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Perception of Access to Supportive Technology and Inclusive ICTs: Special Education Teacher Trainees

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Abstract

Augmentative and alternative communication (AAC) technologies, characterized by universal design, are vital for supporting the functional abilities of people with disabilities, enabling communication, learning, and dignified living. While digital accessibility has seen improvements—through curriculum adaptation, inclusive teaching strategies, and personalized support—significant challenges remain. This study describes the level of knowledge about AAC technologies among university students enrolled in the Special Education degree program at the Specialized University of the Americas in Panama. A scale to measure knowledge and an instrument for incorporating these technologies were applied to a sample of 81 students. The results highlight a major challenge within the education system: training future special education teachers. A paradox was identified wherein educators express strong belief in the educational value of AAC but demonstrate limited concrete knowledge of its applications, especially for low-incidence or complex disabilities. Furthermore, unequal access to technology continues to disadvantage students without devices or reliable internet connectivity, exacerbating existing educational disparities. The findings underscore the urgent need for targeted training initiatives and policies that embed AAC competencies into teacher education curricula to advance equitable and inclusive education.

Keywords: accessibility; inclusive education; equity; augmentative and alternative communication (AAC); teacher training; sustainable education; digital divide

1. Introduction

Educational accessibility stands as a cornerstone of equitable learning opportunities in contemporary societies. Within digitalized learning environments, technology serves as both a catalyst for barrier removal and a means of fostering inclusive pedagogical spaces [1]. Schools function as dynamic ecosystems ideally positioned to respond to diverse learner needs [2], ensuring no student is excluded from developmental opportunities within their educational community [3].

The transformation toward genuinely inclusive education necessitates systemic change—moving beyond physical accommodations to create adaptable structures that honor neurodiversity and functional differences. This transformation requires educators to embrace reflective, participatory pedagogies while institutions develop flexible frameworks capable of supporting students with special educational requirements [4].

Inclusive education draws its philosophical foundation from principles of shared citizenship and educational equity. It envisions learning environments where every student's presence and participation are equally valued, thereby driving profound shifts in educational policy [5]. The

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UNESCO (2009) framework establishes crucial benchmarks for educational access and quality, particularly for populations with special needs. Recent global challenges have further highlighted inclusive education's vital role in advancing social justice, diminishing inequality, and nurturing belonging—objectives aligned with international human rights instruments including the UN Convention on the Rights of Persons with Disabilities (2006) and the Sustainable Development Goals (2015).

While inclusive methodologies demonstrate significant benefits for all learners—enhancing empathy, social cohesion, and multicultural competence [6]—implementation remains uneven across educational contexts. Persistent challenges include inadequate teacher preparation, resource limitations, and prevailing societal attitudes toward disability [7]. Technological innovations offer promising pathways through personalized learning architectures [8] and Universal Design for Learning principles, yet their potential remains partially unrealized without strategic institutional support [9].

The educational system must ensure that schools have resources that are accessible to all students. Online platforms must comply with accessibility standards, guaranteeing that all students can access content and participate in activities equitably [10]. Implementing pedagogical practices that facilitate access to technological resources is essential, such as personalized learning: adapting educational content to individual student needs by providing materials in various formats [11].

Augmentative and alternative communication (AAC) technologies encompass a range of supports for accessing information and promoting skills such as autonomy and social abilities. These technologies are vital for individuals facing communication challenges, enabling them to express feelings and participate in daily activities without speech [12,13]. They can be used temporarily or throughout a person's life [14] and range from low-tech systems (e.g., images, pictograms, gestures) to high-tech devices and software [15,16]. These resources are crucial for ensuring that all students with disabilities have the necessary tools to access quality and inclusive education [17].

A key issue affecting public education systems is the digital divide. Unequal access to technology has left behind students without devices or internet connectivity, let alone adapted or assistive technologies. Another priority is addressing accessibility challenges; while technology can enhance accessibility for some, it can also present barriers, particularly in accessing content [19]. For individuals with educational support needs, learning can be challenging, but the appropriate use of assistive technologies can resolve barriers and accelerate inclusion [20]. The pedagogical approach using technology is determined by the need to understand each student's requirements [21]. Technology fosters autonomy, active engagement, and self-directed learning, serving as a motivational factor for knowledge acquisition and providing alternative perspectives for students with special educational needs [22].

This research aimed to analyze university students' knowledge and attitudes regarding the use of AAC technologies in educational settings. These technologies play a crucial role in fostering inclusion and developing communication skills among students requiring specific support. Through an instrument designed to assess knowledge levels, willingness to implement AAC, and perceived barriers, this study seeks to identify strengths and areas for improvement. The analysis focuses on describing general trends and exploring factors such as academic training.

The study tested the following hypothesis:

H1: There is an association between the level of knowledge of augmentative and alternative communication technologies and the academic training of university students in the Special Education program.

H2: There is no association between the level of knowledge of augmentative and alternative communication technologies and the academic training of university students across different education programs.

The specific objectives were:

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SO1: To determine the degree of knowledge about augmentative and alternative technologies among students in the Special Education program.

SO1: To identify correlations between academic training and the level of knowledge about augmentative and alternative communication technologies.

2. Materials and Methods

2.1. Participants and Sampling

The study utilized a sample of 81 participants from the Special Education program at the Specialized University of the Americas in Panama. A simple random probabilistic sampling technique was employed for this finite, heterogeneous population. The sample size (n = 81) was calculated using the standard formula for known populations:

$$n = (N \times Z^2 \times p \times q) / (e^2 \times (N - 1) + Z^2 \times p \times q)$$

where:

- N = population size
- Z = standardized value for the desired confidence level (90%, Z = 1.645)
- e = permissible sampling error (5%)
- p = proportion of the population with the characteristic (0.5)
- q = 1 − p (0.5)
- The most conservative assumption (p = q = 0.5) was used to maximize the required sample size and ensure robustness under conditions of maximum variance.

2.2. Instrument

Data was collected using the *Questionnaire on Augmentative and Alternative Technologies in the Educational System* (PSIASAAC) [32], a scaled instrument designed to assess teaching professionals' perceptions regarding the use of AAC technologies. The survey, administered via Google Forms, collected sociodemographic and academic information.

The study examined two main variables: (1) Technology access, and (2) Level of knowledge about Augmentative and Alternative Technologies. The instrument's dimensions aimed to gather data on:

- Social validity
- Receptive and expressive language development
- School environment support
- Communicative function and opportunities
- Communication effectiveness
- Quality of collaboration and peer interaction
- Communicative spontaneity

The instrument was self-administered and underwent language validation by a specialist in disability and/or technology. A pilot test was conducted to make necessary adjustments and ensure the statistical validity and reliability required for the study.

2.3. Reliability Analysis

The internal consistency of the questionnaire was assessed using Cronbach's alpha coefficient, calculated with the formula:

$$\alpha = (k / (k - 1)) \times (1 - (\sum \sigma^2 yi / \sigma^2 x))$$

where:

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- α = Cronbach's alpha coefficient
- k = number of items
- $\sigma^2 yi$ = variance of the individual item scores
- $\sigma^2 x$ = total variance of the observed total test scores

2.4. Procedure

The research was conducted in three phases:

1. **Planning and Development:** Included a detailed review of the problem, formulation of objectives, methodology design, sample definition, and a systematic literature review. Ethical approval was obtained from the relevant institutional review board.
2. **Instrument Adaptation:** The selected instrument was reviewed and adapted, including linguistic and cultural adjustments. An expert panel in disability and/or technology evaluated the instrument. Scales, weighting, reliability indices, stability, and internal consistency were analyzed. A pilot test was conducted to refine the instrument.
3. **Data Collection and Analysis:** The instrument was administered, and preliminary descriptive results were obtained. Data were analyzed using statistical tests to examine the research hypotheses. Results were organized into tables and graphs for interpretation.

3. Results

3.1. Sample Profile

The cohort consisted of 45 female participants (55.6%) and 36 male participants (44.4%). The age distribution revealed a concentration within young adulthood: 23–26 years (n = 39, 48.1%), 27–29 years (n = 25, 30.9%), and 18–22 years (n = 17, 21.0%). Regarding educational status, the vast majority (77.8%, n = 63) were full-time students, 12.3% (n = 10) were unemployed, and 7.4% (n = 6) were scholarship recipients. The sample was thus characterized as primarily young, female, full-time students.

Table 1. Sociodemographic characteristics of the participants (n = 81).

Characteristic	Category	n	%
Gender	Female	45	55.6
	Male	36	44.4
Age Group (years)	18–22	17	21.0
	23–26	39	48.1
	27–29	25	30.9
Educational Status	Full-time student	63	77.8
	Unemployed	10	12.3
	Scholarship recipient	6	7.4

3.2. Knowledge and Perceptions of AAC Technologies

Perceptions of AAC technologies—particularly their perceived efficacy in enhancing classroom participation (P2_REC), functioning as educational response tools (P3_REC), and supporting student autonomy (P4_REC)—received consistently high ratings (means ≈ 4.0–4.2 on a 5-point Likert scale), indicating strong participant confidence in their educational utility.

In contrast, knowledge scores regarding disability-specific technologies (e.g., for intellectual, motor, visual, or auditory disabilities) were markedly lower (means ≈ 2.5–3.0). The lowest knowledge levels were reported in domains involving autism (P6_REC) and voice disorders (P10_REC). Higher standard deviations observed in knowledge items reflect substantial inter-individual variability, suggesting disparate prior training or exposure among respondents.

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This indicates a paradox: while educators express strong *belief* in AAC's educational value, they demonstrate limited concrete *knowledge* of technological applications—especially for low-incidence or complex disabilities.

Table 2. Descriptive statistics for perception and knowledge items related to AAC technologies.

Item Code	Domain	Mean	SD
P2_REC	Enhances classroom participation	4.20	0.81
P3_REC	Functions as educational response tool	4.15	0.78
P4_REC	Supports student autonomy	4.02	0.85
P5_REC	Knowledge: Intellectual disability tech	2.87	1.12
P6_REC	Knowledge: Autism tech	2.51	1.24
P10_REC	Knowledge: Voice disorder tech	2.60	1.18

3.3. Attitudes Toward AAC Adoption

Respondents expressed strong willingness to engage with AAC technologies (P11_REC–P14_REC; means > 4.0), reflecting robust openness to pedagogical innovation (P14_REC: M = 4.55). Perceived competence items (P15_REC–P16_REC) also yielded high mean scores (≈4.0), though greater variability in self-rated teaching competence (P15_REC) implies emerging training needs. Collaboration and leadership measures (P17_REC–P19_REC) revealed moderate agreement (M = 3.5–3.9) with elevated variability, indicating uneven confidence in guiding peers or driving institutional change.

Participants prioritized students' cognitive aspects as fundamental when working with AAC, while motor skills were perceived as less relevant. Variables such as person-centered planning and accessibility received the highest mean scores. Regarding barriers, lack of training and financial resources were the most frequently cited obstacles.

4. Discussion

The results support the hypothesis (H_1) that an association exists between the level of knowledge of AAC technologies and academic training, specifically within the Special Education program. This addresses SO_1, revealing that the level of knowledge among the evaluated students is limited and variable. It also addresses SO_2, showing that perceptions of AAC are overall favorable, recognizing these technologies as tools that promote autonomy and accessibility. A high willingness towards innovation and training was noted, though perceived competence in implementation and leadership was uneven.

These findings paint a nuanced picture of the readiness to implement AAC technologies. The potential of these tools for fostering inclusive education is widely acknowledged yet hampered by a critical lack of technical training and equitable access. The uneven distribution of technological resources threatens to widen existing educational disparities.

The discussion extends to the role of technology as a tool for freedom and autonomy for people with disabilities [23,25]. For individuals with visual impairments, technologies like screen readers, magnifiers, and braille interfaces are indispensable [25,33]. For the deaf and hard of hearing, FM systems and AI-powered real-time captioning break down communication barriers and enrich learning through visual channels [27]. For individuals with motor or intellectual disabilities, and particularly for those with Autism Spectrum Disorder (ASD), a range of technologies—from ergonomic hardware and scheduling software to evidence-based strategies like PECS and ABA—are essential for support, learning, and enhancing self-determination [35–38].

However, possessing the tools is insufficient. Knowing how to use them, creating supportive environments, and implementing policies that ensure access for all are essential to unleash their true power for inclusion. This study highlights a significant research void within higher education teacher

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training regarding the practical application of AAC technologies, pointing to a pressing demand for policies that explicitly weave AAC training into the fabric of teacher education.

5. Conclusions

This study concludes that the level of knowledge about AAC technology among the evaluated university students in Special Education is limited and exhibits significant variations. This finding supports the hypothesis that differences in knowledge are associated with academic training. Participants recognized the value of AAC technologies for promoting autonomy and accessibility and showed a high willingness to engage in innovation and training. However, perceived competence in implementation and leadership was not uniform.

The major challenges identified are the critical lack of technical training and the unequal access to technological resources, which risk exacerbating educational inequalities. Special Education programs show the most robust correlation between training and practical knowledge, underscoring the need for a more deeply embedded, pedagogically sound approach to teaching disability-specific technology integration.

AAC technologies are not mere accessories but vital conduits for accessing curricula, developing communication skills, and enabling meaningful participation. Therefore, there is an urgent need for:

1. **Policy Development:** Implementing policies that mandate and support AAC training within teacher education curricula.
2. **Curriculum Integration:** Embedding hands-on, practical AAC training into special education degree programs.
3. **Resource Allocation:** Ensuring equitable access to both high- and low-tech AAC tools for all students and teacher trainees.
4. **Future Research:** Conducting further studies with larger, more diverse samples (including experienced practitioners) to generalize findings and develop effective, contextually relevant training models.

By addressing these needs, the education system can move towards a more sustainable and equitable model where technology truly serves as a bridge to inclusion for all learners.

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