

Report on the LEVEL UP Workshop for Inclusive Undergraduate Computing Education

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1. Overview

I attended a [LEVEL UP workshop](#), sponsored by CRA, ACM, and partner organizations, to "*build consensus around a united vision of inclusive undergraduate computing education*" on behalf of the department. The September workshop in Atlanta was one of six similarly-structured [regional workshops](#) that run through March 2024.

Each regional workshop includes [seven working groups](#):

- [Managing Booming Enrollments without Damaging Diversity Efforts](#)
- [Best Practices for Broadening Participation in Computing](#)
- [Making Departments and Programs More Accessible for Students with Disabilities](#)
- [Different Pathways into Computing](#)
- [AI Systems and Possible Impacts on Diversity and Inclusion](#)
- [Preparing Students for Industry](#)
- [Approaches to Increase Domestic PhD Enrollments](#)

I participated in the working groups on

- [Making Departments and Programs More Accessible for Students with Disabilities](#)
- [AI Systems and Possible Impacts on Diversity and Inclusion](#)

This report describes selected topics in these two working groups, as well as my thoughts on the topics, whether discussed at the workshop or not, particularly as the topics relate to Vandy CS. Comprehensive summaries of working group discussions will be provided at the CRA site after all regional workshops have been completed.

2. Promoting Accessibility for Students with Disabilities

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2. Promoting Accessibility for Students with Disabilities

This [working group](#) was tasked as follows.

“Students with disabilities face challenges of stigma around disability, inaccessible tools and instruction, disability disclosure, and a lack of mentors. Meanwhile, organizational factors and faculty’s individual values and knowledge cause difficulty in the integration of accessibility topics within courses. This working group will explore how to make computing courses more accessible. In addition, this working group will also discuss how best to deal with the rising mental health issues on campuses.”

The working group on accessibility was motivated by NSF's observation that the great majority of Broadening Participation in Computing (BPC) plans submitted by institutions in 2022 did not mention disabilities. Vanderbilt’s plan was something of an exception and addressed autistic and other neuro-diverse students.

To remind yourself of the Vanderbilt CS BPC plan, see https://plans.bpcnet.org/VanderbiltUniversity_ComputerScience_DepartmentalBPCPlan.pdf.

2.1 Autism and Neurodiversity

Neurodiversity was discussed in our breakout group, introduced by another participant, and the issue of accommodating autistic students with respect to group work, as required by our project courses, was raised. That some students might experience more than ordinary discomfort and disadvantage as a result of group work had never occurred to me! I emailed our Student Access Services (SAS) office about accommodations in such cases and received this helpful response from Vanderbilt SAS Director, Jamie Bojarski.

"The way we determine accommodations at Vanderbilt is by reviewing the students’ functional limitations as described by the appropriate professional – usually a psychologist for Autistic students. Depending on their limitations and the requirements of the course, we will work with the instructor to provide equal access without lowering the essential functions/outcomes of the course.

For example, if a student had difficulty working with other groups, we would work with them to see what barriers we could reduce. Do we need to work with them to create a timeline of what is required of them? Should we recommend a role (data collection, writer, presenter, etc)? In some cases we have asked instructors for the student to complete an individual assignment. It truly depends on the learning outcomes of the course, overall course design, and the limitations presented by the student.

If this ever comes up in any of the CS courses, our access specialists are available to work with faculty to produce accessible options."

2.2 Blindness

My own interest in students with disabilities began with my realization several years ago, perhaps when Brightspace starting asking for alternative text for images, that if I ever had a blind student in class I would be hard pressed to provide alternatives to the very large number of technical images

that I use in teaching. My standard alternative text to an image is “If you have problems reading the image then see the instructor.” Its worked for a long time but is inadequate.

Though its a low probability possibility, given the inaccessibility of all of my current materials to the blind, at least during my career horizon, a visually impaired student would have very significant implications for workload, both for faculty and presumably SAS and Center for Teaching too, or so I believe. Searches of NSF awards show that there is research in suitable materials for blind CS students, but standard Web searches reveal general computing affordances but no higher-education CS material that I could find. Accessible materials for the visually impaired is a potential opportunity for Vanderbilt CS. The low probability of blind students enrolling in CS, at Vanderbilt or elsewhere, is likely due to the paucity of appropriate materials, and doesn't welcome visually impaired students!

Even if materials are not prepared or found proactively, I believe the department should be prepared to compensate, with time and money, faculty who are drawn into low probability high impact needs for preparation of materials for blind students, or any other disability for that matter.

2.3 Invisible Cognitive Disabilities and Student Access Services (SAS)

While there was interest in visual impairment and neurodiversity among working group members, most of the session focused on the kind of "invisible" cognitive disabilities that we routinely accommodate through our SAS office. Among the recommendations were

- training on disability/accessibility awareness for faculty and teaching assistants;
- ensuring manifestations of faculty caring/support that are visible to students through syllabus statements and encouragement to seek accommodations if needed;
- evaluation standards for SAS offices on their work with students as well as effectively working with faculty. Personally, I've always had very good interactions with our SAS office (e.g., they want exams 48 hours ahead of time, but they have always accommodated my same-day delivery because that is when my exams are ready -- same day, 6-8 hours in advance). Apparently, good working relationships with offices like SAS are not universal.

2.4 The Role of Project Based Learning

Physical disabilities were not discussed much, though I introduced it into the discussion by relating it to project courses and project-based learning generally, where projects can address access issues, ideally raising awareness, and perhaps drawing students into CS. An exemplar of such a project is from Bobby Bodenheimer's Project in Virtual/Augmented Reality course a couple of years ago, where a student team created an environment that was used to design urban spaces to accommodate the physically disabled.

More generally, project courses for the social good are a potential draw for students into computing, and it motivates, in part, my introduction of [Projects in Computing and Sustainability](#) into our curriculum.

3. AI for Diversity and Inclusion

This [working group](#) was tasked as follows.

“AI systems and tools are here to stay, and they have the potential to bridge current gaps (e.g., intelligent tutors in rural areas) as well as create further divisions (e.g., eliminate jobs that only require a high school diploma). What can/should computing programs do to ensure BPC is not negatively impacted by AI systems and tools? How do we ensure a diverse group is inventing/implementing these systems so these systems are developed with all voices in the room? How can we ensure students think critically about the positive and negative impacts of AI systems on people? In addition, could AI systems/tools be used to help us diversify computing? There is a lot we don’t know. This working group will discuss what we currently know and consider what research problems still need attention.”

I was most interested in the use of AIs to support students in learning and mental health. For example, *how does a practice of conversing with AIs influence student outcomes for marginalized students on paper writing, conversations with humans, interviews, etc?* The group spent considerable time on such issues, and we talked about the use of AIs at different phases of the undergraduate curriculum, where AI LLMs for software development may not be desirable early in a CS student’s education, but very appropriate after they have acquired more skills. On the other hand LLMs may usefully serve as personal tutors early in education, promoting diversity and inclusion in CS education.

A topic that we addressed was AI as an amplifier of student performance, pro and con. Participants recognized the possibility and prevalence of cheating, but also recognized that there are educational settings that are analogous to workplace contexts where LLMs raise the performance of less experienced workers more than AI raises the performance of more experienced workers.

A related topic, which I don’t believe was addressed in our working group’s discussions was AI as an amplifier of speech. A recent [symposium at Vanderbilt on AI, free speech, and civil rights](#) addressed such issues in panels and presentations, including those with Vanderbilt CS participants (Jules White, Jesse Spencer-Smith, Charreau Bell, myself). Amplification of speech is relevant to student empowerment, the courage to speak up, notably for marginalized groups, where *AIs can serve as mediators in human-to-human communication* in a variety of mediums. Underrepresented languages and cultures was also a theme at the AI and civil rights symposium, and cultural sensitivity and respect was significant at the CRA workshop.

Sections 5 and 6 go into more detail about the AI for diversity working group discussions, though again, a much more comprehensive presentation will eventually be available for all working groups.

4. Other Topics of Interest

Other topics that received attention at the CRA workshop included

- (a) pathways into CS;
- (b) the purpose of CS0 (e.g., our Beauty of CS course);
- (c) industry prep, and the opportunities for CS internships for students after CS2;
- (d) micro-internships (e.g., 3 week); and
- (e) micro-credentialing/certification (e.g., 3 week).

What follows draws from the Workshop discussions, but more than previously it draws on my experience as the advisor for non-Engineering CS majors, and all minors regardless of school. There is more opinion here than reporting. But the points are relevant to the Workshop's goals.

4.1 Course Prerequisites, Micro Courses, and Paths through CS

Concerning (a), on pathways, we need attention to the implications of prerequisites on our A&S, Peabody, and Blair CS majors, particularly the implications of mathematics prerequisites. Computing is ubiquitous, there are many CS career opportunities that do not require mathematics, and our program benefits from students outside of Engineering.

Some courses, notably special topics courses, certainly require outside-the-department prerequisites, but I'm concerned that this may creep into depth courses. CS 4260, for example, has a Mathematics probability and statistics prerequisite, and this prerequisite in turn requires other math courses – this is a 3-course stack prerequisite for Introduction to AI, which if taken literally would prevent many, if not most, non-Engineering students from taking intro AI.

The problem is that we have, to date, no mechanism that allows us to drill down to an appropriate educational grain size, in which a student could satisfy prerequisite concepts with a 3-4 week micro course taken over Winter or Summer breaks (see item (e) above). In the case of covering the discrete probability that is advantageous for introductory AI, and which is addressed at many universities in their discrete math course -- our CS 2212 – absent changing CS 2212, we have a 3-course stack math prerequisite! This doesn't seem ideal, particular given demands for AI.

Fortunately for our non-Engineering students, a statistics course from outside mathematics, such as those found in biology, social sciences, or at Peabody are typically accepted as alternatives to the mathematics prerequisites, but this depends on happenstance. After talking with Dan Arena, who teaches CS 2212, I am evaluating the discrete probability chapter in the Zybook used for CS 2212 as the basis of a 2-3 week online module that can be taken by students prior to introductory AI. This will be satisfactory for the AI course that I teach and others, but if an instructor of intro AI wants continuous probability distributions as part of the conceptual prerequisite, then the planned module would not be sufficient. Another option of course is that many non-engineering students will not be able to take introductory AI.

A related problem for CS students from outside Engineering is that our special topics project courses increasingly require mathematics prerequisites. Again, this is understandable, but because

non-Engineering CS majors probably contribute much to our program's diversity, it seems desirable to insure that each semester there is at least one project course that has only CS course prerequisites.

5. Details of AI for Diversity and Inclusion Working Group

The following was posted in advance of the Workshop, and included a reading assignment.

“AI systems and tools are increasingly capable and available to all. While advances in AI has the potential to bridge current gaps (e.g., intelligent tutors in rural areas), it is also leading to potential negative consequences (e.g., eliminate certain white collar jobs). There are successful evidence-based practices for BPC in Computer Science generally, but ensuring broadening participation in AI is still in its infancy.

Reading Assignment

This working group will discuss the opportunities and threats to BPC posed by AI. The group will discuss the following questions and take notes in the corresponding google document. The group will start by brainstorming ideas in a Jamboard: xxx

The group will form smaller groups to discuss each of the following questions

- 1. What are the ways that AI is being (or could be) used at universities specifically to enhance experiences of marginalized students?*
- 2. How do we ensure equitable access to AI education?*
- 3. What are we doing to encourage our students to think about the negative consequences of AI? For examples: potential impacts on people who have been historically marginalized, and implicit bias in AI systems that lead to ethical concerns in the application of AI?*
- 4. What research projects could be developed to advance the potential benefits of AI for diversity, equity, inclusion, and accessibility in computing?*
- 5. Other questions that arise from the readings or your experiences?”*

6. Summary of AI for Diversity Discussion Notes

This is a summarization and discussion with chatGPT on Question 4 of the AI and Diversity discussion (see questions at bottom of Section 5). It is a cute way of presenting a broader summary of the wide ranging discussion. My own contributions in this discussion related to conversations with LLMs, as much for subconscious affirmation for students as for knowledge.

“DO” is DOug.

DO

I would like you to summarize the following discussion notes, beginning with the questions at the start. Since the notes are quite rough, if you believe that you can reasonably fill in some gaps based on your prior knowledge, feel free to do so. I will go through your response. Are you ready for the rough notes?

ChatGPT

Absolutely! I'm ready to help you summarize the discussion notes. Please provide the rough notes, and I'll do my best to provide a concise summary for you.

DO

Q4 Discussion notes How does practice with AIs, including personalized AI tutors, influence marginalized student outcomes in software development, composition, interviews and other human interactions, and other domain knowledge?

Research on the design of personalized AI tutors.

What research projects could be developed to advance the potential benefits of AI for diversity, equity, inclusion, and accessibility in computing?

How does a practice of conversing with AIs influence student outcomes for marginalized students on paper writing, conversations with humans, interviews, etc?

<snip>

ChatGPT

Summary of Q4 Discussion Notes:

Research Questions:

1. *How does practice with AIs, including personalized AI tutors, influence marginalized student outcomes in various domains?*
 - o Emphasis on paper writing, conversations with humans, interviews, etc.
 - o Longitudinal studies needed to explore AI's impact on marginalized students in educational settings.
 - o Comparison of outcomes between marginalized students and the larger student population.

- Investigation into whether AIs in education parallel the productivity increase observed among less skilled workers.
- 2. *How do AI tools affect computer science (CS) education, particularly in programming, based on students' experience in the field?*
 - Exploration of AI coding and its potential to allow non-coding CS students to bypass programming.
 - Identification of proper roles for AI assistants in various aspects of software development, both in practice and teaching.
- 3. *What research projects could advance the potential benefits of AI for diversity, equity, inclusion, and accessibility in computing?*
 - Research supplements for existing projects to integrate AI benefits into diversity, equity, inclusion, and accessibility (IDEAL).
 - Investigation into student use of AI, including ChatGPT, for learning or cheating.
 - AI application in studying depression among college students and addressing mental health issues.
 - Development of culturally sensitive generative AI.
 - Exploration of AI tools as empowerment tools for human expression, especially in storytelling and art.
 - Public repository creation for collaborative AI development and data collection.

<snip>

Overall, the discussion highlights the potential positive impacts of AI in education, particularly for marginalized students, along with the need for ethical considerations and continuous research to maximize benefits and minimize risks.

DO

Thank you. I am curious as to your thoughts. Even though the opening question explicitly mentions "personalized tutors", presumably AI tutors, I really don't see references to personalized tutors in the rough notes. Am I right in that observation?

ChatGPT

Yes, you are correct in your observation. While the opening question explicitly mentions "personalized AI tutors," the rough notes do not explicitly delve into discussions or references specifically focused on personalized AI tutors. The notes touch on the broader impact of AI on marginalized students, including their outcomes in various domains of education, the use of AI in different educational settings, and the potential influence of AI tools on computer science education. However, there isn't a specific emphasis on personalized AI tutors in the provided notes. If personalized AI tutors are a key aspect of the discussion, it might be worthwhile to explore this further or seek additional insights to address this aspect explicitly.

DO

Are you aware on work on AI tutors? Can you cite a few examples? In making the citations doublecheck yourself that the references are real.

ChatGPT

As of my last knowledge update in January 2022, there have been various efforts and research projects related to AI tutors. However, I don't have real-time internet access to provide the latest information or verify current references. Here are a few examples based on my last update:

1. **Carnegie Learning:**
 - o Carnegie Learning has been involved in the development of AI tutors for mathematics education. They use adaptive learning technology to personalize the learning experience for students.
2. **Knewton:**
 - o Knewton is known for its adaptive learning platform that uses AI to provide personalized recommendations and content in various subjects, including math and English.
3. **DreamBox:**
 - o DreamBox Learning offers an adaptive math program for students in kindergarten through eighth grade. It uses AI to tailor lessons based on each student's individual progress and needs.
4. **Smart Sparrow:**
 - o Smart Sparrow provides adaptive e-learning platforms that incorporate AI to personalize educational content. It has applications in various subjects, including science and mathematics.
5. **IBM Watson Tutor:**
 - o IBM Watson Tutor is designed to provide personalized tutoring in K-12 math. It adapts to individual student needs and provides feedback to enhance the learning experience.

Please note that the field of AI tutors is dynamic, and new developments may have occurred since my last update. I recommend checking the latest sources or academic publications for the most recent information and references.

DO

Are you aware of the Betty's Brain project at Vanderbilt University?

ChatGPT

As of my last knowledge update in January 2022, I am aware of the Betty's Brain project at Vanderbilt University. Betty's Brain is a research project led by Dr. Gautam Biswas at the Vanderbilt University School of Engineering. The project involves the development of intelligent tutoring systems using cognitive modeling techniques.

Betty's Brain is designed to be an intelligent learning environment that adapts to the needs of individual students. The system employs artificial intelligence and cognitive modeling to understand how students learn and to provide personalized feedback and guidance. The goal is to create a dynamic and interactive educational experience that supports students in their learning journey.

Keep in mind that developments in research projects can occur, so it's a good idea to check the latest sources or the official website of the project for the most up-to-date information.

DO

What are your thoughts about how any of these cited AI tutoring projects can promote diversity and inclusion in education from elementary school to university?

ChatGPT

AI tutoring projects have the potential to promote diversity and inclusion in education across various levels, from elementary school to university. Here are some ways in which these projects can contribute to fostering diversity and inclusion:

- 1. Personalized Learning:**
 - AI tutors can adapt to individual learning styles and paces, providing a personalized learning experience for students with diverse needs. This personalized approach helps accommodate different learning abilities, ensuring that each student can grasp concepts at their own pace.
- 2. Addressing Learning Gaps:**
 - AI tutors can identify and address learning gaps early on. By recognizing areas where individual students may struggle, these systems can provide targeted interventions to help bridge gaps in knowledge, supporting students who may need additional assistance.
- 3. Cultural Sensitivity:**
 - Projects that incorporate cultural sensitivity, such as considering diverse backgrounds and perspectives, can contribute to creating an inclusive learning environment. AI tutors can be designed to offer content and examples that are culturally relevant and diverse, making education more relatable for students from various cultural backgrounds.
- 4. Accessibility:**

- AI tutors can enhance accessibility by providing tailored support for students with diverse learning abilities, including those with disabilities. Features such as text-to-speech, language translation, and adaptive interfaces can make educational materials more accessible to a broader range of students.
5. **Reducing Bias:**
 - Efforts to minimize bias in AI algorithms can contribute to a fair and inclusive learning experience. AI tutors should be trained on diverse datasets and regularly monitored to identify and rectify any biased outcomes, ensuring that the educational content is equitable for all students.
 6. **Early Intervention for Equity:**
 - AI tutoring systems can assist in early identification of students who may be at risk of falling behind, allowing for timely interventions. This proactive approach supports equity by addressing challenges early in a student's educational journey.
 7. **Supporting Diverse Learning Styles:**
 - Students have different learning styles, and AI tutors can adapt instructional methods to cater to these variations. Whether a student learns best through visual aids, interactive exercises, or other means, AI tutors can customize the learning experience to suit individual preferences.

While these potential benefits are promising, it's crucial to acknowledge and address challenges such as algorithmic bias and the need for ongoing research to ensure that AI tutoring projects truly contribute to diversity and inclusion in education. Additionally, user feedback and iterative improvements are essential to refining these systems for diverse educational settings.

DO

What are your thoughts on possible cons of using AIs, tutors and/or large language models, in college curricula relative to student and faculty diversity and inclusion?

ChatGPT

While the integration of AI, tutors, and large language models in college curricula offers numerous advantages, it also poses potential challenges and cons related to student and faculty diversity and inclusion. Here are some considerations:

1. **Bias and Fairness:**
 - AI models, including large language models, can inadvertently perpetuate biases present in training data. This bias may affect content recommendations, grading, and other interactions, potentially disadvantaging certain groups of students. Ensuring fairness in AI systems is a critical challenge.
2. **Accessibility Barriers:**
 - Not all students may have equal access to technology or the internet. Reliance on AI tools may inadvertently create accessibility barriers for students who do not have consistent access to the required devices or a stable internet connection.

3. **Algorithmic Accountability:**
 - Understanding and explaining the decisions made by AI systems can be complex. Lack of transparency in algorithms may lead to concerns about accountability, making it challenging to address potential issues related to bias or discrimination.
4. **Standardization vs. Diversity of Learning Styles:**
 - AI systems might tend to standardize the learning experience, potentially neglecting diverse learning styles. Some students may benefit more from traditional teaching methods, and an over-reliance on AI could marginalize these preferences.
5. **Faculty Skill Gap:**
 - Integrating AI into curricula requires faculty members to have a certain level of technological proficiency. A potential gap in skills among faculty members could impact the effectiveness of AI integration and the ability to cater to diverse teaching styles.
6. **Data Privacy Concerns:**
 - AI systems often rely on vast amounts of data, raising concerns about student privacy. Managing and securing sensitive information is crucial to maintaining trust and ensuring that data is not used inappropriately.
7. **Lack of Human Interaction:**
 - Overemphasis on AI-driven instruction might reduce the level of human interaction in education. Some students may benefit significantly from personal connections with instructors and peers, and an excessive reliance on AI may diminish these opportunities.
8. **Equity in Access to AI Resources:**
 - Not all educational institutions may have the financial resources to invest in advanced AI tools or technologies. This could create disparities between institutions in terms of the quality of AI-driven educational experiences.
9. **Cultural Sensitivity:**
 - AI models may not always be culturally sensitive or may struggle to adapt to diverse cultural contexts. Content recommendations and language understanding may not fully align with the diverse backgrounds of students, impacting the inclusivity of the learning environment.

Addressing these cons requires careful consideration, ongoing research, and proactive measures to ensure that AI integration in college curricula promotes diversity, equity, and inclusion rather than exacerbating existing disparities. Faculty training, regular audits of AI systems for bias, and feedback mechanisms involving diverse stakeholders are crucial components of a responsible and inclusive approach.