Group Note-Taking in a Large Lecture Class: Design, Implementation, and Evaluation of a Low-Cost Universal Design Practice

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ABSTRACT
Large introductory-level classes provide a cost-efficient approach for universities to serve many students at once, but also present several challenges to learning (e.g., poor visual angles). In addition, more students with declared, undeclared, or undiagnosed learning disabilities are entering the college and university systems. In the spirit of universal design, we created a group note-taking system in our large introductory computer science course to increase interaction amongst students, promote good note-taking strategies, and provide study resources to all students while also fulfilling the role of accommodating for students with learning disabilities. We show that the section of the course taught with our intervention performed significantly better on their final examination compared to a course taught without the intervention. We report that students enjoyed increased interactions with their peers, and that one third of the class self-reported an increase in their note-taking skills. Furthermore, our intervention only required minimal cost to the institution, and no financial cost to students, and is easily implemented in any size class.

Categories and Subject Descriptors
K.3.2 **[Computer and Information Science Education]**;
K.4.2 [**Social Issues**] *Assistive technologies for persons with disabilities*

General Terms
Measurement, experimentation

Keywords
Universal design, teamwork, introductory coursework, note-taking

1. INTRODUCTION
Many universities and colleges use large introductory-level lecture classes as a low-cost way of providing instructional resources to a large number of students. However, large lecture classes may contain several disadvantages, including a general lack of engagement amongst students, increased distractions, and challenging visual and audio characteristics (e.g., poor viewing angles or lack of a sound system.) Furthermore, many of these courses contain new or first-year students, and the large lecture format does not easily provide for opportunities for students to network and engage their classmates, leading to a sense of isolation [20, 21].

A further challenge to instructors of these large courses is the increasing number of students with declared learning disabilities, estimated to have tripled between 1978 and 1998 [12]. NSF considers disabled populations to be underserved within computing [13]. Cavender et al. note that the Taulbee Report, the main demographic report for computer science, does not track the number of students with learning disabilities [6], but 5 to 15% of the student population is estimated to have some form of learning disorder [18]. These statistics, however, may not include numbers of students who opt not to declare their disability, are embarrassed by the declaration process, may not even be aware they have a learning disorder, or are unable to afford diagnosis.

Instructors of all courses including large lectures, have a responsibility to provide students with disabilities equal access to resources. As a result, many institutions have disability resource offices that work with students to provide appropriate accommodations. One accommodation is for the university to hire a note-taker. Note-takers are an effective accommodation since many learning-disabled individuals have great difficulty in organizing information [10]. In particular, much research has investigated the impact of various note-taking strategies on the learning-disabled [16]. Boyle and Weishaar reported that learning-disabled students who learn strategies for note-taking scored significantly higher on measures of free and long-term free recall than those using conventional note-taking [3].

While teaching such strategies and techniques has benefits, it is impractical for a large-lecture course instructor to incorporate these lessons into an often-standardized curriculum. While it may be possible to provide these strategies outside of class, this would not impact students who have not declared their disability, do not know that they have a disability, or are unable to afford the cost of diagnosis, which is $500 at our institution.

In this article, we present the design, implementation, and evaluation of a group note-taking component for a large introductory-level computer science course for non-majors (CS-0). We chose note-taking as a vehicle for universal design [4] in the classroom. Students take notes and publicly publish them to classmates to provide resources to all students, which are especially of value to those with learning disabilities. We opted to make the note-taking intervention a group-based project to

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promote the development of social and academic networks in the large-lecture classroom.

Much research within the computer science education community examines the benefits of active learning (e.g., [1, 8]). Furthermore, research also examines the importance of gaining feedback in large lecture classes through mechanisms such as the Personal Response System (aka "clickers") [5]. Our work builds upon this literature by describing a low-cost active learning process of note-taking.

2. CSCI 1100 Course Overview

CSCI 1100 is a computer science service course (i.e., CS-0) at The University of Georgia, providing a survey of topics within computer science. Students are exposed to core concepts of computing hardware, software, networking, databases, and HTML/CSS principles. They also gain exposure to special research topics such as artificial intelligence, user-interface design, visual analytics, and social networking. The class meets for 50-minute large-lectures on Mondays and Wednesdays, and then meets for 100-minutes of laboratory time (labs are capped at 24 students) on another day. A full-time faculty member teaches the lecture portion of the course while graduate teaching assistants teach labs.

CSCI 1100 enrolls 150-180 students during a typical fall or spring semester. During Spring 2011, 68% of the students were female, and the most popular majors of students in the course included psychology (21%) and childhood and family development (14%). Since CSCI 1100 does not count towards any university requirements, the vast majority of students taking this course are doing so as part of a major-specific requirement. Also, 58% of the students surveyed in this class stated that they were not interested in taking any additional computer sciences courses, indicating that students are indeed required to take this course and are not electing to do so on their own.

3. NOTE-TAKING INTERVENTION

The note-taking intervention was largely based on large lecture note-taking strategies outlined in SciTrainU [19], an inter-college research initiative in developing and promoting universal design practices. We designed our note-taking strategy to leverage the benefits of teamwork. Cooperative learning strategies can improve students' academic success and enjoyment. Moreover, compared to students who work individually, students who work in teams are significantly more likely to agree that a course achieved its learning objectives [22]. Group note-taking satisfies three of the Chickering and Gameson's principles for good practice in education: developing reciprocity and cooperation amongst students, encouraging active learning, and respecting diverse talents and ways of learning [7].

We explicitly sought to incorporate best-practices for teamwork, including smaller group sizes, rotating roles between participants, having accountability via peer review, and providing built-in mechanisms to manage issues. Our strategy for introducing note-taking into the CS-0 course included:

- randomly assigning up to five individuals per team (*small group sizes)*
- half of the teams are tasked to take notes in a given week as well as develop study & review questions for material covered in class and in the textbook
- teams taking notes and creating study questions are divided into the roles of two note-takers, one study question generator, and one compiler who organizes, proofreads, and posts the notes publicly
- roles within each team change each note-taking week (*rotate roles)*
- teams not taking notes in a given week are tasked to review and grade the notes posted by the other teams (*external peer reviews)*
- teams also evaluate their team members' performance (*internal peer reviews)*

In a given week, the teams taking notes posted their notes and study/review questions to the course management system by 11PM on Friday evening. Teams evaluating other teams completed their reviews by 11PM of the following Wednesday evening. In addition, team members complete their internal peer reviews to give the instructor and TA feedback by 11PM on Sunday evening.

The note-taking intervention replaced three individual homework assignment grades (worth 75-points or 9% of the students' grade). In a week that students were tasked to review other teams' notes, students used a "needs improvement", "meets expectations", and "exceptional" grading criteria, which corresponded to scores of 1, 2.5, and 3 points, respectively. Individuals used this criterion to grade the posted notes for content/clarity, organization of notes, and quality of study questions. Grades were based on the average of all peer evaluation scores for a given week. In addition, students received 3.5 points for completing their evaluations of other teams' notes. A maximum of 75-points could be obtained. To further motivate students in the note-taking assignment, we provided an incentive of a full-letter grade boost to the team who had the highest-rated notes at the end of the semester.

3.1 Fall 2010 Pilot Testing

Our initial deployment of the group note-taking assignment occurred during Fall 2010. Our main goals were to explore the logistics of coordinating 31 teams and to gauge student reaction to the assignment. The only additional teaching resource required was the appointment of one graduate teaching assistant to the lecture portion of the course to help coordinate teams.

We experienced a series of setbacks during our pilot run that impacted the ability to carry out the note-taking intervention, mainly due to limitations of the course management system (CMS) and our strategy for assigning groups. Our CMS was Vista Learning System, and we used the discussion boards and assessment features for the group note-taking project. A combination of bugs in the CMS and generally poor response time negatively impacted the ability for teams to upload their notes or save student responses to peer evaluations. Furthermore, our institution experienced a week-long outage of the CMS which caused hardship and difficulties for teams coordinating their note-taking for the week.

Team members were randomly assigned to each group. Unfortunately, we found this assignment method resulted in students communicating only electronically. The instructor and TA received many complaints about team members, so they began a lecture mid-semester by requesting all teams sit with each other during class. Only three teams (out of 31) were able to do so; the rest did not have any idea who their teammates were. We discovered that when teams had been communicating solely via online communication, they often used harsh words. This

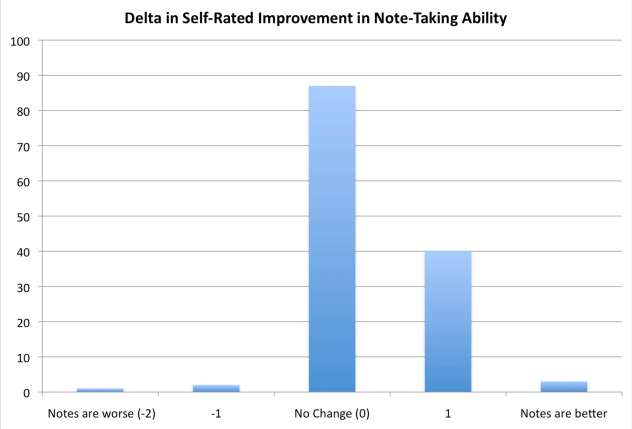

Figure 1: Number students' survey responses indicating improvement (if possible) in note-taking skills.

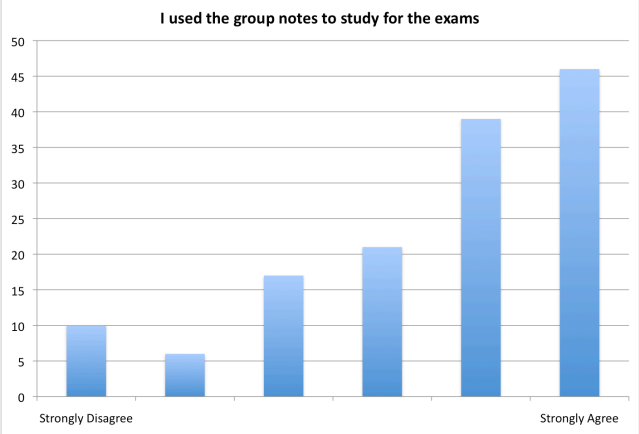

Figure 2: Number of students' survey responses indicating use of group notes to study for exams.

corresponds to existing body of literature that shows that anonymous communication can be aloof [9] and unfriendly [17]. In addition, the instructor and TA were inundated by reports of non-participation amongst group members. Accusations of non-participation were handled on a case-by-case basis, and represented a significant investment of time and energy to resolve.

3.2 Spring 2011 Evaluation Period

We ameliorated the issues with the CMS and group assignments for Spring 2011. First, team members were no longer randomly assigned from students across the entire lecture. Rather, we randomly assigned 34 teams of up to five individuals based on students who had the same weekly lab session. This forced students to physically be in an environment with fewer people at least once a week, allowing for face-to-face interaction.

We built our own Web-based peer review system using an Apache Tomcat JSP server that reliably recorded participation into a MySQL database. Benefits of using our own system allowed us to streamline the process of students rating their teammates, record additional information such as time-stamps, and also reduce the overhead of modifying the CMS to meet our needs. We also had students review their teammates each week to inform the instructor and TA about students who were not participating.

During this phase, every time a group note-taking assignment was completed, students would individually access the website to anonymously rate the participation of other students in their group. The ratings were done on a scale of 1 ("needs improvement") to 5 ("Exceptional"). The internal peer reviews were kept anonymous to students while the instructor and teaching assistant had full information about survey responses.

We also slightly modified the grading criteria we used. In Spring 2011, external peer reviewers could select "needs improvement", "met expectations", or "exceptional" to rate organization, content, and study questions. These ratings corresponded to assigning points of 1.5, 3.5, and 4.25, respectively.

Overall, the group note-taking intervention required minimal effort for the instructor and TA. The creation of the Web-based peer review system took one TA only 20 hours to create. We note that this is a one-time cost. The only other additional resource needed for deploying the group note-taking intervention was again assigning a teaching assistant to the lecture portion of the class. There were no additional grading responsibilities since students were grading each other's notes.

4. RESULTS

We collected information using a variety of quantitative and

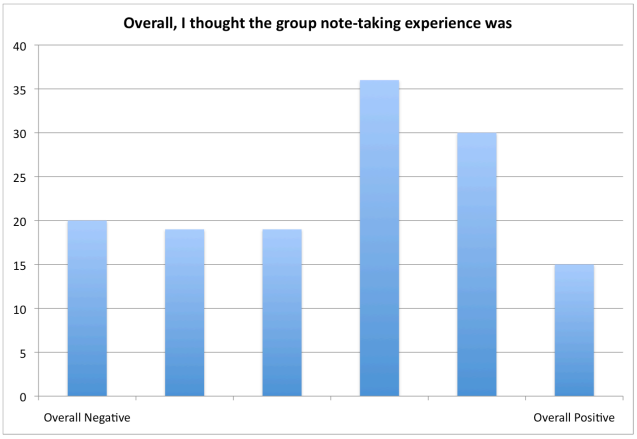

Figure 3. Number of students' responses indicating overall positive or negative experiences with group note-taking.

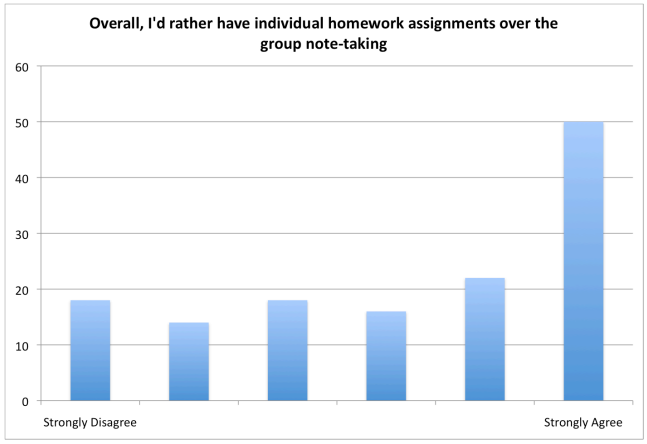

Figure 4. Number of students' responses indicating overall preference for individual assignments.

Table 1: Grouped positive and negative themes in students' impressions of the group note-taking intervention.

Positive aspects of participating in group note-taking	Negative aspects of participating in group note-taking
(66) Used for Studying / Resources	(54) Unequal Distribution of Work
(63) Increased Social/Class Network	(31) Confusion over Deadlines
(42) Acquired New Skills / Abilities	(30) Group Member Can Impact Grade
(28) Provided Academic Support System	(35) Communication & Coordination Issues
(20) Reduced Workload	(12) Peer Review System Flawed/Biased
(16) Broadened Perspectives	(15) Workload too High
(10) Forced to Read Textbook	(14) Felt Project was Busy Work
(4) Reward for Best Notes	(14) Personality Conflicts
	(4) Forced to Attend Lecture

(#) represents number of responses grouped under each theme in a class of 143 students

qualitative measures. We logged all peer reviews for each week, recorded teams' ratings for other teams' published notes and study questions, and compared exam performance of the experimental Spring 2011 course to the results of a conventional Spring 2010 section. We also deployed a survey at the end of the semester to capture overall impressions of the group note-taking project. This survey contained a mix of Likert ratings and free-response questions asking students to list two positive and negative aspects of group note-taking. We analyzed free-response questions using an affinity diagramming technique to establish themes, and used descriptive and inferential measures for other data.

Overall, students in the note-taking section scored significantly higher on their final exam than those in the conventional section ($F(1,299)=8.10$, $p=.005$). However, exam scores did not differ significantly between the two sections for the two midterm exams.

We analyzed our Likert-based survey data using descriptive statistics. Of those students who did not initially rate their note-taking abilities as being perfect (that is, they felt there was no room for improvement), 32.3% of the students indicated an increase in their ability to take notes after completing CSCI 1100 (Figure 1). 65.4% did not believe that their note-taking ability changed in the course, and only 3 students indicated that their note-taking ability was negatively impacted by the course.

Overall, 76.4% of the students indicated that they used the group notes in some form to study for the exams (Figure 2), implying that these resources were indeed of universal design. This was echoed in the free response statements, where the highest number of responses (66) about positive experiences with group note-taking centered on the benefits of having additional resources for studying: *"[group notes were] a good resource for exam time and a good way to make yourself keep up with the class.*"

Students were evenly distributed in their impressions of the group note-taking experience (Figure 3), with 58.2% expressing a positive view and 41.7% indicating a negative view. Many students (63.7%) indicated they would have preferred an individual homework assignment over group notes (Figure 4), mainly because they also indicated that they felt that they did more than their fair share of work within groups (Figures 5, 6). This was echoed in the free-response comments, where the number one theme amongst the comments was an unequal distribution of work. Comments included, "*Not everyone did their fair share" or "if someone did not do what they needed to do, it left others with more work."* However, the actual internal peer review grades assigned by teammates paints a different picture (Figure 7). We discuss this in the next section.

Other frequent positive comments about group note-taking noted the benefits of the assignment facilitating networking in the class (63 comments). Remarks included, "*I had fun working with classmates*" and "*I got to know people I wouldn't have otherwise.*" Other frequent positive comments about the intervention included the benefits of new skills or abilities (42), having a built-in academic support system to ask for clarifications

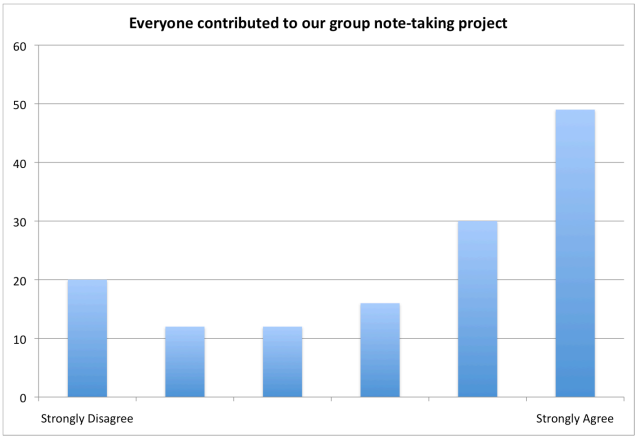

Figure 5. Number of students' survey responses indicating group contributions.

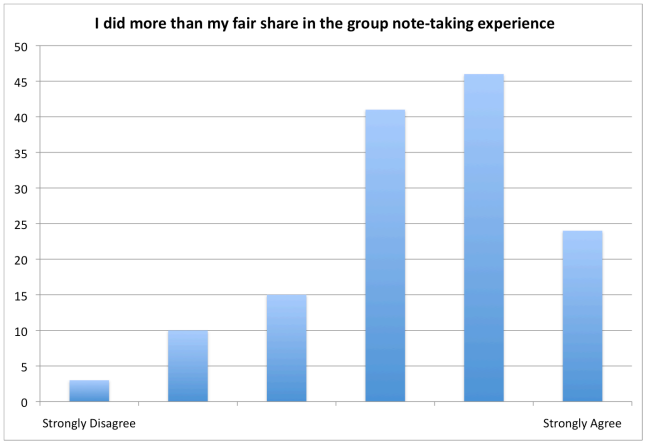

Figure 6. Number of survey responses indicating individual contributions to the group project.

or help (28), and the division of workload (20). Furthermore, 16 students also commented on an appreciation for discovering other students' perspectives on the course material: "*It helped me think of ways to better explain certain concepts*" and that group notes were an "*opportunity to learn something in a different way*" through the group notes.

A frequent gripe of students revolved around confusion regarding deadlines. One student remarked, "*it was easy to forget to do group reviews"* and many others said one of the most negative aspects of group note-taking was, "*forgetting to do evaluations."* Also, students did not care for the deadline for group note postings at 11 PM on Friday: "*11PM on Friday as a due date is not a good time"* and "*Friday night isn't really convenient for weekends when you're going out of town*."

Many students also expressed a fear that their group note-taking process would negatively impact their grades: "*Bad grades effect everyone in the group even if I did my part and no one else did theirs."* Another common complaint about group note-taking was the difficulty of communicating and coordinating amongst team members.

5. DISCUSSION

Our findings illustrate that group note-taking is a promising universal design intervention for a large CS-0 course. We discuss several themes emerging from our findings:

Minimal Cost Intervention for Universities and Students: Financial considerations impact not only the college or university, but also students and their families. Georgia's public school system contains 36.2% rural campuses [11]. This is the third-largest rural student population in the United States. 74.3% of students from rural areas are living at poverty levels [11]. At our institution, 34.4% of undergraduates receive need-based financial aid [14] (including 24.9% of undergraduates receiving need-based Federal Pell Grants). We also note that a state scholarship program for academic achievement provides tuition assistance to 72.2% of undergraduates [15]. Thus, financial considerations of students are important to consider for any classroom innovation. Unlike requiring the purchase a response clicker or additional texts, our innovation does not impose additional financial costs on students.

Furthermore, we believe that financial hardships are a limiting factor in understanding how much of the student population is learning-disabled. At our institution's disability resource office, an official diagnosis of a learning disability is required for students to receive accommodations in the classroom. Testing for learning disabilities at our institution is about $500. This cost may be a huge financial encumbrance for many of our students.

Finally, we note that our note-taking intervention was of minimal cost to the university. The only additional resource required was a single TA assigned to the lecture portion of the course. Smaller-sized courses may not require any additional resources.

Generalizability of Claims: We acknowledge that many factors can influence academic performance in the classroom, such as individual differences, social trends, or unauthorized publishing of previous examinations. To minimize confounding variables, we made the two courses as identical as possible using the same textbooks, lecture slides, and examinations. To avoid having previous semesters' examinations being posted publicly, we did not return examinations to students (but students were encouraged to visit office hours to go over their exams). We strongly believe

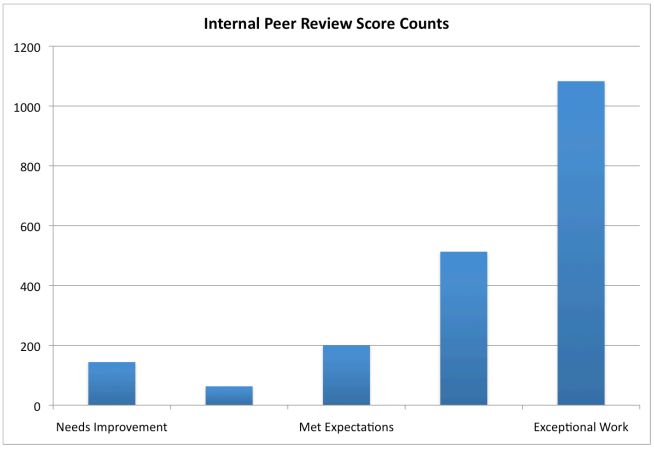

Figure 7. Number of internal peer review scores issued over the semester to teammates.

that note-taking was an effective resource for a non-trivial number of students in the course, as indicated by self-reporting and final examination scores.

Significant Improvement on Final Exam: Students in the note-taking course were able to outperform their counterparts only on the final examination, and not either of the two mid-semester examinations. We believe this may be attributed to two factors. First, the final examination was a cumulative exam, resulting in a greater amount of material being covered. We hypothesize that the public availability of group notes and study guides helped more students effectively study and manage large amounts of information. Second, the material taught after the second exam contained lectures of special topics on computer science, many of which were not in the textbook. We hypothesize that the group notes and study guides were a valuable resource for students reviewing these topics for the final exam.

Perception versus Reality of Grade Impact: As shown in Table 1, many individuals indicated one of the negative aspects of group note-taking was how other students' performance could negatively impact individual grades. This is echoed in Figure 4, where 63.8% of respondents indicated a preference toward individual homework assignments over the group project. We compared the students' grades with and without the group notes components and found that 80.8% of students' final grades did not change; 8.2% of students' grades went down one step (e.g., A to A-minus), 10.3% of students grades went up one step (e.g., B-minus to B), and 0.7% of students' grades went down two steps (e.g., B-plus to B-minus). Thus, the *actual* negative impact on course grades was minimal.

Mismatch Between Survey and Actual Evaluations: During the self-evaluations, a majority of individuals indicated they felt like they did more than their fair share of work during the semester. However, the actual ratings captured during the internal peer review process largely indicated that team members were doing their fair share throughout the semester. We believe this disparity resulted from students being generous during internal peer reviews to avoid "throwing a team member under the bus", either for fear of reprisals or it negatively impacting their grades. In addition, students were aware that the instructor and teaching assistant had access to the internal peer review information, although ratings were kept confidential and anonymous within the teams. Conversely, the cloak of anonymity may facilitate individuals being harsher than during face-to-face interactions [2].

6. FUTURE WORK

In the future, we plan to administer surveys specifically to students with disabilities. In the current study, we showed significant improvements in learning outcomes for the general population (presumably including learning disabled individuals), but we were unable to focus our research on students with disabilities. Earlier, we discussed the difficulties in gathering information about students with disabilities, and we plan to explore methods of identifying and reporting on students with disabilities in our research, including those who have not been diagnosed by our disability resource office.

We also observed that some students had a negative impression of the note-taking intervention because they were concerned that other students could negatively impact their grade. We note that our findings correspond to other researchers' observations that students often resist team projects due to prior negative experiences. We intend to mitigate these negative impacts in two ways. First, we will inform students that group note-taking had an overall positive effect on student grades—very few were negatively impacted and those impacts were small. Second, in future semesters, we will maintain averages with and without group note-taking grades, demonstrating the degree to which the group assignments impact grades.

7. CONCLUSION

In this paper, we describe the design, implementation, pilot testing, and evaluation of a group note-taking intervention in a large CS-0 course. Our specific contributions include:

- A classroom intervention that is of minimal cost to students, institutions, and instructors.
- A universal design mechanism that provides notes and study guides for all students, including those with declared, undeclared, or undiagnosed learning disabilities (an under-served population within computing).
- Quantitative evidence indicating that students in the group note-taking process scored significantly higher on a final examination than students in a conventional course.
- Survey results indicating that 32% of individuals self-reported an increase in their note-taking abilities.
- Students reported benefits such as meeting individuals they would normally have met or interacted with had the group note-taking project not been implemented.

8. ACKNOWLEDGMENTS

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