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Bridging the Gap: Exploring Concurrent Enrollment in External Online Courses Among Computer Science Students

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Abstract

This work-in-progress paper examines the experiences of computer science (CS) students who supplement their formal education with external online courses, such as those offered by platforms like Coursera. Initially aimed at understanding the needs of CS students within their academic programs, the study unexpectedly revealed a prevalent trend: many students enrolled in non-credit-bearing external courses to bridge gaps in their university education. Through interviews with 15 students from 11 different universities, ranging from undergraduate to doctoral levels, this paper explores the motivations behind this concurrent enrollment, the challenges faced within formal CS programs—such as lack of mentorship, underrepresentation, and insufficient preparatory support—and the value students place on external resources. The findings highlight the need for better institutional support, mentorship, and career preparation for CS students, particularly those from underrepresented backgrounds. Additionally, this research lays the groundwork for future studies on the evolving role of external online education in shaping the academic and professional trajectories of CS students.

Introduction

In recent years, the rapid evolution of technology and the growing demand for computer science (CS) professionals have transformed the educational landscape. As universities strive to prepare students for the dynamic tech industry, gaps in formal education have become increasingly evident. These gaps—ranging from insufficient mentorship to a lack of representation and pre-college support—often leave students feeling unprepared for academic progression and career readiness. Consequently, many students turn to external online courses, such as those offered by Coursera, CodePath, or Breakthrough Tech AI, to bridge these deficiencies.

External online courses have gained popularity due to their accessibility, self-paced structure, and ability to offer industry-relevant skills that may be underrepresented in traditional curricula. A 2021 report by Class Central [1] highlights that over 220 million learners worldwide have registered for massive open online courses (MOOCs), a trend driven by the flexibility and tailored learning these platforms provide. However, while these courses offer practical benefits, they also present challenges, such as isolation and a lack of personalized mentorship, which remain critical for holistic development in CS education.

This paper explores the experiences of CS students who simultaneously pursue external online courses alongside their formal education. It is based on interviews conducted with 15 students from 11 universities, including Historically Black Colleges and Universities (HBCUs), Primarily Black Institutions (PBIs), and Predominantly White Institutions (PWIs). The findings reveal significant insights into the motivations behind concurrent enrollment, the limitations of formal CS programs, and the perceived value of external resources.

Moreover, the study highlights the nuanced challenges faced by underrepresented groups in CS, particularly African American and female students, who often report feelings of isolation and underrepresentation. Studies, such as those by Sax et al. [2], indicate that diversity in computing

remains a pressing issue, with only 8.0% of bachelor's degrees in CS awarded to African American students in 2020 [3]. This lack of diversity is compounded by limited mentorship opportunities and insufficient community-building initiatives, which are crucial for the success and retention of underrepresented students [4].

By examining the intersection of formal and external education, this research aims to provide actionable insights for improving institutional support systems. It explores key areas, including mentorship, representation, preparatory resources, and the accessibility of online education for diverse learning needs. These findings contribute to the growing body of literature on the role of online learning in higher education and its implications for underrepresented groups in STEM fields.

The study also aligns with broader discussions about the future of education, particularly the integration of external resources into traditional academic pathways. As universities grapple with the challenges of equipping students for the tech industry, the insights from this research underscore the need for a more inclusive and adaptable approach to CS education.

Methodology

This study employs a qualitative approach to explore the experiences of computer science (CS) students supplementing their formal education with external online courses. The data was collected through semi-structured interviews conducted during the CMD-IT/ACM Richard Tapia Celebration of Diversity in Computing Conference, an event dedicated to promoting diversity within the computing field. The Tapia Conference is a recognized venue for bringing together undergraduate and graduate students, faculty, researchers, and professionals from diverse backgrounds, providing an ideal setting for gathering insights from underrepresented groups in CS education [5].

Participant Recruitment

A random sampling method was used to select participants among conference attendees. This approach ensured diversity in educational backgrounds, institutional types, and academic levels. Table 1. shows the distribution of students by university, where we interviewed a total of 15 students, representing 11 different universities, including Historically Black Colleges and Universities (HBCUs), Primarily Black Institutions (PBIs), Hispanic Serving Institutions (HSIs), and Predominantly White Institutions (PWIs).

Table 1. Distribution of Students by University

Schools	**Number of Students**	**Percentage**
HBCU	4	26.7%
PBI	1	6.6%
HSI	3	20%
PWI	7	46.7%
Total	**15**	**100%**

The students ranged from undergraduate freshmen to Ph.D. candidates, as seen in Figure 1. below, allowing for a comprehensive examination of academic experiences across educational stages.

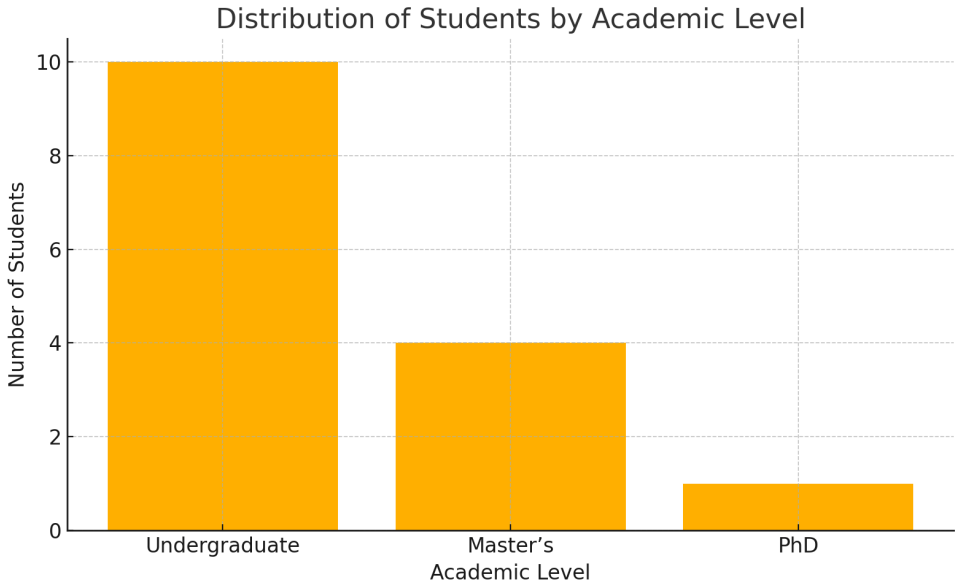

Figure 1. Distribution of Students by Academic Level

Data Collection

The interviews were conducted in person at the Tapia Conference and followed a semi-structured format to allow for both consistency and flexibility in responses. The interview protocol focused on three key areas: (1) Challenges in Formal CS Programs: Questions aimed to identify obstacles students faced in their academic pathways, such as mentorship gaps, lack of diversity, and preparatory inadequacies. (2) Experiences with External Online Courses: Participants were asked about their motivations for enrolling in non-credit-bearing online courses, the perceived value of these courses, and the challenges associated with balancing them alongside formal education. (3) Future Academic and Career Plans: Discussions included students' aspirations for graduate education, industry roles, and the factors influencing their decision-making processes. A visual of these three key areas can be seen in Figure 2. below.

Figure 2. Three Key Areas

The interviews lasted 30–45 minutes on average and were audio-recorded with participants' consent. The recordings were transcribed verbatim for analysis, and identifying information was removed to ensure confidentiality.

Data Analysis

A thematic analysis was performed on the interview transcripts following the six-phase process outlined by Braun and Clarke [6]. This involved familiarization with the data, generating initial codes, searching for themes, reviewing themes, defining and naming themes, and producing the final report. The analysis focused on identifying recurring patterns in students' experiences, particularly regarding their use of external online courses and their perceptions of institutional support. To ensure reliability and validity, multiple researchers independently coded the data before reaching a consensus on the identified themes. This triangulation of data helped minimize bias and ensured the findings accurately represented participants' experiences [7].

Ethical Considerations

Ethical approval for this study was obtained prior to data collection. Participation was voluntary, and all students were provided with informed consent forms detailing the study's purpose, the use of their data, and their right to withdraw at any time. Confidentiality was maintained by anonymizing transcripts and aggregating results in the reporting process.

Limitations

The study has some limitations. First, the sample size of 15 students, though sufficient for qualitative analysis, may not fully capture the diversity of experiences among all CS students. Second, the recruitment of participants from the Tapia Conference may introduce bias, as attendees are typically more engaged in diversity and inclusion initiatives than the broader CS student population.Third, recruitment of participants prioritized black students, due to the project association with IAAMCS, and knowledge around this demographic's concentration in online

programs. Thus, the findings here may not fully represent all student perspectives. Finally, the reliance on self-reported data may lead to recall or response biases. Despite these limitations, this methodology provides valuable insights into the experiences of CS students, particularly those from underrepresented groups, and their use of external online resources.

Findings

The interviews revealed a range of challenges faced by computer science (CS) students in their academic journeys, as well as their motivations for supplementing formal education with external online courses. Through these narratives, a picture emerged of the gaps in institutional support and the lengths students go to in addressing these gaps.

A consistent theme was the lack of mentorship available to guide students through the technical and professional aspects of their education. One participant expressed frustration at missing out on job opportunities, stating, *"I lacked mentorship when applying for jobs and missed the application cycle due to this."* Others echoed this sentiment, emphasizing the absence of career guidance, particularly around technical interviews and job applications. Without structured mentorship, students often had to build their own support systems. For example, one student shared how they had taken the initiative to form an association for women in cybersecurity to address the lack of resources and encouragement for female students in STEM fields.

Representation also emerged as a significant issue, with many students feeling disconnected and isolated within their programs. One student observed that their CS department had only *"one Black woman professor,"* underscoring the stark underrepresentation of minorities in faculty roles. The absence of visible role models compounded the feelings of isolation experienced by students from underrepresented backgrounds. Similarly, another participant described their experience transitioning from an HBCU, where they felt supported, to a predominantly white tech environment: *"I didn't quit because of my friends who were in the program before me. They helped me through it."* These transitions were difficult, with many students highlighting the importance of maintaining community ties to navigate these challenges.

Another prominent theme was the experience of imposter syndrome, particularly among students who lacked early exposure to computer science. A graduate student candidly admitted, *"I felt like I was years behind everyone. They are in this space after having years of experience in the degree, and I did not."* This sense of inadequacy was often exacerbated by insufficient preparatory support at various stages of their education. Several students noted that their programs did not adequately bridge the gap between introductory and advanced coursework, leaving them feeling unprepared for the next academic or professional step. One student explained, *"Because proper support was not accessible within their institutions, they had to go outside of their institutions to find them."*

To fill these gaps, many students turned to external online courses offered by platforms like Coursera, HackMe, and CodePath. These courses were seen as crucial for acquiring the technical skills and knowledge that their formal programs lacked. For some, the decision to take external courses was born of necessity. One participant shared, *"I dropped the class because I had too big of a course load,"* and when asked if earning course credits would have changed their decision, they replied, *"Yes."* Despite the challenges of balancing these courses with their academic

workload, most students expressed a willingness to take online classes again, citing their accessibility and the autonomy they provided.

However, online courses were not without their challenges. While students valued the flexibility of self-paced learning, many struggled with the isolation that often accompanies online education. One participant noted that it was *"difficult to get academic support in an organic way; when you get homework you want to talk it through with classmates, and that is easier to do in person."* Others emphasized the absence of shared learning opportunities and the strained connections with professors in online settings, which limited their ability to network and seek mentorship. As one student succinctly put it, *"Our peers are our future coworkers."*

These findings underscore the critical role of mentorship, community, and preparatory support in the success of CS students. While external online courses provide a valuable supplement, they cannot replace the holistic support systems that universities must build to address the diverse needs of their students. The narratives collected in this study reveal not only the gaps in formal education but also the resilience of students in finding creative ways to overcome them.

Discussion

The findings from this study reveal critical insights into the experiences of computer science (CS) students navigating the gaps in formal education through external online courses. These insights underscore the pressing need for institutions to reimagine their support systems, particularly for underrepresented groups, to better align with the realities of modern education and workforce demands.

One of the most significant themes to emerge was the lack of mentorship and structured guidance within formal CS programs. Students consistently highlighted the absence of mentorship in crucial areas such as technical interviewing, job applications, and career progression. This gap is particularly troubling given the competitive nature of the tech industry, where early preparation can significantly impact career outcomes. As one student noted, *"I lacked mentorship when applying for jobs and missed the application cycle due to this."* Such experiences point to a systemic failure in many CS programs to equip students with practical skills and career readiness. Universities must address this by incorporating formal mentorship initiatives, including access to alumni, professionals, and peers who can offer guidance and insight into the academic and professional pathways.

The issue of underrepresentation and isolation further complicates the academic journeys of many students, particularly African Americans, women, and Hispanic students. The lack of diversity within faculty and peer groups fosters an environment where students feel disconnected and unsupported. For instance, one student observed that their department had *"one Black woman professor,"* highlighting the severe underrepresentation in CS faculty roles. These experiences are compounded for students transitioning from HBCUs, where they often find robust community support, to predominantly white or non-diverse industries, where they become the minority. This stark shift leaves students without the sense of belonging that was integral to their success. Institutions must prioritize creating inclusive environments through targeted recruitment of diverse faculty, community-building initiatives, and partnerships with organizations focused on diversity in tech, such as the Institute for African American Mentoring in Computing Sciences (IAAMCS).

The prevalence of imposter syndrome among participants further illustrates the challenges faced by CS students, particularly those from non-traditional or underrepresented backgrounds. A graduate student articulated this struggle, saying, *"I felt like I was years behind everyone. They are in this space after having years of experience in the degree, and I did not."* This sense of inadequacy often stems from insufficient preparatory support at key academic transitions. Many students reported feeling unprepared for advanced coursework or graduate-level studies due to gaps in their foundational education. Institutions could implement "bridge programs" that provide intensive preparatory support for students transitioning between academic stages, whether from high school to undergraduate programs or from undergraduate to graduate studies.

The rise of external online courses as a supplementary educational tool reflects the inadequacies of formal CS programs in meeting students' needs. Students often enrolled in platforms like Coursera or HackMe to acquire technical skills not adequately covered in their programs. While these courses provide flexibility and autonomy, they also reveal a troubling trend: students feel compelled to seek external resources to succeed in their fields. One participant emphasized the critical role of these courses, stating, *"Because proper support was not accessible within their institutions, they had to go outside of their institutions to find them."* This reliance on external courses raises questions about the role of universities in providing comprehensive, up-to-date curricula that reflect the demands of the tech industry.

Despite the benefits of online courses, such as accessibility and the ability to learn at one's own pace, students identified significant challenges. The lack of community and real-time interaction was a recurring concern, as these elements are vital for collaborative learning and professional networking. One participant observed, *"It's difficult to get academic support in an organic way; when you get homework you want to talk it through with classmates, and that is easier to do in person."* This isolation highlights the limitations of online education in fostering the peer and mentor relationships essential for long-term success. Universities could explore hybrid models that combine the accessibility of online learning with the community-building advantages of in-person education.

Another challenge is the strain placed on neurodivergent students and those requiring accommodations. While some students appreciated the autonomy of asynchronous learning, others found the lack of structured support to be a significant barrier. This finding underscores the importance of accessibility in both online and formal education. Institutions must adopt inclusive teaching practices and offer accommodations to ensure that all students, regardless of their learning needs, have equitable opportunities to succeed.

These findings have important implications for the evolving role of external online courses in CS education. While these courses are invaluable in addressing immediate skill gaps, they could not replace institutional responsibilities. Instead, universities could view them as complementary tools and consider integrating credit-bearing online courses into their curricula. Partnerships with platforms like Coursera or CodePath could help institutions provide high-quality, industry-relevant courses while ensuring students receive academic credit for their efforts.

Next Steps

The findings of this study highlight critical gaps in mentorship, representation, and preparatory support within computer science (CS) programs, and addressing these gaps will require a

systemic and multifaceted approach. One of the most significant needs expressed by students was for comprehensive mentorship programs. Many students struggled with technical interviews, internships, and job applications due to a lack of guidance, often missing important opportunities. One participant shared how they missed an entire application cycle simply because no one informed them of the timeline. To address this, universities could develop structured mentorship initiatives that connect students with alumni, faculty, and industry professionals. Mentorship programs could not only focus on technical skills but also provide guidance on navigating academic transitions and exploring different career pathways. Additionally, pairing students with mentors who share similar backgrounds can foster a stronger sense of belonging and ensure underrepresented students feel supported.

Representation within CS programs emerged as another critical area for improvement. Many students described feelings of isolation due to the lack of diversity in their programs, both among peers and faculty. One student noted that their CS department had only one Black woman professor, illustrating the stark underrepresentation in academic roles. These experiences were particularly pronounced for students transitioning from HBCUs, where a sense of community was integral to their success, to predominantly white or non-diverse environments, where they often felt disconnected. To address these challenges, universities must prioritize hiring and retaining faculty from underrepresented groups and actively create opportunities for students to engage with diverse role models. Community-building initiatives, such as student organizations focused on minority groups in CS, can also provide essential peer support and foster connections that help students navigate challenges.

Another recurring theme was the inadequacy of preparatory support during key academic transitions. Many students felt unprepared when moving from high school to undergraduate CS programs or from undergraduate to graduate studies. One participant shared that their undergraduate program only required a single coding course, leaving them unprepared for the rigor of their master's program. To mitigate these challenges, universities could establish bridge programs designed to strengthen foundational skills in CS and ease transitions between academic stages. Such programs could include coding boot camps, research workshops, or early career readiness initiatives that focus on preparing students for technical interviews and internships.

Students' reliance on external online courses to fill gaps in their education further underscores the need for institutions to modernize their curricula and resources. Many participants turned to platforms like Coursera and HackMe to acquire technical skills not covered in their programs. While these courses provided valuable knowledge, they often came at the expense of academic credit or formal recognition. To address this issue, universities could consider integrating credit-bearing online courses into their curricula through partnerships with established platforms. Such integration would allow students to access industry-relevant topics while ensuring their efforts contribute to their academic progression. However, institutions must also address the limitations of online learning, including the lack of community and mentorship, by adopting hybrid models that combine the flexibility of online courses with the collaborative benefits of in-person learning.

Financial barriers were another significant obstacle for students considering graduate education. While many expressed interest in pursuing advanced degrees, the cost of tuition and living expenses deterred them from continuing their studies. Universities could expand scholarship and fellowship opportunities for underrepresented students and consider providing funding incentives

for those transitioning directly from undergraduate to graduate programs. These initiatives would reduce the financial burden and make higher education more accessible for students who might otherwise hesitate to pursue it.

There are existing diversity focused resources like the Institute for African American Mentoring in Computing Sciences (IAAMCS) but not all students are aware that they exist. For example, most students interviewed were unfamiliar with IAAMCS and its resources, despite its potential to address many of the challenges they faced. Universities could actively promote such programs through CS departments, student organizations, and career services. Including information about these initiatives during orientation sessions and other onboarding events can ensure that more students are aware of and benefit from these valuable resources.

Conclusion

This study sheds light on the significant gaps in mentorship, representation, and preparatory support that computer science (CS) students face in their academic journeys. These challenges are particularly pronounced for students from underrepresented groups, who often navigate feelings of isolation, imposter syndrome, and inadequate institutional support. To bridge these gaps, many students turn to external online courses, which, while valuable, lack the community, mentorship, and academic recognition necessary for holistic growth.

The findings underscore the urgency for institutions to adopt a more inclusive and supportive approach to CS education. Structured mentorship programs, increased diversity among faculty and students, integrated credit-bearing online resources, and robust bridge programs can help address the challenges students face. Moreover, fostering a sense of community, providing tailored accommodations for neurodivergent learners, and expanding access to financial resources are critical steps toward leveling the playing field for all CS students.

By implementing these changes, universities can better equip students to succeed in an increasingly competitive and dynamic tech industry. These efforts will not only benefit individual students but also contribute to diversifying the field of computer science, enriching it with perspectives and innovations that reflect the experiences of all communities. Moving forward, this research lays the groundwork for further exploration of how formal education and external resources can complement one another, ultimately reshaping the academic and professional trajectories of CS students.

References

[1] D. Shah. “By the numbers: MOOCs in 2021.” Class Central. Accessed: Feb. 20, 2025. [Online.] Available: https://www.classcentral.com/report/mooc-stats-2021/

[2] L. J. Sax, M. A. Kanny, T. A. Riggers-Piehl, H. Whang, and L. N. Paulson. “‘But I’m not good at math’: The changing salience of mathematical self-concept in shaping women’s and men’s STEM aspirations,” *Research in Higher Education,* vol. 58, no.7, pp. 763–794, Feb. 2017, doi: 10.1007/s11162-017-9450-6.

[3] National Center for Education Statistics, 2020, “Completions,” Integrated Postsecondary Education Data System (IPEDS). [Online]. Available: https://nces.ed.gov/ipeds/use-the-data

[4] S. Mithun and X. Luo, “Improving perceptions of underrepresented students towards computing majors through mentoring,” in *Proceedings of the 2023 Conference on Innovation and Technology in Computer Science Education V. 1*, Jun. 2023, pp. 26–32.

[5] Center for Minorities and People with Disabilities in IT. “CMD-IT/ACM Richard Tapia Celebration of Diversity in Computing.” CMD-IT.org. Accessed: Dec., 2024. [Online.] Available: https://tapiaconference.cmd-it.org/

[6] V. Braun and V. Clarke, “Using thematic analysis in psychology,” *Qualitative Research in Psychology*, vol. 3, no. 2, pp. 77–101, 2006, doi: 10.1191/1478088706qp063oa.

[7] J. W. Creswell and J. D. Creswell. *Research design: Qualitative, quantitative, and mixed methods approaches*, 5th ed. Thousand Oaks, CA, USA: Sage Publications, 2018.