

## USING PROFESSIONALISM TO IMPROVE STUDENT OUTCOMES IN A COMPUTER SCIENCE SENIOR CAPSTONE COURSE

Alice Armstrong & Carol Wellington  
Computer Science Department  
Shippensburg University  
1871 Old Main Dr.  
Shippensburg, PA 17257  
ajarmstrong@ship.edu, cawell@ship.edu

### ABSTRACT

Starting in AY 2010, the faculty in Shippensburg University's computer science department changed the way it evaluated students' performance in the senior capstone course. We had long included a professionalism grade as part of the final grade, but we continued to see some students exhibit unprofessional behavior. We also noticed that those students who behaved unprofessionally were not able to complete this yearlong project. In AY 2010, the final grade was defined as the product of the quality of a student's deliverables and a student's professionalism. The quality grade started at 0% and increased over the semester as students submitted deliverables. The professionalism grade started at 100% and *could only decrease* over the semester. We designed this new grade calculation to model a professional reputation and to encourage students to stay focused on their projects and pursue them with a consistent effort. Indications from AY 2010 and AY 2011 are that this change to the syllabus has a very positive impact on student outcomes, including a drop in the number of students failing to complete the course and strong approval from our Industrial Advisory Council.

### BACKGROUND

There is broad consensus that teaching professionalism should be part of all computer science curricula as evidenced by its inclusion as a core topic in the ACM's 2008 Curriculum Update[1]. That standard defines professionalism to include "care, attention and discipline, fiduciary responsibility, and mentoring." The 2008 Update is an interim revision of the 2001 standard[2] that specifies that aspects of professionalism should be addressed in introductory courses, intermediate courses like software development or an ethics course, and as part of a senior capstone experience. There is a specific requirement "not only that students *acquire* these skills—either through general education requirements or through courses required specifically for computer science—but also that students *apply* these skills in their later courses."

Fuller, et al[3], acknowledge that assessment of professionalism requires different assessment techniques than assessing computer science content in the curriculum. In fact, their work reveals a "lack of alignment between learning outcomes and assessment practice in the area of professionalism." They advocate for addressing "students' lack of commitment to good engineering principles" by specifically evaluating that commitment through the use of self, peer, and instructor assessment of affective characteristics including professional attitudes and values.

There are a number of existing strategies for assessing professionalism in students. Clark[4] runs a team project course in which professionalism is assessed three ways. First, the instructor evaluates the team's professionalism through a diary of activities maintained by the team. While this is a participation grade, it includes assessment of important decisions and that planning is being carried out carefully. Second, the team's customer assesses their

professionalism three times throughout the project. Finally, self and peer evaluations are completed four times through the semester. These evaluations rate characteristics related to behavior in meetings and individual work habits and are reviewed with the student after each evaluation. All of these assessments are combined and become 10% of the student's grade. Sabin runs a similar course with similar levels of assessment (self and peer, instructor, customer, and external evaluator). These assessments were weighted and combined as 12% of the course grade. Sabin went on to analyze the students' performance to try to distinguish to what extent their success came from their technical skills vs. their professionalism. While the overall performance in both categories was good, their professionalism continued to lag behind their technical skills.

In general, when characteristics related to professionalism are directly assessed and given as feedback to students, the grading strategy is to use that assessment as a small portion (5-15%) of the final grade.

## **OUR COURSE**

In recent years, we detected a disturbing trend developing in our senior capstone course. A significant minority of students was unable to successfully complete the course and graduate on time. As an isolated incident, we might have been able to dismiss this as a poor group of students, an unfortunate class dynamic, or an underprepared instructor. However, this pattern repeated itself for several years running and seemed resistant to the incremental changes we made to the course.

At Shippensburg University, our undergraduate Computer Science program requires a senior capstone research or development project for graduation. Every student selects his or her own topic and a faculty member to be a technical mentor for the project. The course runs two semesters. The first semester includes research and development methods and requires the student to complete a literature summary and propose a project or experiment in their topic area. The second semester contains an ethics component and requires the students to complete their projects. Success in this course requires professional behavior: students have to create and follow a plan, give regular status reports, write technical documents, and present their results to the larger community.

The core of this problem does not appear to be in the technical skills of our students. Most projects failed because the students did not pursue them consistently throughout the term. As one student said, "April seemed so far away in January." While students were required to give regular status updates, they often did not meet the commitments required for each status period, stating that something had been more complex than they expected or that other work had prevented them from achieving their goals.

During this trend, the standard grading strategies for assessing and providing feedback on the professionalism of the student were being applied. Specifically, up to 10% of a student's grade resulted from status reports and meeting commitments. However, this proved insufficient motivation to keep some of the students on task throughout a long project.

## **GOALS**

We believe that all computer science students must be able to complete this type of project in order to be successful upon graduation, so we are committed to making this course work. Also, failing to complete the senior research project has significant consequences for the student; it delays graduation by a year. Therefore, we take this problem very seriously. We set

two goals for the most recent revision of the course. First, we want to reduce the number of course failures and incompletes. Second, if failure seems likely, we want to make that potential clear to the student as early as possible. This way the student would have the longest amount of time available to make better plans for the coming year. We wanted to give students a realistic picture of their future as soon as possible so that students could make the best decisions for themselves.

### **MODELLING EMPLOYER'S ASSESEMENT OF PROFESSIONALISM**

Reviewing the course structure, we decided that assigning only 10% of the grade for professionalism was insufficient to help the students understand how much their professionalism affects their ability to succeed. In past years, when a student lost points for professionalism during a status report, the amount lost was too trivial to affect their grade. In fact, grading this way implied that their professionalism grade could be zero and they could still get a B in the class. Clearly, that was the wrong message to the students.

An employer's overall perception of an employee's professionalism has a number of characteristics:

- It starts high,
- It generally goes down, requiring a dramatic event or a long period of time to raise it, and
- It lowers the employer's trust and taints their perception of the quality of the employee's work.

In order to help our students understand this aspect of professionalism and to reinforce the consistent effort needed to successfully complete a capstone project, we changed the way the course is graded.

### **METHODOLOGY**

Instead of making professionalism one component of the final grade, we wanted to model how professionalism affects perceptions of quality. Student final grades are calculated based on two major grades, the professionalism grade and the quality grade. The quality grade is the traditional portion of the grade. The quality grade started at 0% and built up over the course of the semester based on the quality of a student's deliverables. The professionalism grade started at 100% and could only go down. When a student failed to perform in a professional way, his or her professionalism grade was reduced.

The final grade the student receives is the *product* of the quality and professionalism grades. This effect of this policy is shown in Table 1. If the quality grade is on a border, a small reduction in professionalism can lower the letter grade, and, even if the quality is perfect, if the professionalism goes below 70%, a student cannot receive the minimum required grade of a C for the first semester of the course.

This was a fundamental change to the grading policy and we had to ensure that the students truly understood its repercussions. The syllabus contained the details that are shown in Appendix A. We also tried to impress upon the students the importance of this portion of their grade on the first day of the course by making them sign two copies of the "Grading Policy Acceptance" sheet. They taped one copy into their research notebook and the course instructor kept a copy. We made it abundantly clear that there was no safety net for this course and that graduation could be delayed for an entire year if they were not successful. This was, perhaps, a bit melodramatic. Any course that is required for the program and only offered once a year could

have the same effect on a student's graduation, but we felt it was important to emphasize this up front to drive home the importance of the professionalism grade.

**Table 1:** Effect of the Professionalism Grade

		Quality %															
		100%	98%	96%	94%	92%	90%	88%	86%	84%	82%	80%	78%	76%	74%	72%	70%
Professionalism %	100%	100.0	98.0	96.0	94.0	92.0	90.0	88.0	86.0	84.0	82.0	80.0	78.0	76.0	74.0	72.0	70.0
	98%	98.0	96.0	94.1	92.1	90.2	88.2	86.2	84.3	82.3	80.4	78.4	76.4	74.5	72.5	70.6	68.6
	96%	96.0	94.1	92.2	90.2	88.3	86.4	84.5	82.6	80.6	78.7	76.8	74.9	73.0	71.0	69.1	67.2
	94%	94.0	92.1	90.2	88.4	86.5	84.6	82.7	80.8	79.0	77.1	75.2	73.3	71.4	69.6	67.7	65.8
	92%	92.0	90.2	88.3	86.5	84.6	82.8	81.0	79.1	77.3	75.4	73.6	71.8	69.9	68.1	66.2	64.4
	90%	90.0	88.2	86.4	84.6	82.8	81.0	79.2	77.4	75.6	73.8	72.0	70.2	68.4	66.6	64.8	63.0
	88%	88.0	86.2	84.5	82.7	81.0	79.2	77.4	75.7	73.9	72.2	70.4	68.6	66.9	65.1	63.4	61.6
	86%	86.0	84.3	82.6	80.8	79.1	77.4	75.7	74.0	72.2	70.5	68.8	67.1	65.4	63.6	61.9	60.2
	84%	84.0	82.3	80.6	79.0	77.3	75.6	73.9	72.2	70.6	68.9	67.2	65.5	63.8	62.2	60.5	58.8
	82%	82.0	80.4	78.7	77.1	75.4	73.8	72.2	70.5	68.9	67.2	65.6	64.0	62.3	60.7	59.0	57.4
	80%	80.0	78.4	76.8	75.2	73.6	72.0	70.4	68.8	67.2	65.6	64.0	62.4	60.8	59.2	57.6	56.0
	78%	78.0	76.4	74.9	73.3	71.8	70.2	68.6	67.1	65.5	64.0	62.4	60.8	59.3	57.7	56.2	54.6
	76%	76.0	74.5	73.0	71.4	69.9	68.4	66.9	65.4	63.8	62.3	60.8	59.3	57.8	56.2	54.7	53.2
	74%	74.0	72.5	71.0	69.6	68.1	66.6	65.1	63.6	62.2	60.7	59.2	57.7	56.2	54.8	53.3	51.8
	72%	72.0	70.6	69.1	67.7	66.2	64.8	63.4	61.9	60.5	59.0	57.6	56.2	54.7	53.3	51.8	50.4
70%	70.0	68.6	67.2	65.8	64.4	63.0	61.6	60.2	58.8	57.4	56.0	54.6	53.2	51.8	50.4	49.0	

## RESULTS

In addition to the final course completion statistics, we have some other useful data points from AY 2010 and AY 2011.

- This new policy was greeted with enthusiastically by our Industrial Advisory Council in AY 2010. Members were excited about hiring students trained to behave like employees.
- In AY 2010, two students chose to withdraw after they experienced a significant drop in their professionalism grade. They concluded that they were unable to meet the standards this year and that they would do better when they had fewer demands on their time.
- In AY 2010, two students completed projects before the end of the second semester. It is hypothesized that the professionalism component helped contribute to early completion.
- In AY 2011, only two student required incompletes. One students needed only five extra days. The other student had a medical emergency, and he decided to sit in on the course again in the fall and complete his work then.

Table 2 shows the grade distribution for the second semester of Sr. Research since AY 2007. It is important to note here that, while a C is required to pass the first semester of Sr. Research, a grade of D is a passing grade for the second semester. Failing and incomplete grades are presented as a single group to control for changes in course policies. In AY 2007, the course policy was that no incomplete grades would be given. This policy was changed in AY 2008.

**Table 2:** Grade Distributions

	A	B	C	D	F & Incomplete	Total Students
AY 2007	18%	36%	5%	9%	32%	22
AY 2008	50%	14%	7%	0%	29%	14
AY 2009	12%	35%	12%	0%	42%	26
AY 2010	60%	12%	0%	0%	28%	25
AY 2011	52%	22%	4%	4%	17%	23

AY 2010 and AY 2011 show improvement over the previous years, especially when focusing on AY 2009 and AY 2007. The AY 2008 class was significantly smaller than the other three years, and so it is unclear how well the AY 2008 numbers compare with other years. Table 2 also shows a significant increase in the number of A's and B's in AY 2010 and AY 2011, but it is difficult to identify the source of this change. In addition to adding a professionalism component in AY 2010, opportunities to earn extra credit were also included in the grading policy. These extra credit assignments may account for the higher passing grades in AY 2010 and AY 2011, but there was not enough extra credit available to save a student from failing the course.

## CONCLUSIONS

The impact of the professionalism grade has been noticeable. Students are very focused on their professionalism grade and are interested in maintaining it over the course of the semester. Students remain in better contact with their mentors, and they are showing demonstrable progress at every bi-weekly progress report. These results alone are very encouraging and we plan to continue to use and study the effects of professionalism in our senior capstone course.

The percentage of students who are unable to complete their project on time is down to 28%. It is hypothesized the professionalism training has prepared students to handle finishing their projects independently and efficiently. More data is needed to be able to draw strong conclusions, and we will have another year's worth of data available in May 2012. This additional data will improve our analysis of the effectiveness of professionalism to increase the on-time completion rate.

## APPENDIX A: EXTENSIVE QUOTE FROM THE FIRST SEMESTER SYLLABUS

Your grade has two major components: a **Quality** grade and a **Professionalism** grade. The two portions of your grade are multiplied together to determine your final grade in the course.

Your **Quality** grade is determined by the extent to which you meet the requirements of a specific assignment. Each deliverable or quiz will be worth a certain percentage of your **Quality** grade. There may be opportunities for extra credit (*e.g.* attending a talk) or to otherwise improve a **Quality** grade on a submitted assignment (*e.g.* revising a submitted deliverable).

Your **Professionalism** grade is the grade you receive for your ability to perform in this course as you will be expected to perform in the workplace. The goal of this part of the grade is to help you understand how an employer forms an opinion of you. When you are hired, they have high hopes for you and respect your professionalism. Each time you disappoint your manager, his or her opinion of your professionalism goes down. As your manager for this course, you disappoint me by **not**:

- Attending all classes
- Arriving to class on time & prepared to participate
- Participating fully and respectfully in class discussions, offering constructive critiques on your classmates' work
- Responding graciously to constructive criticism
- Submitting your work complete and on time
- Attending all required meetings with your technical mentor prepared with new work and questions about your progress

- Communicating fully about your progress with your faculty mentor and course instructor
- Actively maintaining your research notebook and primary technical documentation (PTD)
- Communicating promptly with the course instructor and your technical mentor about any illnesses, emergencies, or family obligations you may have
- Providing documentation for any of the above listed reasons for missing class or falling behind on your schedule.

Like your employer's opinion, your **Professionalism** grade starts at 100% and can *only go down*. There are no opportunities for you to gain back points once they are lost in this portion of your grade. If your **Professionalism** grade drops below 70%, it will be impossible for you to pass this course with a 'C', the prerequisite for taking CSC 499. Do not let this happen. Here are examples of how unprofessional behavior will affect your **Professionalism** grade:

- Excused lateness/absence: -1 pt
- Unexcused Lateness: -2 pts (for a class or a meeting)
- Incomplete submission: -1 to -4 pts
- Unexcused late submission: -1 pt for each calendar day late, after 5 days I will not accept the deliverable
- Unexcused missed class meeting or mentor appointment: -5 pts
- Failure to maintain adequate back ups of your work: -5pts
- Misc. transgressions: -1 to -10 pts at instructor's discretion (being unhelpful, disrespectful, rude, or cruel during another student's critique, for example)

***If your Professionalism grade drops below 70% before the end of the semester, you will automatically be given a 'D' in the course. Receiving a 'D' in CSC 498 means that you cannot take CSC 499 in the spring. You will not be able to retake CSC 498 until next fall. You cannot graduate until you have passed CSC 499; therefore, failure to pass this course will delay your opportunity to graduate until Spring 2012.***

## REFERENCES

- [1] *Computer Science Curriculum 2008: An Interim Revision of CS 2001*, 2008, <http://www.acm.org/education/curricula-recommendations>, retrieved 2/28/2011.
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