Ensuring the Educational Success of Students With Special Needs Through Appropriate Assistive Technology Implementation

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Abstract

The need for valid measurement of assistive technology (AT) outcomes as a quality indicator in special education has been called out in the literature. To date, outcome assessments associated with quality of AT have fallen short of satisfactory validation processes. Furthermore, existing research has examined AT from the perspective of the user, neglecting other important points of view, such as educators and preservice teachers at the secondary level. This study identified dimensions underlying AT practice for outcome assessment along with the clusters of validated items on each dimension from the perspective of professors preparing preservice teachers for careers in special education. Using multidimensional scaling, four participants rated 19,404 pairwise comparisons, with the results revealing four underlying dimensions and 11 clusters across the dimensions. While more research is warranted, these dimensions and clusters may be used as a foundation for the development of an assessment instrument to enhance the quality of AT outcomes for students with disabilities.

Introduction

There is a need for valid measurement of assistive technology (AT) device and service outcomes as a quality indicator (Graham & Warnie, 2012). While this need has been well documented in the literature for many years (e.g., DeRuyter, 1995; Smith, 1996), in recent years growing attention has been paid to validation and outcome measurement of AT in response to the demand for evidence-based practices in special education (Agree & Freedman, 2011; Bernd, Van Der Pijl, & De Witte, 2009; Seok & DaCosta, 2014). Even so, to date assessments related to quality of AT have lacked satisfactory validation processes or frameworks to measure AT outcomes (Lenker & Paquet, 2003; Lenker, Scherer, Fuhrer, Jutai, & DeRuyter, 2005).

Research on outcomes assessment and validation of AT measures has mainly examined the quality of AT from the user's perspective instead of other points of view, to include those of the AT subject-matter expert, experienced educator, and preservice teacher at the secondary level. This is not to suggest that the research to date has not made significant contributions. For example, an extensive body of research has established guidelines and standards for determining the quality of AT, such as the *Functional Evaluation for Assistive Technology* (FEAT; Raskind & Bryant, 2002). Yet, despite the importance of assessing the quality of AT devices and services (Lenker et al., 2010), there continues to be a shortage of literature focused on AT evaluation and subsequent validation from the perspective of the AT expert (Seok & DaCosta, 2014).

Toward this goal, this study identified the dimensions underlying AT practice for outcome assessment along with the clusters of validated items on each dimension from the perspective of the AT expert; namely, professors preparing preservice teachers for careers in special education, who not only have considerable knowledge about different facets of special education and the implementation and use of AT, but also play a substantial role in shaping future special educators.

Method

Participants

The study was conducted at postsecondary institutions in the Midwestern United States. Participation was restricted to professors in special education, who had taught students with disabilities, with a minimum of three years' experience in selecting and implementing AT for students with mild or moderate disabilities, as evidenced in six or more semesters of syllabi reflecting AT implementation practices in their course(s) and authorship of five or more articles, chapters, and/or conference proceedings on AT use. Based on these criteria, 10 assistant or full professors were identified using convenience sampling; four responded to the invitation to participate. While all four were regarded as experts in their respective areas of special education, two were considered authorities on learning disability, one on early childhood, and one on behavior disorders.

Materials

The study was based on Seok and DaCosta (2014), who identified valid items and factors for students with mild and moderate disabilities derived from the FEAT, comprehensive literature reviews, and other pertinent content (see Raskind & Bryant, 2002 for a detailed explanation of FEAT). Seok and DaCosta formalized 99 items using a strict, multiphase approach that were rated by 1,472 special education teachers, and then validated using factor analysis (see Seok and DaCosta, 2014, for a detailed explanation). These 99 items were used in the current study.

Given the large number of pairwise comparisons, a website was developed to allow the participants to perform the evaluations at their own pace. The site presented the item to be evaluated while randomly looping through each of the remaining items, affording a way to rate each pairing. A random order was adopted to control for "a systematic item order effect" (Davidson & Sireci, 2000, p. 79). The item to be evaluated was shown at the top of the screen with the items to be compared appearing randomly one at a time below. A new item was randomly generated once the current item was rated against all the others. Comparisons were scored using a 9-point scale, with 1 representing the most extreme degree of dissimilarity and 9 the most extreme degree of similarity. For ease of rating, each item was depicted in a different color than the previous one, offering a visual that the item being rated (against all the other items) had changed.

Procedure

Potential participants received invitation letters that included the URL of the website. Upon accessing the site, they were then presented with the purpose of the study and instructions for how to perform the pairwise comparisons. The potential participants were then asked for their agreement to participate in the investigation. Consent resulted in further instructions, comprising a pairwise comparison example, and prompting participants for their email address and a password, allowing for later login. (The email and password were only used to allow the participant to complete the study in multiple sittings, not for identification.) That is, with the URL, email, and password, participants could log in at any time, and continue their pairwise comparisons. Each login presented participants with the instructions and pairwise comparison example, and then took them to the next pairwise comparison to be rated. Permission to perform the study was granted by the ethics committee of a research center.

Results and Discussion

To determine if the participants recognized dimensions of quality of AT outcomes and if the configuration of the items was represented mathematically, each participant rated 4,851 comparisons, resulting in a dataset of 19,404 pairwise comparisons (4,851*4). The subsequent exploratory data analysis focused on scale construction and dimensionality reduction using multidimensional scaling (MDS). The Statistical Package of Social Science (SPSS) 20.0 was used to develop the MDS matrices.

Multidimensional scaling was chosen because the technique is accepted in educational research and has been used in studies examining learning (e.g., Davison & Sireci, 2000; Seok, 2009). In addition, studies of MDS have mathematically shown that sample size does not have a valid and significant impact on the results (MacCallum, 1979; Rodgers, 1991; Stalans, 1995); finally, a single rater can carry out MDS pairwise comparisons (Stalans, 1995), making MDS well suited for the current study.

The MDS of the proximity dataset was analyzed using PROXSCAL algorithms. Used to determine configurations of items in a low-dimensional space, the PROXSCAL algorithms minimized the normalized raw stress. Stress and fit measures revealed that the normalized raw stress was .07136, *S*-stress was .19190, dispersion was .92864, and Tucker's coefficient of congruence was .96366, showing that the four-dimensional model fit the data well.

That is, the findings revealed four dimensions resulting from exploring the content validity items. Table 1 shows the final multidimensional configurations from the MDS analysis, revealing that the four dimensions extracted from the data are closely related to content validity (O'Neil, Sireci, & Huff, 2004) and contribute to framing the content of assessment (Lenker et al., 2005).

Table 1
Final Positioning of Items in the Multidimensional Space

Items	Dimensions				Items	Dimensions			
	1	2	3	4		1	2	3	4
1	-.272	.320	.311	-.434	51	.069	.558	.352	-.126
2	.139	-.662	-.002	-.002	52	-.072	.389	.530	.150
3	.371	-.547	-.149	.002	53	.476	.400	.151	-.222
4	-.036	-.572	.136	.333	54	.357	.549	-.146	.090
5	.043	-.015	-.051	.677	55	.261	-.192	-.103	.589
6	-.214	.115	.013	-.636	56	-.096	-.035	.672	-.027
7	-.099	-.665	.084	.004	57	.532	.326	-.212	-.167
8	-.366	-.495	.122	.256	58	.395	-.219	.010	-.508
9	-.460	.358	-.328	.096	59	.465	-.123	.413	-.237
10	.243	-.558	.163	.227	60	-.043	-.304	.285	.537
11	-.427	.475	.042	.220	61	.564	.172	-.293	-.110
12	-.189	.563	-.050	.324	62	-.154	-.277	.562	.213
13	-.617	-.262	-.076	-.048	63	-.163	-.540	-.204	-.321
14	-.651	-.025	-.104	.147	64	-.236	.037	.035	.635
15	-.229	.453	-.377	.229	65	.384	-.216	.354	.377
16	-.494	-.087	-.452	.051	66	-.341	.142	-.204	-.536
17	-.185	.456	-.380	-.276	67	-.001	.392	.165	-.533
18	-.027	-.367	-.029	-.569	68	.011	-.487	-.464	-.076
19	.128	-.246	.581	.214	69	.300	.364	-.345	.344
20	-.275	.564	.240	-.078	70	-.066	-.107	.565	-.353
21	-.090	.239	.554	-.301	71	-.087	.301	-.592	-.083
22	-.085	.621	-.046	-.259	72	.219	-.253	-.553	.175
23	-.335	-.172	-.341	-.454	73	-.204	.232	-.148	.592
24	.063	.380	-.542	.132	74	.664	.004	-.072	-.114
25	-.532	.270	-.250	-.196	75	.372	-.504	.233	-.109
26	-.531	-.253	.144	-.305	76	.210	.244	.184	.570
27	-.406	-.185	.506	-.064	77	.365	.167	-.542	.054
28	.098	.332	-.297	-.509	78	-.041	-.362	-.359	-.450
29	.419	.114	.429	-.296	79	-.621	.078	-.232	-.103
30	.361	.274	.219	-.456	80	.165	.085	-.633	-.148
31	.603	-.236	.128	-.153	81	.205	-.517	-.347	.175
32	.355	-.109	-.498	.278	82	-.362	-.456	-.289	.193
33	-.255	-.042	-.621	.039	83	-.315	-.112	-.450	.388
34	.519	-.331	-.017	.288	84	-.050	-.007	-.654	-.159
35	.214	.095	.621	-.150	85	.041	.599	-.307	.069

36	.218	.189	.488	.375	86	-.041	-.094	-.060	-.669
37	-.104	-.206	.247	-.590	87	.000	-.336	-.192	.562
38	.294	.049	-.360	-.498	88	.125	.659	.050	.067
39	.537	-.140	.355	.158	89	-.018	.384	.365	.424
40	.302	.528	.293	-.013	90	.030	-.285	-.610	.037
41	-.245	-.356	.358	-.380	91	-.270	-.366	-.498	.045
42	.359	.406	.253	.318	92	-.606	-.112	.242	.127
43	.596	.217	.107	.214	93	-.536	.228	.204	.276
44	.356	.052	.049	.574	94	-.455	.314	.300	-.254
45	.560	-.165	-.341	-.069	95	-.348	.340	.321	.342
46	.216	-.412	.417	-.249	96	-.511	-.352	.212	.163
47	.496	.124	-.205	.395	97	-.294	-.131	-.050	.599
48	.273	-.358	.121	-.491	98	-.605	.196	.198	-.117
49	-.276	-.522	.282	-.179	99	-.321	-.078	.487	.337
50	.286	.096	-.076	-.606					

In addition to identifying key dimensions, MDS can also be used to identify which clusters fall within each dimension (Seok, 2009). Clusters are one or more unique elements of a whole dimension recognized as being equally related (Rogers, 2003; Vishwanath & Chen, 2006). This additional analysis revealed 11 clusters across the four dimensions. Table 2 shows the selected items in each dimension along with their coordination from Table 1 and clusters with final coordinates.

Table 2
Final Positioning of Items in Each Dimension and Cluster

Dimension 1: *Dependability and Support*
The degree to which the AT device is reliable, and the level of support offered by maintenance personnel to keep it working properly (Batavia & Hammer, 1990; Kajko-Mattsson, Karim, & Mirjamdotter, 2011).

Cluster of *AT Care*

#	Values of Configuration	Items
74	.664	The AT device needs constant adjustment and/or excessive care in everyday use.
43	.596	A special room/environment is required (e.g., heating, cooling, dust free, low or high humidity).
61	.564	The instruction book spells out all maintenance routines to be followed.
45	.560	Problems can arise if the equipment is not operated according to prescribed operating instructions.
39	.537	The device has special design features (e.g., plug-in modules) that can reduce the difficulty of repairs.
57	.532	Routine maintenance is necessary.
47	.496	Care and maintenance are necessary for the AT device to last throughout (and beyond) its expected life.
59	.465	The maintenance record forms are adequate.
58	.395	Maintenance record forms are provided.
3	.371	I have access to somebody whom I can consult with regarding AT.
77	.365	The turn-on/start-up routines must be followed each time the AT device is used.
30	.361	The likely cost of repair is affordable.
40	.302	Spares have been provided for repair.

Cluster of *AT Functionality*

#	Values of Configuration	Items
31	.603	The AT device is covered by public or private insurance (or other financing programs).
34	.519	The AT device must interface with other devices.
65	.384	The device functions as claimed by the manufacturer.
75	.372	There are indications that the equipment is ready to use (e.g., meter readings, lights on or off, signals).
42	.359	These types of devices have a prior breakdown history.
32	.355	There are warranties on the AT device.
50	.286	A technician or engineer is required for initial assembly or installation.

Cluster of *External Reliance*

#	Values of Configuration	Items
53	.476	Special tools are required for assembly, installation, or start-up.
48	.273	The supplier will assemble and/or install the AT device.

Cluster of *Team Participation*

#	Values of Configuration	Items
10	.243	The use of AT devices and services can be monitored by the AT team to ensure successful implementation.
2	.139	I feel confident in my ability to participate in an AT assessment.

Dimension 2: *Device Features*
The characteristics that affect compatibility between the user, the AT device, and academic success (Mirenda, 2001; Monk et al., 2006; Raskind & Higgins, 1998).

Cluster of *Device-User Compatibility*

#	Values of Configuration	Items
88	.659	The AT device depends upon an external power supply or other hook-up.
85	.599	The AT device has safety features (e.g., emergency brakes).
12	.563	The visuals of the AT device look fine.
51	.558	Instructions for assembly and/or installation are included in the manual.
54	.549	Test equipment (e.g., computer, multimeter, oscilloscope) is required for start-up or calibration.
11	.475	The information is presented in an effective way (including use of speech, music, graphics, text, and animation).
24	.380	The visual distance is appropriate for the student.
28	.332	The price of the AT device is appropriate.

Cluster of *Academic-Related Features*

#	Values of Configuration	Items
22	.621	The student has keyboarding proficiency (if applicable).
20	.564	The student can learn to use the AT device during the orientation.
17	.456	The student sustain attention using the AT device.

15	.453	The AT device relates to my school's curriculum.
67	.392	To meet the student's specific needs, other important needs are ignored, such as academics.
9	.358	The AT device and services can help students achieve their IEP goals.
1	.320	I feel confident in my ability to assess students' need for assistive technology (AT).
94	.314	The AT device motivates the student's learning.

Dimension 3: *Ease of Use*
The degree to which the AT device is simple and convenient to operate over time (de Joode, van Heugten, Verhey, & van Boxtel, 2010; Demers, Weiss-Lambrou, & Ska, 2002).

Cluster of *User Friendliness*

#	Values of Configuration	Items
56	.672	Maintenance is easily handled by the student (or personal assistant).
19	.581	The AT device can be used by the student for multiple tasks.
70	.565	The student can independently go through all start-up and diagnostic routines.
62	.562	The instructions are effective.
21	.554	The student has enough overall technology literacy to use the device.
52	.530	The instructions are complete, concise, clear, and easy to follow (i.e., a logical step-by-step procedure).

Cluster of *AT Convenience*

#	Values of Configuration	Items
27	.506	The AT device demonstrates ease of portability across settings.
36	.488	It is reasonable to expect me to carry out some of the repairs.
99	.487	The AT device helps my students become independent.
37	.247	Some types of repairs must be performed by an expert.

Cluster of *Long-Term Use*

#	Values of Configuration	Items
35	.621	The AT device is likely to become obsolete soon due to compatibility problems with devices now being developed.
29	.429	The likely cost of maintenance is affordable.
46	.417	The AT device remains dependable under repeated use.
41	.358	The device is dependable.
26	.144	The AT device is appropriate for future use.

Dimension 4: *Efficiency*
The effectiveness of the AT device in helping the user meet his or her challenges as well as the user's comfort level with the device (Fuhrer, 2007).

Cluster of *User Success*

#	Values of Configuration	Item
5	.677	I am aware of my students' specific academic needs.
97	.599	The AT device helps my students learn how to learn.

95	.342	The interface of the AT device is efficient for my students.
4	.333	I can help my students achieve academically using technology.
93	.276	The AT device meets the students' academic needs.
8	.256	The AT device can help students access the general education curriculum.

Cluster of *Operational Features*

#	Values of Configuration	Item
64	.635	The manufacturer addresses the function of the device.
76	.570	Certain tests or readjustments must be made when the equipment is used during the initial warm-up/use phase.
60	.537	Operation and maintenance manuals are included with the AT device.
89	.424	The AT device can be adapted to hook up in different locations.
83	.388	The AT device has special features to enhance comfort (e.g., a special seating system or shock absorbers in the case of a wheelchair).

Figure 1 depicts each item of the four MDS models mapped in the MDS space. The dimensions and clusters suggest that the validated measure could contribute to the design of conceptual models that may be used to help enhance the quality of AT outcomes.

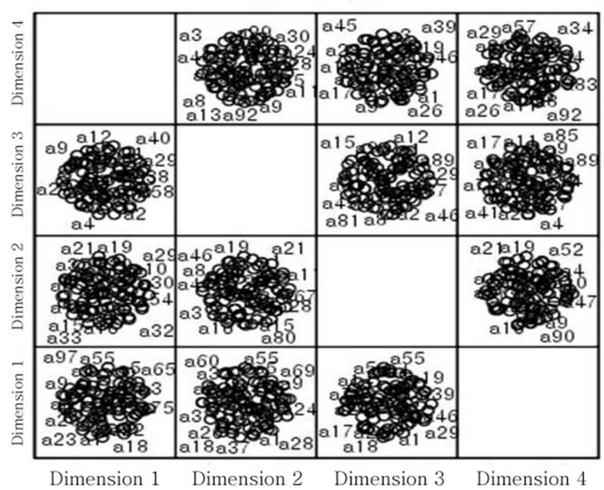

Figure 1. Object points in common space.

Limitations

The findings should be interpreted with care. While the small sample size is not believed to have had a bearing on the MDS analysis, sampling bias is a concern, in that the participants may not be representative of special education professors, thereby warranting caution in generalizing the findings. There is also a concern regarding the items themselves, as technology advancements can quickly lose their relevance, to include AT. Consequently, the items should be reexamined prior to their use, in the context of benefiting today's youth. Furthermore, the AT practices for outcomes assessment primarily focused on the classroom setting; other locales should be examined, to include rehabilitation centers, hospitals, and individual homes to gain additional viewpoints for assessing the quality and outcomes of AT.

Conclusion

The need for valid measurement of AT outcomes as a quality indicator in special education has been widely expressed. However, outcome assessments associated with quality AT have fallen short of satisfactory validation. Furthermore, the existing research has examined AT from the perspective of the AT user, neglecting other important points of view, such as educators and preservice teachers at the secondary level. Toward this goal, the present study validated items for AT evaluation, identifying dimensions that underlie AT practices along with quality of AT outcomes from the perspective of special education postsecondary teachers. Using MDS as the statistical approach, four participants rated 19,404 pairwise comparisons, with the results revealing four underlying dimensions and 11 clusters across the dimensions. While more research is warranted, these dimensions and clusters may be used as a foundation for the development of an assessment instrument to enhance the quality of AT outcomes for students with disabilities.

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