Efficiency vs. Equity: A Critical Look at Group-Based Office Hours in Computer Science

A Research Paper submitted to the Department of Engineering and Society

Presented to the Faculty of the School of Engineering and Applied Science

University of Virginia • Charlottesville, Virginia

In Partial Fulfillment of the Requirements for the Degree

Bachelor of Science, School of Engineering

Thao Nguyen

Spring 2025

Department of Computer Science

Advisor

Joshua Earle, Department of Engineering and Society

Introduction

Office hours are meant to be a lifeline for students seeking academic support, yet for many, they feel more like an obstacle course plagued by long wait times, overcrowded queues, and ineffective help sessions. At universities like the University of Virginia (UVA), office hours are designed with the intention of offering students personalized support and reinforcing course concepts through one-on-one engagement outside of class lectures (Carpenter et al., 2021, pp. 550–555). However, computer science as a major is growing significantly in popularity across universities in the country, leading to high enrollment across programs. According to the 2023 Taulbee Survey, undergraduate computer science programs have experienced a 17.6% increase in awarded BS degrees and 9.5% rise in new majors (Computing Research Association, 2023). As a result, universities face challenges in scaling faculty and TA support due to budget constraints and a shortage of qualified teaching assistants (Seymour & Hunter, 2019, pp. 387–414).

Beyond logistical challenges, office hours suffer from a poor reputation. Despite the emphasis of one-on-one engagement, many students find the wait times and unproductivity of office hours discouraging, causing them to avoid office hours entirely. For students who do attend, it often feels more like waiting in line for tech support than a valuable learning resource. Consequently, office hours are now seen as a last minute resort rather than a reliable, helpful measure (Z. Gao et al., 2022, pp. 300). Students are not the only ones burdened by this system – TAs are also becoming increasingly stressed by these inefficiencies. Longer queues mean shorter, less in-depth help sessions with students which leads to unproductive and ineffective office hours (A. Smith et al., 2017, pp. 549-554).

In particular, for underrepresented students, these inefficiencies pose an even greater barrier to success. Research indicates that students from marginalized backgrounds rely on office

hours as their primary source of help due to limited access to alternative resources such as private tutoring or peer study groups (Barker et al., 2014, pp. 1-19). Thus, poorly structured office hours can widen the educational gap between students by making academic support less effective or accessible, reducing the overall impact of the resource. On the other hand, well-designed systems can help bridge this gap by ensuring that support reaches students in meaningful, inclusive, and efficient ways that promote long-term learning and engagement (Means et al., 2013, pp. 1-47) Since underrepresented students are at greater risk of academic setback, it is important to be wary of long-term consequences like threatened retention in STEM majors like computer science (Seymour & Hunter, 2019, pp. 387–414). Clearly, with no other resource to go to for academic support, inefficient and unreliable office hours only worsen education disparities, disproportionately affecting those who depend on these sessions the most.

Recognizing these challenges, universities like UVA have begun exploring new approaches to improve office hours. Given the increasing demand for office hours and their current inefficiencies, rethinking their structure is essential to ensuring they remain a valuable resource for students. We propose a redesigned office hour system that integrates two core technology solutions: student grouping and AI-driven support. Grouping students with similar questions fosters collaborative learning, reduces redundancy, and enhances peer-to-peer engagement (Kohli et al., 2023, pp. 11–17). Meanwhile, AI chatbots can handle frequently asked questions, allowing TAs to focus on more complex academic concerns. These strategies aim to optimize office hours by improving efficiency and accessibility for a diverse student population. Thus, my research aims to explore how UVA's technologically enhanced office hour system impacts the quality and accessibility of academic support for diverse student populations in computer science.

Methods

Data Collection

      In order to assess the effectiveness of our redesigned office hour system, we primarily collected feedback data through surveys completed by students and TAs at UVA after each office hour session. We collected this data from four CS courses using the enhanced system over two semesters (Fall 2023 – Spring 2024). These surveys captured students' perceived wait times, frustration levels, TA helplessness, question resolution, and overall satisfaction. A total of 1,246 student and 1,241 TA responses provided quantifiable insights into the system's impact on office hour inefficiencies.

      To ensure a thorough evaluation, the survey focuses on both logistical and empirical factors influencing office hour effectiveness. It consisted of five core questions that were designed to evaluate both logistical and qualitative aspects of office hours. First, students recorded their perceived wait times with these answers: "A really long time", "A long time", "A moderate amount of time", "A little time", and "No time". This measured students' perceived wait times, helping assess the impact of grouping on delays. Second, students were asked if waiting in line frustrated them. This provided insight into the psychological impact of waiting to meet with a TA or professor. Third, students were then asked to assess their TA's helpfulness on a scale from 1-5 to allow for comparison between individual and group sessions. Fourth, students were asked to determine if the TA addressed none, some, most, or all of their questions or if the student left even more confused than they came. Again, this helped us analyze differences in thoroughness amongst individual or group sessions. Lastly, overall satisfaction scores on a scale from 1-5 provided an overview of student perspective on each TA session. While student responses assessed their experience with the new system, TA surveys provided insight into its

impact on their workload and effectiveness. TAs were surveyed separately regarding their ability to address student concerns under both individual and group conditions. By integrating these perspectives, this data will help me determine whether structural changes to office hours can enhance both efficiency and learning outcomes.

In addition to the survey results, a comprehensive log tracked all office hour session data. This log recorded key details like student IDs, the nature of the issue, a boolean value indicating whether the student opted for grouping, as well as timestamps for entry, fulfillment, and exit. The queue log was particularly helpful in providing us quantitative data to analyze the average wait and help times across the semesters before and during the enhanced system as well as return rates based on the date. Another log tracked shared group mapping data to identify which sessions were group ones and to collect subsequent data about them. By leveraging this structured data, we were able to establish hard metrics to compare whether or not this new system was truly beneficial in terms of improving times and streamlining queue management.

Technical Overview of System

UVA's office hour system is increasingly overwhelmed by the standard first-in, first-out queue. At peak times, students often faced wait times of an hour or more to meet with a TA – a common issue across large universities, including UVA (A. Smith et al., 2017, pp. 549-554). Since hiring more TAs is not as simple as it seems, the primary focus of my research is optimizing office hour systems to address these limitations effectively and ensure that students still receive the academic support they need. To meet the growing demand, an enhanced office hour system was designed with features like automated student grouping and a future Large Language Model (LLM)-based chatbot for answering common questions. As the AI chatbot is still in development and not yet pushed out for users, my research will not assess its impact on

accessibility. Instead, the effectiveness of grouping students for collaborative office hours will be the central point.

Key to this new system is an automated smart grouping tool that clusters students with similar questions for collaborative sessions with TAs or professors. We chose to incorporate grouping since research suggests students in groups were more satisfied, had higher grades on exams and homeworks, and were less likely to use unsanctioned resources (Calver et al., 2022, pp. 829-835). To implement effective grouping, the system relies on a machine learning-based text similarity approach. This grouping tool uses a Cosine Similarity algorithm, which measures similarity between texts — in this case, student-submitted questions. The algorithm creates a "hyperspace" of word vectors, and questions with smaller angles between them, indicating shared words, are grouped together. This approach enables TAs to address similar issues collectively, increasing productivity and promoting collaborative learning (Hott et al., 2024, pp. 1684–1685). By clustering similar queries, this method streamlines TA workload and fosters peer-to-peer learning, making office hours more efficient and engaging.

Results

Quantitative Findings

Overall, the implementation of the system demonstrated mixed results regarding its effectiveness in reducing student wait times and enhancing overall satisfaction during office hours. Queue time logs primarily provided the quantitative data to highlight patterns in student retention, queue times, and satisfaction levels. One key trend that emerged from the data was the impact of grouping on student attendance. In the course with the most groups, students who met in a group attended office hours more frequently than those who were never placed in a group.

This trend continued in the spring semester, where grouped students had more daily visits than those attending individually. In terms of overall long term retention, all students who were previously placed in a group returned to office hours later on with 85% in the fall and 92% in the spring. Compared to individual rates of 40% in the fall and 55% in the spring, the retention rates for groups are much more promising.

However, the goal of promoting grouping for reducing wait times was not quite achieved. Grouped students waited an average of 66.6 minutes in the fall and 27.4 minutes in the spring compared to the 34.8 mins in the fall and 23.3 minutes in the spring for students who received individual help. This pattern suggests that TAs were more likely to form groups when office hours were particularly busy, perhaps in order to save time. When comparing office hour sessions with similar attendance levels, the trend remained – grouped students still experienced longer wait time than those receiving individual help. Despite the longer wait times, grouped help sessions took less time on average, suggesting improved TA efficiency. TAs spent an average of 17.8 minutes helping grouped sessions in the fall and 12 minutes in the spring whereas an individual session lasted around 12 minutes in the fall and 12.27 minutes in the spring. Given that groups consisted of at least two students, the total assistance time per session being less than double that of individual sessions suggests that TAs were able to address multiple students' concerns efficiently.

Qualitative Findings

In addition to the quantitative data, survey responses offered qualitative insights into how group dynamics affected office hour experiences. When students were led in a group by a TA, both students and TAs reported lower satisfaction rates than individual settings. One recurring theme in student responses was a perceived lack of personalized attention when grouped.

Students felt that in group settings it was difficult to receive individual clarification as TAs spent more time answering other students' questions. This was especially troublesome for those who find it hard to speak up in groups, as they felt they did not receive the necessary support.

TAs also reported that managing groups was challenging as gauging whether all the students fully understood the material was difficult. In computer science courses, where problems are often individualized (like software bugs), TAs struggled to steer the group conversation to be relevant for all students. These observations suggest that students and TAs alike were adjusting to the new group-based format. Compared to the typical one-on-one office hour structure, help for specific problems was not as prominent in groups which some students found difficult to adjust to. Students' expectations for individualized attention likely influenced how they rated overall group satisfaction. Addressing these challenges through tailored group sizes or more targeted group discussions could improve the group session experience for both students and TAs.

An important aspect influencing group satisfaction may have been the nature of the office hour session itself. Both students and TAs indicated that group sessions tend to occur on busier days where the queue was the longest. As a result, students may have been more frustrated by longer wait times, and TAs more focused on getting through the queue rather than providing in-depth help. These frustrations highlighted how difficult it was for students to adjust to group settings where individual attention was already less accessible. The data suggest that these circumstances led to lower satisfaction scores, not because of flaws in the grouping system itself, but due to context and prior expectations.

Thus, while the quantitative data demonstrated that grouping increased office hour retention and enhanced efficiency, the qualitative findings revealed that student expectations for

personalized attention, alongside the high volume of office hour traffic, contributed to the mixed outcomes. The findings emphasize that group session success depends on managing both student expectations and office hour load effectively. While the results underscore the benefits of structured grouping, they also shed light on the challenges of its implementation. Finding the right balance between efficiency and effectiveness is crucial throughout the development process to ensure both aspects are optimized. Ultimately, the insights gained from this analysis will help refine the system, aiming to create a more consistent and impactful office hour experience for all students.

Analysis

The introduction of UVA's technologically enhanced office hour system aimed to streamline academic support while addressing accessibility challenges faced by a diverse student population in computer science. The data revealed that while the new system improves efficiency and engagement, it also presents challenges related to equity, student satisfaction, and resistance to change. By analyzing its impact on the learning experience, accessibility, and adoption, we can better assess the system's overall effectiveness in meeting the needs of all students.

Impact on Learning Experience

The shift toward a more technology-driven approach in office hours by utilizing tools to group students significantly altered the learning dynamics of the system. While this shift brings benefits such as increased engagement and participation, it also introduces challenges that affect the quality of learning. The findings suggest the system helps more students get assistance, but this does not always translate to higher individual learning quality. Some students reported feeling that group sessions moved too quickly, preventing them from processing the material

before moving on. Others expressed concern that they were unable to ask follow-up questions as freely as they could in a one-on-one setting, which could impact their ability to resolve deeper conceptual misunderstandings. This rapid pace may lead to only surface-level understanding of complex material, which is not ideal for students who require deeper exploration of concepts.

One of the key benefits observed was increased student engagement, with data showing that students who frequently used the system returned to office hours for more help, indicating that the structured format encouraged long-term retention in seeking assistance. Research supports this, highlighting that students who engage in active learning and discussions with peers and instructors develop a deeper understanding of the material compared to those who passively receive explanations (Kohli et al., 2023, pp. 11–17). Additionally, group-based learning fosters collaborative problem-solving skills, which are crucial for success in both academic and professional settings. However, while the system increased participation, it led to mixed perceptions of learning effectiveness. Students who were grouped together expressed dissatisfaction with the lack of personalized attention, as they were picked up from the queue quicker but did not receive the individualized support they preferred. This highlights that, while peer learning has its advantages, it cannot fully replace direct instructor support, especially for students who need personalized instruction to grasp complex concepts. Moreover, an overreliance on group interactions may disadvantage students who prefer tailored individual instruction or struggle with speaking up in group settings.

Additionally, the system's technology-driven approach altered the pacing and structure of traditional office hours which had unintended consequences for students who preferred more flexibility and informal interactions with TAs. Fears that the rigid queue system and too much encouragement of grouping made office hours feel transactional could reduce opportunities for

organic, back-and-forth discussions. While grouping may help streamline logistics, it is not a one-size-fits-all solution and may not serve all students equally. This suggests that while technology could potentially improve efficiency, it must be carefully designed to preserve the benefits of traditional, personalized academic support.

Equity Considerations

The primary motivation behind my research was to determine whether UVA's office hour system could increase accessibility and equity by ensuring that more students, regardless of their background, had the opportunity to receive reliable and consistent help. This issue of accessibility is particularly significant given the challenges many students face in the current office hour structure. Office hours have traditionally favored students who could afford long wait times, creating barriers for those with busy schedules or other strict time constraints (Y. Gao et al., 2022, p. 994). Consequently, students who cannot access timely support are at greater risk of falling behind in their coursework, which can impact their grades and reduce engagement with the material (Kinnunen & Simon, 2010). While grouping and AI integration are promising and have potential, exploring additional measures may be key to truly meeting the needs of all students.

Despite the positive intentions of the new system, the findings clearly reveal some unexpected results. The findings suggest that equity improvements were not as evenly distributed as intended as the system's effectiveness varies across different student demographics. Another challenge that emerged from the findings is the varying effectiveness of the group-based model across different student groups. Research on collaborative learning environments indicates that some students may experience higher levels of imposter syndrome or may be hesitant to speak up in group settings, which can reduce the effectiveness of group-based academic support

(Henry, 2013, pp. 645–650). This poses a challenge to the grouping model, as the primary goal is to ensure all students feel comfortable and are successful in collaborative settings. If certain groups of students lack confidence in group interactions, the new office hour structure could be ineffective, ultimately failing to provide the quality help needed and undermining the mission of improving accessibility.

In addition to these demographic differences, the system's reliance on technology also poses challenges for some students. While we have not pushed out the AI chatbot feature yet, it is important to keep digital literacy in mind for the future. Varying levels of digital literacy can impact the effectiveness of advanced technology tools like AI chatbots. The system's reliance on technology for accessing help may have also created additional barriers for some students. Those who were less familiar with the software or had limited access to reliable internet or devices may struggle to fully utilize the system, reinforcing existing inequities (A. Smith et al., 2017, pp. 549–554). This could be an inherent flaw in the system, as excessive reliance on technology might lead to unintended consequences that drive away some students completely. While it is more flexible and accommodating for most students, not all students will be benefiting from a technologically dependent system (Y. Gao et al., 2022, pp. 994). To ensure these enhancements truly improve accessibility, alternative support options should be available, ensuring all students are actively engaged and receive valuable assistance.

Adoption and Resistance

Although the new office hour system aims to improve efficiency and accessibility, its ultimate success hinges on both student and TA adoption. The findings indicate that while TAs generally found the system beneficial for managing high-demand office hours, students were more resistant to it, mentioning concerns over satisfaction and perceived instructional quality.

Since students typically enter office hours expecting individual assistance but are instead placed in groups due to long wait times, their overall experience is often negatively affected. This resistance to grouping is understandable, as traditional office hours have long been viewed as opportunities for individualized attention (M. Smith et al., 2017, pp. 14-29). This suggests that grouping alone may not be able to address all student concerns, and additional strategies — such as flexible formats or targeted TA training — could help bridge the gap.

Resistance to grouping in general is expected as traditional office hours have a perceived standard of individual help. Studies suggest that students often resist active learning strategies at first because they require more engagement than passive lecture-style assistance. Active learning techniques, like group work, demand higher cognitive involvement, which can initially feel uncomfortable for students who prefer a more passive role. However, over time, students tend to see long term benefits such as greater retention and improved problem solving skills (Calver et al., 2022, pp. 829–835). This indicates that resistance to grouping at office hours may not be a sign of ineffectiveness but rather a natural response to change. If the system is implemented more gradually and accompanied by targets to demonstrate its benefits, students may become more accepting over time.

Lastly, faculty and TA approval is critical to the system's adoption. While many TAs appreciated the efficiency improvements, some expressed concerns that group-based office hours made it more difficult to assess individual student understanding. In traditional one-on-one settings, TAs have a clearer view of each student's grasp of the material, allowing them to provide tailored feedback (Tulane & Beckert, 2011, pp. 44-55). If TAs believe the system hinders their ability to provide high-quality instruction, they may be less likely to fully engage with it. Combined with managing large volumes of students simultaneously, this can lead to increased

burnout, reduced teaching quality, and higher turnover rates among TAs (Carpenter et al., 2021, pp. 550–555). Ensuring that TAs receive proper training on how to effectively facilitate group learning, as well as strategies for monitoring individual student progress in a group setting, could be the key to addressing these concerns and improving both satisfaction and system adoption.

Discussion

Conclusion

Blending technology into traditional office hours presents both promising opportunities and notable challenges. Our research demonstrated that while student grouping significantly improved retention rates and encouraged more frequent office hour attendance, it did not achieve the anticipated reduction in wait times across all classes as expected. Instead, grouping appeared to be a strategy TAs used during peak demand times when the line was already long. However, the increased efficiency of help sessions for grouped students suggests that TAs were able to address multiple concerns effectively within a shorter period. In terms of student opinion, the feedback from students was mixed, highlighting areas for improvement. Many felt uncomfortable asking questions in a group and others preferred one-on-one interactions for personalized support. These results emphasize that while technology-driven solutions like grouping can enhance the accessibility and engagement of office hours, additional methods should be used to further optimize office hours. Future improvements, including our integration of AI chatbots, may further streamline the system and reduce bottlenecks. Also, instead of relying solely on grouping, investing in alternative approaches — such as hiring more TAs from diverse academic and cultural backgrounds — may actually help better serve students who rely on office hours.

Ethical and Social Implications

The findings from my research highlight how the current system has successfully increased student participation in office hours by streamlining queues and optimizing TA availability. With goals of reducing wait times and improving access, the system aims to provide more students with the opportunity to receive academic support. However, a one-size-fits-all approach cannot be applied to learning, as students have different needs, and a technological shift in office hours brings with it ethical and social consequences, especially concerning equity and inclusivity.

While the system strives to ensure that no student is unfairly advantaged by their ability to wait in line or use technology, it does not fully eliminate existing structural barriers. For example, students with external obligations — such as work or family responsibilities — may still find it difficult to attend office hours. Similarly, students with learning disabilities or language barriers may encounter difficulties in group settings, where they might feel less comfortable asking questions or contributing to discussions. If the system is not designed with these considerations in mind, it risks inadvertently reinforcing pre-existing disparities in academic support access, excluding certain groups from the benefits of the system. Therefore, keeping grouping as an option rather than a requirement is crucial to ensuring inclusivity, as it accommodates diverse learning styles and needs. This flexibility allows students to choose the format that best supports their individual learning preferences, thereby promoting equity in academic support.

Future Work and Recommendations

Based on the previous findings, I have several recommendations for improving UVA's office hour system. First, the system could incorporate a need-based prioritization method that

factors in previous office hour attendance, the urgency of help needed, and student performance indicators to ensure an equitable distribution of TA time. By utilizing existing data from platforms like Gradescope and Canvas, student data, such as current grades, could be introduced and analyzed to further tailor the allocation of TA resources. Another recommendation is to provide specialized training for TAs on group facilitation, as not all TAs are naturally skilled at managing group discussions effectively. Offering TAs training on inclusive teaching practices can help prevent certain students from dominating discussions while ensuring all voices are heard and contributing.

Given the high enrollment trends in computer science courses, providing additional academic resources beyond office hours could be helpful in managing high volumes. Too much traffic during office hours can deter students from attending, even when they need help (Guerrero & Rod, 2013, pp. 403–405). For example, discussion forums, targeted review sessions, and asynchronous help platforms would ensure students with scheduling constraints or digital problems still receive the help they need. More importantly, UVA should consider hiring additional TAs from diverse backgrounds to provide personalized support and broaden cultural and academic accessibility. This approach could reduce the overreliance on grouping and offer more individualized, flexible support structures for students if budget constraints allow.

Ultimately, UVA's newly enhanced office hour system is an exciting major shift in academic support, but its design must evolve to better accommodate the diverse needs of students. By integrating flexibility, inclusivity, and a student-centered approach, UVA can create academic support systems that are not just efficient, but truly effective in supporting all computer science learners. A system that balances grouping with alternative, inclusive strategies will not only be efficient but also more equitable and sustainable in the long term.

References

Barker, L. J., O'Neill, M., & Kazim, N. (2014). Framing classroom climate for student learning and retention in computer science. *ACM Transactions on Computing Education (TOCE)*, *14*(1), 1-19.

Calver, J., Campbell, J., Craig, M., & Lam, J. (2022). The impact of optional groups on students. In *Proceedings of the 53rd ACM Technical Symposium on Computer Science Education-Volume 1* (pp. 829–835).

Carpenter, S. K., Pashler, H., Wixted, J. T., & Vul, E. (2021). The impact of teaching on faculty burnout in higher education. *Educational Psychology Review, 33*(2), 550-555.

Computing Research Association. (2023). The Taulbee Survey. https://cra.org/wp-content/uploads/2024/05/2023-CRA-Taulbee-Survey-Report.pdf

Gao, Y., Yan, Z., & Han, M. (2022). Rethinking online office hours: Challenges, benefits, and future directions. In *Proceedings of the 53rd ACM Technical Symposium on Computer Science Education* (pp. 994).

Gao, Z., Heckman, S., & Lynch, C. (2022). Who uses office hours? A comparison of in-person and virtual office hours utilization. In *Proceedings of the 53rd ACM Technical Symposium on Computer Science Education-Volume 1* (pp. 300).

Guerrero, M., & Rod, A. B. (2013). Engaging in office hours: A study of student-faculty interaction and academic performance. *Journal of Political Science Education, 9*(4), 403–405. https://doi.org/10.1080/15512169.2013.835554

Henry, T. R. (2013). Creating effective student groups: An introduction to groupformation.org. In

Proceedings of the 44th ACM Technical Symposium on Computer Science Education (pp.

645–650).

Hott, J. R., Floryan, M., & Basit, N. (2024). Towards more efficient office hours for large

courses: Using cosine similarity to efficiently construct student help groups. In

Proceedings of the 55th ACM Technical Symposium on Computer Science Education V. 2

(pp. 1684–1685). https://doi.org/10.1145/3626253.3635544

Kinnunen, P., & Simon, B. (2010). CS majors' self-efficacy: Challenges and directions.

Proceedings of the Sixth International Workshop on Computing Education Research.

Kohli, S., Ramachandran, N., Tudor, A., Tumushabe, G., Hsu, O., & Ranade, G. (2023).

Inclusive study group formation at scale. In *Proceedings of the 54th ACM Technical

Symposium on Computer Science Education-Volume 1* (pp. 11–17).

Means, B., Toyama, Y., Murphy, R., & Baki, M. (2013). The effectiveness of online and blended

learning: A meta-analysis of the empirical literature. Teachers College Record, 115(3),

1–47. https://doi.org/10.1177/016146811311500307

Seymour, E., & Hunter, A.-B. (2019). *Talking about leaving revisited: Persistence, relocation,

and loss in undergraduate STEM education* (pp. 387–414). Springer.

Smith, A. J., Boyer, K. E., Forbes, J., Heckman, S., & Mayer-Patel, K. (2017). My digital hand:

A tool for scaling up one-to-one peer teaching in support of computer science learning.

Proceedings of the ACM Technical Symposium on Computer Science Education,

549–554.

Smith, M., Chen, Y., Berndtson, R., Burson, K. M., & Griffin, W. (2017). "Office hours are kind of weird": Reclaiming a resource to foster student-faculty interaction. *InSight: A Journal of Scholarly Teaching, 12*, 14–29.

Tulane, S., & Beckert, T. E. (2011). Perceived utility and knowledge of graduate teaching assistants. Journal of the Scholarship of Teaching and Learning, 11(4), 44–55.