

Mastery of Assistive Technology in K-12 Education

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Abstract

This article describes the evaluation of a prototype of the *Continuum of AT Mastery (CATM)*, an instrument developed for measuring individual progress toward mastery of assistive technology (AT). In this second of two one-year studies, we examined the applicability of the *CATM* in K-12 educational settings. This manuscript includes results of field testing of the *CATM* in K-12 schools and presents results of inter-rater and test-retest reliability.

Keywords: assistive technology, mastery, outcomes, disability, K-12 education

Introduction

This report presents the results of the second of two one-year studies on mastery of assistive technology (AT). The first employed a Delphi Panel to develop a conceptual framework for talking about mastery of AT and to create an instrument for measuring individual mastery (Satterfield, et al., 2021, Satterfield et al, 2024). The resulting measure is called the Continuum of AT Mastery (CATM). The second study examined the application of the CATM in K-12 education. This study employed multiple focus groups to help enhance the instrument before field testing the CATM in four separate public and private K-12 settings. These studies were supported by faculty development grants from the Georgia Tech Research Institute.

AT in Education

Assistive Technology has been viewed as an important tool to facilitate learning in educational environments (MacLachlan, & Scherer, 2018). The National Longitudinal Transition Study (NLTS, 2012) represented the first large-scale research to examine AT use and outcomes in K12 education. The findings of this study suggested

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that students who used AT in high school tended to graduate from high school in greater numbers, go on to postsecondary education settings more frequently, and find paying jobs after high school more often than those who do not use AT in school (Bouck, Maeda, & Flanagan, 2012).

Focus on AT Mastery

While a few studies point to comfort and experience using AT in high school as an indicator of future educational success (Satterfield, 2020, Poudel, 2014), the nature of mastery of AT remains obscure (Satterfield et. al., 2024). Much of the research into outcomes of AT use has centered more on performance and less on the nature of that use: the importance and benefits derived by the person using the AT (Satterfield et.al., 2024, Desmond et.al., 2018). The individual user of the AT is best positioned to determine the value and importance of their use of AT (Satterfield et.al., 2024, Desmond et.al., 2018, Krantz, 2012).

Effective use of AT in post-secondary academics appears to be influenced by several factors: 1) the environment (beliefs about, support for, and endorsement of AT use), 2) the individual (their resolve, perseverance, and self-advocacy) and 3) the technology itself: manageability, infrastructure, and assistance needed. (Lang et al., 2014). Goegan et al. (2019) point out that personal growth and the readiness of the individual (training, experience using AT, etc.) are essential in the achievement of effective AT use [29].

Deci and Ryan (2000) have observed that as people confront and manage the challenges of daily life, they develop skills and mastery. This necessitates the identification of the behaviors that produce success and the development of related competencies and insights. Schieman & Turner (1988) assert that persons with disabilities often have difficulty addressing personal challenges in their environment.

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Many lack tools and strategies with which to overcome obstacles and establish a personal sense of control. Establishing a sense of personal mastery through the use of AT may be a means to lessen the impact of environmental and social challenges faced by persons with disabilities (Lachman & Weaver, 1998; Turner & Roszell, 1994).

However, use of the AT tool itself is but one aspect of mastery. Deciding how and when to use the AT is another. This process necessarily relates to the personal goals and the assigned tasks the individual faces. Initially, direct support is critical to aid the student in the effective use of the AT tool. But the development of mastery requires that the focus must shift from externally guided use to self-directed use. The impetus must transition from external to intrinsic (Deci and Ryan, 2000; Deci et al., 1991).

The context for the conceptualization of AT Mastery has drawn upon three existing frameworks: (1) Janice Light (1989) and her widely accepted Four Competencies for effective use of Augmentative and Alternative Communication (AAC); 2) the Continuum of Communication Independence, developed by Patricia Dowden to describe the progression of five stages through which individuals with complex communication needs (CCN) pass on their way to being independent communicators using AAC (Brady, et al., 2012); and 3) Gerald Craddock's (2006) work that suggested that there were three stages through which AT users progressed: novice to transitional user to power user of AT, suggesting a set of common characteristics among AT users that could be used to identify their individual current level of operation.

The Continuum of Assistive Technology Mastery (CATM)

The initial study of AT Mastery involved a Delphi Panel that identified 20 characteristics of mastery that clustered around four constructs:

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1. Experience (Access, Opportunity for Use, etc.)
2. Knowledge (Functional, Technical Knowledge, etc.)
3. Proficiency (Technical Skills, Troubleshooting, etc.)
4. Personal Connection (Self-Advocacy, Motivation, Independence, etc.)

The Panel identified four stages through which individual passed in their pursuit of AT Mastery: 1) Novice user, 2) Context-dependent user, 3) Transitional user, and 4) Power user. The initial CATM provided users with a grid to assign a mastery level to each of the characteristics of mastery. Raters used a four-point Likert scale to assess individuals for progress toward AT Mastery for each of the 20 indicators. An overall score as well as scores for each construct were provided.

Objectives

The objectives of this study were to 1) Examine the factors associated with AT Mastery in the context of K-12 education; 2) Validate the modified CATM and test the instrument's internal reliability; 3) Set out policy and research agendas for the Mastery of AT program of research.

As we examined the first objective, the factors associated with AT Mastery in the context of K-12 education, we sought to answer several questions. Were the factors that were identified in our original study applicable in school settings? Were there other factors to consider? Did these characteristics need to be clarified to simplify the CATM's use in the context of education? The second objective was to conduct preliminary psychometric testing of the CATM, specifically: face validity, inter-rater reliability, test-retest consistency, and the consistency within each of the four constructs. Our field testing included interviews with educators who we hoped would share anecdotal information that could elaborate upon our statistical results. Our final objective was to forge an agenda for the Mastery of AT program of research, as well as

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a compilation of policy implications of AT Mastery in K-12, as a seedbed for future articles and additional studies. These objectives were addressed through three phases of research: 1) focus groups to review the CATM, 2) field testing, and 3) a focus group to discuss policy and research issues in AT Mastery.

Phase 1: Focus Group Review of the CATM

Methods

Participants

The first activity in this study was to gather stakeholders in the areas of K-12 and AT. These stakeholders were invited to take part in a series of focus groups to examine the CATM for suitability in educational settings. There were 18 participants in these groups, including teachers, practitioners, parents, developers, and students. Seven participants were people with disabilities, and three were parents of children with disabilities. Seven were practitioners or service providers, three were K-12 educators, and four were high school students. The participants were divided into 3 groups. One group was comprised exclusively of high school students. The other two groups were made up of adults from various backgrounds and a broad range of expertise with AT in K-12 settings (see Table 1).

Table 1. Table of Initial Focus Group Participants

Partic. #	Group	Role	Work Setting	Industry Area	Disability	Area of Expertise	Practitioner/ Svc. Provider
1	1	Researcher/ Educator	University Services	Disability Services	NA	Transition/ All	Y
2	1	Home Educator	Education	Home Educator	Parent of a child with disability	Motor/Comm.	NA

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3	1	AT Specialist	State Service Agency	Disability Services	NA	Transition/ All	Y
4	1	SLP	Private Industry	Education	NA	Comm.	NA
5	1	Researcher	Academia	Academia	NA	General	NA
6	1	Educator	K-12 Special Education	Education	NA	General	NA
7	2	Educator	K-12 Special Education	Education	NA	Significant disabilities	NA
8	2	Practitioner/ Svc Provider	Academia	Academia	Motor	All.	Y
9	2	Manager/ Researcher	University Services	Accessibility	Vision	Vision/ Access	Y
10	2	Professor/ Researcher	Academia	Academia	LD/ Parent of child w/ disability	LD/	Y
11	2	Consultant	Private Industry	Disability Services	NA	General	Y
12	2	CEO/ Consultant	Private Industry	Computer Accessibility	NA	Vision/ Access	NA
13	2	AAC Specialist	Private Industry	Comm.	Parent of student with disability	AAC/ Low Vision	Y
14	2	Researcher	Academia	Academia	NA	General	NA
15	3	Student	High School	Education	Motor/ Comm.	Comm.	NA
16	3	Student	High School	Education	LD/ADHD	LD/ADHD	NA
17	3	Student	High School	Education	LD/ADHD	LD/ADHD	NA
18	3	Student	High School	Education	Motor	Motor/ Access	NA

Comm.=Communication

Focus Group Methodology

Each of the three groups met twice with the research team. The first meeting was to get an overview of the CATM and to discuss initial observations. Each participant was asked to use the CATM after the session to do a self-assessment and then assess one or two other people, taking notes on their observations. Two weeks later, the focus

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groups reassembled to share their observations and suggestions. These reflections and insights were discussed within the groups. Participants were asked to comment specifically upon the clarity of the directions, questions, and choices, as well as the structure and content of the CATM. Ideas for refinements to the CATM were solicited.

Results

Face Validity. The participants affirmed the structure and organization of the original CATM that emerged from the earlier study. Generally, the focus groups agreed with the descriptions of AT users at each of the four stages of development on their way to AT Mastery. The participants confirmed that the four stages presented in the CATM were an accurate mapping of the journey that people with disabilities followed. They affirmed that employing a four-point Likert scale was appropriate for scoring the CATM. The participants affirmed the face validity of the CATM instrument. However, the participants provided useful suggestions regarding improvement of the clarity and presentation.

Response set. Several focus group members felt that the rubric-style CATM that emerged from the original study was too wordy and presented formidable dense text that might be daunting to some raters. The focus group suggested that most answers could be phrased in terms of actions that were assessed by frequency or amount. It was suggested that the CATM employ a sequence of: “Little, Some, A Lot, Always”, or “Limited, Occasional, Frequent, Always” for the Likert scale response sets. There was consensus among focus group members that this simplified approach was easier to use. The participants also suggested that a “description” field be inserted in the CATM beside the indicator to provide a short elaboration on each factor. This would help give clarity to the characteristic being considered.

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Mastery of what? While there was general agreement that the instructions for the CATM were clear, the focus groups suggested that greater clarification was needed around the question of “what is being assessed”? Was the individual being rated on their overall AT Mastery? Or should the assessment focus on mastery of a particular AT item? The focus group asserted that there was greater utility and value in asking questions about mastery of specific AT. Other participants suggested that this would help to prompt the rater, at the beginning of the CATM process, to identify the specific AT being employed and the purpose for which the AT was being used (i.e. Using ABC screen magnifier to read assignments in language arts class). The focus groups agreed that being asked to specify the AT being evaluated and its purpose/context would help prevent confusion and make the interpretation of the CATM results more meaningful and precise.

Final stage of mastery. The focus groups also agreed that the CATM was essentially tracking a personal journey in the life of a person who used AT to do various things for themselves. If AT Mastery is indeed a journey, the participants expressed concern that the original term (“power user”) that was used to describe the final stage, might not be appropriate. The term “power user” seems to connote a sense of finality or “having arrived,” which might not accurately describe what takes place as the individual approaches AT Mastery. The participants suggested that the term, “empowered user” was more representative of this stage.

Not-applicable items. Regarding choices, some focus group members suggested that there might be situations in which one of the characteristics did not apply. An example that was cited was evaluating the factor "Expanding Knowledge of AT" (Able to get knowledge about AT: community, mentors, conferences, etc.) was inappropriate for an elementary or middle school student. Some focus group members observed that

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cases having an “N/A” or “not applicable” option would be helpful. Otherwise, the overall CATM score would be lower and perhaps be seen as “penalizing” the student.

Other panelists suggested that it was appropriate to score an indicator for which a student was not yet ready, in the category of “Novice.” For them, it stood to reason that students would engage with that indicator when it was developmentally appropriate and that the resulting CATM score was accurate in its reflection of that status. There was no consensus among focus group participants on this question.

Student focus group participants also affirmed the validity and structure of the CATM. They suggested that, while some older students could complete the self-assessment effectively, younger students might not be ready to do a meaningful CATM self-assessment. However, they suggested that the CATM could be redesigned as a game where students engaged in activities that revealed their level of mastery. An interactive, gamified CATM could be more engaging for a broader range of students, and for younger students as well.

Discussion: Mastery of AT focus groups

The participants in this part of the study affirmed the face validity of the CATM and agreed that the instrument produced an accurate assessment of a student’s level of AT Mastery. They agreed that the CATM helped identify where an individual was on their journey toward AT Mastery and provided context for developing the next steps.

User-Centered Focus. There was strong consensus that the construct we are calling Personal Connection to AT was important and represented a key aspect to understanding an individual’s growth and development of mastery. While the performance of tasks was important, they argued that mastery of AT is an individual journey. The path to independence and self-advocacy may differ for each person and

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may develop at a different pace, but participants in our study felt that developing a Personal Connection to their AT would be essential to the establishment of mastery. This distinguishes the CATM from other instruments and frameworks for discussing AT outcomes.

Student Group Suggestions. Much discussion and brainstorming took place around the student focus group's idea of gamifying the CATM. However, it was generally agreed that the prospect of gamification would need to wait until after the CATM had been tested and used by many more individuals. The most plausible context for such activity was envisioned around a well-tested future iteration of the CATM linked to a database of suggested individual goals (that had been associated with responses to the CATM and AT used). As students took part in a game *with* “challenges” to address with their AT, the activities over which they demonstrated mastery could be mapped to this database. A score could be produced by the mastery they demonstrated while addressing the challenges in the game. Unmet challenges would help identify the next steps and future goals.

Suggested Modifications to CATM for Use in K-12

The suggested changes to the response set wording and the reduction of dense text were incorporated into the CATM prior to field testing. The CATM was also modified to include spaces to enter the specific AT being used and the purpose or activity for which the AT was used. The term “empowered user” was adopted to replace “power user” where it appeared in the CATM.

Phase 2: Field Testing the CATM

Methods

Participants

The next step in this study involved field testing the CATM for inter-rater reliability, test-retest consistency, and internal consistency across the four constructs. There were 33 educators who completed our field testing. This group consisted of 20 teachers, seven therapists, and six ‘other’ paraprofessionals or administrators. These participants were from two public school systems and two private school settings. Details of the participants’ sites and levels taught are shown in Table 2.

Table 2. Field Testing Participants by Site and Education

<u>Site</u>	<u>Site 1</u>		<u>Site 2</u>		<u>Site 3</u>		<u>Site 4</u>	
	<u>(N=15)</u>		<u>(N=9)</u>		<u>(N=3)</u>		<u>(N=6)</u>	
<u>School Level</u>	<u>N</u>	<u>%</u>	<u>N</u>	<u>%</u>	<u>N</u>	<u>%</u>	<u>N</u>	<u>%</u>
<u>Elementary</u>	<u>9</u>	<u>56.3</u>	<u>0</u>	<u>0.0</u>	<u>3</u>	<u>18.8</u>	<u>4</u>	<u>25.0</u>
<u>Middle</u>	<u>3</u>	<u>25.0</u>	<u>9</u>	<u>75.0</u>	<u>0</u>	<u>0.0</u>	<u>0</u>	<u>0.0</u>
<u>Elementary/Middle</u>	<u>3</u>	<u>60.0</u>	<u>0</u>	<u>0.0</u>	<u>0</u>	<u>0.0</u>	<u>2</u>	<u>40.0</u>

There were 35 students involved in field testing. These were selected and assigned to raters by a site coordinator at each site so that the research team had no contact with the students. Since there was no intervention and no alterations to instruction or daily schedule, the Institute’s Institutional Review Board (IRB) approved the protocol for this project without a requirement for consent or assent. Nevertheless, the site coordinators were provided with letters to send home to parents explaining the research that was taking place. This strategy facilitated data

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collection and privacy but limited our ability to collect demographic information at the student level.

Field Testing Methodology

For the field testing, triads of raters evaluated the same students on the same AT and task (e.g., using XYZ text reader to read social studies assignments in class) to assess internal consistency and inter-rater reliability at time one (T1). The triads were asked to repeat the surveys evaluating the same students and AT a second time (T2) two weeks after T1 for intra-rater and test-retest reliability. Interviews were conducted with educators after their CATM assessments were completed. The questions asked were aimed at enhancing the useability and establishing the validity of the tool (see Appendix II. Interview Questions).

CATM Scoring

Responses to the CATM survey are scored on a four-point Likert scale that yields a total Mastery of AT score (potential range of scores from 20-80) and the four sub-scales scored as described below:

- Experience with AT (possible range 4-16): 4 items, scored limited to always
- Proficiency with AT (possible range 4-16): 4 items scored limited to always
- Knowledge of AT (possible range 5-20): 5 items scored little to expert
- Personal Connection to AT (possible range 7-28): 7 items scored little to always
- Total CATM Score (possible range 20-80)

Field Testing Results

Sample and Data Source

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The convenience sample of 33 raters collectively completed 196 surveys at the time of analysis. Raters completed between one (two raters) and 11 (two raters) surveys each. The mean number of surveys per rater was 5.9 (SD=2.1) and the median was six. Most raters (79%) completed at least six surveys (three students at two time-points) per the instructions provided.

To avoid a lack of independence in the data we used only the 105 T1 surveys to assess the internal consistency of the CATM. The inter-rater reliability sample consisted of 33 students each evaluated by three raters (data from two students were excluded from the analysis due to only two raters completing the CATM for those students).

The total sample size for the Test-Retest analysis was 91. When the time between testing was computed, the number of days for some individuals exceeded our cut-off of thirty days (they were instructed to complete T2 at two to three weeks.) The final sample size for Test-Retest was 75 after excluding those with greater than 31 days between measurement occasions to avoid potential history or maturation confounding. The sample size for each psychometric analysis is listed in Table 3 below.

Table 3 Sample Size and Notes by Test

Reliability Testing	Valid N (Ratings)	Notes
Internal Consistency	105	33 raters; 35 students, Time 1 data only
Test-Retest	75	Ratings >31 days b/w test and retest not included
Inter-rater	33	2 of the 35 students had only 2 raters

Rater Roles

As shown in Figure 1, teachers accounted for 55% of raters, followed by therapists, paraprofessionals, administrators, and others. Table 4 provides the number of surveys completed by rater role.

Figure 1. Role of Raters

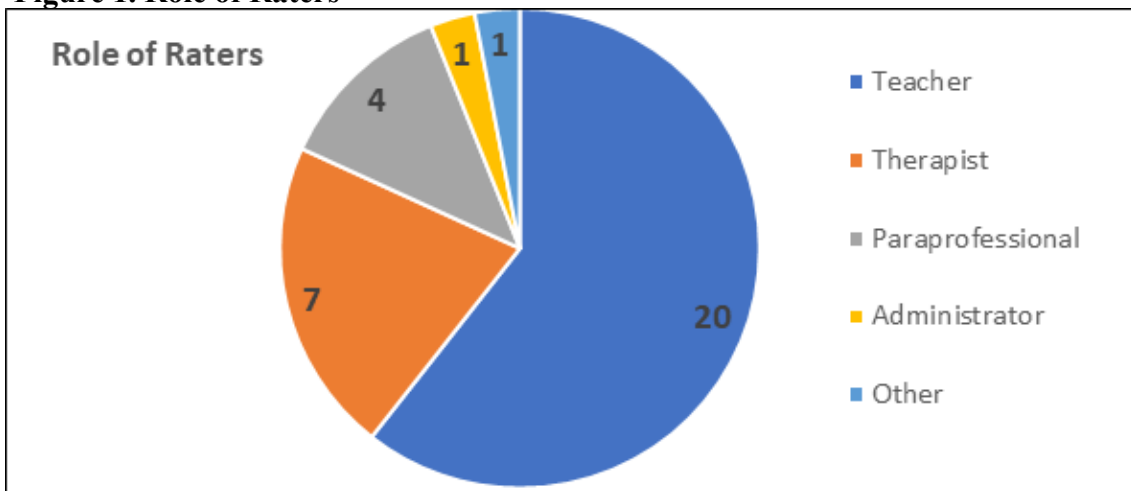


Table 4. Rater Role and Surveys by Role

	Survey N	%	Rater N	%
Administrator	3	2.9	1	2.9
Paraprofessional	13	12.4	4	12.4
Teacher	58	55.2	20	55.2
Therapist	27	25.7	7	25.7
'Other'	4	3.8	1	3.8
Total	105	100	33	100

Statistical Analysis

Reliability: Internal Consistency

Internal consistency of the CATM with this sample of raters was estimated based on Cronbach's alpha for each of the CATM sub-scales (Cronbach, 1951). Taber (2018) suggests calculating alpha across all items is not justified in a scale with multiple constructs because of a lack of uni-dimensionality and violation of the assumption of the tau equivalent model.

As shown in Table 7, the internal consistency for each of the CATM sub-scales was good to excellent. Alpha values ranged from .89 for the Proficiency subscale to .94

for the Personal Connection subscale exceeding our a priori established alpha level of .70. This is indicative of an instrument with acceptable internal consistency.

Table 7. Alpha values for the CATM Subscales

Category	N of items	α
Experience with AT	4	0.845
Proficiency with AT	4	0.891
Knowledge of AT	5	0.915
Personal Connection to AT	7	0.940

Reliability: Inter-rater

Intra-class correlation (ICC) estimates and their 95% confident intervals were calculated based on a mean-rating ($k = 3$), consistency, 2-way random-effects model with 33 students using T1 (only) data to avoid potential confounding due to lack of independence from the raters evaluating the same students twice.

Interpretation of ICC values was guided by parameters suggested by Koo & Li (2016), and widely accepted as convention: ($< 0.5 =$ Poor; $0.5-0.75 =$ moderate; $0.75-0.90 =$ good, very good; $>.90 =$ excellent). An acceptable degree of reliability was found between raters on the Total CATM. The average measure ICC was .77 with a 95% confidence interval from .59 to .88, $p < .001$.

The subscales displayed mixed, but promising results. As shown in Table 8 estimates ranged from a low of .67 for the Knowledge construct to a high of .78 for the Experience construct.

Table 8. Inter-Rater Reliability of CATM Constructs and Total CATM Score.

CATM CONSTRUCTS	ICC	Lower Bound	Upper Bound	F Test Value	df1	df2	Sig
Experience	0.758	0.568	0.872	4.127	32	64	<.001
Proficiency	0.822	0.682	0.906	5.608	32	64	<.001
Knowledge	0.673	0.418	0.828	3.06	32	64	<.001

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Personal Connection	0.705	0.474	0.844	3.385	32	64	<.001
CATM Total	0.771	0.593	0.879	4.374	32	64	<.001

Descriptive Statistics by Rater Role

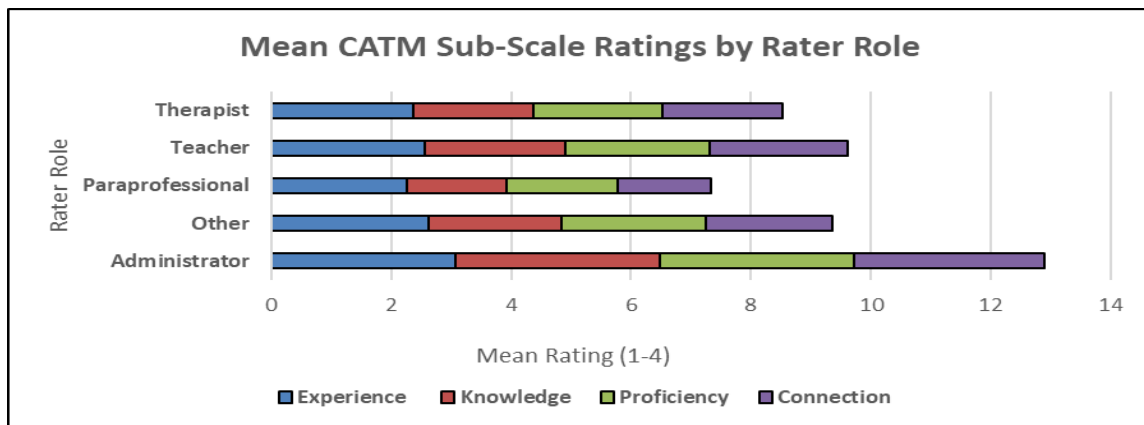
Table 9 and Figure 2 depict subscale means by role of the rater.

Paraprofessionals (descriptively) had lower mean scores on two subscales and the total scale compared to the other raters. Conversely – the administrators gave the highest ratings.

Table 9. CATM Sub-Scale Means by Rater Role

	Admin	Other	Para	Teacher	Therapist
Experience	3.08	2.59	2.25	2.57	2.35
Proficiency	3.25	2.34	1.85	2.41	2.11
Knowledge	3.40	2.13	1.68	2.35	1.98
Connection	3.17	2.05	1.55	2.29	1.97
CATM	3.22	2.28	1.83	2.40	2.10

Figure 2. CATM Sub-Scale Means by Rater Role



If the means were vastly different contingent upon rater roles, we would want to examine the CATM results categorically to determine if there was agreement in the overall categorization/classification of students (i.e., novice, power user). This is challenging because the role was not consistent in the rater triads in this sample. Some

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students were rated by three teachers, others by one teacher and two paraprofessionals, etc. Table 10 shows the results of categorization by rater role, that is, the number and percent of students classified as Novice to Power User by the role of the rater.

Table 10. CATM Total Categorized by Rater Role

	Novice		Context-Dependent		Transitional		Power User		Total	
	N	%	N	%	N	%	N	%	N	%
Administrator	0	0	0	0	2	2	4	17	6	3
Other	0	0	0	0	8	8	0	0	8	4
Paraprofessional	2	29	13	20	7	7	0	0	22	11
Teacher	2	29	27	42	66	66	12	50	107	55
Therapist	3	43	24	38	18	18	8	33	53	27
Total	7	100	64	100	100	100	24	100	196	100

The teachers appeared descriptively, to rate the largest proportion of transitional and power users whereas the therapists were responsible, proportionally, for the largest amount of novice and context-dependent classifications. This can be seen graphically in Figure 3. This (Figure 3) illustrates agreement and differences observed in CATM ratings when viewed by the rater role in this convenience sample in which the roles were not evenly distributed.

Figure 3. CATM Categorization by Role (%) in Each Category

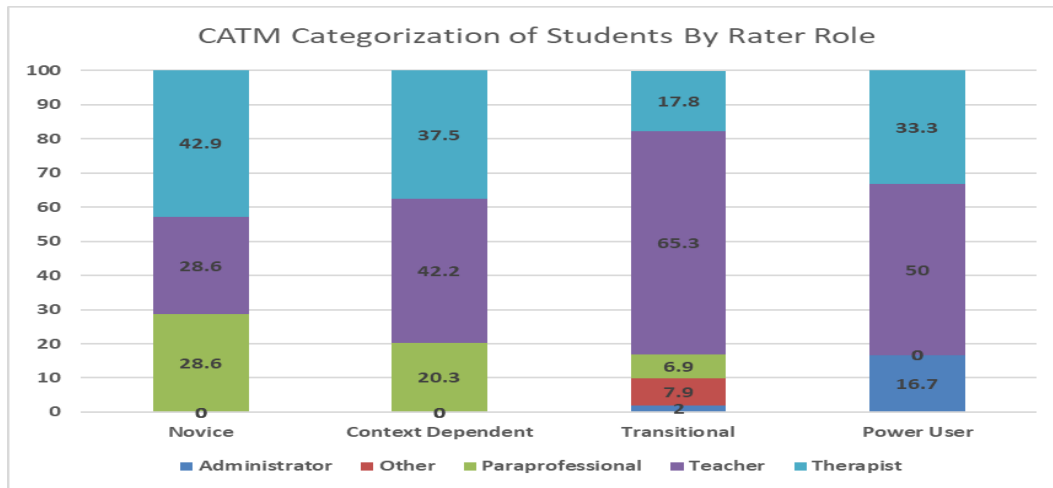


Table 11 shows the number and percent of absolute agreement between/among the members in the rater triads. There was consensus among raters for 45% of the students rated and only one instance where all three raters disagreed.

Table 11. Rater Agreement of AT Mastery Classifications

Agreement among rating triads	N	%
All 3 raters agreed	15	45 %
2 out of 3 raters agreed	17	52 %
No raters agreed	1	03 %

Reliability: Test-Retest

The time between measurement occasions ranged from 4 to 82 days. To avoid potential history or maturation confounds, data from raters with T2 greater than 31 days were excluded from the analysis. This resulted in a final Test–Retest sample of 75 cases. Reliability between test and retest was computed through the single measure of intraclass correlation coefficients (ICC) on the Time1 and Time2 scale means.

Following recommendations by Parsons, et al. (2019), we report two-way mixed effects

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models for absolute agreement, ICC (2,1), and consistency, ICC (3,1). All analyses were conducted using IBM SPSS Statistical package (Version 29, 2023).

CATM TOTAL

As shown in Table 12, acceptable reliability was found between T1 and T2 on the Total CATM. The single measure ICC was .84 for absolute agreement. This is conventionally considered as good Test-Retest reliability.

Table 12. Intraclass Correlation Results Table for Test-Retest of Total CATM

	Intraclass Correlation	Lower Bound	Upper Bound	F Test with True Value 0	df1	df2	Sig
Consistency	0.862	0.790	0.911	13.52	74	74	<.001
Absolute	0.841	0.721	0.906	13.52	74	74	<.001

CATM SUBSCALES

As shown in Table 13 below, all the subscales except for Experience displayed acceptable or “good” test-retest reliability (ICCs ranging from .76 to .88.)

Table 13. ICC Results for Test-Retest of CATM Constructs

CATM CONSTRUCTS	ICC	95% CI Low	95% CI High	F-Test	DF	sig
1.Experience	0.691	0.551	0.793	5.463	74	<.001
2.Experience	0.675	0.523	0.784	5.463	74	<.001
1.Knowledge	0.897	0.842	0.934	18.48	74	<.001
2.Knowledge	0.884	0.801	0.931	18.48	74	<.001
1.Proficiency	0.840	0.757	0.896	11.47	74	<.001
2.Proficiency	0.818	0.689	0.89	11.47	74	<.001
1.Personal Connection	0.793	0.69	0.864	8.645	74	<.001
2.Personal Connection	0.778	0.656	0.857	8.645	74	<.001

1=consistency, 2=absolute agreement

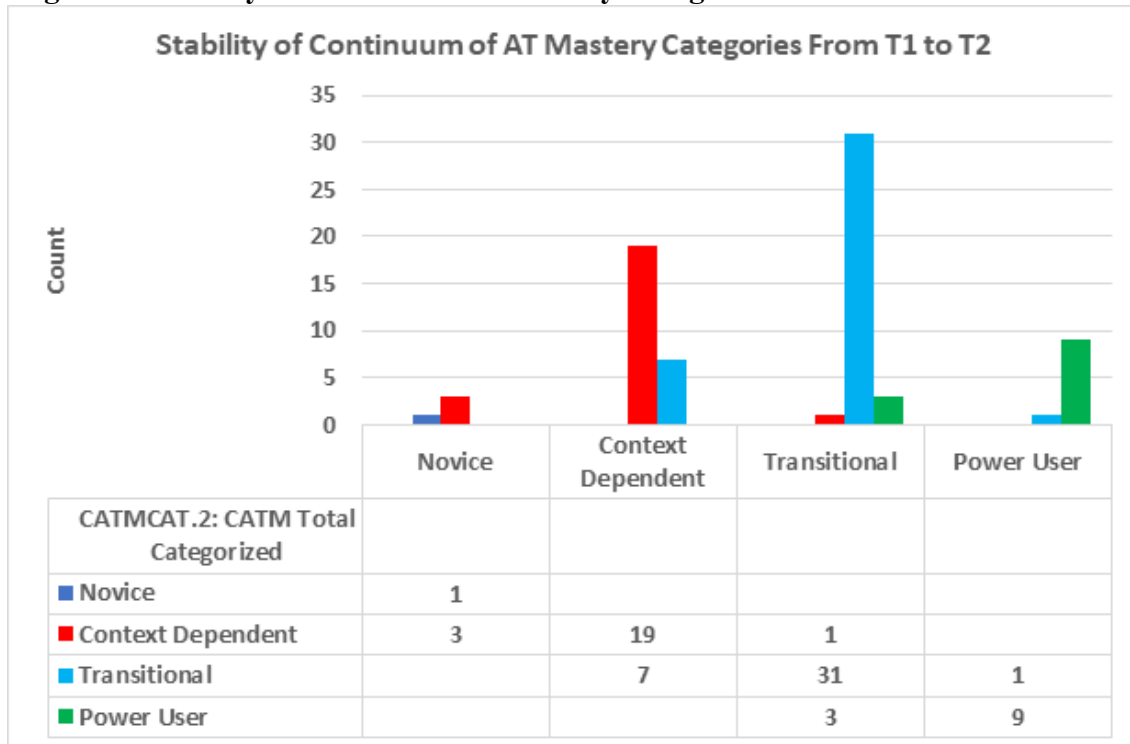
Reliability of Classification

Because the CATM generates the classification of AT users, the stability of classification categories was examined. The consistency of ratings between time of

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measurement for each category was tested using weighted Kappa. The CATM categorizations exhibited acceptable stability over the two-week testing interval (Kappa = .682; $p = <.001$). Figure 4 shows a cross-tabulation of T1 and T2 classifications on the continuum.

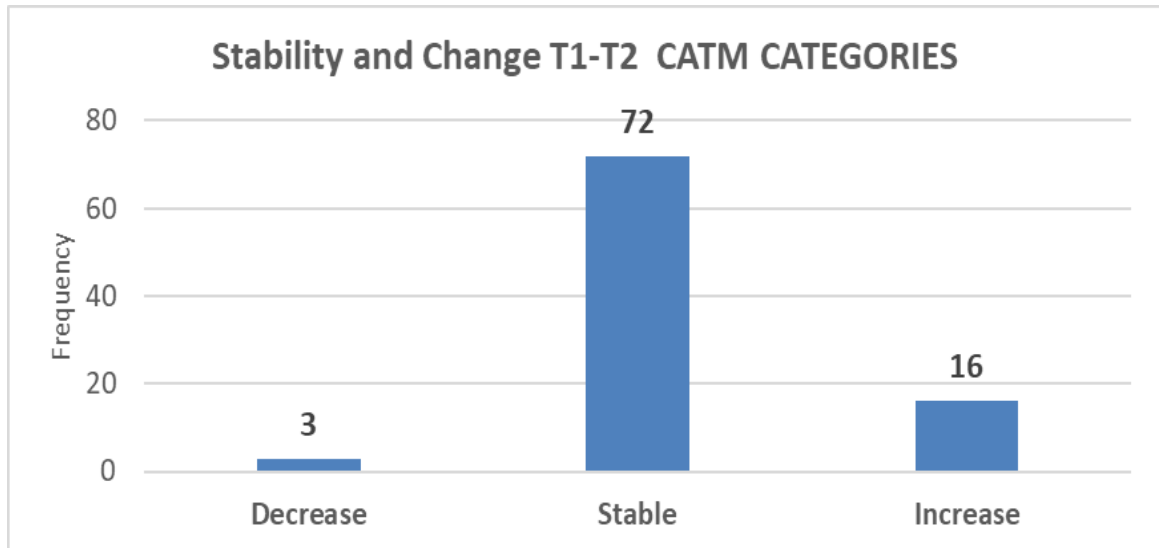
Figure 4. Stability of Continuum of Mastery Categories Over Two Weeks



As shown in (see Figure 4) the first column and first row the Novice classification was stable for 1 student, but not for 3, these students moved up to the Context Dependent category. Row 2 shows T1-T2 stability for 19 students, but 7 Context Dependent ratings shifted up to Transitional at T2. In the third column, there were 31 stable Transitional classifications and 4 not stable; 1 dropped to Context Dependent, and 3 increased to Power Users. Finally, the Power User category had 9 consistent ratings from T1 to T2 and one that changed to Transitional between measurements. Overall, the CATM was stable across categories. Those classifications

that shifted tended to advance up the Mastery continuum, as illustrated by the summary data shown in Figure 5.

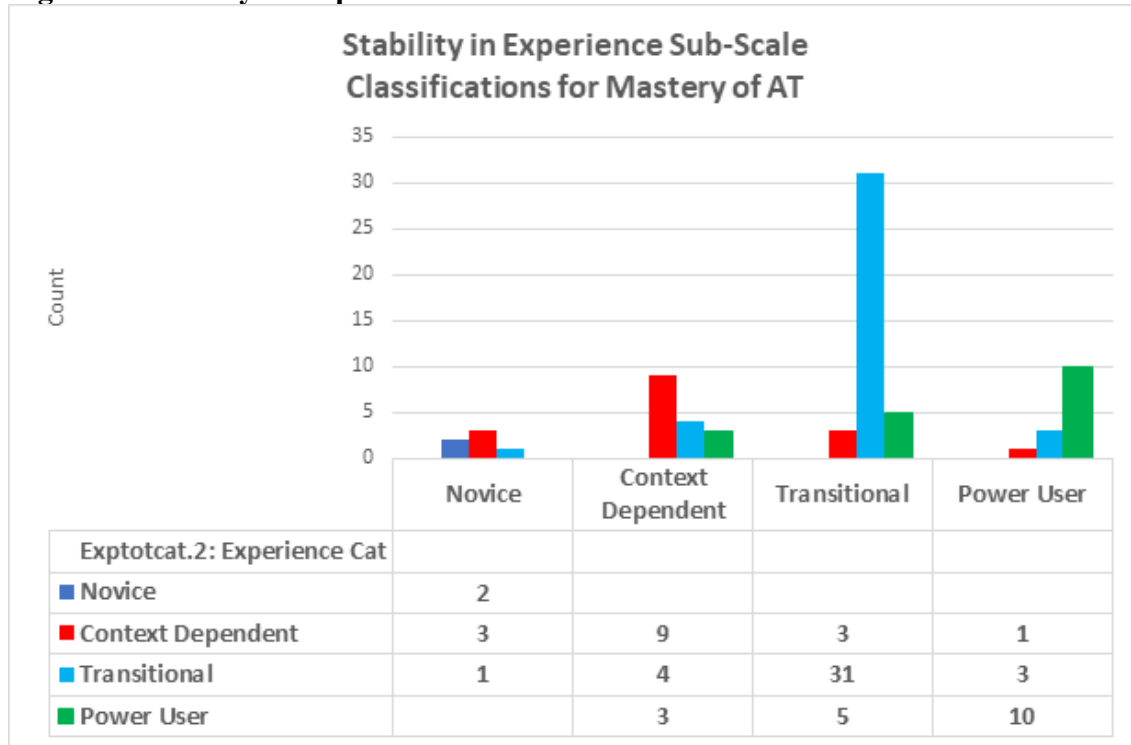
Figure 5. Change in CATM Classifications



Test-Retest: Experience Sub-Scale

The Experience sub-scale categorizations exhibited poor stability over the two-week rating interval ($Kappa = .551$; $p = <.001$). Figure 6 below shows T1 and T2 classifications. As shown in the first column and first row the ‘Novice’ classification was stable for 2 students, but not stable for 4. Row 2 shows T1-T2 stability for 9 ‘Context Dependent’ classifications but an increase in 7. In the third column, there were 31 stable ‘Transitional’ classifications and 8 not stable (5 up, 3 down). Finally, the ‘Power User’ category had 10 consistent ratings from T1 to T2 and four that changed between measurements.

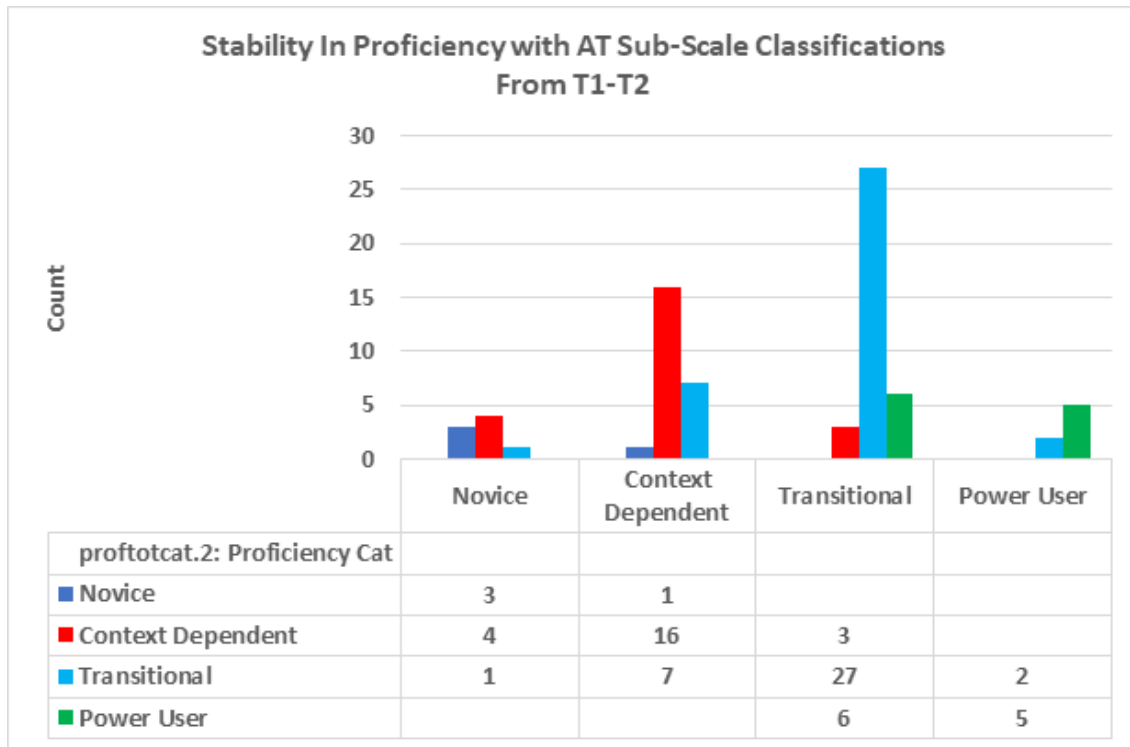
Figure 6. Stability in Experience Sub-Scale



Test-Retest: Proficiency Sub-Scale

The Proficiency sub-scale categorizations exhibited poor stability across time (Kappa = .505; $p = <.001$). The graph below (see Figure 7) shows T1 and T2 classifications. As shown in the first column and first row the ‘Novice’ classification was stable for three students, but not stable for five who all increased. Row 2 shows T1-T2 stability for 16 ‘Context Dependent’ ratings, but change in 8; 1 decreased, and 7 increased. In the third column, there were 27 stable ‘Transitional’ classifications, three decreases and six increases. Finally, the ‘Power User’ category had five consistent ratings from T1 to T2 and two that changed between measurements.

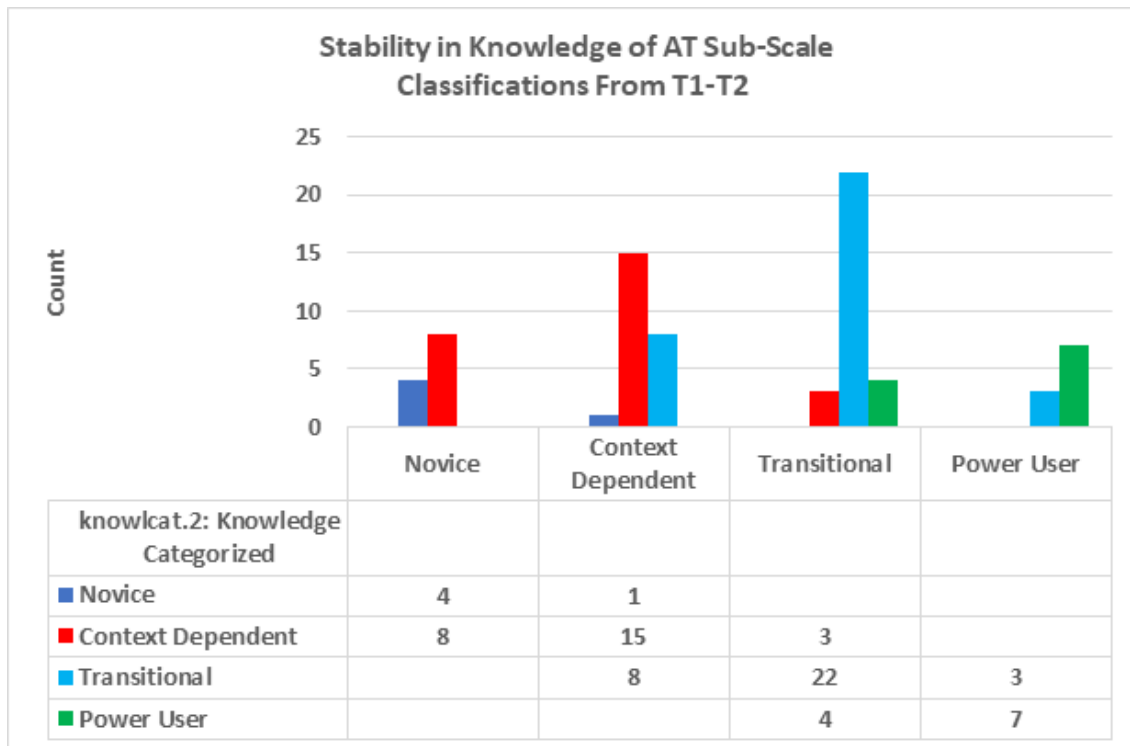
Figure 7. Stability in Proficiency Sub-Scale



Test-Retest: Knowledge Subscale

The Knowledge sub-scale categorizations exhibited poor stability across time (Kappa = .504; $p < .001$). The graph below (see Figure 8) shows T1 and T2 classifications. As shown in the figure, row 2 shows T1-T2 stability for 15 and change in 9. In the third column, there were 22 stable Transitional classifications and 7 not stable. Finally, the Power User category had seven (7) consistent ratings from T1 to T2 and 3 that changed between measurements dropping down to a Transitional.

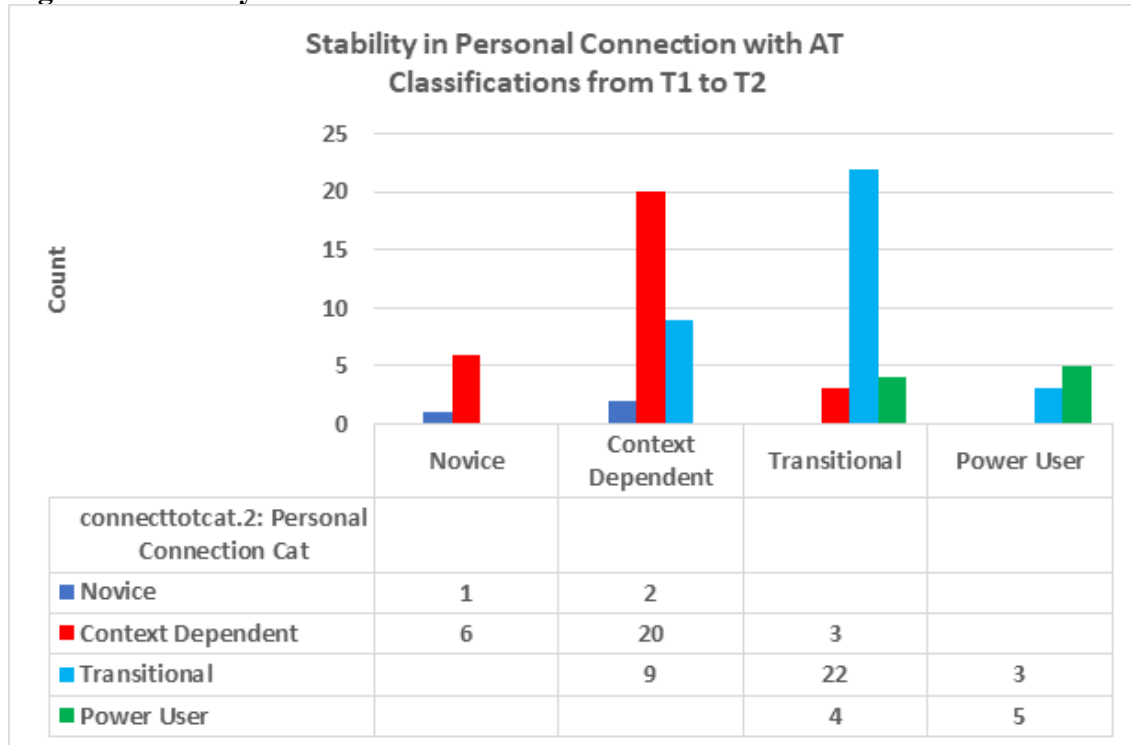
Figure 8. Stability in Knowledge Sub-Scale



Test-Retest: Personal Connection Sub-scale

The Personal Connection sub-scale categorizations exhibited poor stability across time (Kappa = .477; $p < .001$). The graph below (see Figure 9) shows T1 and T2 classifications. As shown in the first column and first row the Novice classification was stable for one student, but unstable for six. Row 2 shows T1-T2 stability for 20 Context-Dependent classifications but two decreases and nine increases. In the third column, there were 22 stable Transitional classifications and 7 not stable; three decreased and four increased. Finally, the Power User category had 5 consistent ratings from T1 to T2 and 3 that shifted down to Transitional between measurements.

Figure 9. Stability in Personal Connection Sub-Scale



Subscales Classification Summary

Table 14 presents a summary of the weighted Kappa values for the four sub-scales as well as the CATM total.

Table 14. Weighted Kappa Values for Sub-Scale Classifications from T1-T2

Sub-Scale	k	p
Experience with AT	.551	<.001
Proficiency with AT	.504	<.001
Knowledge of AT	.477	<.001
Personal Connection to AT	.445	<.001
TOTAL CATM	.682	<.001

While categorizations for the total CATM (see Figure 5) appear fairly stable, categorizations on the individual sub-scales (figures 6 through 9) were less stable. To provide greater granularity, an analysis of the frequency of change in categorization from T1 to T2 by field test site is provided in Table 15.

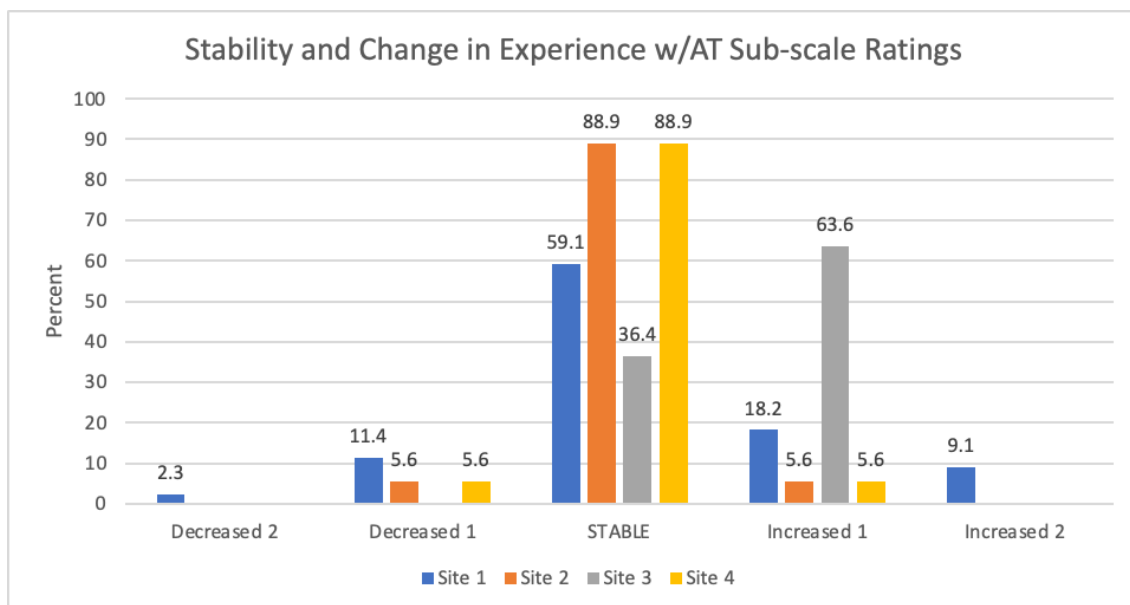
Table 15. Frequency of Change in Category for student ratings From T1-T2

Change in Category	Site 1		Site 2		Site 3		Site 4	
	N	%	N	%	N	%	N	%
-2	1	2.3	0	0	0	0	0	0
-1	5	11.4	1	5.6	0	0	1	5.6
0	26	59.1	16	88.9	4	36.4	16	88.9
1	8	18.2	1	5.6	7	63.6	1	5.6
2	4	9.1	0	0	0	0	0	0

As shown, Sites 2 and 4 both had 89% consistency of ratings (0 change in category), whereas Site 1 had 59% and Site 3 only had 36% consistency from T1 to T2.

We also examined consistency for the sub-scale categories (Novice to Power User) by site. Figure 9 shows good stability for Sites 2 and 4 for the Experience with AT sub-scale and less consistency for Sites 1 and 3.

Figure 9. Stability & Change in Experience with AT Categorizations by School



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As depicted in Figure 10, Site 4 was stable in Proficiency with AT sub-scale Category ratings, but the other sites were less stable with decreases and increases in ratings between the two time points.

Figure 10. Stability & Change in Proficiency with AT Categorizations by School

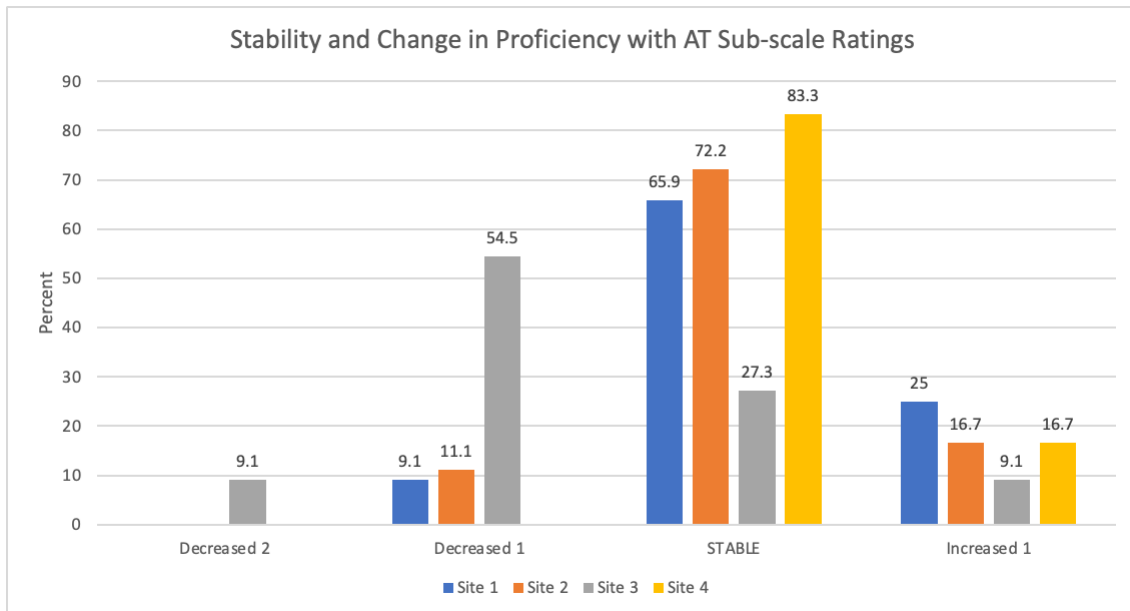
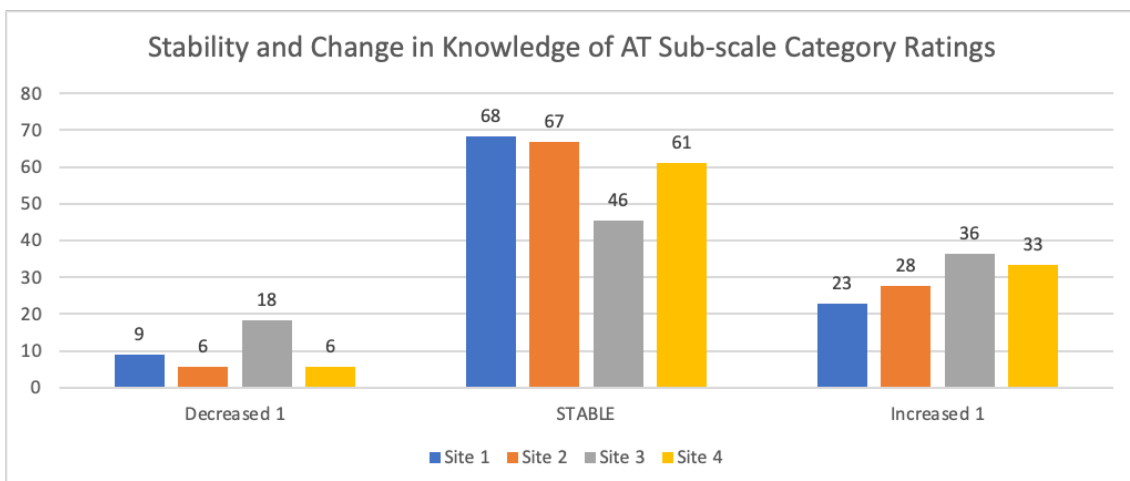
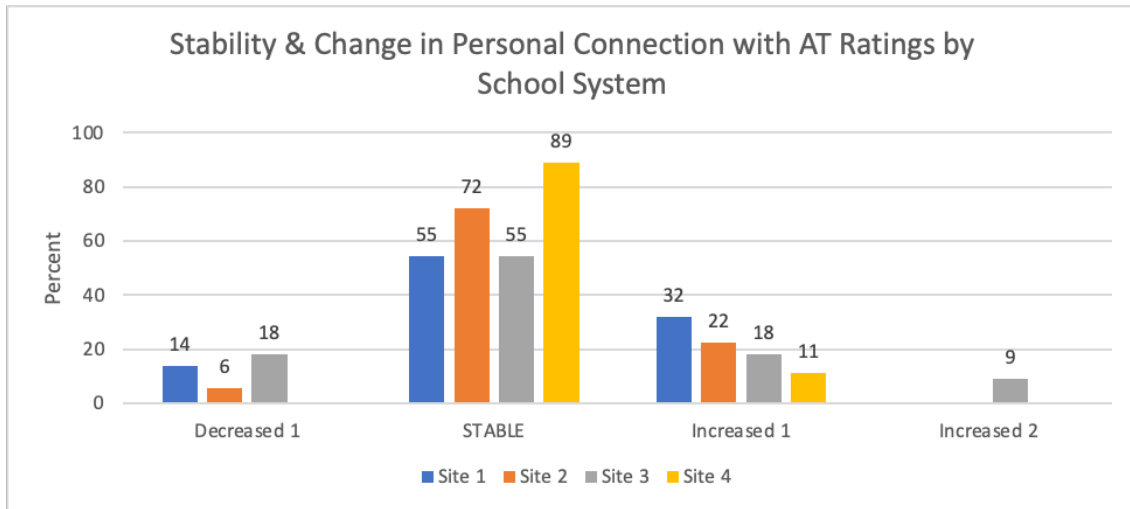


Figure 11. Stability & Change in Knowledge of AT Categorizations by Site



Figures 11 and 12 show the changes in the sub-scales of Knowledge and Personal Connection to AT, respectively. Stability across categories and time was poor to fair for most of the sites on these two constructs.

Figure 12. Stability & Change in Personal Connection with AT Categorizations by Site



Reliability of CATM and Sub-Scale Classification. The reliability of classification into the Novice, Context-Dependent, Transitional, or Power User categories was not stable across testing times for the sub-scales as estimated by weighted kappas (.445-.551). However, the total CATM was borderline stable (.682).

Table 16. Summary Table of Psychometric Testing in K-12 Classrooms for the CATM

CATM Constructs (Item N)	Internal Consistency N=105 α	Inter-Rater Reliability N=33 Cases / 3 Raters			Test Re-Test Reliability N=91 Cases Agreement (A) Consistency (C)				Classification K
		ICC	[95% CI]	F**	ICC (A)	ICC(C)	[95% CI]	F**	
Experience (4)	.845	.758	(.568 -.872)	4.127	.675	.691	(.523 -.784)	5.46	.551
Proficiency (4)	.891	.822	(.682 -.906)	5.608	.818	.840	(.632 -.869)	11.47	.504
Knowledge (5)	.915	.673	(.418 -.828)	3.060	.884	.897	(.801 -.931)	12.14	.477
Connection (7)	.940	.705	(.474 -.844)	3.385	.778	.793	(.656 -.857)	8.645	.445
CATM Total (20)	*	.771	(.593 -.879)	4.374	.841	.862	(.721 -.906)	11.96	.682

** all sig <.001

Discussion of CATM Psychometrics

Preliminary Psychometrics

The preliminary psychometric analyses demonstrate that the CATM has good reliability. The panel and focus group affirmed the conceptual framework and basic structure of the CATM. Users of the CATM have reported broad agreement that the CATM's evaluation results have presented an accurate reflection of the users being evaluated.

Internal Consistency: The internal consistency of the CATM constructs is presented in Table 7. Per convention, we did not estimate reliability for the Total CATM on this multi-construct measure. Alpha values ranged from .89 to .94 exceeding the recommended alpha level of .70. This is indicative of an instrument with good reliability.

Table 11 suggests that there was a high level of agreement among raters. There was only one instance in which there was no agreement among raters. While the examination of rater roles (Table 10) was hampered in this study by an uneven distribution and was inconclusive, it nonetheless suggests that an examination of rater roles using the CATM in future studies could provide useful insights as to how rater roles might influence rating results.

Inter-rater reliability: Results of the calculation of the Intra-class correlation coefficients is presented in Table 8. The CATM showed good reliability; the average measure ICC was .77 with a 95% confidence interval from .59 to .88, $p < .001$. The subscales displayed promising results with ICC values ranging from .67 to .76.

Intra-Rater - Test-Retest Reliability. Tables 12 and 13 indicate that good reliability and high stability were found between two testing occasions on the CATM as a whole. The single measure ICC was .84 for absolute agreement for the total CATM. All the subscales displayed acceptable to good test-retest reliability (ICCs ranging from .68 to .88.) To limit maturation confounding errors, we chose to exclude scores where

the difference between T1 and T2 was 31 days or greater. Nevertheless, we did allow instances where the T1-T2 difference was 14-30 days – exceeding the original protocol stipulation of two weeks to be as inclusive as possible and in deference to sample size. This source of variance may have introduced bias at the construct level, if not the overall instrument level, especially in this age group. The complexity of the instructions provided by the research team to site leaders was a contributing factor in this situation.

Some instability between test-retest instances was observed in the Personal Connection with AT construct. We also observe that inter-rater reliability measures produced slightly lower ICC values for Knowledge of AT and Personal Connection with AT. The interviews with educators following the field testing suggested that rater roles and the educators' expectations of student progress during the term of the study were likely contributors to the instability in these results. Further, data points out that one site was the source of much of the observed instability (see Table 15). The fact that the overall shift in ratings was overwhelmingly upward (see Figure 5) along the continuum of growth in AT Mastery, reinforces the plausibility of this explanation.

Examination of difference in scores for CATM categories

Although stable overall, the CATM scores did show some instability from T1 to T2 for some raters. Table 15 depicts the change in stage (Novice, Context-Dependent, Transitional, Empowered User) rating by student from the time of the first rating (T1) to the second rating (T2) for the full CATM. A positive number means an increase along the Mastery continuum a negative means a decrease. We would hope to see all 0s to indicate consistency between the relatively short two-week time frame unless a student experiences a change in AT Mastery during that time.

Rater Roles. Examination of inter-rater reliability data (Table 11 and Figure 3) suggests that further study of rater roles (Teacher, Therapist, Paraprofessional, etc.) may

be warranted. This sample was limited, and the roles were not evenly distributed. While questions regarding the differences in perspective could not be adequately addressed from data in this study, information from interviews of educators who participated in field testing has suggested questions for further study. These include: 1) what roles are better suited to conduct a CATM assessment and 2) do certain rater roles have greater insight into some constructs than others?

Discussion of these questions emerged organically in some of our interviews. Educators revealed that sometimes they were familiar with the student such that no direct observation was needed to complete the CATM. At other times, raters were not as familiar with a student and sought to observe the student before conducting an assessment. Some educators felt that they had to make assumptions regarding items in the Personal Connections construct, as they had limited involvement with the student. Because of the uneven distribution of rater roles in our sample, a systematic analysis could not be completed. However, the available data suggest that there might be value in future studies that identify this issue for study and seek a sample that could provide better visibility to these questions.

Interviews with Educators Following Field Testing

Twenty-three educators took part in interviews following their fieldwork with the CATM. Among these were ten teachers, three Occupational Therapists, six Speech-Language Pathologists, two Assistive Technology professionals, and two paraprofessionals (see Table 16). Each participating educator was presented with the interview questions in advance (see Appendix II). Twenty of the educators said that they reviewed these questions before meeting with the research team. Three said that they did not review them ahead of time.

Table 17. Educators Taking Part in Interviews

Unique ID	School	Role/ title?	Focus	Level	Grade
1	Site 1	OT		MS	
2	Site 1	Para	VI	ES	
3	Site 1	Para	SpEd	ES	
4	Site 1	SLP		ES	
5	Site 1	T	GenEd	ES	5 th
6	Site 1	SLP		ES	
7	Site 1	OT		ES	3 rd
8	Site 1	T	SpEd	MS/ES	
9	Site 1	T	RegEd	MS/ES	5th ELA
10	Site 1	T	Resource	ES	3 rd
11	Site 1	SLP		MS/ES	3 rd
12	Site 2	ATP		MS	
13	Site 2	SLP		MS	
14	Site 2	SLP		MS	
15	Site 3	T	SpEd	ES	5 th
16	Site 3	T	GenEd	ES	5 th
17	Site 3	T	ELA	ES	5 th
18	Site 4	T		ES	4 th
19	Site 4	OT		ES	4 th
20	Site 4	SLP		ES/MS	1st-8 th
21	Site 4	T	GenEd	ES	4 th
22	Site 4	T	SpEd	ES	4 th
23	Site 4	AT Dir		ES/MS	1st-8 th

Participants agreed that the CATM produced an accurate assessment of the student’s level of mastery of the AT in use. All 23 participants indicated that they had a positive impression of the CATM as an instrument and the project as a whole. There were 18 participants who suggested that the CATM was easy to implement, three said that they had some initial difficulties, but were able to use it. Two did not comment on ease of use.

Instructions. Participants identified some difficulty with how instructions were communicated to educators who served as raters. The use of dense text in the printed instructions from the research team made it hard for some educators to identify what

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was expected of them. In addition, miscommunication between local site leaders and educators who used the CATM produced confusion regarding timelines and procedures. The research team relied upon a team leader in each setting to recruit the participating educators, help obtain consent, and coordinate the assignment of students. The assignment and use of teacher and student codes was confusing for some participants. It was suggested that this process be spelled out more clearly. These communication difficulties were not related to the use of the CATM, but rather to the protocol for the field testing (e.g., timing, setting up the triads, assignment of participant ID codes).

Use of the CATM.

Support for use. Some educators expressed a preference for greater guidance and direction. Two educators expressed a need for more examples or a rubric with more description of each factor. (i.e., “What would *independence* look like for the person who is at the *Context-Dependent* stage and who is using a text reader?”). They suggested that applying the factors in the CATM was somewhat abstract and that a more descriptive framework would be helpful. Three participants noted that the practice self-assessment using the CATM that was suggested in the directions was very helpful.

Differences between first and second assessments. We asked the educators if there was any difference between the first and second assessments with the CATM. Eleven of the participants suggested that the second review was easier because of their familiarity with the tool and that the second assessments were completed more quickly. Nine remarked that the period between the two assessments was too short as they were anticipating student progress in the second assessment. Three educators reported that they did note progress in a student’s AT use.

The research team mentioned, but did not draw attention to, the fact that inter-rater reliability and test-retest reliability were the aims of this field test. Nine participants confessed that they did not pick up on these objectives or were unaware of the nature of test-retest reliability testing. They shared that they wanted the students they evaluated to demonstrate progress. They did not feel that two weeks was enough time between CATM assessments. The research team wondered if they may have resisted conducting the second assessment in the time specified in the protocol. None of the participants said that they had intentionally delayed the second assessment.

AT Use Beyond Class. Participants also identified some difficulties related to assessing a student's broader use of AT. Two educators suggested that it was difficult to ascertain the use of AT in the environment beyond their classroom. They reported being unaware of what the student had done with AT in the home or community. Others suggested that they did not know how the AT was being used in other classes with other teachers.

Observation. When asked about whether they observed students using AT in order to complete the CATM, nine of the participating educators said that observation was unnecessary, as they already knew these students well. Six said that they did observe, but that they were not sure observation would always be required. One itinerant educator suggested that for her, it depended upon how closely she had worked with the student and for how long. Seven educators did not comment on the need to observe students.

Personal Connection to AT. Educators were asked to comment about the section of the CATM known as “Personal Connection to AT”. All participants said they saw value in the inclusion of this section in the CATM. Ten made specific comments describing the section as “important”, “relevant”, and “appropriate”. Six others agreed

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that it was valid to include this section in the CATM, but they suggested there were some challenges to rating these items accurately.

The participants identified two areas of difficulty in assessing students in this area: 1) Three participants pointed to the perceived stigma associated with AT use that might cloud actual mastery. Some students might decline to use AT tools available to them when they feel that doing so makes them stand out as different. This aspect could make several factors more difficult to observe.

2) Three participants expressed concern that, while the section was valuable, it was hard to rate students without making assumptions. They pointed to students with executive function challenges. In areas where mastery involves some aspect of planning ahead, these educators suggested that these students might not present behaviors consistent with characteristics described in the CATM, even though they might be capable or have the desire to do so. This might put the assessor in a position of having to assume that what was observed was the limit of the student's capacity.

The fact that there were educators who expressed a need for more examples or a rubric with a more descriptive framework was interesting. Their comments seem to challenge the consensus of advice from the focus group on this topic. The focus group has suggested that the wordiness and text density of the original CATM instrument were somewhat daunting. It may be worth noting that some members of the focus group did not object to the more detailed rubric-style description of the stages for each factor.

Other observations. Two educators reported that one of the students (with an Intellectual Disability) they assessed presented periodic learning loss to the point that one day the student demonstrated great awareness and capability and other days appeared to forget everything. The educator was unsure how to capture this in the CATM. One participant posited that some students may have been too young for this

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assessment, as their AT development was only beginning. Other students were observed to be reluctant to engage their AT during class when they were the only ones in the class who had AT.

Suggested changes.

The educators we interviewed were unanimous in their view of the CATM as complete and that no factors were out of place or did not belong. When asked for suggestions to improve the use of the CATM, six participants suggested that the instructions were clear and that no changes to the CATM were needed.

When asked about specific improvements to the CATM, the following suggestions emerged:

- Ten educators asked for a “notes” section where the assessor could record comments and observations about the student that could be retained with the record of the CATM evaluation.
- Five educators suggested that some of the factors might not apply to a particular student and requested an option to answer “N/A” for “not applicable” or “did not observe this”. When asked about the factors that comprised the CATM, two participants suggested that the item Expanding Knowledge (Able to get knowledge about AT: community, mentors, conferences, etc.) might not be appropriate to expect from students who are in elementary school. One educator said that as she thought about it, the fact that they would be rated as a Novice on this item was actually accurate and that the rating would be something to build upon in the future.
- Two participants wondered aloud about how the CATM might address the case where a student used multiple forms of AT simultaneously. How would the CATM address issues occurring in one form of AT upon which the use of another AT tool depended?
- One participant suggested including a “prompting level” indicator that recorded how much prompting it took to get the student to initiate use of their AT.

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- Two educators suggested a goals bank be developed with the CATM to help identify the aspects to work on next and shape intervention ideas.

Applications of the CATM.

Participants were asked how the CATM might be used in K-12 school environments. The CATM was seen as a way to engage parents and other teachers and therapists in discussions around the application of AT for a specific student:

- Six educators suggested that if completed by parents and teachers, the CATM would be helpful to gain insight into how and when the student used their AT outside of class. Five participants asserted that the CATM was a good framework for reporting on progress to parents in general.
- Nine pointed out that CATM results could help guide discussions in IEP meetings, provide a means of tracking of AT progress, and serve as a framework for suggesting strategies and next steps for the student.
- Five educators thought that the CATM could help provide evidence that supports other IEP goals, as many students have AT use written into some goals as well as having goals related to independence and self-advocacy in their IEPs.
- Four educators suggested that the CATM could be incorporated into the AT intake process within a school or a district and could provide support for a consideration process approach to AT recommendation and follow-up.
- Two participants saw the CATM as a way to support requests for AT funding and suggested that the CATM could also support program evaluation within a building or a district. They suggested that scores over time for multiple students would indicate the overall effectiveness of a program's support for student AT use and mastery.

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- Three said that CATM results would also indicate areas where the program might be strengthened, or aspects emphasized in the future.

Participants also felt that the CATM could be important for transitions:

- Two participants asserted that the information from the CATM as being useful when a student changes classroom teachers or is assigned to a new therapist within a school.
- It would also be helpful when a student moves between schools or levels within a school or system.
- Being able to gather from the CATM insight into the level of mastery as well as areas of strength and weakness could be very helpful for the teacher or therapist as they plan for working with the student.
- Four educators said the CATM instrument was a way to track and plan progress and strategies for AT as students prepare to transition from K-12 school to other settings (postsecondary education, workplace, community settings).

Others pointed out that the CATM fostered important professional collaborations and encouraged student self-advocacy.

- Use of the CATM was seen by four participants as a way to engage faculty and administration in discussions of AT that could bring heightened awareness of AT and issues related to AT.
- Five participants said they saw the CATM as a means to secure teacher and therapist buy-in to student use of AT in instructional settings.
- Three participants saw the CATM as a way to support self-advocacy in students by fostering student self-reflection. It could assist teachers in identifying areas in

which a student needs encouragement and support or perhaps a “nudge” to try or to step out in a particular area.

Discussion of Interviews with Field Test Participants

The composition of the group of educators who participated in post field-test interviews is shown in Table 17. The interview questions are listed in Appendix II.

Issues with timing. In this study, the CATM ratings remained generally stable across categories. Shifts in classifications generally marked improvement along the Mastery continuum as shown in Figure 5. One site (see Table 15), however, demonstrated greater instability in the test-rest analysis. During our post field-test interviews the research team listened for indications as to what might have caused this. It was clear from participant comments that most educators at this site anticipated that students would show progress on the second assessment. Some reported frustration with the requirement that the second assessment should come only two weeks after the first. They reported wanting to delay the T2 rating to allow progress to be more evident. This site also had the largest number of participants involving multiple classrooms and involving several itinerant therapists. As such, the coordination task for the local team leader was the most challenging of all the sites. It seems clear that while researchers sought not to influence the thinking of participants as they approached the CATM, they may not have provided sufficient context for educators to grasp the test-retest nature of their task. The educators’ default consideration may have naturally shifted to looking for evidence of student progress and may have been reflected in ratings at T2. The introduction of disparate objectives - the research goal of reliability testing to show stability and the educator goal to show improvement - is a source of variance in the current study and is likely related to the T1-T2 protocol variance discussed above. This

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should be addressed more directly in the instructions accompanying future CATM reliability testing opportunities.

This is reflective of the challenges inherent in measuring stability in a maturational process or a continuum, where we expect to see movement. Especially, when the raters are educators who are by nature encouraging, evoking, and expecting to see change in the participants.

Suggested Improvements in CATM. Participants made several suggestions to enhance the CATM instrument. The suggestion of adding a “notes” section to the CATM assessment was embraced by the research team. This suggestion will be incorporated into future iterations of the CATM. The team will explore the relative value of four construct-linked notes areas or a single pop-up notes area for the CATM as a whole.

After the initial focus groups’ strong advice to simplify the rubric that was part of the original CATM in favor of a simplified presentation, it is worth noting that two educators said they would like to have had a more detailed set of examples or descriptions of individual behaviors for each item at each stage. Despite the potential for dense text reading challenges, it appears that some educators believed a more descriptive, fleshed-out rubric (like the original) might be of value. The researchers will explore whether providing more detailed descriptions, but “on demand” as a pop-up, would address the preferences and needs of both groups.

Regarding the suggested addition of a “N/A” for “not applicable” or “did not observe this” answer, the research team observed that some aspects of this discussion related more to the participant’s interpretation of the instructions than to the particular

choice. The research team decided to make no changes now but to explore the possible inclusion of a “N/A” choice in future studies.

The idea that raters might not be aware of the larger context of a student’s AT use suggests that an informational question might be added to the beginning of the CATM assessment of others. (i.e. "Does the student use this AT in other settings?) A space might be provided to list these - if known. This would draw attention to AT use in other contexts and perhaps foster useful discussion about consistency of use. The research team decided to consider informational questions such as this in future iterations of the CATM.

Conducting Observations and Rater Roles. Some of the participating educators said that personal direct observation of students was unnecessary to complete the CATM, while others thought that observation was helpful and of some importance. These comments highlight the issue of how well an educator actually knows the student they are assessing and may shed light upon the rater role data displayed in Tables 9 and Figure 2. In some public school environments, SLPs may see students only outside of the classroom setting. A classroom teacher who sees them daily may also work with many other students at the same time. Cooperative teachers and paraprofessionals may have direct engagement with fewer students but spend more time working with students that use AT.

Seventeen of the participants said that they did not think student observation would be required prior to assessing. However, at least one suggested that the need for observation depended upon how well the educator knew the student. One question that the research team wondered about was how the educator’s role might impact how they assessed a student. A related question was whether CATM assessments conducted by those who do not work with the student regularly or closely might be different from

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those working closely with a student. The data collected during the field study (see Table 11, Figure 3) suggests that this might be true. As observed previously, the Rater Roles were not evenly or consistently distributed across sites in this study. Further research is warranted before any conclusions should be drawn.

Applications of the CATM. Educators and focus group participants expressed confidence that the CATM would be of primary value in tracking the progress of an individual student. Participants observed that the tool would help quantify, or at least make more concrete, some of the elusive discussions at Individual Education Program (IEP) meetings around whether a student is making progress with the AT they use. The educators observed how the use of the CATM fostered constructive discussions among those using it in this study. Thus, the instrument should also serve as a valuable framework for discussion of AT during parent conferences and with students themselves. Participants also observed that, if properly applied to critical tasks, the CATM could help prepare individuals who are entering the workplace.

If differences in role might influence the CATM assessment process, the research team wondered if conducting the CATM “in the round” (having multiple educators, parents, and others assess the student) might be helpful. Would the different perspectives presented help provide a more complete view of the student’s AT use? It might be interesting to see how AT use differs at different points of the day and in different settings (e.g. when the person who prompts the student to use the AT is not present).

Educators also suggested that the CATM might also serve as a tool for program evaluation. By providing feedback on individual student progress, the CATM offers a program a means to examine the effectiveness of AT decision-making, training, and support.

Phase 3: Policy & Research Agenda Focus Group

Methods

A third phase of this project was a day-long meeting of AT and K-12 stakeholders to identify implications for policy and further research around the Mastery of AT. Eleven participants (see Table 18) took part in a full day of discussion about the possible implications of this project. Eight participants met face-to-face with the research team and 3 participated remotely. Most participants were research or policy experts or stakeholders representing multiple areas of the fields of K-12 education and AT.

Table 18. Research Focus Group Participants

Participant Backgrounds* (N=11)	N	%
Research	8	73%
Policy	7	64%
K-12 Education	7	64%
Person with Disability	2	18%
AT Professional/Specialist	4	36%
Participant in field testing	1	9%
Panel Member from earlier study	3	27%
Initial Focus Group Member	4	36%

*Not mutually exclusive

The methodology and the preliminary field-test findings were presented to the Policy & Research Focus Group. Participants were asked to critique the methods and results, focusing on what the research team may have missed. The group was asked to identify public policy issues related to AT Mastery and education. They were also asked to suggest research questions that might be worthy of future study.

Research and Policy Focus Group Findings

Research questions. After reviewing the activities and findings of this project, the Policy & Research Focus Group developed a list of research questions for the Mastery of AT program of research to explore going forward. The research team gathered the comments from the focus group to help them prioritize these research questions.

Priorities identified for future research on mastery of AT included:

1. How do we strengthen psychometrics associated with CATM: content validity, convergent and divergent validity, factor analysis, and correlations between CATM & other demographic indicators?
2. How does the CATM apply to specific types of technology? Select some common types of AT and do a deeper dive – include performance scores.
3. How does the use of the CATM affect outcomes (employment, post-secondary education, independent living, etc.)?
4. What is the relationship between the use of the CATM and adoption of AT and abandonment of AT?
5. Explore further the effectiveness of self-assessment with the CATM vs. other assessments. How do evaluations by others compare with self-assessments? What kinds of insights emerge from such comparisons?
6. How do the CATM results complement/differ from the research on AAC use and competency?

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7. Explore ways for students to use the CATM for self-assessment. Is there a threshold age where self-evaluation with the CATM becomes useful? What modifications to the CATM might be required for use by students?
8. How might the CATM be used with people with Intellectual and Developmental Disabilities (IDD)? Would modifications to the CATM be required for use by the individuals themselves?
9. Explore how the use of the CATM might be of value to “non-disabled” individuals who work in the field of AT (developers, educators, etc.). Would understanding how their “journey” is similar to/ different from persons with disabilities impact their work in the field? If the CATM was used to assess teachers, paras, therapists, etc., could this form the basis for/contribute to the development of a credentialing process?
10. What might be the application of the CATM to the broader population of persons without disabilities?
11. What is the relationship between AT Mastery and total cost of education? What might the return on investment be for a district’s investment in AT Mastery?
12. Confirm the hypotheses about the useability of the CATM.
13. How do differences in role (teacher, therapist, paraprofessional, administrator) impact the ratings of students with the CATM?
14. Explore how university Offices of Disability Services might use the CATM to help support students with disabilities in post-secondary settings. How might the CATM support or be used in their process?
15. Explore the addition of gaming elements (e.g., badging) to encourage mastery by students. For example, a badge might be awarded for the use of multiple AT tools.

Policy Considerations. The participants identified several aspects of policy and practice that widespread use of the CATM could influence. Concerning overall AT policy, the panel observed that Federal policy often has a “trickle-down effect” on local districts and schools. They suggested that the CATM might impact federal, and subsequently state, and local AT policy, in the following ways:

- The CATM could contribute to a more comprehensive definition of AT.
- The CATM could contribute to data collection on AT usage and progress.
- The CATM could impact policy related to the provision of AT & funding. For example, should all students be assessed for AT? Or do we wait until students struggle before we intervene?
- If AT Mastery in high school is associated with better performance in post-secondary education (Satterfield, 2020; Poudel, 2014), what steps might we take to help more of our students be successful?

Other specific suggestions from the participants included:

1. The CATM could support accountability for tracking AT implementation. Specifically, the CATM could support monitoring schools and districts for compliance, and measure progress at several levels.
2. The CATM could be used to Differentiate AT skills from external factors impacting the AT use experience (e.g., inaccessible websites and other content)
3. The CATM could help assess course accessibility (e.g., evaluate all AT tools used by teachers and students to find out where the inhibitors and bottlenecks might be).

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The participants agreed that use of the CATM would increase stakeholder engagement. Assessments using the CATM can lead to engaging educators and administrators in conversations with parents about AT in ways that can bring AT out from its “silo” and be seen as a key facilitator of learning for students with disabilities. Our research focus group participants also suggested that the CATM might raise the profile of technology in the classroom and the momentum for adding AT standards to teacher prep programs (e.g., Council for Exceptional Children Standards)

Some participants suggested that training students and teachers together in applications of assistive technology had an equalizing effect. Teachers can learn from the students' tech know-how/mastery. The group also noted that raising teachers' capacity to develop accessible content would optimize AT use and minimize student frustration.

Discussion of Policy and Research

Policy Implications

The Policy & Research Agenda Focus Group suggested that the CATM could serve as a catalyst for change on a larger scale. Because it conceptualizes the concept of mastery in a quantifiable manner, the CATM could be used to impact policy relative to data collection around AT use. Because the CATM is user-centric, participants suggested that it may lead to a more comprehensive definition of AT.

The panelists also pointed to several areas in which the CATM could have an impact on the development of policy in K-12. Most obvious to the panel was the opportunity that the CATM provides for the engagement of stakeholders in meaningful and productive discussions around AT. These appear to be possible in informal as well

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as formal settings. They appear to be useful in discussions regarding individuals as well as classrooms, buildings, and district-wide levels.

As stakeholder involvement increases around the CATM, special education teachers and administrators, parents, and general educators will become more vocal and influential in the policymaking process. The group felt that this momentum could gain traction immediately in existing initiatives, such as the Multi-Tiered System of Supports (MTSS). They felt that the use of the CATM could present evidence that could reshape this process

The CATM can contribute evidence and outcomes data similar to the findings of the National Longitudinal Transition Study (Bouke, et.al., 2012). This can impact classroom productivity outcomes. The panel discussed an example where a student who reads at grade level but struggles to complete assignments, may read and complete work three times faster when supported by a text-reader. Participants felt that widespread use of the CATM could open the door to thinking about how AT can impact more students given the disparities in the diagnosis of learning disabilities.

The panel also felt that the CATM could affect “messaging” around AT. The panel suggested that the CATM supports the perspective that technology can make a difference for all students. The CATM can help remove stigma by expanding the definition of AT to include general technology features used in an assistive manner. Essentially, we all use AT. Further, it can be used to undermine the ableist notion that we have to remediate every child. The operative question is no longer “Does the child need assistive technology?” Now we ask, “Which technology helps them most?”

The focus group members suggested that the CATM could be an important tool in removing gatekeepers to AT. The CATM brings visibility to the mastery process and allows the teacher to observe how AT has changed students’ progress and their level of

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engagement. Field test participants observed that the CATM would lead to greater teacher buy-in. The participants suggested that the use of the CATM could help administrators better understand their role in both assistive teams and general technology. Many panelists reported that the real gatekeeper was the administrator at the building level - where they felt the CATM would have the greatest impact on engagement.

Future Research Priorities

The Policy & Research Agenda Focus Group pointed out that, despite the positive feedback, encouraging psychometric results, and positive reports from the field, this program of research is still at an early stage. Providing structured opportunities to collect data on larger numbers of individual assessments would be necessary before the capability of the instrument can be fully understood.

Participants identified several research priorities for the future. The greatest attention was placed upon discovering how appropriate the CATM might be in other contexts (i.e. workplace, community living) and for persons with various disabilities (in particular physical disabilities, and blind/low vision) as well as how effective the CATM is for different kinds of assistive technology. Other questions given high priority included: 1) examining the relationship of Mastery of AT and AT adoption and abandonment, 2) exploration of the limits of self-assessment with the CATM, and 3) revisiting comparisons of the CATM and the research on Competency in AAC use. The research team is looking at how these priorities might be addressed in future studies.

Study Conclusions

Study Limitations

While this study produced some useful findings and raised some intriguing questions, the study was limited in size and experienced issues that likely introduced variance. While these are common in studies based in educational settings, the result is that care should be taken not to generalize the findings too broadly.

Sample size. This study was blessed to have the participation of two school systems and two private schools all of whom take use of AT with students with disabilities seriously. Nevertheless, the size of the field study sample was smaller than the project plan had anticipated. Participation by other educational entities was limited by commitments to other innovations and changes to the instructional program. The timing of our study was not convenient for several local education agencies. Thus, the psychometric findings of this study, while positive and encouraging, are not definitive. The research team plans to continue seeking validity and reliability data in future studies to bolster these preliminary findings.

Departure from Protocol. The research team mentioned but did not draw the attention of field test participants to the fact that inter-rater reliability and test-retest reliability were the aims of this field test. Nine participants confessed that they did not pick up on these objectives or were unaware of the nature of test-retest reliability testing. They shared that they wanted the students they evaluated to demonstrate progress toward mastery. They did not feel that two weeks was enough time between CATM assessments. The research team wondered if they may have resisted conducting the second assessment in the time specified in the protocol. These factors may have introduced variance into the process.

Reliability. While Figure 5 indicates that the test-retest results reflect a level of stability for the CATM, a closer investigation into the categorizations within the individual constructs (figures 6-9) suggests less stability. An analysis of Table 15

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reveals that most of the variance emanates from one particular site. Participants from this site disclosed in interviews how they were expecting to see a difference between the T1 and T2 assessments. This emergence of competing objectives may help explain some of the observed variance. Nevertheless, conclusions regarding the reliability of the CATM remain tentative, pending further testing of the instrument.

Limited AT Involved. This study was conducted in K-12 settings, and as such, these findings relate to educational contexts and tools. Many of the assessments in the field testing involved AT that supported reading assignments (text-to-speech, TTS) in the classroom or supported classroom communication (AAC). Not all forms of AT were involved in this study. Future research should explore the use of the CATM with other AT tools.

Further study is needed for assessments of AT Mastery in transition, workplace, and independent living settings. In addition, while the CATM was designed so that it could be used for self-assessment, this study explored the use of the CATM for administration by a third party, such as a teacher or therapist. Greater examination of the implications of using the CATM to evaluate others is warranted.

Final Observations

The study described in this report is the second in a series of investigations envisioned for this program of research. While these studies are not determinative, the emergence of the CATM has provided a framework for discussing AT outcomes from the individual user's perspective and a tool for measuring individual progress toward mastery. While this project produced encouraging results, this program of research is still in a formative stage and many questions remain to be addressed.

This study sought to explore applications and effectiveness in K-12 education.

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Educators who took part in the field testing remarked repeatedly that the CATM evoked meaningful conversations and engaged parents, administrators and others who had formerly remained on the periphery of such AT discussions. While no Individual Educational Plans (IEPs) took place during our research, participants pointed often to the valuable contribution they believed the CATM would make to these meetings. The ability to quantify progress and to access a “map of the journey” could be important benefits as teachers and parents worked with students to shape instructional goals for the years ahead.

Specifically, there is a need to explore the applicability of the CATM across the range of disabilities among AT users and the diversity of needs and related issues they face. Some people use multiple AT tools together to achieve their desired ends. It remains to be seen whether modifications to the CATM are required for the tool to be of value in all contexts.

While more work is needed in the areas mentioned, the CATM framework provides educators with a more practical context for discussing the effective use of AT in the classroom and its impact on student learning outcomes. The fact that the CATM incorporates the personal development of the AT user provides unique insight into the support students may need to become empowered users of their technology. This study suggests that the CATM might be used to expand how the field explores the outcomes of AT use. The CATM recognizes the individual differences among people with disabilities and presents a platform from which to explore the impact of AT in other contexts and with the broad range of users.

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Appendix I

Questions for Focus Group

First Session: Regarding the construct of the CATM tool:

- Are instructions clear? Identify specific things to clarify.
- Are the questions clear? Identify specific things to clarify.
- Are the answer choices clear? Identify specific things to clarify.
- Are there any words that need further definition? Identify specific words to clarify.
- Are there questions related to Mastery of AT that have been omitted?
- Are all of the factors appropriate? Are there questions, items included that do not belong?
- Are there factors related to Mastery of AT that have been omitted?
- Do the groupings of factors in the CATM make sense?
- Would you make any changes to the CATM level descriptions?
- Should the questions be weighted differently?
- Should the scoring system be modified?
- Should the results be presented any differently?

Second session: Regarding applications for the CATM Tool:

- Revisit questions from first session. Would you answer any of these questions differently?
- How and where might this CATM assessment be used (applied)?
- Who should administer the assessment?
- What is missing or left out of this assessment that could make it more useful (provide for greater applicability)?

Appendix II

Interview Questions for Educators who administered the CATM

1. Preliminary:
 - a. Did you get to review these questions before the interview?
 - b. What is your role/ title? (Sp. Ed Teacher, Reg. Ed Teacher, Therapist, Para, etc.)
2. What were your overall impressions?
 - a. Of the project?
 - b. Of the CATM?
3. Were our instructions for your involvement clear?
 - a. Are there any ways you might suggest for improving the process?
4. What were your experiences administering this instrument?
 - a. Did you feel that you had enough familiarity with the students you surveyed that you could complete the CATM without observing them?

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- b. If you did physically observe the students when you did CATM, what did you look for? Any observations about this process that were noteworthy?
 - c. Were there any questions on the CATM that were confusing?
 - d. Is there anything about mastery of AT that the CATM did not assess that you think should be included?
 - e. Are there any characteristics of AT Mastery in the tool that you think don't belong?
 - f. Did you find it difficult to complete the section on Personal Connection to AT? Any observations or thoughts about why that was difficult?
5. Did you encounter any difficulties when assessing students?
 - a. Did you feel qualified/ prepared to administer the CATM?
 - b. What additional training or preparation would you have liked to receive before administering the CATM?
 - c. Did any students stand out as unusual or difficult to assess using the CATM?
 - d. What about them did you find difficult to assess?
6. How would you describe the differences between administering the 2nd Survey from the first?
 - a. What changes did you observe?
 - b. In your own perspectives on AT?
 - c. What do you think might account for any changes?
7. Are there any ways you might suggest to improve this instrument?
 - a. What would you say about the ease-of-use of this tool?
 - b. Do you feel that this instrument produced an accurate report of the student's progress toward mastery of AT?
8. What are some ways you think this instrument could be used in K12?

Appendix III: Continuum of AT Mastery (CATM) Instrument

Instructions

Use the matrix/scoresheet as follows:

For each line, choose the column that best describes the individual's level for that indicator/predictor.

Date	7/12/2022
Survey Version	1.2 Other
Survey Participant	
Role of person doing assessment *	Self <input type="text"/>
What Assistive Technology is this tool measuring? *	<input type="text"/>
What is the AT being used for (what is the goal)? *	<input type="text"/>

*Required field

Section A. Experience with AT

Category	Description	Novice AT User Rarely does these things 1 point	Context Dependent AT User does these things sometimes 2 points	Transitional AT User does these things often 3 points	Power User of AT does these things almost all the time 4 points
Access To AT:	Usage, training, support for AT that is appropriate for individual	<input type="radio"/> Limited	<input type="radio"/> Occasional	<input type="radio"/> Frequent	<input type="radio"/> Always
Opportunity to Use AT:	Use AT in real world, multiple settings	<input type="radio"/> Limited	<input type="radio"/> Occasional	<input type="radio"/> Frequent	<input type="radio"/> Always
Positive Experience with AT:	Meets user needs, matches abilities, supports their interests	<input type="radio"/> Limited	<input type="radio"/> Occasional	<input type="radio"/> Frequent	<input type="radio"/> Always
Time to Experiment & Learn:	Individual develops strategies, customizes features, pushes AT to do more of what they want it to do.	<input type="radio"/> Limited	<input type="radio"/> Occasional	<input type="radio"/> Frequent	<input type="radio"/> Always

Section B. Proficiency with AT

Category	Description	Novice AT User Rarely does these things 1 point	Context Dependent AT User Does these things sometimes 2 points	Transitional AT User Does these things often 3 points	Power User of AT Does these things almost all the time 4 points
Effective Use:	Use AT to participate, do things they want to do	<input type="radio"/> Limited	<input type="radio"/> Occasional	<input type="radio"/> Frequent	<input type="radio"/> Always
Trouble Shooting:	Maintaining their AT	<input type="radio"/> Limited	<input type="radio"/> Occasional	<input type="radio"/> Frequent	<input type="radio"/> Always
Technical Skills:	Skills needed to make AT do what they want	<input type="radio"/> Limited	<input type="radio"/> Occasional	<input type="radio"/> Frequent	<input type="radio"/> Always
Problem Solving:	Using AT to solve problems in the environment	<input type="radio"/> Limited	<input type="radio"/> Occasional	<input type="radio"/> Frequent	<input type="radio"/> Always

Section C. Knowledge of AT

Category	Description	Novice AT User rarely does these things 1 point	Context Dependent AT User Does these things sometimes 2 points	Transitional AT User does these things often 3 points	Power User of AT does these things almost all the time 4 points
Functional AT Knowledge:	Familiar with personal AT. Customized approach to using features, personalized strategies for use	<input type="radio"/> Little	<input type="radio"/> Some	<input type="radio"/> A Lot	<input type="radio"/> Expert
Technical AT Knowledge:	Basic AT skills, understandings compatibility issues and technology requirements	<input type="radio"/> Little	<input type="radio"/> Some	<input type="radio"/> A Lot	<input type="radio"/> Expert
Knowledge of AT Options:	Know what AT tools exist, aware of personal strengths & weaknesses, and how AT may be able to help	<input type="radio"/> Little	<input type="radio"/> Some	<input type="radio"/> A Lot	<input type="radio"/> Expert
Expanding Knowledge of AT:	Able to get knowledge about AT: community, mentors, conferences, etc.	<input type="radio"/> Little	<input type="radio"/> Some	<input type="radio"/> A Lot	<input type="radio"/> Expert
Making Informed Choices of AT:	Able to choose AT, make decisions about their AT	<input type="radio"/> Little	<input type="radio"/> Some	<input type="radio"/> A Lot	<input type="radio"/> Expert

Section D. Personal Connection to AT

Category	Description	Novice AT User Rarely does these things 1 point	Context Dependent AT User does these things sometimes 2 points	Transitional AT User Does these things often 3 points	Power User of AT Does these things almost all the time 4 points
Self-Advocacy:	Able to describe AT needs and explain why they are important	<input type="radio"/> Little	<input type="radio"/> Some	<input type="radio"/> A Lot	<input type="radio"/> Always.
Adaptability:	Able to make adjustments to become more effective at using AT	<input type="radio"/> Little	<input type="radio"/> Some	<input type="radio"/> A Lot	<input type="radio"/> Always
Flexibility:	Able to deal with things when they go wrong or when there are difficult situations with AT	<input type="radio"/> Little	<input type="radio"/> Some	<input type="radio"/> A Lot	<input type="radio"/> Always
Persistence:	Ability to stay with an AT task rather than giving up	<input type="radio"/> Little	<input type="radio"/> Some	<input type="radio"/> A Lot	<input type="radio"/> Always
Independence:	Uses AT without assistance (Can include working independently once AT has been set up for them)	<input type="radio"/> Little	<input type="radio"/> Some	<input type="radio"/> A Lot	<input type="radio"/> Always
Motivation:	Drive to use AT comes from inside the individual	<input type="radio"/> Little	<input type="radio"/> Some	<input type="radio"/> A Lot	<input type="radio"/> Always
Proactive:	Looks ahead to foresee AT issues and plans or acts to address them	<input type="radio"/> Little	<input type="radio"/> Some	<input type="radio"/> A Lot	<input type="radio"/> Always

Submit