

**DZIAŁ TEMATYCZNY:**  
**Technologie wspomagające uczniów z niepełnosprawnościami**

Forum Pedagogiczne  
10 (2020) 2

Submitted: 17.04.2020

Accepted: 24.06.2020

DOI: 10.21697/fp.2020.2.02

DAVE L. EDYBURN\*

*University of Wisconsin, Milwaukee, USA*

**INCLUSIVE TECHNOLOGIES:  
ASSISTIVE TECHNOLOGY FOR ALL LEARNERS**

**Abstract:** Education is the investment a society makes in each new generation of children and youth. Given a future that may not look like the past, how do we re-assess the purpose of education? In the words of Aoun (2017), how do we robot-proof our curriculum in order to prepare students for a future where humans and robots will compete for jobs? The purpose of this article is to describe the concept of assistive technology and explore its transformation to technology-enhanced performance as a means of supporting the educational productivity of all learners. Examples are provided to help diverse learners in every classroom as they seek to meet high academic standards relative to executive functioning, reading, writing, and solving mathematical problems.

**Keywords:** assistive technology; inclusive technology.

Education is the investment a society makes in each new generation of children and youth. We currently live in a period of transition from economies that were based on manufacturing to economies based on information. Economists have come to view educational attainment as an important variable for assessing the economic vitality of countries around the world (Lutz, Butz, & Samir, 2017). In a global economy, a country's educational system is often viewed as the raw materials of economic growth in the Information Age; much the same way that agriculture, lumber, and minerals were the raw materials of the 1800s industrial society.

When education is viewed as an engine of economic development, policy makers tend to become actively engaged in issues of educational reform. That is, there is considerable attention devoted to raising educational standards, measuring student competencies and outcomes, as well as maximizing the return on investments in innovative learning technologies (Edyburn, 2013). However, there is no playbook for

---

\* Ph.D. Dave L. Edyburn, School of Education, University of Wisconsin, Milwaukee, USA; e-mail: edyburn@uwm.edu.

policymakers and educational leaders regarding the forecasts of pending economic disruption.

For example, how will quality of life be affected if the predications associated with climate change are actualized (Haines & Ebi, 2019)? Or, what happens to the function of education if predications about automation and disruption of the workplace come to fruition (i.e., self-driving cars become ubiquitous; robots displace workers; Aoun, 2017; Frischmann & Selinger, 2018)? Or, what happens to a society when demographic patterns characterized by fewer workers and more retirees impact the societal safety net (Grawe, 2018)?

Given a future that may not look like the past, how do we re-assess the purpose of education? In the words of Aoun (2017), how do we robot-proof our curriculum in order to prepare students for a future where humans and robots will compete for jobs? The purpose of this article is to describe the concept of assistive technology and explore its transformation to technology-enhanced performance as a means of supporting the educational productivity of all learners.

### **Assistive technology (traditional)**

The definition of assistive technology (AT) is often traced back to the 1988 United States law known as the Tech Act (Public Law 10-407, The Technology-Related Assistance for Individuals with Disabilities Act). The World Health Organization (2020) describes AT as follows:

- Assistive technology is an umbrella term covering the systems and services related to the delivery of assistive products and services.
- Assistive products maintain or improve an individual's functioning and independence, thereby promoting their well-being.
- Assistive technology enables people to live healthy, productive, independent, and dignified lives, and to participate in education, the labour market and civic life. Assistive technology reduces the need for formal health and support services, long-term care and the work of caregivers. Without assistive technology, people are often excluded, isolated, and locked into poverty, thereby increasing the impact of disease and disability on a person, their family, and society.

Historically, assistive technology has taken various forms and is most widely associated with applications that help individuals who are blind, visually impaired, deaf, hard of hearing, or physically impaired. These disabilities impair sensory processing or mobility and are often considered low incidence; impacting only a small percentage of the population. However, with the 1997 reauthorization of the Individuals with Disabilities Education Act (Public Law 105-17), educators were mandated to *consider* assistive technology when they prepared each student's individual education plan (IEP). Intentionally or not, this legal requirement

seemingly expanded the application of assistive technology to all students with disabilities (Edyburn, 2003).

The current conceptualization of assistive technology is problematic for several reasons. First, the function of a technology does not change based on who uses it. For example, if I have a disability and use the software program *Inspiration* ([www.inspiration.com](http://www.inspiration.com)), a concept mapping program to support pre-writing, and you use the same program but do not have a disability, then the software is considered *assistive technology* for me (because I have a disability) and considered *instructional technology* for you (because you need/want it to make writing easier). This definitional problem of assistive technology is troublesome as it does not offer clarity around interventions because we cannot readily discern who has a cognitive processing disability and who is developmentally operating as a novice learner. How can the same product be called assistive technology for one student but not assistive technology for another student?

Second, the definitions of assistive technology devices and services neglect to identify and operationalize the missing leg of a three-legged stool. That is, outcome. As is, there is nothing in the definitions that speak to the benefits and outcomes that should be achieved from the use of assistive technology. This is a significant problem for many school administrators who are presented with “wish lists” of technologies from parents, educators, advocates, and others who “hope” technology will help a child. Without a legal expectation that assistive technology use will produce measurable benefits, the profession has neglected the establishment of a scientific evidence base that answers the question: For whom, and under what conditions, does assistive technology enhance performance?

Finally, the field of assistive technology has been under assault from the development of universal design for learning (UDL). While UDL was never intended to replace assistive technology, there is general confusion about how to provide technology-based interventions for students that struggle. The UDL notion that tools can be given to all students is a powerful service delivery model. Yet, UDL suffers the same definitional problem as assistive technology in that it does not have any measurable outcomes associated with its use (Edyburn, 2010).

### **Reconceptualizing assistive technology as technology-enhanced performance**

Current assistive technology service delivery systems have over-emphasized tasks associated with selection of assistive technology and devoted little effort to enhanced functional outcome. Morphing the concept of assistive technology into a new updated form allows a subtle shift in emphasis. That is, it matters little what form the technology comes in (i.e., low-tech, high-tech), rather what matters is that appropriate tools have been acquired and used to enhance functional performance. Refocusing our attention away from the stuff of assistive technology to the results, will signal a developmental maturation of the profession. Further, the concept of

technology-enhanced performance eliminates the artificial boundaries between technology use by individuals with disabilities and their non-handicapped peers. In every classroom, there are a considerable number of students whose performance fails to meet the expected standards. As a result, why are students without disabilities denied the opportunity to use appropriate technologies that could enhance their performance? Isn't everyone entitled to the tools they need to be successful?

### **Recognizing academic diversity**

Let's assume it is July and you have yet to receive a class list of the students who will be in your classes this academic year. Based on your experience, should you expect to meet students who...

- ...are unable to read at grade level?
- ...do not like to write?
- ...have difficulty remembering things?

While these challenges are often characteristic of individuals with disabilities, they are often developmental and commonly found in all classrooms. As a result, why not provide accommodations in advance? How can we think about learning in order to embed technology supports before students fail?

One metaphor for thinking about the ways in which technology can be used to enhance academic performance is to consider the fairy tale Goldilocks where a young girl enters the home of three bears. As she explores their porridge, chairs, and beds, in each situation she is seeking what is "just right." Thinking about education in a global context requires educators to think about how they need to maximize educational opportunities and benefits. To do so, requires that we not only learn to recognize academic diversity but also learn how to respond in ways that ensure that students. If we expect students to sample from a buffet of inclusive technologies to ensure that they have the supports they need to be successful in achieving high academic standards within the rigid time constraints of the curriculum.

Classrooms that provide inclusive technologies offer tools and resources that will support diverse learners before they fail. Less attention is devoted to the *how* of performance because of the intense focus on achieving the academic outcomes.

### **Responding to academic diversity**

To assist educators in the instructional planning process it may be helpful if the profession focused on answering three kinds of questions:

- What types of challenges will diverse students typically encounter in trying to achieve in meeting grade level expectations?
- What types of instructional strategies facilitate teaching and learning?

- What types of inclusive technologies provide a practical means of implementing each instructional strategy?

The template illustrated in Table 1 can be used by teachers to create technology consideration menus. If we pooled our collective insight, we could produce resource guides that answer the three questions above and provide valuable guidance for teachers seeking to help diverse learners succeed. The left column describes the instructional challenge that diverse learners struggle to achieve. The middle column summarizes the various instructional strategies that might be used. The right column lifts specific inclusive technologies that could be provided to all students within the classroom or given to a specific student as needed.

Table 1: Template for Creating Technology Consideration Menus

Instructional Challenge	Instructional Strategies	Inclusive Technologies

Source: own elaboration.

In the sections that follow, examples of how this planning template could be used to locate appropriate instructional and assistive technologies to help diverse learners in every classroom will be provided to help students as they seek to meet high academic standards relative to executive functioning, reading, writing, and solving mathematical problems.

### Executive functioning

Executive functioning (EF) is an important meta-cognitive skill. Essentially it is the dynamic process of self-regulation regarding what one should do, what resources are needed, and how priorities may change while trying to achieve a goal. This skill is learned over time but is particularly problematic for students with impulse control issues, working memory deficits, organizational strategies, lack of persistence, and/or self-control (see Table 2). Many teachers will model these processes by using a think-aloud model since we cannot see how each other thinks about solving a problem. Some teachers will provide checklists to students so that they can observe the progress they make on a sequence of tasks.

Table 2: Executive Functioning

<b>Instructional Challenge</b>	<b>Instructional Strategies</b>	<b>Inclusive Technologies</b>
Difficulty in prioritizing tasks based on changing situations or resources and managing time	Provide instruction on developmentally appropriate strategies to develop EF	Enhancing and Practicing Executive Function Skills with Children from Infancy to Adolescence <a href="https://developingchild.harvard.edu/resources/activities-guide-enhancing-and-practicing-executive-function-skills-with-children-from-infancy-to-adolescence/">https://developingchild.harvard.edu/resources/activities-guide-enhancing-and-practicing-executive-function-skills-with-children-from-infancy-to-adolescence/</a>
		E-Book: Executive Function 101 <a href="https://www.understood.org/en/learning-attention-issues/child-learning-disabilities/executive-functioning-issues/ebook-executive-function-101">https://www.understood.org/en/learning-attention-issues/child-learning-disabilities/executive-functioning-issues/ebook-executive-function-101</a>
	Teach students how to listen to a lecture and take notes on the most important points	Cornell Note Taking Method <a href="https://www.wikihow.com/Take-Cornell-Notes">https://www.wikihow.com/Take-Cornell-Notes</a>
	Create an assignment calculator to embed resources to support each subtask and help students manage their time on a research and writing project	Assignment Calculator <a href="https://www.lib.umn.edu/ac">https://www.lib.umn.edu/ac</a>
Difficulty managing homework and other out-of-class assignments and deadlines	Integrate todo list into Google Classroom tools	Google Tasks <a href="https://support.google.com/a/users/answer/9308887#!/">https://support.google.com/a/users/answer/9308887#!/</a>
	Manage one's todo list by storing it in the cloud	Remember the Milk <a href="https://rememberthemilk.com">https://rememberthemilk.com</a>
		Todoist <a href="https://todoist.com">https://todoist.com</a>
		Evernote <a href="http://evernote.com">http://evernote.com</a>
		Things <a href="https://culturedcode.com/things/">https://culturedcode.com/things/</a>
	Use a todo list system with behavioral supports	Habitica <a href="https://habitica.com/static/home">https://habitica.com/static/home</a>
	Emphasize visual planning	Quire <a href="https://quire.io">https://quire.io</a>
		Notezilla <a href="https://conceptworld.com&gt;Notezilla">https://conceptworld.com/Notezilla</a>
	Track time spent on each todo item	ToDoList <a href="http://abstractspoon.com/wiki/doku.php?id=start">http://abstractspoon.com/wiki/doku.php?id=start</a>

Source: own elaboration.

### Reading

The span of reading levels in any given classroom can be considerable. As a result, how might a teacher provide access to appropriate reading materials for students? Table 3 summarizes a variety of instructional challenges, strategies, and inclusive technologies that can be helpful in supporting diverse readers.

Table 3: Reading

Instructional Challenge	Instructional Strategies	Inclusive Technologies
Student needs to practice specific pre-reading skills.	Access free online early literacy curriculum in four languages.	The LiteracyCenter.Net <a href="http://literacycenter.net">http://literacycenter.net</a>
Student needs to find appropriate materials to read.	Access free online leveled books.	StarFall <a href="http://starfall.com">http://starfall.com</a>
		Reading AtoZ <a href="http://readinga-z.com">http://readinga-z.com</a>
	Access current events written at multiple Lexile Levels	Newsela <a href="http://newsela.com">http://newsela.com</a>
		Tween Tribune <a href="http://tweentribune.com">http://tweentribune.com</a>
	Locate books that are written at available in multiple levels.	Start to Finish Books <a href="http://donjohnston.com">http://donjohnston.com</a>
	Read ebooks written by children.	Tar Heel Reader <a href="http://tarheelreader.org">http://tarheelreader.org</a>
	Provide multimedia books.	BookBox <a href="http://bookbox.com">http://bookbox.com</a>
		Storyline Online <a href="http://storylineonline.net">http://storylineonline.net</a>
Student needs opportunities to connect reading and writing.	Create reading materials that include picture supports.	PictureIt, PixWriter <a href="https://attainmentcompany.com/technology/slater-suncastle-products">https://attainmentcompany.com/technology/slater-suncastle-products</a>
Student is unable to read due to an inability to see or understand text.	Provide the information in an audio format.	Audible.com <a href="http://audible.com">http://audible.com</a>
		Bookshare <a href="https://bookshare.org">https://bookshare.org</a>
	Use a word processor that features speech; Copy and paste text and have student listen to the information.	Read&Write <a href="http://texthelp.com">http://texthelp.com</a>
		Write OutLoud <a href="http://donjohnston.com">http://donjohnston.com</a>
		WordQ <a href="http://wordq.com">http://wordq.com</a>

Source: own elaboration.

### Writing

There are many places in the writing process that students can get stuck: Developing an idea about what to write, conducting research on the topic, creating a first draft, revising their work, and more. Table 4 summarizes a number of common challenges student writers may face and offers strategies and tools to support the writing process.

Table 4: Writing

Instructional Challenge	Instructional Strategies	Inclusive Technologies
Developing the writing mindset through daily writing exercises.	Provides a single word prompt; you have 60 seconds to write about it.	Oneword <a href="https://oneword.com/">https://oneword.com/</a>
	A free online digital journal. Daily journaling is a great way to develop writing skills.	Penzu <a href="http://penzu.com/">http://penzu.com/</a>
	Sends a weekly writing challenge to write a response that is less than 100 words.	100 Word Challenge <a href="http://100wc.net/">http://100wc.net/</a>
Students sometime have a difficult time identifying an appropriate topic on which to write a research report.	Topics and resources for elementary and middle school students.	42explore <a href="http://42explore.com">http://42explore.com</a>
	This web site summarizes key issues associated with many contemporary topics to help researchers select an appropriate angle to research before reading tons of information.	CQ Researcher Hot Topics <a href="http://library.cqpress.com/cqresearcher/">http://library.cqpress.com/cqresearcher/</a>
Students are unable to read the information they have gathered to obtain necessary background information for their report.	Provide text to speech tools to allow students to listen to the text that they cannot read independently.	Natural Reader (Windows & Macintosh software) <a href="http://natural-readers.com">http://natural-readers.com</a>
	Provide access to tools that help students summarize what they have read in order to ensure they understand the key ideas.	Text Compactor <a href="http://textcompactor.com">http://textcompactor.com</a>

<b>Instructional Challenge</b>	<b>Instructional Strategies</b>	<b>Inclusive Technologies</b>
Students struggle to plan the focus of their writing because they do not understand their topic or the subtopics that they will include.	Provide students with digital writing planning tools.	Cmap <a href="http://cmap.ihmc.us/">http://cmap.ihmc.us/</a>
		Draftbuilder <a href="http://donjohnston.com">http://donjohnston.com</a>
		Inspiration <a href="http://inspiration.com">http://inspiration.com</a>
		Kidspiration <a href="http://inspiration.com">http://inspiration.com</a>
Students have a difficult time learning how to format reference citations properly and how to correct cite with source within the text of a document.	Teach students how to access and use one of the following tools that have been designed to help writers effectively cite sources using any of the population citation formats.	Citation Machine <a href="http://citation-machine.net/">http://citation-machine.net/</a>
		NoodleBib <a href="http://noodletools.com/">http://noodletools.com/</a>
		Easy Bib <a href="http://easybib.com/">http://easybib.com/</a>

Source: own elaboration.

### Mathematical problem solving

Some students struggle with the conceptual foundations of math while other students get tripped in the calculations. A developmental delay in the later often interferes with the acquisition of higher-level mathematics. Table 5 highlights a number of instructional challenges, strategies, and inclusive technologies that could be used to support diverse learners.

Table 5: Math

<b>Instructional Challenge</b>	<b>Instructional Strategies</b>	<b>Inclusive Technologies</b>
Students struggle to grasp the meaning of numbers, magnitude, and basic operations.	Provide early learning math activities involving number recognition, learning to count, and simple problems that provide application of these skills.	Literacy Center Education Network <a href="http://literacycenter.net/lessonview_en.php">http://literacycenter.net/lessonview_en.php</a>
		Early Childhood Education – Math Activities <a href="https://thinkport.org/early-childhood-math.html">https://thinkport.org/early-childhood-math.html</a>

Instructional Challenge	Instructional Strategies	Inclusive Technologies
		Math Games <a href="https://pbs.org/parents/search/ages-all/topics-all/shows-all/types-all/keyword-math+games">https://pbs.org/parents/search/ages-all/topics-all/shows-all/types-all/keyword-math+games</a>
Students struggle with the conceptual understanding of math processes	Provide students with access to virtual manipulatives to explore the underlying concepts associated with mathematical problems	Visual Fractions <a href="http://visualfractions.com/">http://visualfractions.com/</a>
		National Library of Virtual Manipulatives <a href="http://nlvm.usu.edu/en/nav/vlibrary.html">http://nlvm.usu.edu/en/nav/vlibrary.html</a>
		Conceptumath <a href="http://conceptuamath.com/">http://conceptuamath.com/</a>
		CalculatorNation <a href="http://calculationnation.nctm.org/Games/AboutCalculationNation.aspx">http://calculationnation.nctm.org/Games/AboutCalculationNation.aspx</a>
Students need to learn how to solve a new type of math problem.	Provide interactive practice problem sets that use algorithms to analyze performance and errors. These types of tools serve to build fluency and automaticity in solving a particular type of math problem.	BrainStorm <a href="http://stormthetest.com/math/">http://stormthetest.com/math/</a>
		eMath <a href="http://myemath.com/">http://myemath.com/</a>
		Math-Whizz <a href="http://whizz.us/">http://whizz.us/</a>
		IXL <a href="http://ixl.com/">http://ixl.com/</a>
		Illuminations <a href="http://illuminations.nctm.org/ActivitySearch.aspx">http://illuminations.nctm.org/ActivitySearch.aspx</a>
Students struggle with to how to solve a specific math problem.	Provide access to online math instructional resources.	WebMath <a href="http://www.webmath.com">http://www.webmath.com</a>
		Kahn Academy <a href="http://khanacademy.org/">http://khanacademy.org/</a>
		Math Forum <a href="http://mathforum.org/">http://mathforum.org/</a>
Students are unable to complete calculations mentally.	Provide access a calculator or to free online calculators.	Google Calculator <a href="http://www.google.com/help/features.html">http://www.google.com/help/features.html</a>
		Wolfram Alpha <a href="http://wolframalpha.com/">http://wolframalpha.com/</a>
		Martindale's Calculators On-line Center <a href="http://martindalecenter.com/Calculators2.html">http://martindalecenter.com/Calculators2.html</a>

Source: own elaboration.

### Concluding thoughts

Diverse students are found in every classroom. Yet few teachers have been prepared to think about the challenges students will encounter and the ways in which technology supports can be embedded within the curriculum to reduce or minimize the impact of a disability and ensure that all students can access, engage, and benefit from instruction. Opportunities to rethink the role of assistive technology to meet a county's needs for education to serve as an economic engine will have significant impact on economic vitality in a global economy. Consideration of the function that all technologies service to enhance performance provides an opportunity to rethink the role of assistive technology in inclusive environments. Exploring ways to harness the value of technology to augment human performance will be a critical feature of the future of education where citizens and robots either compete or work collaboratively.

### References

- Aoun, J.E. (2017). *Robot-proof: higher education in the age of artificial intelligence*. Cambridge, MA: MIT Press.
- Edyburn, D.L. (2013). Critical issues in advancing the special education technology evidence-base. *Exceptional Children*, 80(1), 7–24.
- Edyburn, D.L. (2010). Would you recognize universal design for learning if you saw it? Ten propositions for new directions for the second decade of UDL. *Learning Disability Quarterly*, 33(1), 33–41.
- Edyburn, D.L. (2003). Rethinking assistive technology. *Special Education Technology Practice*, 5(4), 16–22.
- Frischmann, B., & Selinger, E. (2018). *Re-engineering humanity*. NY: Cambridge University Press.
- Grawe, N.D. (2018). *Demographics and the demand for higher education*. Baltimore, MD: Johns Hopkins University Press.
- Haines, A., & Ebi, K. (2019). The imperative for climate action to protect health. *New England Journal of Medicine*, 380(3), 263–273. <https://www.nejm.org/doi/full/10.1056/NEJMr1807873>
- Lutz, W., Butz, W.P., & Samir, K.E. (Eds.) (2017). *World population and human capital in the twenty-first century: An overview*. London: Oxford University Press.
- Public Law 100-407. (1988). *Technology-Related Assistance for Individuals with Disabilities Act*.
- Public Law 105-17. (1997). *Individuals with Disabilities Education Act Amendments of 1997*.
- World Health Organization. (2020, May 18). Assistive technology. Retrieved from <https://www.who.int/news-room/fact-sheets/detail/assistive-technology>.

## TECHNOLOGIE WŁĄCZAJĄCE – TECHNOLOGIE WSPOMAGAJĄCE DLA WSZYSTKICH UCZĄCYCH SIĘ

**Streszczenie:** Edukacja to inwestycja, którą czyni społeczeństwo w każde nowe pokolenie dzieci i młodzieży. Biorąc pod uwagę przyszłość, która może nie wyglądać jak przeszłość, jak możemy ocenić cel edukacji? Mówiąc słowami Aoun (2017), chodzi o odpowiedź na pytanie: jak opracować program nauczania przygotowujący uczniów do funkcjonowania w przyszłości, w której ludzie i roboty będą wykonywać pracę? Celem tego artykułu jest opisanie koncepcji technologii wspomagającej i prześledzenie jej transformacji w stronę zwiększania skuteczności uczenia się, wspomaganego przez technologię jako sposobu wspierania sukcesu edukacyjnego wszystkich uczniów. Przedstawione propozycje odnoszą się do uczniów we wszystkich klasach i mają za zadanie wspieranie ich w sprostaniu wysokim standardom związanym z czytaniem, pisanem i rozwiązywaniem problemów matematycznych.

**Słowa kluczowe:** technologia wspomagająca; technologia włączająca.