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Twelve Tips for Creating a Culture that Supports All Students in Computing

As faculty, we often respond to critiques of the lack of diversity in computing by bemoaning the unjust distribution of pre-college educational opportunities or the difficulties of recruiting students. Rarely do we turn inward to consider how our actions and attitudes reinforce a negative culture of computing. However, it is within our institutions, departments, and classrooms where we have the greatest potential for creating a culture that supports all students. Even small changes to improve our local culture and the climate that it creates could help to ameliorate the impact of the unjust distribution of pre-college educational opportunities and could counteract attrition patterns that tend toward further segregating computing [25,30]. Our work to develop a supportive culture and community at our educational institutions can also help students develop the skills they need to improve the culture within the tech industry. In the best-case scenario, our students can learn from their mistakes, feel like they belong, learn from and with their peers, and learn to mitigate and address bias. This article summarizes four common challenges in creating a productive department culture, and for each provides a question summarizing the challenge and three research-based tips for addressing it. These challenges likely cross disciplines, but are urgently necessary to address in computing to respond to the lack of diversity.

Do your students seem reluctant or embarrassed to get things wrong?

Students might be afraid of making mistakes if they think that computer science requires innate ability. As educators we know that learning takes time and mistakes should be expected. This mindset that success in a field requires innate ability can lead students to pursue ineffective strategies for learning [7]. To encourage students to learn from their mistakes and embrace challenge, we need to help them develop what psychologist Carol Dweck calls a "growth mindset." [7] This is the idea that your ability can grow with practice.

- **Embrace questions you can't answer and your mistakes:** We may find it embarrassing when a student asks a question that we can't answer. This is an opportunity to show students that everyone has the opportunity to learn. Similarly, when you make mistakes in or out of class, embrace them. You can apologize, but it is important to model for students that mistakes aren't embarrassing—they are expected and are opportunities to learn. An instructor's negative reaction to their own mistakes can lead to the development of a "defensive climate" in the classroom, which is characterized by competitive behavior and a lack of empathy [2].

- **Tell students you believe in their ability to learn:** Students are more likely to respond positively to feedback, and learn from that feedback, if you express that

you have high standards and believe in the students' ability to meet those standards [33]. This is helpful to remember when meeting with students one-on-one. Additionally, some educators email all students who did poorly on a test to provide resources that might be helpful to them and express a belief in their ability to learn the material.

- **Attribute students' current abilities to their effort and experience and not innate ability:** It is important that students believe that their success is within their control [20]. Unfortunately, it is common to assume that a student's skills—developed through previous effort and experience—are evidence of innate ability [2]. It can be helpful to provide students additional opportunities to practice. For example, in an introductory course involving programming, students might want to practice programming with one of these online resources with lots of practice problems: [28,34,35].

Do your students sometimes ask questions or make statements that might make some students feel that they do not belong?

Most classrooms have students with varied levels of previous experience, which we all know can be complicated! Even if we are committed to all students' learning and success in the course, students might be intimidated by other students in class who have more experience [15]. These negative emotions of intimidation can be barriers for student learning [20]. Additionally, students might make biased statements that have a differential impact on some students.

- **Set clear expectations for behavior in class:** By providing clear directives about students' behavior you can help students understand what is and is not appropriate. For example, you might tell students to raise their hand to answer a question. This can provide students a chance to think before hearing an answer and can allow you to distribute opportunities to speak among students. The guidelines you provide about students' behavior can help show

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that you believe in all students' ability to learn [4]. You can state the goal that students will learn from and respect their peers [5].

- **Explain to students that even good intentions can lead to negative impact:** Often students who ask questions that are intimidating to other students are just excited about the material and do not realize the potential impact on other students. Even if students have less earnest intentions, it is likely wise to assume the best of intentions. However, it is important to help students understand that good intentions are not enough and that it is our responsibility to learn the ways we have negative impact even without bad intentions [36]. Consider talking to the student privately after class to help them understand the potential impact to other students and how you would like them to change their behavior. If a student asks an advanced or out-of-scope question during class, you might say "That's a great question, but isn't closely related to our course content. Let's chat about it after class. It might even be a little intimidating to other students, but I'm sure that wasn't your intention."

- **Practice how you will respond to biased comments:** How you frame your expectations for classroom behavior and how you respond to inappropriate behavior is important for shaping the culture within your classroom [4]. To be prepared to respond in ways consistent with your goals for the classroom community, you should practice what

you will say in different situations. This practice is important for responding to bias and even responding when students ask potentially intimidating questions. Research has found that people who have practiced confronting bias are more likely to confront bias that they observe [24], and practice will help in confronting any difficult in-class student behaviors. If a student says something biased in a one-on-one setting you might be able to engage them with "what makes you say that?" [23] If a student says something biased in class, you might buy yourself some time and say "I'm not sure what to say, but your comment is important to talk about. Let's chat after class and we can follow-up in the next class."

Do your students report feeling frustrated, isolated or unsure how to solve their problems on their own?

We want our students to learn and this involves challenging them! Unfortunately, it is virtually impossible to provide exactly the right level of challenge for all students. If we integrate collaboration into our classes and coursework, we can help students tackle challenges beyond their current level of ability and ultimately expand their skills [38]. They might also be able to recognize that getting stuck on a problem is normal. Helping students make connections to their peers is also important for students' feelings of belonging [37,39].

- **Avoid competitive course policies:** Competitive enrollment to pursue a

major or grading on a curve can lead to students perceiving the environment as competitive or the courses as "weed-out" courses [16]. These experiences of "weed-out" courses can discourage students and lead to attrition [30]. For example, female students tend to leave the computer science major with higher grades than their male peers [1].

- Tell students what collaboration is and is not allowed: We want students taking advantage of all the opportunities to learn. If we do not make what is allowable explicit, students might not take advantage of these forms of collaboration such as pair programming, asking a peer for help debugging, or brainstorming an approach to the problem with a peer. Collaboration can help dispel misconceptions about computer science as solitary and help students know how to get started. Research has shown that providing clear instructions to students about what steps they should take to be successful is important for student learning and success [40].
- Integrate collaboration in class through active learning: Active learning, which frequently includes collaboration, has been shown to increase exam scores and decrease failure rates [8]. Computer science education research frequently finds positive outcomes for integrating collaboration [29].

In addition to the tips above, you might point students to resources to help them get unstuck, such as the poster with debugging tips found at [17].

Do students report experiencing bias in your department or courses?

Students often face bias on college campuses, which can have negative implications for students' opportunities to learn [33]. For example, Harper and Hurtado [12] summarize research that documents persistent trends in students' reports of "prejudicial treatment and racist campus environments." We need to pay attention to the varied experiences of our students to help all students learn, and it is important that our students learn the skills

of addressing bias that they will need as they take on positions of leadership after college.

- Identify ways your bias might shape your interactions with, or evaluation of, students: While bias is typically seen as unconscious, our efforts to mitigate our bias needs to be conscious [13]. As emphasized above, our intention not to be biased does not mean that this will be the impact. It is important to identify places where we make quick judgements or decisions and identify ways in which these decisions might be unintentionally shaped by bias. As a starting point, research has shown that bias can shape grading [21], expectations of students [9], judgements of which students should be placed in a high track [14], which students a teacher pays attention to [10], and how teachers respond to students [11]. EQUIP (Equity QUantified In Participation) [31] is a classroom observation tool for measuring equity in whole-class discussions, which can be helpful in documenting the unintentional impact of bias, such as calling on some students more frequently than others. There are additional resources for teachers to reduce bias from the Teaching Systems Lab at MIT [22], from the Southern Poverty Law Center [32], and CSTeachingTips [18].
- Have empathy for students: Faculty-student interaction was one of the most important predictors for retention [3]. Okonofua, Pauneskua, and Walton [27] found that when faculty take students' perspectives and have

an empathic response it helps develop positive relationships with students and can mitigate bias. For example, a teacher in their study explained their approach: "'I try to remember that they are all the son or daughter of someone who loves them more than anything in the world. They are the light of someone's life!'" [27, p. 5223].
- Teach students about bias and how they can respond: It is important that students understand and learn to mitigate their own bias. Project Implicit at Harvard University (implicit.harvard.edu) has online implicit bias tests to raise awareness about bias. Knowing about bias isn't enough. Everyone needs to learn to respond to bias. The National Center for Women and Information Technology (NCWIT) provides resources for teaching students about bias [26] and for helping us and our students learn to respond to bias [24].

We need to act to improve the culture of computing at our institutions and beyond

Without our effort, our classroom culture might inadvertently reinforce some of the negative stereotypes of the tech industry. As instructors and administrators, we can adopt practices that lead to a more supportive culture within our institution. Most of these practices are not specific to CS, but given the lack of diversity in CS may be more acutely needed. For example, a report from the Computing Research Association (CRA) [6] found that departments who have responded to

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growing enrollments with a consideration of the implications for the diversity of their student body have higher percentages of female students and students of color. Positive interaction with faculty is one of the most promising strategies for retaining students [3]. You can find more tips for reducing bias and encouraging students to seek help on [19].

This article is part of a four-part series planned by the ACM Retention Committee, which was founded in November 2016 by co-chairs Alison Derbenwick Miller (Oracle) and Chris Stephenson (Google). The committee seeks to better understand "the current issue of retention in 4-year, post-secondary CS education programs." In this work, the committee builds upon decades of research from a variety of fields that is relevant to understanding and addressing current retention issues. The initial work of the committee includes synthesizing and disseminating recommendations from this research within four articles for *ACM Inroads*:

1. *Also in this issue:* Henry Walker, Retention of Students in Introductory Computing Courses: Curricular Issues and Approaches (p. 14)

2. *This article:* cultural factors that may lead to student attrition.

3. *To appear in 2018:* other student-related factors impacting students and retention within computing majors.

4. *To appear in 2018:* a wrap-up of the committee's discussions, analyses, and suggestions following its first full year of deliberations as well as a discussion of how these issues might vary for minority serving institutions. ❖

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