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Review of terminology used in course-based engineering design for disability research

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Abstract

The purpose of this review paper is to identify terminology used in course-based engineering design for disability research papers to refer to individuals with disabilities, as well as to recommend which words to continue to use in practice. Designing with the disabled community in mind, such as through universal design or designing assistive devices, is a wide field of inquiry. As we teach our students about designing for disability, language is crucial. In a systematic review of engineering education papers, we identified those examining the outcomes of course-based engineering design projects related to disability and extracted all references to disabled folks. To determine acceptable use of these terms, we conducted a survey of the phrases used more than once alongside a random sample of single-occurrence terms. Participants (n=53), with a wide range of ages, disability status, and design experience, rated whether they would use each term. We present here the ratings of each term and provide guidance on acceptable terminology based on the survey results. Words used more than once were generally considered acceptable, and only 2 out of the 34 phrases used more than once ("the disabled" and "the handicapped") were under 25% acceptability (2 standard deviations below average). These recommendations have the potential to improve the quality of engineering design education as well as increase inclusive practices in the design research community.

Introduction

How design engineers refer to their customers is a key aspect of building relationships with customers. For example, creating a persona [1] for a customer based on their job title may guide designers to view the customer's needs through their employment, though the actual customer may value other aspects of their identity more highly. Similarly, when designing for and with disabled customers, designers need to be aware of terminology, as referring to a customer as "differently abled" versus "wheelchair user" may lead to different perceptions of customer's needs. Engineering design educators also must be aware of the terminology used when teaching students about designing for disabled customers. In this paper, we explore the terminology used in design engineering education research in the context of designing for and with disabled customers.

Designing for disabled customers is an explicit focus in Design Justice [2] and Universal Design [3], [4], though when designing for a general audience, all products will likely be used by a disabled customer, since a quarter of the US adult population is disabled [5]. Designing for the disabled community is a common design project assignment [6], [7], [8], [9], which can successfully fulfil the Accreditation Board for Engineering and Technology (ABET) requirements to apply engineering design to "meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors" [10]. Students' design process for and with the disabled community supports their learning of customer needs analysis and customer interaction in the design process.

Disability Studies is an interdisciplinary field focusing on the social and historical context of disability. Core principles of Disability Studies dictate that the study of disability must be social, foundational, interdisciplinary, participatory, and values-based [11]. An example of disability being social is the social model of disability which focuses on society's disablement of people, or the way society has built our environment and culture to hinder access [12], [13]. The social model is especially important when discussing terminology because some phrases focus more on the environment (e.g. "inaccessible entryway for wheelchair user") while others focus on the "inability" of disabled folks (e.g. "person with limited mobility"). The present study seeks to explore terminology used to refer to disabled users in research on course-based engineering design projects.

Our main research question is *RQ1: How is disability referred to in research on course-based engineering design projects?* In order to explore the wide range of terminology, we will also investigate *RQ2: How acceptable are the terms used to refer to the disabled community in research on course-based engineering design projects?*

Methods

Positionality

The first two authors are disabled, and all authors have design engineering backgrounds. The first author has been involved in multiple design methods courses as a teaching assistant. The second author has been involved in design methods courses as well as researching assistive technology. The last author has been involved in design methods courses at multiple levels of instruction. As this study is being presented to design engineering education researchers, recommendations and assumptions may be made with this audience in mind.

Data Collection

This work is part of a larger systematic review [14] that extracted papers that focus on designing for disability in course-based design projects from engineering education conference proceedings and journals. The inclusion criteria were: (1) published by the American Society of Engineering Education (ASEE), the Journal of Engineering Education, or the International Journal of Engineering Education, (2) published between January 1996 and November 2023, and (3) described at least one course-based engineering design project focused on designing for the disabled community. Articles were excluded if they were (1) not available in English, (2) the full text was not available, or (3) was a "Work in Progress." The keyword search strategy is below:

(disab* OR "assistive technology" OR rehabilit* OR prosthetic* OR "special needs" OR handicap* OR ADA OR therap*) AND (design* OR capstone* OR project OR projects OR course).

During the data extraction phase of the systematic review, words used to refer to disabled folks in the research article were extracted. The extracted terminology was sorted into multiple uses and single uses, where 34 words were used more than once, and 266 words were used only once in the 60 articles from the systematic review. To represent the acceptability of these terms in an

unbiased manner, we conducted an anonymous survey where participants answered the following question for each term with yes or no:

Is this a terminology you would use to refer to someone or group of people?

Each participant evaluated a total of 67 terms during the survey: the 34 terms that appeared more than once across different papers and 33 single-occurrence terms that were randomly selected from the terminology list of 266 single-use words, which ensures that a roughly equivalent number of single and multi-occurrence words were represented. The survey presented all terms in a randomized order and asked participants whether they would use each word or not. There was an optional open-ended question at the end of the survey for final comments or further descriptions. The survey was distributed through disability-related and professional-development slack groups, emails to colleagues at various universities, and listservs across multiple regions of the US. A total of 53 people completed the survey, with 17 being disabled and 35 having disabled family members, friends, or co-workers. Additionally, 46 participants had either earned or were in the process of completing a bachelor's degree in engineering, and all but three participants had experience with engineering design projects, either in their job, through coursework, or in their personal lives.

Data Analysis

Data was analyzed using R version 4.4.2 with a significance level of $\alpha = 0.05$. After conducting summary statistics for each phrase, the data was also grouped by disability status and disability proximity (whether a participant has disabled family, friends, or co-workers), and a two-way ANOVA was run for the two groups' perceived acceptability of each term. For terms that had an interaction p-value of less than 0.1, a Dunn test was run to determine which interactions (within disability status or proximity) were significant, if any. For each term, an "acceptability score" was used to display the percentage of participants who found the term acceptable to use. In alignment with disability studies, the results will highlight the acceptability score computed based on results from disabled participants.

Results

The most common words that were used to refer to individuals with disabilities in this study were variations of "persons with disabilities", "user", "client", "disabled individual", "patient", "handicapped individuals", and "the disabled" (Table 1). The average acceptability was 68% and the standard deviation was 22%. The only words used multiple times in the research papers that were under 25% acceptability (selected as the threshold because it was two standard deviations below average) were "the disabled" and "the handicapped" (Table 1). The least acceptable single-occurrence word under 25% acceptability was "CA (Challenged Athlete) sailors." The most acceptable terms were "students with disabilities," "people with disabilities," "children with disabilities," and common phrases used to refer to customers such as "client," "customer," and "participant," with acceptability above 90%. Figure 1 shows the acceptability of each word as rated by all participants, and Table 1 in the Appendix presents the same information in a table format.

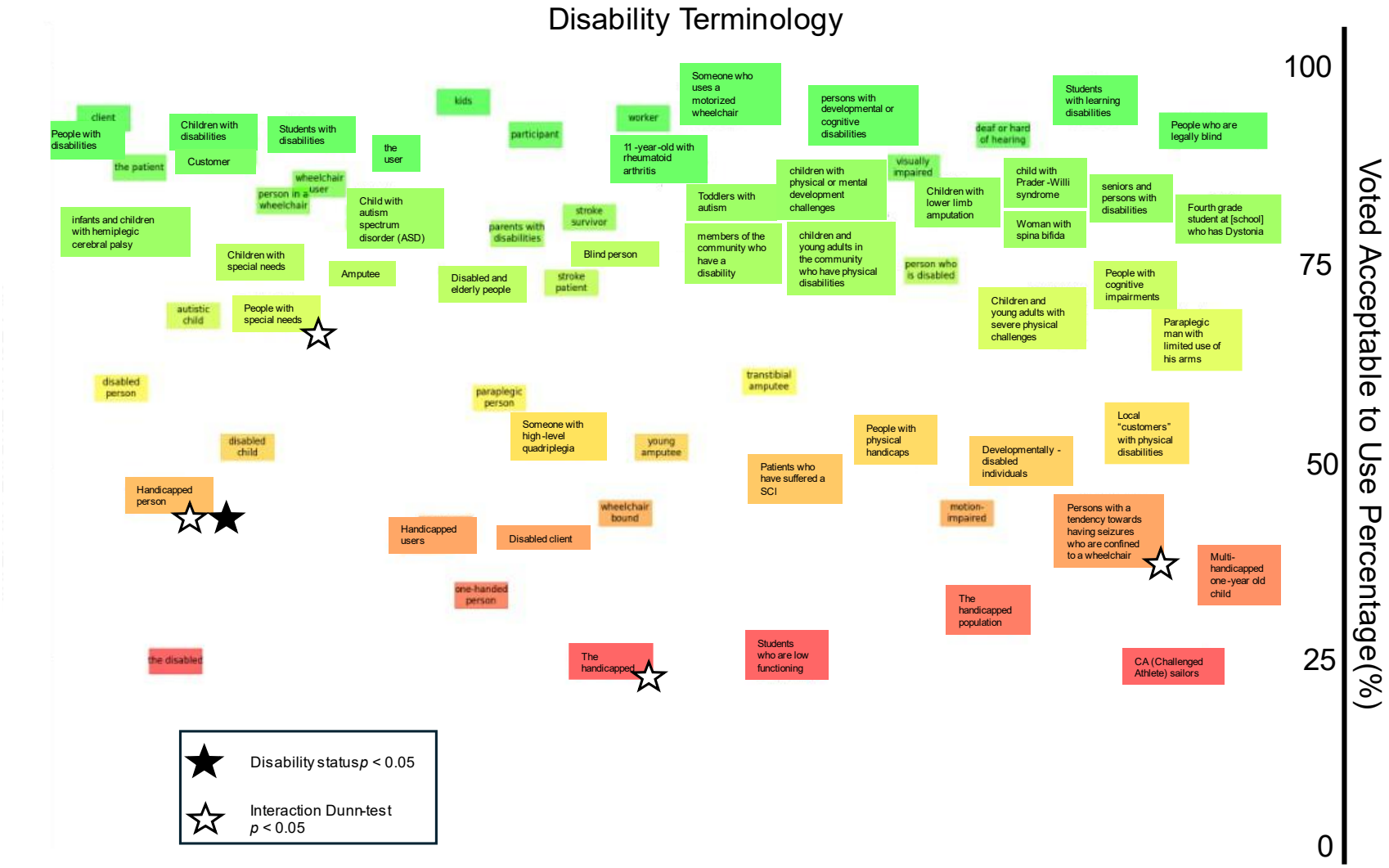

Figure 1: Acceptability of Disability Terminology from all participants. Gradient of color indicates acceptability. Filled in black star indicates significant difference in acceptability by disability status, and hollow star indicates significant interaction between disability status and proximity for acceptability of phrase.

We conducted a two-way ANOVA to understand the relationship between terminology acceptability, disability status, and disability proximity for each phrase used to refer to the disabled community. Disabled participants found the phrase “handicapped person” significantly less acceptable than non-disabled participants ($p = 0.041$). Fourteen phrases had an interaction with a p-value less than 0.1, seen in Figures 2A through N, which indicates a potential for. significant interactions between disability status and proximity according to the Dunn-test (Figure 2). Four terms had significant differences (Dunn-test $p < 0.05$) between non-disabled participants with differences in disability proximity: “handicapped person” ($p = 0.003$, Figure 2F), “people with special needs” ($p = 0.030$, Figure 2H), “persons with a tendency towards having seizures who are confined to a wheelchair” ($p = 0.039$, Figure 2I) , and “the handicapped” ($p = 0.019$, Figure 2L). For all four of these terms, non-disabled participants with close proximity to the disabled communities’ acceptability ratings were more closely aligned with the disabled participants. Additionally, among participants with close disability proximity, disabled participants found the term “the disabled” significantly more acceptable than non-disabled participants ($p = 0.039$) according to the Dunn-test.

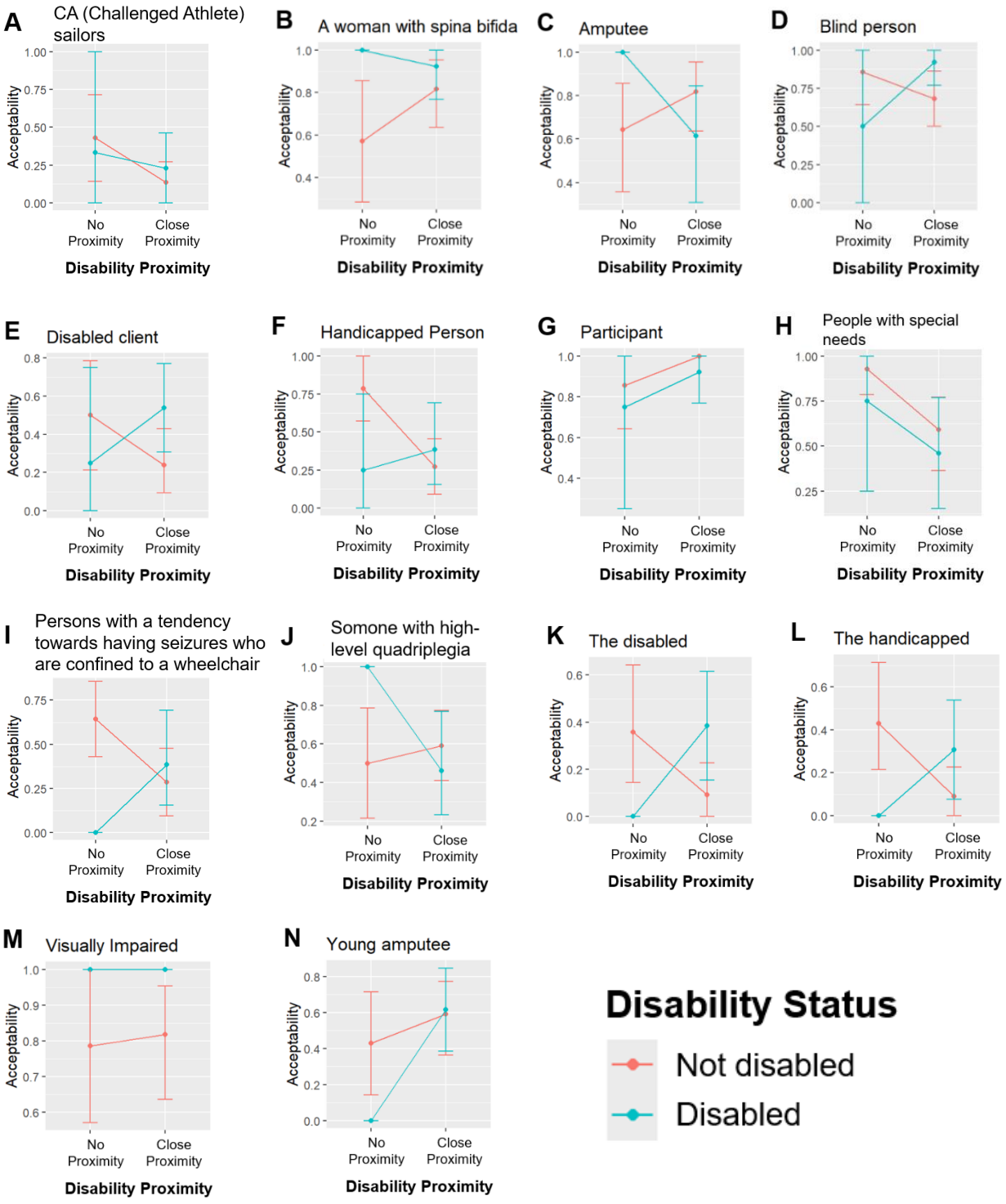

Figure 2: Interaction plots for 14 terms with interaction effects. The plots show the direction of interaction as well as indicate general agreement/disagreement between groups. Error bars indicate 95% confidence interval.

Discussion and Conclusion

A group of 53 disabled and non-disabled people were surveyed on the acceptability of 67 phrases used to refer to the disabled community in design engineering education research publications. One limitation of this work is that this is a small sample size that has a sampling bias towards an interest in disability terminology. Future work should intentionally engage more members of the disabled community, as well as recruit outside of pre-existing interest in disability studies.

The phrases assessed in this work ranged from high acceptability (94% of participants found the phrase acceptable) to low acceptability (22% of participants found the phrase acceptable). There is a wide range of acceptability of terms used to refer to the disabled community, which is aligns with the diverse language preferences within the disability community itself [15]. This shows the need for discussion among the design engineering community on terminology. While phrases like "students with learning disabilities" were indicated to be acceptable and phrases like "the disabled" had low acceptability, there is a large group of phrases that require nuance, as acceptability depends on context. For example, the disabled community is split on person-first (e.g. "person with a disability") versus identity-first (e.g. "disabled person") language. Preferences vary by disability category, gender, country, and age [15].

Uniquely, when non-disabled folks had significantly different perceptions of acceptability as a factor of disability proximity, those who do have disabled family, friends, and co-workers more closely aligned with disabled participants' perceptions of acceptability. This indicates that being in community with disabled folks more closely aligns non-disabled folks' language with the disability community's preferences. Though, among participants with close disability proximity, non-disabled participants found one term, "the disabled," significantly less acceptable than disabled participants. The acceptability among disabled participants was 30%, which is still unacceptable, but the discrepancy indicates that even among those with close disability proximity, there is disagreement among disabled and non-disabled folks. Communication about terminology is essential for establishing acceptable terminology across community and for each individual context.

Before teaching our future engineers how to design for disabled customers, terminology and context should be explored. This can be done through engaging with the disability community (e.g. disability scholars on your campus) before or during a class session, through professional development training sessions, or through engagement with media created by the disability community (e.g. media by Alice Wong [16], [17] or Imani Barbarin [18], documentaries such as Crip Camp[19], books on disability [20], lectures hosted by the disabled community [21], [22]). This continuous learning journey can also be shared with the students, as they will need to gain experience building strong relationships with customers. Future work for terminology use includes investigating the terms used in classrooms and syllabi, as research articles are just one avenue for showcasing design projects for disabled audiences.

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Appendix

Table 1: Disability terminology count, acceptability score, and ANOVA results. P-values below 0.1 are highlighted in grey, and p-values achieving statistical significance ($p < 0.05$) are indicated with an asterisk (*)

			p-values		
Phrase	Count	Acceptability	Interaction	Disability Status	Disability Proximity
11-year-old student with rheumatoid arthritis	1	84.9%	0.214	0.655	0.973
a woman with spina bifida	1	79.2%	0.065	0.169	0.224
amputee	2	73.6%	0.063	0.736	0.831
autistic child	3	66%	0.399	0.642	0.645
blind person	2	77.4%	0.035*	0.549	0.885
CA (Challenged Athlete) sailors	1	25%	0.061	0.549	1.000
child with autism spectrum disorder (ASD)	2	79.2%	0.223	0.640	0.739
child with Prader-Willi syndrome	1	83%	0.150	0.478	0.615
children and young adults in the community who have physical disabilities	1	76.9%	0.180	0.182	0.404
children and young adults with severe physical challenges	1	67.9%	0.428	0.738	0.739
children with disabilities	3	90.4%	0.517	0.525	0.724
children with lower limb amputation	1	86.8%	0.143	0.520	0.752
children with physical or mental development challenges	1	81.1%	0.681	0.815	0.881
children with special needs	2	73.6%	0.101	0.367	0.668
client	11	94.3%	0.150	0.193	0.859
customer	3	90.6%	0.506	0.537	0.700
deaf or hard of hearing	1	90.6%	0.112	0.294	0.529
developmentally-disabled individuals	1	46.2%	0.159	0.336	0.376
disabled and elderly people	2	67.9%	0.290	0.339	0.344
disabled child	3	49.1%	0.158	0.189	0.330
disabled client	2	38.5%	0.096	0.377	0.426
disabled person	10	55.8%	0.234	0.237	0.761
fourth grade student at [school] who has Dystonia	1	79.2%	0.437	0.568	0.711
handicapped person	7	43.4%	0.015*	0.041*	0.387
handicapped users	2	39.6%	0.308	0.348	0.425
infants and children with hemiplegic cerebral palsy	1	79.2%	0.232	0.710	0.898
kids	2	94.3%	0.231	0.300	0.534

local "customers" with physical disabilities	1	50%	0.564	0.597	0.862
members of the community who have a disability	1	79.2%	0.204	0.709	0.716
mother with cerebral palsy	1	83%	0.239	0.497	0.538
motion-impaired	1	39.6%	0.466	0.894	0.971
multi-handicapped one-year old child	1	32.1%	0.377	0.542	0.776
one-handed person	2	35.8%	0.254	0.255	0.923
paraplegic man with limited use of his arms	1	64.2%	0.215	0.893	0.999
paraplegic person	2	56.6%	0.173	0.865	0.919
parents with disabilities	2	79.2%	0.283	0.446	0.983
participant	2	92.5%	0.056	0.426	0.864
patients who have suffered a SCI	1	45.3%	0.279	0.421	0.862
people who are legally blind	1	90.6%	0.524	0.558	0.840
people with cognitive impairments	1	68.6%	0.852	0.863	0.927
people with disabilities	33	90.6%	0.506	0.537	0.700
people with physical handicaps	1	50.9%	0.328	0.663	0.707
people with special needs	3	66%	0.019*	0.158	0.872
person in a wheelchair	4	83%	0.605	0.932	0.977
person who is disabled	1	73.1%	0.132	0.612	0.782
persons with a tendency towards having seizures who are confined to a wheelchair	1	39.2%	0.037*	0.193	0.422
persons with developmental or cognitive disabilities	1	86.8%	0.288	0.474	0.523
seniors and persons with disabilities	1	81.1%	0.137	0.180	0.401
someone who uses a motorized wheelchair	1	92.5%	0.323	0.439	0.788
someone with high-level quadriplegia	2	56.6%	0.063	0.609	0.824
stroke patient	2	73.6%	0.105	0.455	0.798
stroke survivor	2	81.1%	0.106	0.587	0.944
students who are low functioning	1	22.6%	0.204	0.319	0.659
students with disabilities	3	90.4%	0.197	0.647	0.746
students with learning disabilities	1	92.3%	0.701	0.776	0.803
the disabled	6	22.6%	0.020*	0.409	0.431
the handicapped	2	22.6%	0.020*	0.164	0.913
the handicapped population	1	28.3%	0.187	0.448	0.956
the patient	10	86.8%	0.224	0.288	0.452
the user	13	92.5%	0.416	0.417	0.437
toddlers with autism	1	82.7%	0.227	0.551	0.555
transtibial amputee	1	58.5%	0.433	0.542	0.765
visually impaired	1	86.8%	0.057	0.811	0.886
wheelchair bound	2	39.6%	0.423	0.662	0.669

wheelchair user	3	84.9%	0.392	0.653	0.877
worker	2	94.3%	0.522	0.963	0.987
young amputee	2	50.9%	0.056	0.173	0.694