On the benefits of specialized settings for deaf and hard of hearing students in computing

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***Abstract*—Deaf and hard of hearing (DHH) students face barriers to communication and comprehension in typical education settings. The current study found that DHH computing students enrolled at institutions that specialize in DHH accessibility have greater access to mentorship, stronger self-efficacy in their computing ability, and a greater sense of belonging in the computing community compared to DHH students enrolled at non-specialized institutions. These findings suggest that DHH students are likely to thrive in computing programs within institutions that identify as DHH accessible.**

Keywords—accessibility; special needs; institutional support; self-conceptions; diversity

I. INTRODUCTION

Deaf and hard of hearing (DHH) students face a number of barriers to achievement in education settings as a function of their special needs regarding communication and comprehension. In the hearing world, DHH students typically lack access to trained professionals to facilitate achievement [1]. By extension, this suggests that DHH computing students lack access to mentors, which is particularly important for people who are in the minority within organizations e.g., [2]. The hearing world also often has low performance expectations of DHH students, which is rooted in a lack of exposure to successful DHH students [1]. Accordingly, DHH students tend to have low self-esteem in learning environments that are unaccustomed to serving students with special needs [3]. This is important because positive perceptions of one's self-worth and ability in academic settings are critical to persistence and achievement [4]. Finally, in the hearing world, DHH students lack access to peers and role models who are "like them", a sense that they are understood by others, and a feeling that they "belong" [1]. Importantly, feeling a secure sense of belonging is a strong positive predictor of academic engagement and persistence [5].

Given the hearing world's limited ability to provide mentorship, support for intellectual enrichment, and social connectedness for DHH students, DHH computing students may experience optimal academic and career preparation at institutions that are strongly committed to providing strong support and full inclusion for DHH students. In the current work, I label these types of institutions as "specialty institutions", and assess whether DHH students majoring in computing at specialty institutions are more likely to have (a) a mentor, (b) higher computing self-efficacy, and (c) a stronger sense of belonging in the computing community than DHH students majoring in computing at non-specialized institutions. Importantly, I also include a sample of hearing students as a comparison group against which both groups of DHH students' access to mentors and subjective experiences are compared.

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II. METHOD

A. Participants

Thirty-five undergraduate students who self-identified as DHH (n = 18 at Non-Specialized Institutions; n = 17 at Specialized Institutions), and 20 self-identified hearing students participated in the current study in exchange for being entered into a raffle to win a $100 gift card.[1] All students in the sample reported that they were majoring in a computing field.[2] Of note, the distribution of students' gender, race/ethnicity, and academic year did not differ across institution type (e.g., the proportion of women was statistically equivalent across all three comparison groups). This is important, given the fact that students' access to mentors, self-efficacy, and sense of belonging tend to be lower among students who belong to underrepresented groups (e.g., women in computing fields; see [7]) and students who have had less time to development mentor/mentee relationships as well as their computing identity (i.e., first and second year students). Thus, students across comparison groups were similar on a number of dimensions that might otherwise explain their access to mentors and subjective experiences in computing.

[1] The sample under analysis in the current paper was extracted from a larger sample of students (N = 4061), who were recruited from a sample of 90 computing departments in the U.S. In the full sample, 4018 students identified as hearing. A random sample of 20 hearing students was extracted from the larger sample to create a hearing comparison group. Subsampling in this manner is common practice when sample sizes across comparison groups are dramatically different; this strategy promotes more equal variability among groups than would be the case among dramatically different sample sizes [6]. Visit www.cra.org/cerp for more information on this data collection initiative.

[2] "Computing field" is defined as either computer science; computing engineering or electrical and computer engineering; computing information systems; or another computing-related field including interdisciplinary fields with a strong computing component (e.g., computational biology or digital media).

B. Procedure

Students were invited to complete an online survey sent to a national sample of colleges and universities during the fall 2014 academic semester. Embedded within the survey were questions pertaining to access to mentorship, self-efficacy, and belonging.

1) *Mentorship.* Students were asked *Who do you go to most often for career advice and assistance?* and were to select one person from the following: *No one; A professor within my department; A professor at my college/university who is outside of my department; An individual I met through a formal mentoring program sponsored by an outside organization;* or *Someone else.*

2) *Self-efficacy.* Students responded to seven questions assessing self-efficacy (e.g., *I am confident that I can quickly learn a new programming language on my own*) using a scale ranging from *(1) strongly disagree* to *(5) strongly agree*. Items had good internal reliability ($\alpha = .84$; [8]), so were averaged to create a composite measure.

3) Belonging. Four items were used to assess belonging (e.g. *I feel welcomed in the computing community*), using a scale ranging from *(1) strongly disagree* to *(5) strongly agree*. Items had good internal reliability ($\alpha = .69$), so were averaged to create a composite measure.

III. Results and Discussion

See Table 1 for descriptive statistics for the analyses that follow.

1) *Mentorship*. A Pearson Chi-Square test indicated that DHH students at non-specialized institutions were significantly more likely to say that they went to *No one* for mentorship compared to DHH students at specialized institutions $p < .05$, and compared to hearing students, $p < .05$.

2) *Self-efficacy*. A one-way Analysis of Variance (ANOVA) indicated that students' self-efficacy differed across groups, $F(2,52) = 4.45$, $p < .05$. Dunnett t tests indicated that DHH students at non-specialized institutions felt lower self-efficacy than their counterparts at specialized institutions, $p < .05$, as well as hearing students $p = .05$.

3) *Belonging*. A one-way ANOVA indicated that students' sense of belonging differed across student group, $F(2,52) = 5.09$, $p < .05$. Dunnett t tests indicated that DHH students enrolled at non-specialized institutions felt a weaker sense of belonging in computing than did DHH students at specialized institutions, $p < .05$, and hearing students, $p < .05$.

The current research suggests that institutions offering extensive access to educators and professionals who specialize in educating DHH students, and offer a critical mass of peers who are "like them" may provide benefits for DHH computing students. DHH students at specialized institutions with these supportive characteristics reported access to role models, self-efficacy in computing, and a sense of fit in the computing on par with hearing students. Future research should focus on learning how non-specialized schools might effectively mimic characteristics of specialized schools so that DHH students' positive experiences are generalized to non-specialized institutions.

TABLE 1. ACCESS TO MENTORS, SELF-EFFICACY, AND SENSE OF BELONGING BY STUDENT GROUP

	Has "no one" as a mentor	**Self-Efficacy, (1) Low – (5) High**		**Belonging, (1) Low – (5) High**	
	Frequency	***M***	***SD***	***M***	***SD***
DHH NSI, (n = 18)	45% $_a$	3.33 $_a$	0.59	3.13 $_a$	0.80
DHH SI, (n = 17)	12% $_b$	3.87 $_b$	0.88	3.88 $_b$	0.77
Hearing, (n = 20)	15% $_b$	3.99 $_b$	0.68	3.80 $_b$	0.78

Note. M = Mean; SD = Standard Deviation; NSI = Non-Specialized Institution; SI = Specialized Institution. Subscripts that differ within columns indicate a statistically significant difference, $p \leq .05$.

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