact, or piece of evidence, is then "annotated"[5] with a student's written narrative. This reflective practice helps students recognize the value of their experiences and situate their work in a cohesive presentation of their professional identities. In many educational settings, digital portfolios are used extensively to enact meta-cognitive practices of learning development, professional career preparation, and program assessment. This project takes these uses to a new

level by exploring how digital portfolios can be used to promote integrative thinking about professional identities that include both teaching and research. Digital portfolios are ideally suited to this task because they are flexible, they promote student motivation and ownership, and they can be situated outside of established course structures and even linked with multiple institutions. Importantly, digital portfolios are promising vehicles for integrative thinking, in which future faculty can bring together their professional role identities in teaching, research, service and lifelong learning.

The conceptual foundation of our study draws on theory informing education and identity. We take a constructivist educational approach, in that we believe that students are active participants in their learning, and that learning is personally and socially contextualized[6]. In terms of identity, we employ Ashforth's delineation of role identities, in that all individuals hold multiple roles that they negotiate over the course of their lives (macro) and on a constant basis (micro)[7]. Importantly, individuals engage in "presentation of self" that involves a complex construction of essential characteristics along with perspectives of who they want to be and how they think others expect them to be[8]. In developing methods to evaluate our portfolio process and assessment protocols, we established two research questions:

- RQ1: Do student portfolio narratives reflect integrative thinking about their professional identities?
- RQ2: If so, in what ways does integrative thinking surface?

These research questions attempt to first confirm whether or not the experience of building a P2P portfolio encouraged integrative thinking, and, if so, to explore how the process influenced this development.

II. Relevant Literature

The phrases "integrative learning" and "integrative thinking" have been operationalized in a broad range of educational literature, including business[9, 10, 11], environmental education[12], psychology[13, 14, 15], and interdisciplinary studies[16, 17, 18]. Integrative learning is defined by the AAC&U as "an understanding and a disposition that a student builds across the curriculum and co-curriculum, from making simple connections among ideas and experiences to synthesizing and transferring learning to new, complex situations within and beyond the campus"[19]. Integrative thinking is defined as "the ability to constructively face the tensions of opposing models, and instead of choosing one at the expense of the other, generating a creative resolution of the tension in the form of a new model that contains elements of the both models, but is superior to each"[20]. The ability to manage complexity and problem solving is echoed throughout the literature on both integrative thinking and learning, and thus speaks to our goals of helping graduate students prepare for careers that require non-uniform professional roles. In developing our curriculum and assessment processes, we closely follow the guidelines for integrative and applied learning as one of the "Essential Learning Outcomes" set forth by the AAC&U[19], but also consider the specific context of graduate school, focusing on engineering and science students who are pursuing academic goals that include both research and teaching. We consider not only cross-curricular and cross-contextual integrations but also the ability to manage multiple and sometimes conflicting role identities[7].

Typically, integrative learning and thinking is difficult to implement in traditional educational institutions because integration across disciplines and contexts does not easily fit in functional, siloed traditions. As explained on the AAC&U website, since

> integrative and applied learning is about making connections, this learning may not be as evident in traditional academic artifacts such as research papers and academic projects unless the student, for example, is prompted to draw implications for practice. These connections often surface, however, in reflective work, self assessment, or creative endeavors of all kinds. […] Through integrative and applied learning, students pull together their entire experience inside and outside of the formal classroom; thus, artificial barriers between formal study and informal or tacit learning become permeable[21].

Assignments that encourage integrative thinking often require students and instructors to pull from resources beyond a single classroom and even beyond the bounds of the university to connect with non-academic sites of work and application[22]. Also, integrative learning assignments usually require reflective practice in which students engage in ways of thinking and synthesizing that may not be familiar to them, such as "dialectical thinking, metaphorical thinking, building a metalanguage, and developing common ground"[18, p. 51].

Likewise, integrative learning is difficult to measure and assess. The AAC&U undertook an 18-month collaborative project that included faculty and other academic professionals in creating rubrics to measure each of the AAC&U's "Essential Learning Outcomes." The VALUE (Valid Assessment of Learning in Undergraduate Education) Initiative resulted in 15 rubrics[21], including a rubric for Integrative Learning that includes five criteria:

- connections to experience,
- connections to discipline,
- transfer,
- integrated communication, and
- reflection and self-assessment.

These rubrics have been implemented at many schools across the nation, including LaGuardia Community College, Manhattanville College, Pace University, Boston University, Stony Brook University, Virginia Tech, and Prairie State College. These are only a few of the diverse array of institutions collaborating in a 3-year FIPSE-funded grant called the Connect to Learning project (C2L)[23]. At the University of Michigan, Melissa Peet has also built on the AAC&U's work to establish six dimensions of integrative learning as a foundation for a conceptual model informing her portfolio process, Integrative Knowledge Portfolio Process (IKPP) also a 3-year FIPSE-funded grant[24]. The IKPP and Michigan portfolio was established "in order to create a pedagogy and technology to help students know and articulate what they have learned at UM," particularly in terms of how their learning was valuable to them and how they would apply it in their careers[24, p. 12]. Peet developed a 37-item survey that quantitatively linked her six dimensions to the reflective process of presenting evidence of work along with narratives in a digital portfolio. In addition to these measures of the integrative learning construct, McNair and Louis created a role identity survey that measures students' perceptions of their professional roles in both their current activities and as projected in their future careers[25]. Both Peet's and Louis & McNair's quantitative instruments measure constructs that are desired outcomes of portfolio work.

However, these quantitative measures serve as only partial descriptions of student learning; a preferable but time-consuming approach is that of analyzing student portfolios. As Banta states, "authentic assessment—using actual student work products that reveal their responses to the learning opportunities they are experiencing—is the best type of measurement for suggesting directions for improvement"[26]. This article presents qualitative data from student portfolios in our project that have been coded for instances of integrative thinking.

III. Portfolio to Professoriate: The P2P Project

This study is part of an NSF-funded project designed to encourage reflective practice in graduate students who are constructing professional identities as both researchers and educators. We have developed a digital portfolio process, Portfolio to Professoriate (P2P), and assessment protocol that guides students through building a portfolio and encourages their development of integrative thinking. P2P is a curriculum for graduate students in STEM, with an emphasis on engineering students. As of this publication, the P2P curriculum has been piloted on five campuses under different circumstances, using different incentives. The P2P curriculum divides the process of creating a professional digital portfolio into ten weekly tasks, each of which takes between thirty minutes to an hour to complete. A fundamental part of the P2P process is the weekly feedback to students on their portfolio progress provided by faculty. In addition, at each campus, students have been offered the opportunity to engage in a peer feedback process—sometimes online and other times in person.

Throughout the ten weeks of creating a professional portfolio, students are asked to upload evidence of and write narratives about their accomplishments in four categories: 1) Research, 2) Teaching, 3) Service, and 4) Lifelong Learning.

Typically, students upload published papers or powerpoints used during conference presentations as evidence for the "Research" section of their portfolio. They also commonly upload visuals depicting their research—charts, illustrations, photos and even a few videos. For the "Teaching" section of their portfolio, the usual evidence uploaded can be anything from a syllabus or a test they created to a teaching philosophy or a video of them actually teaching. Student evaluations are also used. For the "Service" section of their portfolio students who are at the very beginning of their careers often have multiple pieces of inspiring evidence. They have started Engineers Without Borders chapters at their institutions, they have reviewed conference papers for a professional organization, they have mentored undergraduate engineering students at their institutions. But the most common service activity used as evidence in a "Service" section of P2P portfolio is working with K12 students in an engineering context. This includes everything from judging statewide robotics competitions to teaching unprivileged five and six year olds how to build a bridge during summer camp. For the "Lifelong Learning" section of their portfolio, learning a language and advanced mastery of a musical instrument are popular choices, as is pursuing a graduate certificate in teaching or another STEM field.

Each piece of evidence students upload is typically documenting a specific professional accomplishment. Students are then asked to write narratives to pair with their uploaded evidence. These narratives not only provide helpful background on the circumstances of the accomplishment, but also speak to what the student learned through the process.

In addition, during the P2P curriculum, students are asked to create a "home" page that welcomes readers and explains the contents of the portfolio. They are also asked to create an "about" page for their portfolio that typically displays a short bio of the student, a photo, contact information, and—often—a link to their CV.

IV. Methods—Qualitative Coding for Integrative Thinking

A. Participants

Graduate students in engineering disciplines from four research universities agreed to participate in the P2P curriculum as part of our research study. The study included taking pre/post-surveys on role identity, constructing a digital portfolio, and participating in an interview or focus group. The focus of analysis in this paper is actual student work from digital portfolios. The pool of participants made up five cohorts differentiated by individual contexts and the following factors: stipend, incentive, required for course credit, and required for assessment (these factors are listed in Table 1 and discussed in more detail in the Results section). A total of 46 students signed up for the study, with varying degrees of completing full portfolios. 41% of students who began the study completed full portfolios (these figure are listed in Table 2 and discussed in more detail in the Results section). All participants signed IRB-approved consent forms.

Table 1

Institutional Implementation Circumstances for Professional Portfolio Project

	Term	R1	Stipend	Course Credit	Required by Department for Assessment	Other institutional circumstances
A	AY 2011—2012	Yes	Yes	No	No	All volunteers, two in person meetings
B	Winter/ Spring 2012	Yes	No	No	No	All volunteers, all participants part of a cohort related to another topic, met weekly
C	Spring 2012	Yes	No	No	No	All volunteers, all participants part of course on teaching
D	Spring 2012	Yes	No	No	Yes	All volunteers
E	Fall 2012	Yes	No	Yes	No	All student in a course that awarded 20% of course grade for completing portfolio according to a rubric standard

Table 2

Professional Portfolio Completion Rates by Institutional Implementation Circumstances (Incentives)

	Number of students signed up to participate in portfolio project	**Number who created a digital portfolio initially**	**Number who did *some* portfolio work *(less than half)***	**Number who completed portfolio**	**Completion rate**
A	11	11	10	8	72%
B	16	12	9	2	12%
C	9	5	3	1	11%
D	4	3	2	2	50%
E	6	6	6	6	100%
Totals	46	37	30	19	41%

B. Data Collection

Student work on digital portfolios was collected from their websites at the end of the curricular period for each cohort. The portfolios were transferred to offline documents in order to ensure stability and consistent objects of analysis throughout the analysis phase. Digital portfolio work includes images, documentation of work (e.g., presentation files, documents, images, and videos), written narratives, and links between internal pages of sites and from the home site to external sites. All of these elements were viewed as parts that work together to create units of meaning. For example, a piece of documentation is "annotated" by a student's written narrative, which explains the context of the documentation and makes connections to the student's professional roles.

In addition, researchers wrote case studies on each student, noting patterns of student progress throughout the portfolio curriculum, including factors such as demographics; adherence to, consistency in, and ownership of portfolio process; response to feedback from both faculty and peers; and quality of portfolio according to criteria such as writing, visuals, navigation, and audience.

C. Measures

A coding scheme was developed via an iterative process by four researchers. Three researchers separately open-coded[27] one student portfolio around the broad ideas of integration of the categories required in the portfolio curriculum (teaching, research, service, and lifelong learning). Together with the fourth researcher, all coders compared codes and established a codebook that included both roles and qualities, and also differentiated between overlap and integration (see Table 3). Then the initial three coders used this set of codes to again analyze a portfolio, iteratively coding and comparing coding choices until reaching a reasonable degree of agreement. The coders then coded the rest of the portfolios (in cohorts A, B, and C). Cohorts D and E are currently in the process of being coded.

Table 3 *Identity Integration Codebook*	
Degree of Integration	
Overlap	Loose connection. Loose interaction. Accidental.
Integrate	Deep connection. Experiences from one role influencing another another role. Fused together. Intentional.
Roles	
The role of teacher	Imparting knowledge or giving instruction.
The role of researcher	Creating new knowledge. Investigation.
The role of service volunteer	Unpaid work for the benefit of others.
The role of student	Formal role, being in the classroom. Structured activities. Obligatory.
The role of learner	Pursues learning in a variety of contexts. Self-directed and self-motivated.
The role of professional [insert type of professional here:_____]	Use this code for roles like engineer, designer, etc.
Qualities	
The quality of lifelong learning	Driven to continue learning outside formal classroom circumstances. Learning that has taken place outside the classroom. Applying past knowledge to new situations. Learning for the sheer pleasure of learning. "Lifelong, voluntary, and self-motivated pursuit of knowledge for either personal or professional reasons" http://en.wikipedia.org/wiki/Lifelong_learning
The quality of curiosity	Drive for knowledge. Inquisitive.
The quality of altruism	Interest in or drive toward improving the lives of others.
The quality of creativity	Artful. Using imagination. Developing an original idea/solution.

D. Analysis

Once all portfolios from cohorts A, B, and C had been coded, instances of integration were compiled to determine a) number of instances of integration, and b) location in portfolio of integration instances. These results were then analyzed at face value and compared with case study data for emergent patterns that would indicate: a) if integrative thinking was being demonstrated, b) which portfolio categories (teaching, research, service, lifelong learning, other) contained more instances of integrative thinking, and c) factors that encouraged engagement in the portfolio process.

V. Results of Qualitative Coding for Integrative Thinking and Learning

After a year and a half of having graduate students create professional portfolios using the Portfolio to Professoriate (P2P) curriculum, a number of findings have emerged. Our current findings concern implementation circumstances, portfolio categories, and peer feedback. Additional findings, including one on the influence of narrative forms on integration, will be finalized in summer 2013.

Finding A: Implementation Circumstances and Completion Rates
One of the goals of P2P has been to study the effects of implementation circumstances on portfolio creation rates. In educational settings, portfolios are most often implemented in a course and are typically a graded assignment. Since not every program can implement portfolios under those circumstances, it was important to test other implementation circumstances.

P2P has tested five implementation circumstances to date and will test a sixth in the spring of 2013. These implementation circumstances and their affect on portfolio creation rates are summarized in Table 1.

- A: Volunteers were sought in an engineering department on an R1 campus. Volunteers were paid $500 at the end of an academic year in which graduate student volunteers created professional portfolios. Volunteers met, in person, with the grant PI, twice (once at the beginning of the process and once at the end.) Regular faculty feedback was available via email. In addition, an opportunity for peer feedback was also available via email, and 72% of students participated. The completion rate in the stipend implementation circumstance was 72%.

- B: Volunteers were sought from an interdisciplinary cohort of STEM graduate students on an R1 campus. Volunteers were not paid a stipend. Volunteers did meet weekly in relation to their interdisciplinary cohort project. Portfolios were not the subject of the weekly meetings. Regular faculty feedback was available via email. In addition, an opportunity for peer feedback was also available via email, but only 12% of students participated. The completion rate for the unrelated weekly cohort meetings implementation circumstance was 12%.

- C: Volunteers were sought from an interdisciplinary course on teaching for graduate students on an R1 campus. Volunteers were not paid a stipend. Volunteers did meet weekly in relation to their teaching course. Portfolios were not the subject of the weekly classes. Regular faculty feedback was available via email. In addition, an opportunity for peer feedback was also available via email, but no students participated. The completion rate for the unrelated weekly course meetings as a part of a course implementation circumstance was 11%.

- D: Volunteers were sought in an engineering department on an R1 campus. That department required a portfolio from all students for program assessment. Volunteers were not paid a stipend. No weekly meetings were held. Regular faculty feedback was available via email. In addition, an opportunity for peer feedback was also available via email, but no students participated. The completion rate for the portfolio for assessment requirement by department implementation circumstance was 50%.

- E: Students in a course on teaching for graduate students on an R1 campus were required to complete a portfolio (according to a standard on a rubric) in order to receive 20% of their grade for the course. Students were not paid a stipend. Portfolio topics were addressed during weekly class sessions. Regular faculty feedback was available via email. Two, in

person, peer feedback sessions were conducted in class and, thus, 100% of student participated. The completion rate for the portfolio required for 20% of a course grade implementation circumstance was 100%.

These findings indicate that while course credit provides the highest completion rate, stipends and department requirements show some promise. However, other implementation circumstances that involve cohorts of students who gather for a different purpose have proven to be less effective. An additional cohort of students will volunteer for the P2P process in Spring 2013 to allow further examination of incentives that have been less effective thus far.

Finding B: Integration and Portfolio Categories

As mentioned earlier, the P2P digital portfolio process requires students to upload evidence of accomplishments and write a narrative describing the accomplishment in four categories (Research, Teaching, Service, and Lifelong Learning.) It was, thus, of interest to determine in which category instances of integration occurred most frequently. In Table 4 below, narratives that fall into a specific category are counted and instances of integration in a single narrative are counted. Thus "1 had 2" in the table below would mean that 1 narrative in a specific category has 2 instances of integration. Table cells with more than one number phrase indicate that multiple pages in that category contained instances of integration. The left column contains codes for individual portfolios. The miscellaneous category in the table below refers to a wide variety of narratives including text from a home page, text from an about page, narratives written on career interests during childhood, and philosophy statements unrelated to teaching. Finally, the categories are grouped on the bottom row to reflect the authors' impression of Teaching and Research as well-defined categories familiar to most graduate students; and Service, Lifelong Learning and Miscellaneous as less well-defined categories that not all graduate students have encountered previous to creating a portfolio.

An interesting finding (evident in Table 4) is that integration showed up across different parts of the portfolios, including Research, Teaching, Service, Lifelong Learning, and Miscellaneous pages. However, it appears that less defined categories, such as Service, Lifelong Learning, and Miscellaneous, together outnumber the instances of integration in more familiar categories of Teaching and Research.

Finding C: Peer Feedback

In the world of academe, expert feedback—feedback from faculty to students, feedback from journal editors to faculty—is the norm. Students even often complain about not getting enough feedback on papers from faculty. But at the same time, expert feedback does not always affect performance for students.

When P2P staff began the project, they assumed that the quantity and frequency of expert feedback on student digital portfolios would be a significant factor in the success of the project. But after observing the effects of expert feedback and also including instances of peer feedback in the project and observing their effects, an interesting finding surfaced. While students may request and desire expert feedback, it is peer feedback that has resulted in the quickest, most dramatic, and most effective changes in P2P digital portfolios.

For instance, at institution A, although it had been suggested to a student multiple times that a particular page was visually difficult to read and should be re-formatted, only after similar peer feedback occurred was the change made. P2P staff saw this repeated numerous times at other pilot institutions. Seeing the digital portfolios of their peers seemed to be much more motivating to students—in terms of making visual improvements to their portfolios. Those visual changes made the portfolios look more professional, and also took audience into consideration in significant ways. In addition, they tend to make the portfolios easier to read, visually. Additional data will be available in summer 2013, after visual evidence of portfolio appearances during each week of the program has been gathered and analyzed.

Table 4

Completed Portfolios Only, Comparing Integration by Location in Portfolio

Completed portfolios	Integration in Research pages	Integration in Teaching pages	Integration in Service pages	Integration in Lifelong Learning pages	Integration in Misc. pages	Totals
A:1	0	1 had 1	0	1 had 2	1 had 3 1 had 1	7
A:4		1 had 1	1 had 1	1 had 4	1 had 1 1 had 4 1 had 1 1 had 1	13
A:5	1 had 1 1 had 5 1 had 6	1 had 1 1 had 1 1 had 1 1 had 3 1 had 1 1 had 1 1 had 1 1 had 1 1 had 1	1 had 2 1 had 2	1 had 2 1 had 2	1 had 3	34
A:6	1 had 1 1 had 3	1 had 1 1 had 1 1 had 1 1 had 1	0	0	1 had 1 1 had 1 1 had 5 1 had 3	18
A:7	1 had 1	1 had 2	0	0	1 had 1	4
A:8	0	1 had 1	0	0	1 had 1	2
A:9	1 had 1	1 had 1 1 had 1 1 had 1 1 had 2 1 had 1	1 had 1 1 had 1 1 had 1	1 had 1	1 had 2 1 had 2	15
A:10	0	0	1 had 3	0	0	3
B:2	1 had 1	0	1 had 4	1 had 2	0	7
B:4	1 had 1	1 had 1	1 had 1	0	1 had 3	6
C:1	1 had 4	1 had 1 1 had 1 1 had 2	1 had 8	0	1 had 1 1 had 4	21

Totals by Individual Category	24	31	24	13	38	
Totals by Grouped Category	55		75			

An interesting finding (evident in Table 4) is that integration showed up more often in parts of the portfolios unrelated to Research and Teaching. Sometimes these instances of integration were found on Service and Lifelong Learning pages. Sometimes these instances of integration were found on other miscellaneous pages of the portfolio.

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VI. Discussion and Conclusion

The P2P project has studied fewer than fifty student portfolios to date and thus our findings are not statistically significant. But in the digital portfolio field, the kinds of questions the P2P project is asking—questions about what implementation circumstances lead to the highest portfolio completion rates, questions about whether integrative thinking is more likely to occur when students write about unfamiliar topics, and questions about whether peer feedback is more effective than faculty feedback—are significant questions. Portfolio institutions, in the past, have typically focused a lot of energy and funding on getting portfolios implemented and established. It is less typical for those institutions to do research on how portfolios affect students. And it is even less common to make that research public. Findings from the P2P

project will hopefully lead institutions who have successfully implemented portfolios to now turn their attention to the types of questions the P2P project is asking, to ask those questions on their campuses, and to share the results.

In particular, the finding that integrative thinking took place more often in P2P portfolio categories that were not Research or Teaching is intriguing. In considering this finding, the P2P staff posits that research and teaching are well-defined areas for portfolio students. They all enter the P2P process with clear definitions of research and teaching. But for areas like service and lifelong learning—and certainly for areas like writing their own short bio for an "about" page—P2P students are often complete newcomers. For instance, many are unfamiliar with the concept of "service" as it is defined in academe and have to be coached to understand that their volunteering activities are referred to as service in the academy. Also, most students have never written a bio about themselves in a professional context. It could be that when students are free of pre-conceived notions of what a category is supposed to contain—as they are for the service category—they are more likely to integrate that category into other aspects of their professional lives. Thus, we are more likely to see students integrating their teaching role into their narratives on service, etc.

As we consider that, we must ask ourselves about the assignments we are giving our students. We know that integrative thinking is a skill that is vital for our students' success as they graduate into an increasing complex world and into an ever-evolving workplace. Are we giving them assignments that require integrative thinking? Or are we assigning work that requires them to stay in their already siloed thinking about research and teaching?

If, for instance, writing narratives about service activities results in more instances of integrative thinking, what does that mean for our classroom practices? Service learning has become a popular pedagogical practice in undergraduate education. Perhaps if we required our graduate students to teach their area of research to youngsters attending a summer camp, our students would become more integrated professionals. The concept of 15% time and 20% time have been made popular by 3M and Google. Perhaps the benefits of those corporate practices can be mapped to our P2P findings. When our brightest engineers step out of the lab and out of the silo, perhaps they are more likely to integrate scientific knowledge in ways that are not only innovative for communities they serve, but in ways that are growing them professionally. These are questions worth asking and practices worth trying since we need our brightest engineers to become the teachers of the future.

Directions for future research will focus on continuing to test implementation of professional portfolios in different settings. In these settings, we will explore ways for facilitators to customize portfolio requirements to address both their own learning goals and a broad array of possible careers, as called for in various reports that foretell a globalized era requiring integrative thinking skills[28, 29]. We also will continue to develop and test rubrics that are instructional as well as evaluative, and flexible enough to be used for peer feedback and self-assessment. Finally, we will also pursue development of quantitative measures of integrative role identities to track benchmarks and changes in student perceptions as they transition from graduate school to professional careers.

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