Classroom Audio Distribution in the Postsecondary Setting: A Story of Universal Design for Learning

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Abstract

Classroom Audio Distribution Systems (CADS) consist of amplification technology that enhances the teacher's, or sometimes the student's, vocal signal above the background noise in a classroom. Much research has supported the benefits of CADS for student learning, but most of it has focused on elementary school classrooms. This study investigated the effects of CADS in the postsecondary setting. Surveys and focus groups were used to elicit the perspectives of both students and professors toward CADS in university classrooms, revealing many themes and multidimensional attitudes. Teachers' and students' perspectives are considered within the principles of Universal Design for Learning (UDL), which encourages a flexible approach toward teaching in order to include as many different types of students as possible in the learning process. CADS is seen as one way to support UDL in higher education settings.

Keywords: *Classroom audio distribution systems, Universal Design, higher education, voice amplification, student support*

Classroom audio distribution systems (CADS), also known as classroom sound field amplification, is a method for enhancing the teacher's, or sometimes the student's, vocal signal above the background noise in a room (Smaldino & Flexer, 2012). CADS consists of a transmitter, a receiver, and an amplifier, using infrared or FM radio technology. Ideally, the speaker's voice is spread uniformly to each listener in the room through one or more loudspeakers at a comfortable and consistent listening level (Whyte, 2010). Research confirms the positive effects on students' learning when the classroom listening environment is enhanced through teachers' amplification (Flagg-Williams, Rubin, & Aquino-Russell, 2009; Flexer, 2005; Massie & Dillon, 2006; Millett, 2008).

Flexer (2005) notes the following student populations that especially benefit from CADS: those with hearing impairments, auditory processing problems, cognitive disorders, learning disabilities, attention and behaviour problems, and articulation disorders. Those learning in a language that is not their primary language also benefit, allowing them to hear every word clearly (Nelson, Kohnert, Sabur, & Shaw, 2005). In fact, all young children benefit since the ability to distinguish targeted speech sounds, especially within conditions of noise, does not fully develop until puberty (Flexer, 2005; Nelson & Soli, 2000). Bennett (1994) estimates "as many as one-third of the students in a typical classroom run the risk of academic difficulties because of the acoustical conditions present" (p. 45). Thus, there are myriad reasons why enhancing the acoustical quality of the classroom listening environment is critical. Improving the acoustics in the room is one part of the solution; enhancing voice volume and distribution, the focus of this study, is another.

Most of the research on CADS and its implications for learning has been with children in K-12 schools. In their reviews of the literature, Rosenberg (2005) identified only four studies specific to higher education and Millett (2008) identified only four additional ones. Our own search within the EBSCO database revealed few others. Yet, learning in postsecondary

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classrooms is similarly largely dependent on verbal communication and merits greater analysis of the listening environment.

The few studies that have examined higher education learning environments tend to focus on the inadequate acoustical quality of university classrooms with respect to background noise, reverberation, and distance between the speaker and the listener (Hodgson, 2002, 2004; Kennedy, Hodgson, Edgett, Lents, & Rempel, 2006; Larsen, Vega, & Ribera, 2008; Woodford, Prichard, & Jones, 1999). For example, Larsen et al. (2008) compared the speech recognition performance of students with normal hearing in two college classrooms, one of which met the American National Standards Institute ([ANSI]; 2002) acoustical standards required for elementary school classrooms. In both classrooms, they compared speech recognition with and without the use of CADS. Not only did they find that following the acoustical standards benefited learners in postsecondary classrooms, but also CADS improved speech recognition in all classroom environments. Woodford et al. (1999) examined the acoustics in seven different classrooms at a large university and found that noise levels exceeded the recommended maximum (as determined by Clabaugh, 1993). Seventy-five percent of students indicated they had experienced difficulty understanding the instructor, but with CADS, the students and instructors noted improved listening conditions.

Two studies looked at the benefits of CADS beyond general improvement of the listening environment. Smaldino, Green, and Nelson (1997) considered the effects on college students in a phonetics course, specifically chosen because the course content required fine auditory discrimination. The results indicated a positive benefit for using CADS in that course, but the implications focussed mainly on applying the information to K-12 classrooms. Valente (1998, as cited in Rosenberg, 2005) demonstrated improvement in the academic achievement of college students with the use of CADS, based on improved exam scores.

Our study thus fills a significant gap in the literature. Specifically, we examine the role of CADS for university students within the context of Universal Design (UD), a concept that is being increasingly applied to educational contexts across North America (Burgstahler & Cory, 2008; Higbee & Goff, 2008). UD began as an architectural and environmental concept, focusing on not just accommodating persons with disabilities but, rather, at the start designing products and environments that are more functional for everyone. Welch (1995) put it this way:

> [Universal Design] emphasizes a creative approach that is more inclusive, one that asks at the outset of the design process how a product, graphic communication, building, or public space can be made both aesthetically pleasing and functional for the greatest number of users. (p. iii)

He refers to UD as a "value system" that embraces human diversity as the norm, suggesting a radical paradigmatic shift.

Within education, the principles of UD have been most commonly expressed in the terms of Universal Design for Learning (UDL) and Universal Design for Instruction (UDI) (see McGuire, Scott, & Shaw, 2006 for a full discussion of the distinction between these and other terms). The Center for Applied Special Technology (CAST) has led the development of principles and applications of UDL, particularly at the K-12 level. On their website (2015), CAST describes UDL as "a framework to improve and optimize teaching and learning for all people based on scientific insights into how humans learn." As a result of brain-based research, there is greater awareness in K-12 education about the variability in the way students learn. To that end, UDL promotes the development of best practices in all aspects of the learning environment and pedagogy in order to reach the widest possible range of learners (Rose, Harbour, Johnston, Daley, & Abarbanell, 2006; UDL, n.d.). The definition of UDL adopted by CAST (2011) is as follows:

> The term UDL means a scientifically valid framework for guiding educational practice that:
>
> a. Provides flexibility in the ways information is presented, in the ways students respond or demonstrate knowledge and skills, and in the ways students are engaged; and
> b. Reduces barriers in instruction, provides appropriate accommodations, supports, and challenges, and maintains high achievement expectations for all students, including students with disabilities and students who are limited English proficient. (p. 6)

These objectives are met through flexible curricular designs, providing multiple means of representation (presenting information and content in different ways), multiple forms of action and expression (differentiating the ways that students can express what they know), and multiple means of engagement (stimulating interest and motivation in learning). At the postsecondary level, UD initiatives have been most typically expressed

through UDI. Similar to UDL, "UDI is an approach to teaching that consists of the proactive design and use of inclusive instructional strategies that benefit a broad range of learners, including students with disabilities" (McGuire et al., 2006, p. 169), without compromising academic standards. While UDL is largely a response to brain-based research, the impetus for UDI has come from the increasing diversity found in the postsecondary student body, particularly with respect to the increasing number of students with cognitive disabilities. According to Burgstahler (2008), "diversity has become a fact of life in higher education" (p. 4). A study in 2003 found that the average percentage of postsecondary students with disabilities (those registered to receive disability related services) varies from ½% to 6% and noted that these figures are dramatically increasing (Fichten et al., 2003). Furthermore, of the students who report having disabilities, the majority and fastest growing group are those who have "invisible disabilities" that affect learning (Burgstahler, 2008), including hearing, learning, attention, and communication differences, all of which relate to CADS. UDI is considered a tool for faculty to reflect on their practice and develop more inclusive instruction. Closely paralleling the seven well-established principles in UD (Connell et al., 1997), UDI contains nine principles (adapted from Scott, McGuire, & Shaw, 2001; Roberts, Park, Brown, & Cook, 2011):

1. Equitable use – accessing course information in a variety of formats;
2. Flexibility in use – varying instructional methods;
3. Simple and intuitive – clearly describing course expectations for grading, in different formats;
4. Perceptible information – necessary information is communicated effectively, regardless of ambient conditions, or the students' sensory abilities, or language competency;
5. Tolerance for error – anticipating variation in the pace of learning, and providing ongoing feedback on coursework (rather than just final exams);
6. Low physical effort – instruction is designed to minimize nonessential physical effort;
7. Size and space for approach and use – allowing for use regardless of a student's body size, posture, mobility, and communication needs;
8. A community of learners – the instructional environment promotes interaction and communication among students and between students and faculty; and
9. Instructional climate – instruction is designed to be welcoming and inclusive, while maintaining high expectations.

The fundamental premise of UDL and UDI is thus inclusive education, shifting our attention from a deficit model that accommodates individual students to one that seeks to reach the widest possible range of students. It is a proactive process rather than a reactive one (Burgstahler, 2008). UD, UDL, and UDI represent a value that assumes diversity to be the norm, and anticipates diversity in all aspects of educational planning and instruction. In this context, CADS needs to be given serious consideration as a support for learning by all students.

In our discussion, while UDI is the more common term used in higher education, we prefer to follow the practice of the recent symposium on Universal Design at the University of New Brunswick (Bokhorst-Heng & Flagg-Williams, 2014) by using the term UDL in our work. In using UDL, we place the emphasis on student learning, while at the same time acknowledging that it is the responsibility of the institution and the instructors to design their instructional and classroom practices with diversity in mind.

Context

The context of this study is a small private liberal arts university in Canada. At the time of the study, there were approximately 825 students and 50 faculty members at the university. In addition to a general liberal arts curriculum, the university also has a Bachelor of Education (B.Ed.) program and an Advanced Education Certificate program for in-service teachers. With the completion of new construction in October 2010, CADS was installed in all of the new classrooms (RedCat NXT integrated flat-panel speakers with Redmike VC infrared pendant-style microphones, by Lightspeed Technologies). Two classrooms in an older building also used the systems before the equipment was moved to the new facility. In addition, the lecture hall in an older building is equipped with a wireless beltpack transmitter and Peavey mixer and speaker system. The types of amplified classrooms throughout the university include small and medium-sized rooms, large lecture halls, and classes of both large and small numbers of students. When the new system was installed, a university technology specialist provided a brief orientation to all faculty members.

Methodology

Purpose

Our study examined the perspectives of both students and professors regarding their experiences and attitudes. We wanted to know:

1. What are the attitudes that this university's professors and students hold toward the use of CADS in their classrooms?
2. How are these attitudes and experiences interpreted with respect to higher education teaching and learning?
3. What are the implications of these attitudes and experiences for the effective implementation of CADS in higher education?

To answer these questions, we administered a university-wide survey for students and faculty, and conducted four focus group discussions: undergraduate students, B.Ed. students, Advanced Education Certificate students, and faculty.

Participants

All students and faculty members at the university were invited to participate in the study by completing a survey. Students were invited through the professors of core courses, thus ensuring access to the entire student body; faculty members were invited through email. A total of 324 students (39% of total sample size) completed the survey and, of these, 307 indicated they had experienced the use of CADS at some point in their education either as user or listener. Identifying information on the student surveys included only their year or program in the university. The 307 participants included in our analysis identified themselves as follows: 52 first year; 26 second year; 30 third year; 45 fourth year; 111 B.Ed; 38 Advanced Education Certificate (Graduate); and 5 'Other' (such as Part Time) students. Given the small size of the student population, our analysis grouped students according to undergraduate, B.Ed and Advanced Certificate (the latter being the only two postgraduate programs at the university). Undergraduate classes tend to be larger, and hence provided a distinct perspective; classes in the B.Ed program tend to be smaller, but also this group had a unique perspective as future educators who were already familiar with the broader ideas of inclusion and UDL; and the graduate students are professionals in the field of education and hence have K-12 experience in addition to experience as students in the university. Seventeen (34%) faculty members completed the survey. Sixteen indicated they had more than five years of teaching experience at the time of the survey.

There were four focus groups, each formed through a convenience sample (those who responded to an email invitation to participate, controlling only for gender – although in forming the undergraduate group, only male students were available at the times scheduled) and each comprised of four participants: Undergraduate students (four males), B.Ed. students (two male, two female), Graduate students (two male, two female), and Faculty (two male, two female; two were Education Faculty). All of the student group members had experience with CADS in at least one of the university's postsecondary classrooms and all of the faculty members had used the technology at some point in their teaching. All of the Advanced Education students and some of the B.Ed. students had additional experience using it when teaching in K-12 classrooms.

Instrumentation and Procedures

The study involved two survey questionnaires: one for the students and one for faculty. The student questionnaire was adapted from Cornwell and Evans (2001), changing the wording to suit the university context (for example, instead of school work, learning) and to reflect the system used at the university (instead of FM system, amplification system). It included the following questions:

1. Do you think amplification of the teacher's voice helped you in your learning? Please tell us how you think it has or has not helped your learning.
2. Would you like to see voice amplification used in more classrooms?
3. If you could change the amplification system in some way, what would you do?

To ensure anonymity, student surveys were distributed, administered, and collected during class by the instructor who then submitted the materials to an office administrator. Students were told participation was voluntary and would not influence their grades.

Faculty surveys were adapted from Cornwell and Evans similar to the student surveys, and we added an additional open-ended question to give faculty an opportunity to expand their ideas. Questions included:

1. Do you think that having the voice amplification system in your classroom benefits your students? Please tell us how you think it does or does not benefit your students.
2. Do you think using the voice amplification system is beneficial to you as a teacher?
3. If you could change the voice amplification system in some way, what would you do?

4. Is there any further information about voice amplification that would be beneficial to you in your use of this technology?

Surveys were completed voluntarily, in respondents' own time and anonymously submitted to an office administrator. Data collection through surveys was completed within a one-week time period in a winter semester.

Subsequent to the surveys, we conducted one faculty and three student focus groups. The discussions were semi-structured, and each ran for about 30-45 minutes. The questions were designed to elicit a more nuanced understanding of the issues raised in the survey responses. Prompts included questions such as:

1. Some respondents indicated that the use of voice amplification had a positive effect on student learning. Let's discuss this in greater depth: What might be the positive benefits you have experienced with respect to your learning? Perhaps you feel that the use of voice amplification has not had a positive effect on your learning – can you expand on this?
2. Have you used voice amplification in your role as a student? If so, did using it have any effect on you as a speaker?
3. Most research concerning voice amplification has been done in the context of elementary education. Do you think there is anything unique about its use with adults that might indicate different benefits or challenges?

Focus group discussions were recorded and transcribed for analysis.

Procedures of Analysis

The surveys elicited both quantitative and qualitative data. The quantitative data was related to respondent characteristics and used to determine respondent validity (e.g., if the respondent had no experience with CADS, their survey was not included). In analyzing the survey's qualitative data, we took each question separately and, following an inductive process outlined by Cresswell (2013), developed codes and themes as they emerged. To ensure inter-coder reliability (Cresswell, 2013), we first each took the same five surveys and independently coded them; we then met to discuss the codes we had developed and came to agreement on the definitions and applications of the codes. We each coded different sets of surveys and combined our findings. Responses to the survey questions were mostly one-sentence answers or short phrases, which were tabulated to get a sense of the priority of the coded themes. The same process of determining inter-coder reliability was used in analyzing the focus group data. We also tabulated the number of speaker turns during focus group discussions that related to the different codes.

Results

While our survey questions were fairly broad, some very consistent themes emerged (see Table 1). Our first question was whether, and how, CADS improved student learning. Answers to this question in the student surveys mostly related to improved attention (15.6%), although often with the caveat that it depended on the classroom size and number of students in the class (14.2%). When students were asked what they would like to change about CADS, concerns about the quality of the technology (14.1%) and the need to provide better training and support for the users of the technology (4.3%) dominated their responses. Faculty also indicated the need for improved technology to enhance the effectiveness of amplification (17.2%); however, only 1.6% felt they needed any training in using the technology. Their bigger concern (26.6%) had to do with the voice factor: Technology was mostly seen as necessary to compensate for one's soft voice, or conversely not needed "because I have a loud voice."

We took the information generated by the survey responses to our focus groups to probe these issues more deeply. Subsequent analysis of our focus group conversations revealed seven main themes regarding their experiences with CADS: *impact on learning; classroom management; conditions of learning; usage; health and wellness; identity; and inclusion.*

Impact on Learning

Impact on learning was most commonly expressed in terms of how amplification enhances student attention, and its importance to students' own learning management. In the B.Ed., graduate, and faculty focus groups, respondents noted the importance of overcoming various sources of background noise: from building construction, road works, and traffic heard through open windows; noise polluting sounds coming from other classrooms such as moving furniture; and sounds within the classroom, such as typing. In the words of one participant, "You got 20 people on their laptops. They're taking notes… when you go home you can still hear the clicking sound! That's something you really hear." The effect of background noise was described by participants as "distracting," and most felt that amplifying the teacher's voice helped to mitigate that

distraction. A graduate student expressed this idea by saying, "I like to use my computer to take notes, but [CADS] would take away that sound." Some faculty members found their students to be "more alert" and to "drift" less often when amplification was used. One gave the example, "If there are students talking in the last row… that's a big distraction to the students in the last row who want to listen to the lecture and take down all the notes;" CADS would help.

In the faculty focus group a great deal of the conversation about students paying attention converged on the cognitive connections between learning and attending. They discussed the amount of information students naturally miss due to inattention as well as the limits of the human attention span. Some wondered if amplification could really help when these limitations on learning are always present, but the consensus was that it could. For example, one faculty respondent noted that "the amplification system clearly hits the auditory side," referencing multiple pathways for learning. Another noted, regarding attention span limitations, "If we're losing them through them not being able to hear, it's going to be even shorter" without amplification.

The faculty, graduate, and B.Ed. focus groups all maintained that student attention has a major impact on learning even in the postsecondary classroom, and that CADS was a major player in enhancing that attention. One graduate student's opinion was that, "We're here paying for our courses, so most of us want to do well so we want to hear as much as possible." This was true when students used CADS in their presentations as well, resulting in other students paying better attention. And, as one faculty member noted, "A lot of learning occurs as a result of what students [say] and if students can't hear other students, you're losing."

The undergraduate students, however, had a different perspective about the impact of CADS on their learning. They acknowledged that when professors used CADS, it kept them "awake" and focused, but, unlike the other groups, they did not think this was a significant issue in higher education contexts. "We're not from high school or anything like this, so, where, we can focus better…[the] lower level schools [are] not as attentive as we are," they pointed out. "When it comes to middle school, you have kids who talk, you know, they pass notes and there's a lot of noise going around. We're more matured and so there's not that roughhousing going on." However, their perspective changed when they discussed the impact of CADS on the attention of the audience when they were the presenter:

> For presentation as a student, you're always worried about, 'am I going to lose your attention' or 'am I going to gain their attention' or 'are they going to talk if I don't', or 'are they going to drown me out' [with distracting noises]. For me, I found that if you have the mic, they are going to hear no matter what they do.

This distinction between attitudes as learners and as presenters was not seen in the other focus groups.

Finally, a thought-provoking nuance of the *impact on learning* theme came from the B.Ed. focus group. They discussed how attention might vary from situation to situation. One respondent observed that it wasn't necessarily just noise that was distracting, but also "where I'm at in my head space on a given day." When students feel focused, the noise may have less effect than when they are feeling on the fringes. Also, some noise is expected and thus may not be as distracting: "Like the construction noise doesn't bother me [because I'm used to it]." However, "when something is out of the ordinary, it's harder to tune that out" – like the clicking of a pen, "and all I could do is not turn around [and say] 'stop doing that!'" One student called it the "'participation factor'" and noted how "there's times when you may be zoned out, but if you do have the amplification, you can still catch a part of it."

Classroom Management

A second theme that emerged from our data was the role of amplification in classroom management. As with impact on learning, this theme was sometimes discussed in terms of the postsecondary setting and sometimes in reference to K-12 schools. All of the focus groups, except undergraduates, felt amplification enhanced teacher 'presence' throughout the classroom. For example, a B.Ed. student said:

> [In university] we do a lot of group work. So, when it comes time to call us back together, there are times, especially at this time of the year when we all know each other, things are starting to go off the rails [and CADS helps to get the class back on track].

A faculty member who wished amplification was in the science labs said:

> When they're moving around [the lab], and you have to be different places… I would want to see [CADS installed]…you can see somebody doing something wrong three benches over and you're over here, you can't get to them because you've got rows and benches [in your way].

Some graduate students with experience using CADS in elementary school settings described teacher "presence" as the ability to maintain student attention all over the room, particularly when speakers are mounted in more than one location on the ceiling. Even in university classrooms with only one wall-mounted speaker, respondents felt amplification broadened the teacher's presence in the room, a feeling referred to succinctly by one faculty member as "omnipresence," or, as put by a B.Ed. student, "artificial proximity… because you feel that voice is behind you."

Furthermore, all of the focus groups (again, except undergraduates) noted that students were less likely to miss important points and instructions did not have to be repeated as often by teachers when CADS was used. This was seen to be important because, as one B.Ed student described it, the issue even "compounds itself…you're trying to think, what did I miss? And then you're actually missing what she, what the person is saying right now."

Enhanced voice clarity was mentioned in our survey responses, so we wanted to seek a deeper understanding of its meaning through the focus group responses. It seemed to be related to the previous idea about not missing important information. With the B.Ed participants, it meant "more projection from the microphone," which meant "you are actually getting it quicker, clearer." Another B. Ed. student described clarity as "audible," and being able to "make out the voice," while another thought of clarity as being "sharper sound;" that is, "I don't have to stop and think and question, 'what did he or she say.'" And within the faculty group there was agreement that a speaker with an accent could be heard and understood more clearly by using the microphone.

Faculty members also talked about how CADS had a role in "conditioning" the class to begin: "When you started adjusting [the microphone] around your neck, then they know the lecture is going to begin and, you know, they have to pay attention." Faculty members also used descriptive terms such as a "sense of importance" or "a stronger measure of presence." In the graduate student group, however, there was a debate about whether this same idea conveyed a negative message because it was too formal: "There is a level of separation… it doesn't really radiate a conversational atmosphere; it is more of a listen-to-this type of thing." In this regard, the group generally agreed that teachers need to be more "interactive to engage the students; step [engagement strategies] up."

Conditions of Learning

By *conditions of learning*, we mean the learning environment: how amplification contributes to the classroom setting, such as helping to reduce anxiety or to create a calm atmosphere. One of the B.Ed. students who had a background in substitute teaching made the observation:

> For some students, I think it's a matter of even tone of voice. When you are in front of a class or in a class, you have to raise your voice in order to be heard. Some students don't necessarily take that as just an increase in volume. They take, they feel an increased anxiety, and they react to that.

CADS allows the teacher to speak in a "normal voice" and hence does not "get that raised voice issue." While most of this discussion was related to K-12 teaching, a faculty member spoke of this notion in the postsecondary classroom: "If students can hear you, that is going to speak well to the way they view you… like, I can hear them, they are caring about making sure that I'm listening."

Classroom size emerged as another relevant aspect of the *conditions of learning* theme at the postsecondary level. All of the groups recognized that CADS is essential in large lecture halls. For example, an undergraduate noted, "If you have a class of two hundred, I think it will be worth it." But some participants pointed out that amplification was not really needed in small rooms and/or classes with just a few students. Some also felt that professors with naturally loud voices became too loud when amplification was used in small settings. One B.Ed. student offered, "If it's too loud, then that's just as much a distraction." A faculty member mentioned this, too: "I am used to projecting… I have a 'stand in front of people' voice…it was too hard on me mentally to dial that back [when using a microphone]."

Overall, though, there was more discussion about the advantages of CADS in the learning environment. A common thread was how it helped those with soft voices. Examples were: "I remember when one of my professors lost her voice and the mic did help with that;" and "even the small classrooms [without amplification], there were times, if you're sitting on the outside, it is difficult to hear the prof because they are focused on the back of the room;" and [some professors] "stick to their notes; they are looking at their notes when they are talking to you and they really do need a little extra amplification."

Usage (The Human Factor and the Technological Factor)

When our participants discussed issues related to using the equipment, two often-conflating aspects emerged: technical difficulties and operational difficulties. This topic especially pre-occupied the undergraduates, comprising almost half of their discussion. All groups recognized the importance of training on proper usage of the equipment.

One problem involving both usage and technology was static coming from the loudspeakers. The undergraduate participants described it as "constant humming" and distracting. One respondent said, "It's just something that you have to get through to focus… As a college student, I have no problem focusing on the prof. It is just when you are in the classroom for three hours, it bothers you." And a B.Ed. student described the static as being "nasty sometimes." The problem had to do with setting the correct volume level on the microphone as well as on the display control module on the wall. One student noted some professors did not know how to use these controls, resulting in interference or inconsistent volume control. Another highlighted the disruption in the flow of the class when the professor had to adjust the volume control on the wall module. In contrast to the view presented (mostly) by the undergraduate participants, most faculty members felt they were competent in using the equipment, and only one felt the need for improved understanding of the equipment's volume control. They did note other challenges related to the technology, but tended to minimize them by posing constructive solutions.

A second problem related to usage, or the "human factor" as one student put it, concerned issues specific to wearing the pendant microphone. For example, "It rubs against…button or chains or anything, it keeps making that [unwanted sound]." "[It would] pick up everything that's close…like…ruffling every time it rubs against the shirt." In all focus groups, respondents recognized that, as with any new technology, such issues could be avoided through practice and training. One graduate student put it like this: "You have to get used to it…it's not natural, it's not part of your body." Another said, "It's not just a matter of practice; it's a matter of taking the time and explicitly telling someone, 'you want to make sure to avoid doing this while the mic is on.'"

A third usage issue, raised by the undergraduate students, had to do with different input sources feeding into a single speaker system. They talked about the anxiety they felt when watching videos in class: "Everybody cringes and plugs their ears because…the volume just isn't consistent with the prof speaking and then the level of volume coming through the computer." They also described how some professors would increase the volume on the display control module to adequately amplify their voices. But, if the volume on the computer was already on a high setting, the sound would, of course, be very loud, and as such, "there's always that moment of dread" when the sound source switches from voice to audio-visual media. Given these experiences, some undergraduate students made it clear they preferred a professor's natural voice to an amplified one, even though they recognised that informed users could manage the effect of the discrepant input sources. On the other hand, some undergraduates valued the improved sound quality of audio-visual media using the integrated system.

From the students' perspectives, learning to use amplification competently was something they wanted for themselves as well as for their professors. As one undergraduate put it:

> I think it will be beneficial for the student body to have microphones to use. Because there's a nerve factor that comes behind using the microphone… At some point down the road [in life]...there is [likely to be] an expectation that you'll stand behind the podium, and use the mic.

The B.Ed. students similarly felt the need for repeated practice with the microphone, indicating that, in the words of one, "The anxiety comes from just not being exposed to the technology." Another student commented: "It is nerve-wracking at first [because] you hear yourself. You're not used to hearing yourself and you are hearing yourself coming from the speaker at the other side of the room." But, with repeated practice, one student found her anxiety lessened: "I know the last couple times I used it, I forgot I've got it on… I find I'm more relaxed now using it, and I can talk normal and everyone seems to hear me just fine."

One more way the human factor plays a role is when users forget they are wearing a live microphone at times when it should be turned off. One B.Ed respondent observed that, "Working in the [K-12] school system, I think one of the biggest negative effects of these microphones is that teachers sometimes forget that they have them on," especially when having a private conversation with someone or even talking to oneself. A faculty member recalled a similar situation: "I was playing a game with the class and I brought [one group] into a huddle [to whisper something to them] and [the rest of the class] all just started laughing because I still had it on."

Health and Wellness

The importance of using CADS with respect to health and wellness featured prominently in the faculty discussions, together with the need to enhance the voices of soft-spoken people, taking up about half of their conversation. Their comments included ones like, "You don't feel you need to force your voice. You talk in a more conversational manner;" and "For me, using it in a classroom, it's an energy-saver," and "I did have laryngitis once, and then that really helped." But the primary focus of health and wellness for the graduate and B.Ed. participants (the undergraduate members were silent on this issue), and even some of the faculty, centred on the K-12 context, rather than higher education. A graduate student mentioned, "I know teachers that had to take time off because… the doctor told them that you have to rest [your voice] and they have to go to therapy or learn another way to talk." Another recalled that, without amplification, "In September, when I finished the first days, I always had a sore throat because I'm always straining my voice." Thinking about his future teaching context, a B.Ed. student felt amplification would be particularly helpful in a gym setting: "[Physical education teachers'] voices are raspy because they have to make it at such a high level for everybody to hear because it is such a big space."

Identity

An interesting theme that emerged was the impact of CADS on the user's identity, usually expressed as an increased sense of importance or confidence, although for some, a negative impact as well. This theme did not feature prominently, but it was an intriguing insight. Some of the undergraduate students talked about how access to microphones would be in keeping with the general ethos of the Business degree program. They observed that there is a sense of authority that comes with using the microphone:

> When you have the mic, you are the one that is on the floor. So you feel like you are a star…the person with the mic will obviously be the one that everyone's going to be directing their attention to; it highlights the person who's talking.

Thus, attention is given to that person not just because their voice can be heard, but also "because they have a mic." Another undergraduate said, "When you have the mic, you have the power. You have the authority in that classroom. That is your class. So it boosts confidence in the person speaking… [the microphone] changes the dynamic of the class."

Interestingly, the opposite of this view appeared in some of the other discussions, ranging from discomfort to anxiety. One faculty member recalled, "I didn't like it around my neck so I kept taking it off." Shyness or anxiety was also discussed, as in a graduate student's comment: "At first you're shy because you're not very used to it; being a shy person, maybe it would affect you a little bit." Another said, about getting used to the microphone, "When I was [accidentally] hitting it, I was noticing that it was making a noise and I was afraid to make the people jump out of their seats, I guess." Also, a faculty member gave an example of an undergraduate student who was uneasy giving presentations in class and was too nervous to use the microphone.

Both the faculty and the B.Ed. groups discussed the stigma that some people associate with using amplification. One B.Ed. participant put it like this: "People look at it too as, oh, my voice isn't strong enough… it's almost like an insult… as if it's a reflection on the person themselves." The faculty group also recalled instances of people who would not use it: "You go to conferences and the keynote speaker refuses the microphone…in a lecture hall with 300 people" and "I think there is a measure of embarrassment on the part of the adult" and "It is suggesting that you can't do it by yourself; you require an aid." In each of these conversations, participants agreed it is incumbent upon speakers to overcome their reluctance, and that increased access and training would not only diminish the anxiety but also the perceived stigma associated with using CADS.

Inclusion

One theme that emerged from the graduate student and faculty groups (but not the B.Ed. or undergraduate groups) was that CADS could make the higher education classroom more inclusive for students with hearing impairments. Respondents recalled university students they had known who benefitted greatly from the technology: "I'm just thinking of [a peer]; you can tell that it bothers her when she's not able to hear because she wants to learn." One faculty member observed that, while in K-12 classes a student's hearing impairment is likely to be identified, an adult student might not share this type of personal information with a professor. As such, it was important to be proactive in the use of CADS, especially since, as both faculty and graduate students noted, all students in any classroom would benefit from this technology. For one student, it was a matter of respect: "In the classroom where, if somebody has some sort of hearing impairment…it is important to respect [that person]."

Discussion

While the postsecondary classroom becomes increasingly diverse, current thinking among those providing student support is grounded in UD. As its underpinning, UD has long embraced the view that diversity is the norm within the human population (Welch, 1995). The construct of UDL applies this thinking to the classroom through flexible teaching approaches and reduction of barriers to learning (CAST, 2011).

The results of this study indicate that the role of CADS within the UDL framework can be complex and multidimensional, permeating all aspects of learning. To sum up our results, its role may be seen as (1) providing flexibility in presenting and accessing information or providing appropriate accommodations and (2) a method for managing the learning environment in terms of acoustics and universal access to verbal communication.

In terms of providing flexibility and accommodations, disability service providers may find in CADS one more technological tool for helping make the higher education classroom environment more inclusive. From our data, it is apparent that CADS provides specific instructional flexibility. CADS can help faculty be more flexible in presenting information that is clearly understood within many types of learning activities. Students can demonstrate their knowledge and skills by making their own presentations with verbal clarity. Students' confidence can be built by frequent exposure to using a microphone themselves. While the present study did not identify any student disabilities, research from K-12 schools and extension of the comments from our participants indicate that CADS may be able to serve as an accommodation to reduce barriers to learning for those with disabilities related to hearing, auditory processing, and attention deficits (Flexer, 2005). Our study did not result in themes specifically related to English language learners, but according to research with younger students, the improved learning environment provided by CADS may also assist this student population (Nelson et al., 2005).

Our results highlighted other benefits of CADS in regard to voice enhancement for those instructors with naturally soft voices or temporarily strained voices from fatigue or from illness. It was also noted that CADS can provide universal support for learning by amplifying voices or media above temporary background noise or to manage the verbal lectures in large classrooms or with large groups of students. Our participants also noted that CADS affects both instructors and students who use it with respect to a feeling of confidence and identity in the classroom. The improved attention from the listeners not only helps them individually, but also improves overall classroom engagement.

If disability service personnel are considering CADS as a pedagogical tool to enhance the learning environment of all students, there are a number of technical and educational factors that must be considered. To fully maximize the potential of CADS, faculty members must be educated on its use. Training should include the technical procedures, but also take into account the impact that CADS has on both the learner (such as focus as a listener and public speaking skills) and the educator (such as classroom presence and voice wellness). Users need to be involved in conversations about how CADS can enhance classroom management and engage all students in the learning experience.

Further, those planning to implement CADS need to recognize that the type and quality of technology selected, its installation, and its availability to instructors and students are all essential parts of providing an optimal listening environment. Whyte (2010), an educational audiologist, states: "It is important that soundfield systems are installed correctly, in appropriate places in the classroom and with consultation of the teachers who will be using them; training in the use of soundfield systems is essential" (p. 1). Jónsdóttir (2002) similarly points to the technical problems and teachers' lack of skill as being the main negative features of the use of CADS. Along these lines, our participants provided a great deal of input on the positives and negatives of the technical aspects of CADS as well as the need for and benefits of training its users. Our conclusion is that training should involve how the technology can be effectively fused with pedagogy leading to one more way to put UDL into practice in higher education.

Limitations and Further Research

The main limitation of this study is its focus on students' and faculty's perceptions, rather than on measurable factors such as grades, speech perception, or attention levels. Along the same lines, the study did not measure the hearing abilities of our students or the acoustical quality of the classrooms. Our participant groups were somewhat limited in that the sample size was small and some of the participants had prior knowledge about the use of CADS in K-12 schools. Nevertheless, the results of this investigation contribute to a deeper understanding of CADS in the postsecondary setting, a part of UDL.

In our study, awareness of the pedagogical significance of CADS was heightened and a number of significant issues were identified, but it is clear that research with CADS in higher education needs

a great deal more attention. Those working in postsecondary disability services may be well situated to focus attention on this topic. Those who assist with the professional development of faculty in UDL may investigate the feasibility of incorporating CADS technology into that training. The degree of benefit CADS could provide for specific student populations, such as those with hearing disabilities or attention deficits or those whose first language is not English, would be an important aspect to study at the postsecondary level as well. Future researchers may want to consider how learning is enhanced with CADS in classrooms where microphones and speaker systems already exist or where they may be retrofitted. Of course, the ideal setting for future research is one where a newly built facility includes CADS in its classrooms. In any future research with CADS, the goal is to obtain a deeper understanding of how universal design in architecture and technology can partner with universal design for learning in an effort to enhance the learning experiences of *all* students in broader inclusionary practices.

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Acknowledgement

The authors wish to thank all of the students and faculty members who participated in the study and Stacie Reck for her assistance in the data collection phase of this research.

Table 1

Survey Responses (% of total statements)

Code	Description	% of Total Statements (Students)	% of Total Statements (Faculty)
Access	Increased access to the technology	4.3%	9.4%
Attention	Use of technology improve attention, concentration, focus and enhances hearing	15.6%	7.8%
Calmer	Use of technology contributes to a more calm, positive classroom environment	0.4%	0%
Clarity	Improvement in specific aspects of verbal communication, such as clarity of the instructor's voice	8.1%	1.6%
ENG	Increased student engagement	0.4%	0%
ENV	Specific environments where the technology is the most or least effective (such as large classrooms)	14.2%	15.6%
INC	Improved inclusion of all participants in class	3.0%	1.6%
LRN	Positive hearing-learning connection explicitly stated	2.5%	9.4%
NEG-G	General negative comment, such as not worth the expense	6.4%	0%
NEG-S	Specific negative comments such as 'it gives me headaches'	2.1%	0%
NOD	The technology makes no difference	6.7%	0%
POS	General positive comments such as 'I like it' or 'don't change it'	6.6%	0%
SLF	A sense of self; more confidence	0%	6.3%
TEA	Teaching is enhanced, allows for mobility, improved teacher presence in the classroom	1.5%	1.6%
TEC	Specific technical difficulties related to the equipment such as static, feedback, speaker placement	14.1%	17.2%
USG	Users are unfamiliar with proper usage of the technology; more training/support is needed	4.3%	1.6%
VOI	Technology improves voice volume/ projection; reduces strain on the voice	8.8%	26.6%
		*99.00%	*100.2%

Note. * totals do not add up to 100 due to rounding