

Personalized and Blended Learning

Micah Swartz

Blended Learning

Personalized Learning

Personalized and blended learning are approaches to learning that provide tailored educational experiences and often utilize technology. These approaches developed from a need to provide high-quality, individualized learning that could meet the unique needs of each student, and they provide flexibility and frequently include students' voices in the learning process. Pressey and Skinner, two pioneers of personalized learning, developed devices that aimed at improving learning by offering physical devices students could individually interact with. While blended learning was not formally mentioned until the late 1990s, much of what was called personalized learning has become blended learning. Advancements in the World Wide Web spurred the development of learning management software and self-directed learning apps, the latter finding widespread use in K-12 education since 2010 or so. The continual development of technology leaves room for new meanings of personalized and blended learning.

It's no secret that students are growing up and learning in a technology-saturated society, with technology infused into many aspects of life including education. In an effort to combat student engagement and motivation issues, address personalized learning trajectories, and allow for a more dynamic, responsive, and culturally relevant way of learning, educational technologies have been designed and developed (J-Pal, 2019; Patrick et al., 2013). At the forefront of this advancement comes personalized learning (PL) and blended learning (BL), education programs that have seen widespread use across America and the world (Barbour, 2018; Brass & Lynch, 2020; J-Pal, 2019; Pane et al., 2015; Schwirzke et al., 2018).

In this chapter, I will address the origins of PL by analyzing literature and research for ways PL has been defined. Next, I will delve into the beginnings of BL, examining existing literature and research to explore the various definitions and conceptualizations of BL. Before examining PL or BL, I will start by giving a brief overview of educational technology. Figure 1 provides a general timeline of the development of educational technology that illustrates an overview of significant achievements and their time points.

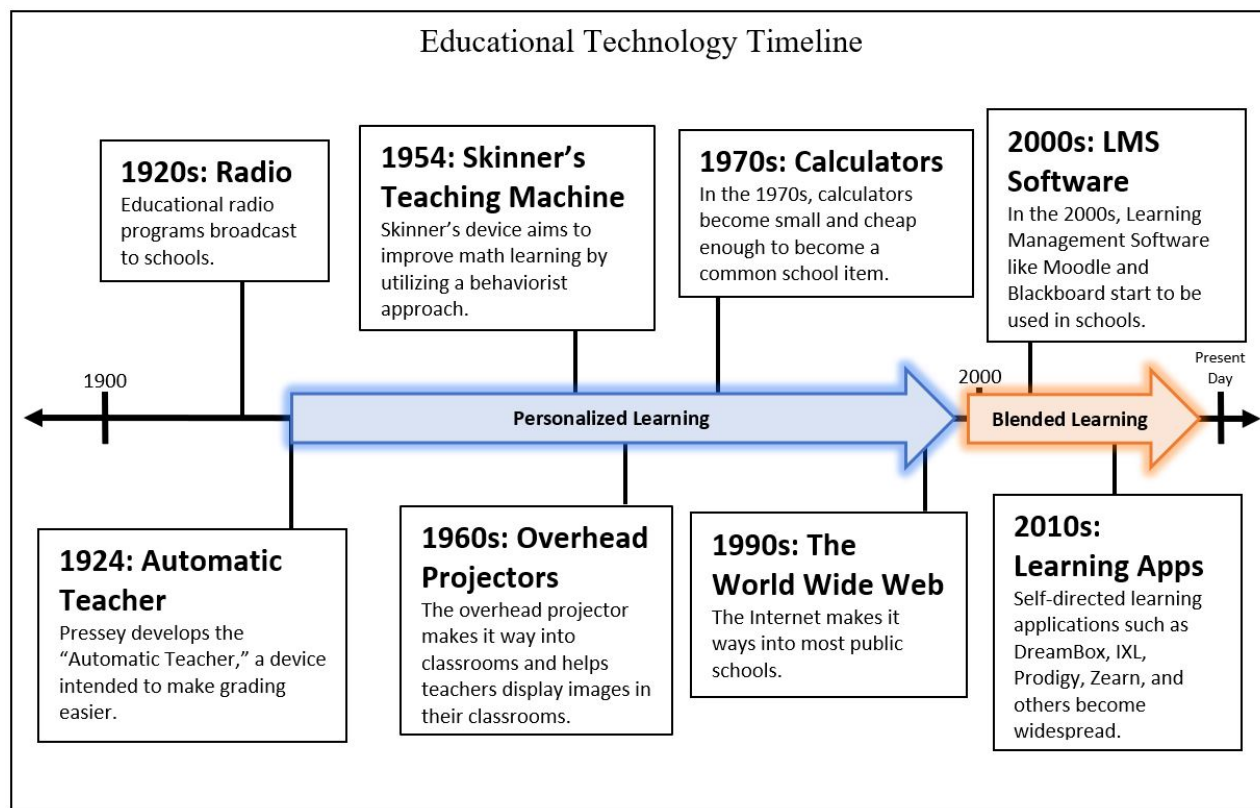
An Overview of Educational Technology

In the 1920s, educational radio programs began to be listened to in schools (Halper, 2021). Tufts University began to utilize a local radio station to broadcast lectures and make knowledge accessible to all. Other school districts and universities began producing educational broadcasts while some were uninterested. Midway through the 1920s, Pressey developed the Automatic Teacher, a device that ended as a flop (Pressey, 1926, 1963). Later, Skinner's teaching machine made a wave as it promised to offer more individualized learning and challenge students based on their

abilities (Skinner, 1958). Overhead projectors and scientific calculators were two notable technologies that had a big impact on the way teachers and students interacted and learned (Hamrick, 1996; Zimmerman et al., 2018).

Figure 1

Educational Technology Timeline



The rise of the Internet, or the World Wide Web, gave way to the development of Learning Management Systems like Moodle, Canvas, and Blackboard which profoundly changed how teachers teach and manage their students (Coates et al., 2005). As the Internet developed and its capabilities expanded, new technology and learning apps such as DreamBox, Zearn, Prodigy, and IXL became widely utilized with over 14 million students using IXL worldwide (IXL, n.d.), one in four elementary students in the U.S. using Zearn (Zearn, n.d.), and six million students in the U.S. engaging with DreamBox (DreamBox Learning, 2022). The future of educational technology continues to expand as the needs of students, teachers, and administrators change and develop.

Figure 1 also shows the timeline of personalized learning (PL) and blended learning (BL). PL started in 1924 with the Automatic Teacher and has continued to the present day. BL was first formally mentioned in the late 1990s, but much of what was called PL became BL. PL and BL are not mutually exclusive terms with the definitions of these two terms overlapping. This will be unpacked in the next two sections.

A Concise History of PL

Personalized learning (PL) and blended learning (BL) were developed from a need to provide high-quality, individualized learning that could meet the unique needs of each student (Alammary et al., 2014; Watters, 2023). In the past few decades as educational technology has developed, PL, BL, e-learning, online learning, and other names have been used synonymously (Singh & Thurman, 2019) when in fact, these terms mean different things (Graham et al., 2013). For the sake of this chapter, I will focus on PL and BL as these learning programs are two prominent technology programs in education (Barbour, 2018; Brass & Lynch, 2020; J-Pal, 2019; Pane et al., 2015; Schwirzke et al., 2018).

One of the earliest mentions of PL or BL came in the 1920s when Pressey developed what he called the Automatic Teacher (Pressey, 1926; Watters, 2023). In her book reviewing the history of PL devices, Watters describes Pressey's development of the Automatic Teacher, a device that would allow teachers to quickly grade students' exam answers. Essentially the Automatic Teacher was a testing device that kept a tally of the number of correct answers. For instance, a student would sit down next to the Automatic Teacher and on a window of the device, a question would read, "All squares are rectangles: (1) True, (2) False." The student would then hit the number corresponding to the answer they believe to be a true and another question would be presented in the window of the device. The Automatic Teacher would keep track of the number of correct questions and give that total at the end of the exam. While Pressey believed the Automatic Teacher could save schools on labor costs by decreasing the time needed to grade exams, the device proved to be too expensive for schools and full of complications.

A few decades later, Skinner created the teaching machine, a machine that utilized a behaviorist approach to learning. The device came out of an experience that Skinner had when visiting his daughter's private school in 1953. After seeing some students wriggle with boredom after completing their assigned problem while other students sat with frustration after getting stuck, Skinner decided to build a device that would offer individualized learning that could be controlled by the student. During his visit to the classroom, Skinner noticed "the students were all forced to proceed at the same pace through the lesson, regardless of their level of ability or comprehension" (Watters, 2023, p. 20). The teaching machine was invented to help students learn by reinforcement and repeated behavior management. Ultimately, the PL offered by the teaching machine was short-lived as the 1960s brought a wave of thinking called New Math which took a cognitive science approach to learning. This theory of learning went directly against Skinner's behaviorist belief which he used in developing his teaching machine.

One of the biggest worries from K-12 teachers during the emergence of PL, seen throughout Pressey and Skinner's development of PL devices, was that these teaching devices would be used to replace teachers or justify increased class sizes (Brass & Lynch, 2020). Educators and others also pointed out that the teaching machines did not teach students, rather, the devices were only able to help students with rote learning, not "real learning" (Pressey, 1963). Pressey acknowledged that "doubts have been raised as to whether human learning of meaningful material" could take place with PL devices such as the teaching machine (Pressey, 1963, pp. 2-3).

These primitive devices, the Automatic Teacher and the teaching device, soon led to more advanced technology and a new understanding of PL as cognitivism began to replace the widely adopted theory of learning of behaviorism (Brass & Lynch, 2020). While most of the PL technologies in the 20th century ended as blunders, the 21st century brought a new wave of collaborations between education agencies, businesses, government interests, and philanthropic organizations (Ball, 2012). Education agencies (e.g., Texas Education Agency, Ohio Department of Education) have taken an interest in developing PL and BL programs while big businesses such as Facebook and Google have also played a role in funding and/or developing PL and BL programs (Brass & Lynch, 2020). Additionally, philanthropic organizations like the Bill and Melinda Gates Foundation and the Chan Zuckerberg Initiative have supported educational technology companies focused on developing PL programs and software (Pane et al., 2015).

Personalized learning, or PL, is a pervasive term that has different meanings which vary based on the product it is representing and the organization or administration defining it (Shemshack & Spector, 2020). In 2013, Patrick et al. propose a working definition of PL:

Personalized learning is tailoring learning for each student's strengths, needs and interests — including enabling student voice and choice in what, how, when and where they learn — to provide flexibility and supports to ensure mastery of the highest standards possible. (p. 4).

Shortly after this definition was given, a group of educators, philanthropic organizations, and technology advocacy groups including the Bill & Melinda Gates Foundation, Afton Partners, the Eli and Edythe Broad Foundation, CEE Trust, Christensen Institute for Disruptive Innovation, Charter School Growth Fund, EDUCAUSE, iNACOL, the Learning Accelerator, the Michael & Susan Dell Foundation, and Silicon Schools came together in 2014 to create a new definition of PL that could serve as a starting point for a collective understanding of PL. They defined PL as comprised of four

pillars: competency-based progression, flexible student learning environments, personal learning paths, and learner profiles (EducationWeek, 2014). RAND researchers Pane et al. (2015) detailed that while the field does not have one shared definition for PL, there are several important attributes to look for when identifying PL:

(1) systems and approaches that accelerate and deepen student learning by tailoring instruction to each student's individual needs, skills, and interests; (2) a variety of rich learning experiences that collectively prepare students for success in the college and career of their choice; and (3) teachers' integral role in student learning: designing and managing the learning environment, leading instruction, and providing students with expert guidance and support to help them take increasing ownership of their learning. (pp. 2-3).

Interestingly, technology is not explicitly mentioned in any of these definitions but is the implied pathway to implement PL. The authors go on to explain that while these are core elements of many PL programs, due to the competitive nature of grants to purchase PL software and implement this type of learning program, schools often creatively implement PL making it look different from school to school. Pane et al. (2015) also detail five strategies present in most PL school programs, with four of the five strategies coming from the four pillars developed by the Bill and Melinda Gates Foundation and others in the 2014 meeting in which an initial definition of PL was constructed (EducationWeek, 2014). The added strategy or pillar that Pane et al. (2015) make note of is “emphasis on college and career readiness” (p. 3). This strategy posits that a PL should ensure students are developing the skillset and knowledge needed to be ready for college. This includes both academic and non-academic skills that will set students up for success in college upon graduating from high school.

More recently, the U.S. Department of Education, Office of Educational Technology released a national education technology plan that included a definition of PL. In their 2017 report, they defined PL as “instruction in which the pace of learning and the instructional approach are optimized for the needs of each learner” (p. 9). The report stresses that a PL should be based on the individual needs of each learner and be driven by the interest of learners. Moreover, the Office of Educational Technology emphasizes that activities with a PL program are often self-initiated. This emphasis on self-initiation leads to the notion of BL and how the two learning programs, BL and PL are related.

Just as there have been multiple meanings and definitions of PL (Shemshack & Spector, 2020; Singh & Thurman, 2019), there is also a cloud of mystery surrounding BL (blended learning) and its meaning (Thorne, 2013; Tucker, 2012). In connecting PL and BL, several bridges of understanding have been presented. Patrick et al. (2013) view BL as a “delivery mechanism” for PL. While they do specify that PL can be done without technology, they also note that it is “very difficult to scale PL for each student in a classroom and school without effective and meaningful applications of technology to enable the differentiation and flexibility in pacing required” (p. 14). Hence, BL allows PL to be scaled via technology such that differentiation and flexibility in pacing can be achieved. Similar to Patrick et al., the U.S. Dept. of Education, Office of Educational Technology note in their 2017 report that engaging and empowering students to learn through PL technology also affords educators opportunities to utilize BL. But what is BL? And how has it been defined? In the next few pages, I will give a historical overview of BL as I have done for PL.

A Concise History of BL

While PL has early roots that can be traced back to the early 1900s (Pressey, 1926; Skinner, 1958), BL was not first described until much later. BL is a relatively new learning program that has just begun to see widespread use (Picciano, 2006) and has often been referred to by a host of names, including hybrid learning, technology-mediated learning, web-enhanced instruction, web-assisted instruction, and mixed-mode learning (Delialioglu & Yildirim, 2007). As Graham et al. (2013) point out, BL has been often misidentified. Stein and Graham (2020) also note that there is no single definition of BL though many exist. In 1997, Moore first described what is now known as BL, but used the term “distance education” and defined it as learning that takes place when “learners and instructors are separated by space and/or by time” (p. 22). This notion of learning in a different place or time is currently acknowledged as a key tenet of BL by many educators and educational technology advocacy groups. One of the earliest instances BL was formally recognized

came in 1999 when EPIC Learning announced it would “begin offering its Internet courseware using the company’s Blended Learning methodology” (PR Newswire, 1999). Soon after, Driscoll (2002), a consultant working for IBM released a definition of BL based on extensive research that culminated in a book. She gave four different definitions for BL:

1. To combine or mix modes of web-based technology (e.g., live virtual classroom, self-paced instruction, collaborative learning, streaming video, audio, and text) to accomplish an educational goal.
2. To combine various pedagogical approaches (e.g., constructivism, behaviorism, cognitivism) to produce an optimal learning outcome with or without instructional technology.
3. To combine any form of instructional technology (e.g., videotape, CD-ROM, web-based training, film) with face-to-face instructor-led training.
4. To mix or combine instructional technology with actual job tasks in order to create a harmonious effect of learning and working. (p. 1).

In positing four definitions of BL, Driscoll noted that BL has had varied interpretations for different people. This notion was also acknowledged by Picciano (2006) who detailed that BL comes in “many shapes, flavors, and colors” (p. 96) and consequently, looks very different from classroom to classroom.

Over the past two decades of educational technology research, several characteristics of BL have emerged. Researchers have described BL as utilizing multiple pedagogical approaches (Christensen et al., 2013; Driscoll, 2002; Garrison & Kanuka, 2004; Graham, 2006; Graham et al., 2019; Picciano, 2006; Parsad et al., 2008; U.S. Dept. of Ed., Office of Ed. Technology, 2017). While some researchers have explicitly stated BL is a combination of instructional approaches (Driscoll, 2002; Garrison & Kanuka, 2004; Graham et al., 2019; Picciano, 2006; Parsad et al., 2008; Ward & LaBranche, 2003), others have described multiple approaches to learning which often includes face-to-face instruction and computer-mediated or online instruction (Graham, 2006; Jacobs, 2003; U.S. Dept. of Ed., Office of Ed. Technology, 2017). Individualized or optimized learning is another feature that has been provided in multiple definitions of BL (Driscoll, 2001; Singh & Reed, 2001). This feature has also been argued as an advantage of BL (Zhang et al., 2020).

Many recent definitions of BL (Christensen et al., 2013; Garrison & Kanuka, 2004; Parsad et al., 2008; Staker, 2011; U.S. Dept. of Ed., Office of Ed. Technology, 2017) propose online or web-based technology as a key characteristic while older definitions often don’t include this detail (Graham, 2006; Singh & Reed, 2001; Picciano, 2006). Similarly, definitions from Staker (2011) and onward emphasize student autonomy over students’ learning experience (Staker, 2011; Staker & Horn, 2012; Christensen et al., 2013; Graham et al., 2019; U.S. Dept. of Ed., Office of Ed. Technology, 2017). Often, the phrase “time, place, path, and/or pace” is used to describe the control BL gives students over their learning. This was first introduced by Staker in 2011. Table 1 lists several major characteristics of BL as suggested by different researchers. While this list is not comprehensive, it does cover nearly two decades of BL definitions and includes the most widely accepted definition.

The most notable change to the way BL was defined came when Staker (2011) defined BL as “any time a student learns at least in part at a supervised brick-and-mortar location away from home and at least in part through online delivery with some element of student control over time, place, path, and/or pace” (p. 5). This definition adds several new features to BL, all of which will be explored in the next section. Most notably, Staker’s definition underscored that students should have some control over the time, place, path, and/or pace at which they are learning with BL. Other researchers and institutions (Christensen et al., 2013; Graham et al., 2019; Staker & Horn, 2012) have adopted this tenet of BL, with the most recent definitions of BL in Table 1 extending Staker’s (2011) notion.

Table 1

Characteristics of blended learning—A Synthesis of Definitions (Chronologically Organized)

Author	Definition of <i>blended learning</i>	Characteristics across definitions				
		A combination of pedagogical approaches	Emphasis on individual/optimal learning	Technology is online/web-based	Instructional technology component	Emphasis on student autonomy over learning experience
Singh & Reed(2001)	Optimizing achievement of learning objectives by applying the “right” learning technologies to match the “right” personal learning style to transfer the “right” skills to the “right” person at the “right” time.		X		X	
Driscoll (2002)	(1) To combine or mix modes of web-based technology to accomplish an educational goal.	X	X	X		
	(2) To combine various pedagogical approaches to produce an optimal learning outcome with or without instructional technology.	X	X		X	
	(3) To combine any form of instructional technology with face-to-face instructor-led training.	X			X	
	(4) To mix or combine instructional technology with actual job tasks in order to create a harmonious effect of learning and working.	X	X		X	
Garrison & Kanuka (2004)	The thoughtful integration of classroom face-to-face learning experiences with online learning experiences.	X		X		
Picciano (2006)	A wide variety of technology/media integrated with conventional, face-to-face classroom activities.	X				

Author	Definition of <i>blended learning</i>	Characteristics across definitions				
		A combination of pedagogical approaches	Emphasis on individual/optimal learning	Technology is online/web-based	Instructional technology component	Emphasis on student autonomy over learning experience
Graham (2006)	Face-to-face instruction with computer-mediated instruction.	X			X	
Parsad et al. (2008)	A combination of online and in-class instruction with reduced in-class seat time for students.	X		X	X	
Staker (2011)	Any time a student learns at least in part at a supervised brick-and-mortar location away from home and at least in part through online delivery with some element of student control over time, place, path, and/or pace.			X	X	X
Christensen et al.(2013)	A formal education program in which a student learns at least in part through online learning, with some element of student control over time, place, path, and/or pace, at least in part in a supervised brick-and-mortar location away from home, and the modalities along each student's learning path within a course or subject are connected to provide an integrated learning experience.			X	X	X
U.S. Dept. of Ed., Office of Ed. Technology (2017)	Learning that occurs online and in-person which allows students to have some control over time, place, path, or pace of learning.	X		X	X	X
Graham et al. (2019)	The strategic combination of online and in-person learning where students	X		X	X	X

Author	Definition of <i>blended learning</i>	Characteristics across definitions				
		A combination of pedagogical approaches	Emphasis on individual/optimal learning	Technology is online/web-based	Instructional technology component	Emphasis on student autonomy over learning experience
	have some control over time, place, path, and/or pace.					

In 2011, Staker defined BL in a research report published by the Innosight Institute. This institute was later renamed the Clayton Christensen Institute for Disruptive Innovation (CCIDI), a think tank aiming to disrupt the normative ways teachers teach and students learn. The CCIDI has focused on BL for over a decade, creating an online hub called the Blended Learning Universe, which looks to support educators, policymakers, and innovators. Their most recent definition of BL is one that has received widespread recognition from many state departments of education and researchers alike. Several state agencies including the Colorado Department of Education, the Minnesota Department of Education, the Ohio Department of Education, and the Texas Education Agency have adopted tenets from Christensen et al.'s (2013) definition of BL:

A formal education program in which a student learns at least in part through online learning, with some element of student control over time, place, path, and/or pace, at least in part in a supervised brick-and-mortar location away from home, and the modalities along each student's learning path within a course or subject are connected to provide an integrated learning experience. (Christensen et al., 2013, p. 7).

In recent years, BL has been defined by the U.S. Department of Education, Office of Educational Technology (2017) as "learning [that] occurs online and in person augmenting and supporting teacher practice" where BL "allows students to have some control over time, place, path or pace of learning" (p. 10). Since Christensen et al.'s (2013) definition of BL, nearly all further definitions of BL have come from one or more tenets of this definition, but Smith and Hill (2019) point out there is still a "lack of definition, clarity and consistency" (p. 390) with BL research. Oliver and Trigwell (2005) warn that inconsistent and unclear use of BL will continue to confuse until conceptual problems are fully addressed. We can see these inconsistencies Oliver and Trigwell warn of when examining the various definitions of BL in Table 1.

Conclusion

In this article, I have given a brief overview of personalized and blended learning. A timeline for major educational technology including BL and PL was given and examples of each type of technology were presented. Moreover, I synthesized BL definitions by comparing and contrasting several key features. This article outlines the development of personalized and blended learning and the inventions that mark significant points in the development of each educational technology.

References

- Alammary, A., Sheard, J., & Carbone, A. (2014). Blended learning in higher education: Three different design approaches. *Australasian Journal of Educational Technology*, 30(4).
- Ball, S. J. (2012). *Global education inc: New policy networks and the neo-liberal imaginary*. Routledge.

- Barbour, M. K. (2018). A history of K-12 distance, online, and blended learning worldwide. *Handbook of research on K-12 online and blended learning*, 2, 21–40.
- Brass, J., & Lynch, T. L. (2020). Personalized learning: A history of the present. *Journal of Curriculum Theorizing*, 35(2).
- Christensen, C. M., Horn, M. B., & Staker, H. (2013). Is k-12 blended learning disruptive? An introduction to the theory of hybrids. *Clayton Christensen Institute for Disruptive Innovation*.
- Coates, H., James, R., & Baldwin, G. (2005). A critical examination of the effects of learning management systems on university teaching and learning. *Tertiary education and management*, 11(1), 19–36.
- Delialioglu, O., & Yildirim, Z. (2007). Students' perceptions on effective dimensions of interactive learning in a blended learning environment. *Journal of Educational Technology & Society*, 10(2), 133–146.
- DreamBox Learning. (2022, September 20). *School districts nationwide accelerate student math and reading achievement with Dreambox Learning®*. DreamBox Learning - Online Math & Reading Solutions for Students K-12. Retrieved from <https://www.dreambox.com/press/school-districts-nationwide-accelerate-student-math-and-reading-achievement-with-dreambox-learning>.
- Driscoll, M. (2002). Blended learning: Let's get beyond the hype. *E-learning*, 1(4), 1–4.
- EducationWeek. (2014, October 20). Personalized learning: A working definition. *EducationWeek*. <https://www.edweek.org/technology/personalized-learning-a-working-definition/2014/10>.
- Halper, D. L. (2021, September 15). *Can radio really educate?* JSTOR Daily. Retrieved from <https://daily.jstor.org/can-radio-really-educate/>.
- Hamrick, K. B. (1996). The history of the hand-held electronic calculator. *The American Mathematical Monthly*, 103(8), 633–639.
- IXL. (n.d.). *Our story*. IXL Learning | Our story. Retrieved from <https://www.ixl.com/company/story#:~:text=IXL%20is%20now%20used%20by,at%20home%20by%20families%20worldwide>.
- Jacobs, J. A. (2003). Knowledge infusion: blending learning opportunities to enhance educational programming and meetings. *Association Management*, 55(5), 26–32.
- J-PAL Evidence Review. (2019). Will Technology Transform Education for the Better? Cambridge, MA: *Abdul Latif Jameel Poverty Action Lab*.
- Garrison, D. R., & Kanuka, H. (2004). Blended learning: Uncovering its transformative potential in higher education. *The internet and higher education*, 7(2), 95–105.
- Graham, C. R. (2006). *Blended learning systems. The handbook of blended learning: Global perspectives, local designs*, 1, 3–21.
- Graham, C. R., Borup, J., Short, C. R., & Archambault, L. (2019). *K-12 blended teaching: A guide to personalized learning and online integration*. Provo, UT: EdTechBooks.org. Retrieved from <http://edtechbooks.org/k12blended>.
- Graham, C. R., Woodfield, W., & Harrison, J. B. (2013). A framework for institutional adoption and implementation of blended learning in higher education. *The internet and higher education*, 18, 4–14.
- Moore, M. (1997). Theory of transactional distance. In D. Keegan (Ed.), *Theoretical principles of distance education* (pp. 22–38). Routledge.
- Oliver, M., & Trigwell, K. (2005). Can 'blended learning' be redeemed?. *E-learning and Digital Media*, 2(1), 17–26.

- Pane, J. F., Steiner, E. D., Baird, M. D., & Hamilton, L. S. (2015). Continued Progress: Promising Evidence on Personalized Learning. *Rand Corporation*.
- Patrick, S., Kennedy, K., & Powell, A. (2013). Mean What You Say: Defining and Integrating Personalized, Blended and Competency Education. *International Association for K-12 Online Learning*.
- Parsad, B., Lewis, L., & Tice, P. (2008). *Distance education at degree-granting postsecondary institutions: 2006-2007* (pp. 90-95). Washington, DC: National Center for Education Statistics, Institute of Education Sciences, US Department of Education.
- Picciano, A. G. (2006). Blended learning: Implications for growth and access. *Journal of asynchronous learning networks*, 10(3), 95–102.
- Pressey, S. L. (1926). A simple apparatus which gives tests and scores—and teaches. *Sch. & Soc.*, 23, 373–376.
- Pressey, S. L. (1963). Teaching machine (and learning theory) crisis. *Journal of Applied Psychology*, 47(1), 1.
- PR Newswire. (1999). *Interactive Learning Centers Announces Name Change to EPIC Learning*.
- Schwirzke, K., Vashaw, L., & Watson, J. (2018). A history of K-12 online and blended instruction in the United States. *Handbook of research on K-12 online and blending learning*, 2, 7–20.
- Shemshack, A., & Spector, J. M. (2020). A systematic literature review of personalized learning terms. *Smart Learning Environments*, 7(1), 1–20.
- Singh, H., & Reed, C. (2001). A white paper: Achieving success with blended learning. *Centra software*, 1, 1–11.
- Singh, V., & Thurman, A. (2019). How many ways can we define online learning? A systematic literature review of definitions of online learning (1988-2018). *American Journal of Distance Education*, 33(4), 289–306.
- Skinner, B. F. (1958). Teaching Machines: From the experimental study of learning come devices which arrange optimal conditions for self-instruction. *Science*, 128(3330), 969–977.
- Smith, K., & Hill, J. (2019). Defining the nature of blended learning through its depiction in current research. *Higher Education Research & Development*, 38(2), 383–397.
- Staker, H. (2011). The rise of K-12 blended learning: Profiles of emerging models. *Innosight Institute*. Retrieved from <https://www.christenseninstitute.org/wp-content/uploads/2013/04/The-rise-of-K-12-blended-learning.emerging-models.pdf>
- Staker, H., & Horn, M. B. (2012). Classifying K–12 blended learning. *Innosight Institute*. Retrieved from <https://www.christenseninstitute.org/wp-content/uploads/2013/04/Classifying-K-12-blended-learning.pdf>
- Stein, J., & Graham, C. R. (2020). *Essentials for blended learning: A standards-based guide*. Routledge.
- Thorne, K. (2003). *Blended learning: how to integrate online & traditional learning*. Kogan Page Publishers.
- Tucker, C. R. (2012). *Blended learning in grades 4–12: Leveraging the power of technology to create student-centered classrooms*. Corwin Press.
- U.S. Department of Education, Office of Educational Technology. (2017). *Reimagining the role of technology in education: 2017 national education technology plan update*. Retrieved from <https://tech.ed.gov/files/2017/01/NETP17.pdf>.
- Ward, J., & LaBranche, G. A. (2003). Blended learning: The convergence of e-learning and meetings. *Franchising World*, 35(4), 22–23.

Watters, A. (2023). *Teaching machines: The history of personalized learning*. MIT Press.

Zearn. (n.d.). *Zearn Math Efficacy Research*. Real Impact for All Kids. Retrieved from [https://about.zearn.org/research#:~:text=Zearn%20is%20the%20501\(c,kid%20is%20a%20math%20kid](https://about.zearn.org/research#:~:text=Zearn%20is%20the%20501(c,kid%20is%20a%20math%20kid).

Zhang, J. H., Zou, L. C., Miao, J. J., Zhang, Y. X., Hwang, G. J., & Zhu, Y. (2020). An individualized intervention approach to improving university students' learning performance and interactive behaviors in a blended learning environment. *Interactive Learning Environments*, 28(2), 231–245.

Zimmerman, J., McAllister, K. S., & Ruggill, J. E. (2018). The Overhead Projector: Visuality and Materiality. In *The Routledge Companion to Media Technology and Obsolescence* (pp. 90–102). Routledge.



Micah Swartz

Texas State University

Micah Swartz is a Mathematics Education Ph.D. student at Texas State University and is a 2022 recipient of the National Science Foundation Graduate Research Fellowship. Currently, he is collecting data for his dissertation which examines the relationship between blended learning and other self-directed technology and students' mathematics identity and motivation. He is passionate about research involving technology and education, and working to ensure that technology is used in a responsible and ethical manner.

This content is provided to you freely by EdTech Books.

Access it online or download it at

https://edtechbooks.org/studentguide/personalized_and_blended_learning.

