

## **A Batch of One: A Conceptual Framework for the Personalized Learning Movement**

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Variation in definitions and models of personalized learning has created confusion and disagreement among practitioners and scholars. However, personalized learning continues to be broadly promoted and funded within schools. This paper offers an inclusive definition of what is happening within the personalized learning movement and aims to be inclusive of diverse epistemologies and cultures. To do this, we revisit the seminal metaphor of the factory model of schooling and follow contemporary changes seen in manufacturing to highlight similar trajectories seen in both fields and justify this new definition, which states that personalized learning is the mass customization of learning through a unique combination of automated and student-centered pedagogies. We then propose the Personalized Learning Continuum Framework (PLCF) as a conceptual framework for this movement to help practitioners and researchers describe the relationships between various models as a function of Academic Learning Time, pedagogical methods founded on contrasting philosophical traditions, and the distribution of power in learning.

Personalized learning is spreading across schools in the United States. Some view this spread as an illumination, while others see it more as a virus (Boniger, Molnar, & Saldaña, 2019; Pane, Steiner, Baird, & Hamilton, 2015). Personalized learning is so varied in its description, enactment, and evaluation, that the concept is foggy and confusing at best. According to the 2017 National Education Technology Plan, personalized learning is a means to “afford historically disadvantaged students greater equity” and includes “instruction in which the pace of learning and the instructional approach are optimized for the needs of each learner” (p. 9). This big promise of personalized learning is further elevated as philanthropists continue backing initiatives with millions of dollars for personalized learning initiatives across the nation (US Department of Education, 2017; Boniger et al., 2019). As the world of K-12 views it, personalized learning encompasses seemingly infinite programs (both technology-enabled and analog), instructional strategies, and frameworks. Some definitions prioritize competency-based education or learner agency; others focus on unique pacing or learning preferences. Without specific examples, additional explanations, job aids, or qualifying details, K-12 classroom teachers lack the conceptual clarity required to turn personalized learning into classroom practice (Gross & DeArmond, 2018). Teachers and school leaders struggle to make sense of the messy and contradictory descriptions that support strategic planning and concrete goals. Educators’ initial excitement about the promises of personalized learning often quickly wanes as they are left with more questions than answers.

The process of identifying the key traits or components of personalized learning and providing high-quality experiential learning to educators seeking to learn more is a chief challenge of educator preparation providers and professional development agencies. This paper seeks to conceptually acknowledge all the proponents and critics by offering an inclusive definition of what is happening within the personalized learning movement.

## LITERATURE REVIEW

Cohesively describing personalized learning is a challenge as many varied and contradictory instructional strategies and school structures are cited as enactment of personalized learning. Scholars disagree on the foundational components of what personalized learning looks like with some focusing first on student-centered pedagogy and others focused on technocentric solutions. Scholars like Watson and Watson (2016) situate their conceptualizations of personalized learning on the student-centered nature of instructional strategies; while other scholars like Bingham, Pane, Steiner, and Hamilton (2018) consider technology as the critical differentiator. These two conceptual lenses can produce two very different models of personalized learning. For example, Watson and Watson (2016) consider Montessori

education as personalized, because of the incorporation of student choice, student self-regulation, mastery grading philosophy, portfolio assessments, and teacher-as-guide approach; however, Montessori schools strictly limit technology use (MacDonald, 2016). In contrast to Watson and Watson (2016), Bingham et al. (2018) conducted a personalized learning study that only included models with “some kind of digital content or learning platform” (p. 466), prioritizing technology as a differentiator. The schools in the study primarily used learner profile data and blended learning instructional strategies as critical components of their personalized learning models (Bingham et al., 2018).

These variations challenge the appropriateness of model comparison. Another technocentric model, Summit Public Schools’ personalized learning model contrasts with Montessori dramatically, especially in terms of technology use. Summit Public Schools is a school management company funded by the Chan Zuckerberg Foundation (Williamson, 2018). To personalize instruction, Summit Schools employ an adaptive learning software tool, Summit Personalized Learning Platform, which has been a major component of the instructional day requiring some students to work in the system for five hours each day (Edelman, 2018). One might ask, how it is possible that both Montessori and Summit Public Schools could both be a model of personalized learning, when their philosophical traditions and use of technology and student-centered pedagogy are so divergent? This variation in models makes it difficult to understand the personalized learning movement, makes it appear like anything could be personalized learning, and makes personalized learning even more challenging to translate into something functional for one’s own school or classroom.

While the implementation of personalized learning models varies significantly, there are also some commonalities and overlaps among the existing descriptions that support our understanding of which characteristics contribute to understanding the concept. However, consensus around personalized learning is lacking (Boniger et al., 2019). In seeking the earliest applicable conceptualizations, Burr et al. (1970) claims that personalized learning encompasses the total environment for learning, the interests and other variables of individual students, the teaching-learning situation, and the participation of students in the planning, doing, and appraising of their learning experiences. Culatta and Fairchild (2016) gathered and analyzed a collection of influential definitions, revealing the following eight themes that demonstrate the variance and accord of personalized learning conceptualizations: competency-based progression, student needs, standard alignment, student interests, student ownership, socially embedded, formative assessment, and flexible learning environments. The following table (Table 1) summarizes the personalized learning features highlighted by major educational policymakers as identified by Culatta and Fairchild (2016).



This variation in definitions creates confusion not only among practitioners, but also among researchers. Researchers are already making efforts to investigate the effectiveness of personalized learning, but without a common conceptual understanding, the relationship between two or more implementations cannot be clearly described or easily transferred to other settings. Conceptualizations should inform methodological choices when investigating specific models. To assist in describing the relationships various models have with one another, we leverage a historically significant analogy from the manufacturing perspective to develop an inclusive definition of personalized learning.

### THE FACTORY MODEL ANALOGY

The factory model analogy is not new to education. John Franklin Bobbitt, an influential academic out of the University of Chicago in the early twentieth century, brought concepts of scientific management from the field of manufacturing into education. Building from his work (Bobbitt, 1941), the factory model of schooling solidified across the country with the introduction of learning outcome measures, curriculum standards, and high-stakes testing. Au (2011) describes this educational design:

Students are the “raw materials” to be produced like commodities according to specified standards and objectives. Teachers are the workers who employ the most efficient methods to get students to meet the pre-determined standards and objectives... The school is a factory assembly line where this process takes place. (p. 27)

In this model, the scientific management of teacher work is achieved through surveillance in the form of administrator walk-throughs, district-level common formative assessments, pacing guides, scripted curricula, and high-stakes testing. This model of schooling has been critiqued as dehumanizing of learners, decontextualizing of knowledge, and de-skilling of teachers (Apple, 2012; Au, 2011). Furthermore, in treating learners like assembly line products feeding them a common curriculum at a common pace, the factory model has over-produced students who lack flexibility and a diversity of specialized skill sets required in both the knowledge economy and rapidly changing socio-politics of the modern era (Hedrick, Homan, & Dick, 2017; Kline & Williams, 2007). This gap has created tension between schools and their stakeholders, leading to social dissent around the value of education and the relevance of educational credentials (Albrecht & Kerebenick, 2018). Many individuals have claimed that the interest in personalized learning is actually a shift away from the factory model of education

(Basham, Hall, Carter, & Stahl, 2017; Patrick, Kennedy, & Powell, 2016); however, we argue that personalized learning is not actually a rejection of the factory model, but instead parallels a similar shift which started in manufacturing in the 1980s. Schooling is not evolving away from a manufacturing model, but instead evolving in its footsteps.

### **The Shifting Factory**

Since the late 1980s consumers have increasingly demanded more customization in services and products and wanted to be able to provide input on the products and services they purchase (De Silveira, Borenstein, & Fogliatto, 2001; Fogliatto, De Silveira, & Borenstein, 2012). This demand required a rethinking of the mass production of the standardized product. To answer this demand, the manufacturing industry has been using consumer data collected from various sources including social media and purchase histories to target marketing efforts and to shift from a mass production model to a mass customization model. In addition to consumer data, manufacturers create personalized consumer experiences through reinvented supply chain structures using flexible manufacturing processes and modern technologies (Fogliatto et al., 2012). Deloitte (2015) claims that three levels of product and service personalization, which provide the consumer with a varied level of power in the product produced, have emerged, including: mass personalization, mass customization, and bespoke. Mass personalization is when products and services are mass produced but “can be modified by the business to meet consumer preferences identified through existing data about the individual” (Deloitte, 2015, p.8). Mass customization is when “products are mass produced but the consumer is offered some limited options of customization” (p. 8); bespoke refers to products and services co-designed by the consumer and the business to produce a unique, one-of-a-kind product. Some manufacturing scholars claim that this bespoke level of manufacturing is an emerging phenomenon referred to as Industry 4.0, where products and services are no longer required to be produced in small or medium batches, but a batch of one (Deloitte, 2015; Torn & Vaneker, 2019). Mass production seen in the historic factory model of manufacturing has evolved with technology into a new distributed and technologically rich model of scaled customization.

We argue a similar shift is occurring in schooling within the United States 40 years after it started in the manufacturing industry. Schools are now testing scaled customization models of teaching and learning under the title of personalized learning. Table 2 lists current examples of instructional strategies in schooling that reflect the mass customization patterns seen in the manufacturing industry. A select collection of instructional strategies currently espoused in personalized learning models are presented next to the three levels of mass customization in manufacturing.

**Table 2**  
**Mass Customization in Manufacturing and Schooling**

Manufacturing Industry Levels of Mass Customization	Example Strategies for Mass Customization of Schooling	Levels of Customization in Schooling
Mass personalization	Adaptive learning software, Flipped-classroom video lectures, Adaptive learning assessments (Patrick, Kennedy, & Powell, 2016)	Instruction is modified by the software or teacher to meet learner needs identified through existing data about the learner.
Mass customization	Choice boards (Heacox, 2018), Universal Design for Learning (Rose & Meyer, 2002), Learner profiles (Bray & McClaskey, 2012)	Instruction is mass produced but the learner is offered some limited options of customization.
Bespoke	Student-designed project-based-learning, Student-teacher co-planning, authentic portfolio assessment (Glowa & Goodell, 2016)	Learning experiences are co-designed by the learner and the teacher resulting in a unique, one-of-a-kind process and/or product.

Table 2 is inclusive of the variable instructional strategies evident in models of personalized learning, even those models that appear philosophically opposed to one another, such as the Summit Schools model and the Montessori model. However, further conceptualization using established educational theories and epistemological traditions will help us define personalized learning inclusively and provide researchers and practitioners a framework to distinguish one model from the next revealing their relationships.

**AN INCLUSIVE DEFINITION**

To be an inclusive definition, personalized learning should avoid culturally or epistemologically specific description. To this end, we define personalized learning as the mass customization of learning through a unique combination of automated and student-centered pedagogies. The array of pedagogies employed in a model of personalized learning will provide varied opportunities for learners to exert power in the decisions of how they pursue mastery of learning. We assert that previous definitions created confusion by including what was being customized and the means by which customization occurred. By diving into unique approaches to customization, these definitions were founded on assumptions that were epistemologically

and culturally specific; therefore, they could not represent consensus. Here we expand our definition with a framework to help researchers and practitioners in sorting, situating, and/or relating current and future models of personalized learning employed in schools. More than an upgraded factory model analogy, this definition is informed by multiple theories, including pedagogical theories, theories of time in schooling, and theories of power and agency. From these theories we present the Personalized Learning Continuum Framework that allows diverse models and approaches to personalized learning to be described and compared.

### **Contributing Theories**

Teacher-centered pedagogies of the factory model were already scaled to serve masses of students simultaneously. These pedagogies, often perceived as a manifestation of Taylorism, or scientific management, in the curriculum continue to be ubiquitous in schools (Kim, 2017; Stoller, 2015). Teacher-centered pedagogies depend heavily on lecture, direct instruction, demonstration, and textbooks as the primary means of knowledge delivery (Mascolo, 2019). This type of pedagogy positions the teacher as an active agent that fills the passive agent, the learner, with static and fixed knowledge. Teacher-centered pedagogies require the physical and mental submission of the learner, who has little agency in the learning process and must submit to the authority of the teacher. These pedagogies are grounded in an empirical view of knowledge, meaning that knowledge and truth exist outside and independent from the learner. This view of knowledge allows for straightforward right-or-wrong feedback on recall questions for assessment. Teacher-centered pedagogies work well in the mass production factory model where standardized output was desirable. Lecture halls with hundreds of learners allow for scaled learning, but historically teacher-centered pedagogies were difficult to customize for learners. Unique learning needs were a challenge to this mass production model and learner difficulties were seen as a deficiency in the learner, not a deficiency in the pedagogy, the teacher, or the factory model, itself. To increase the likelihood of a common output of learners, accommodations of those learners seen as non-standard led to the development and evolution of special education, gifted education, differentiation, and individualized instruction. These interventions were still directed by the teacher, or active agent, increasing the number of teachers needed and raising costs of schooling (Chaikind, Danielson, & Brauen, 1993; Imazeki, 2018).

### **Automated Pedagogies**

In 2007, Johnathan Bergman and Aaron Sams wanted to help athletes who missed their classes for sporting events and were falling behind. To address these non-standard learners who could not comply with the mass

spacing of the traditional classroom, Bergman and Sams video recorded their lectures and allowed learners to view these lectures during non-school hours. By recording their lectures, these teachers automated their lectures in a way that allowed custom delivery times and frequencies using computers. While not the first to flip or invert their classroom, Bergman and Sams popularized the flipped classroom model with their book, *Flip Your Classroom: Reach Every Student in Every Classroom Every day* (2012), which provides teachers a model for automating their own teacher-created or teacher-curated direct instruction.

Similar to the flipped classroom strategy, adaptive learning software also requires a computer as the delivery mechanism rather than the teacher. Adaptive learning software that assigns lessons to individual learners based on their responses to assessment questions, is the automation of scripted curricula. Teachers no longer need to deliver scripted lessons, and learners get a custom pace and path through a pre-defined curriculum catalog. Adaptive learning software customizes the mass delivery of scripted curricula. Since new educational technologies and associated pedagogies are emerging where the teacher is no longer the center of delivery, we see a need for a new term that effectively communicates new delivery dependencies. *Automated pedagogies* are instructional strategies that use computer systems to deliver curriculum content to learners. This definition requires some passivity of the learner in order to differentiate it from student-centered uses of educational technology. Automated pedagogies grant increasing curricular decision making and authority to the computer algorithms and their software developers, while further reducing or removing the teacher influence that is evident in teacher-centered instruction. The automated pedagogies of personalized learning diminish the demand for teacher expertise and time and perpetuate limitations on student agency toward less-substantive choices of where or when learners engage.

### **Student-Centered Pedagogies**

Student-centered pedagogies were popularized with the progressive education movement in the early 1900s with scholars like Dewey (1938) and Piaget (1948). Progressive pedagogies are founded in a constructivist view of knowledge. This world view asserts that because knowledge is constructed by the learner it cannot be decontextualized and fixed outside the learner but must be constructed through action in the world. Since the learner is central to the construction of knowledge in the progressivist worldview, student-centered pedagogies are inherently custom or personal in nature (Fostnot & Perry, 1996; Matthews, 2003). However, such pedagogies require the teacher to be a coach or a guide, which is time and labor intensive of teachers (Garrett, 2008; An & Reigeluth, 2011; Aslan & Reigeluth, 2015).

Student-centered strategies also require learners to switch from a passive role to an active one and regulate their own learning, which if the learner is incapable or unwilling can be a barrier to implementation (Aslan & Reigeluth, 2015). Benefits of student-centered pedagogies include learner motivation and student agency in selecting learning tasks and driving pacing; however, the effectiveness of such pedagogies remain in debate (Brooks, 2013; Kirschner, Sweller, & Clark, 2010). Such pedagogies include project-based learning, collaborative learning, problem-based learning, culturally-relevant pedagogy, inquiry learning, and experiential learning (Kirschner, Sweller, & Clark, 2010; Mascolo, 2019).

Technology is now supporting teachers in scaling these already-personal pedagogies more effectively (Colbert & Arboleda, 2016). For example, digital portfolio systems allow learners to organize and present artifacts from student-centered learning experiences. Data tracking systems support teachers who are facilitating learners working on varied projects, while cloud-based services are supporting student collaboration and teacher oversight/guidance. Digital communication systems allow for asynchronous engagement and feedback between peers and teachers. Learning management systems help facilitate once synchronous classroom processes into asynchronous processes such as assignment or project presentation or collection. Since personalized learning models will employ a unique combination of automated and student-centered pedagogies, the role of the teacher and the skill required will vary. Schools employing automated pedagogies may choose to have fewer or lower-skilled teachers, *or* they may reallocate highly-skilled teacher time to focus on student-centered pedagogies, which traditionally are difficult to scale due to teacher time limitations. Boniger et al. (2019) caution against the disabling of professional teachers as seen in some models that prioritize automated pedagogies.

### **Instructional Time and Mastery Learning**

The construct of time is ill-defined, culturally specific, and lacks inherent meaning (Gándara, 2000). Still the concept of time in relation to schooling has been a point of discussion throughout the modern history of schooling. In efforts to standardize and quantify secondary education programs, the Carnegie Foundation for the Advancement of Teaching established 14 Carnegie units over a four-year period as a standard high school education. Specifically, 120 seat hours of instruction in a subject area constitute a Carnegie high school credit, and the degree to which a learner understands the content delivered is not (Gándara, 2000).

Time in relation to learning was seminally reconceptualized in terms of student aptitude by John Carroll in his *Model of School Learning* (1963). Carroll asserts that, instead of scores from intelligence tests, a student's

aptitude is a function of time spent learning and time needed to learn. Bloom (1968) built further onto Carroll's model to articulate his mastery of learning philosophy, which affirms that any student can learn any academic outcome if he or she is given sufficient time and quality instruction. Bloom claims that what defines sufficient time for mastery will vary for every student. This theory of mastery and its claim that learners need varied time engaged in instruction to be successful has perpetuated in the literature since Bloom's time. However, the standard 120 seat hour requirement, has not changed over the past 113 years, and learning continues to be measured in terms of seat time despite these advancements in conceptualizations of time for learning.

Academic Learning Time (ALT) emerged in the 1980s and is still often cited today. ALT was cited by Gettinger and Seibert (2002) as "the amount of time during which students are actively, successfully, and productively engaged in learning" (p.1). ALT has been found to be positively associated with academic achievement, including greater academic gains in classrooms where teachers allocate more time to learning activities (Fisher et al., 1981). The manner in which a teacher conceptualizes time in a learning environment often influences the teacher's philosophy of learning and subsequent instructional planning, as well as the expectations of the learners. Personalized learning models acknowledge learner variation, and accommodate with varied time, pace, or place of learning. Mastery learning is dependent on having the flexibility to vary ALT; however, who is deciding how learner time is being spent? Some models of personalized learning that depend heavily on automated pedagogies limit learner influence, or agency, over ALT, while other models require more decisions from teachers and/or learners.

### **Learner Agency and Power**

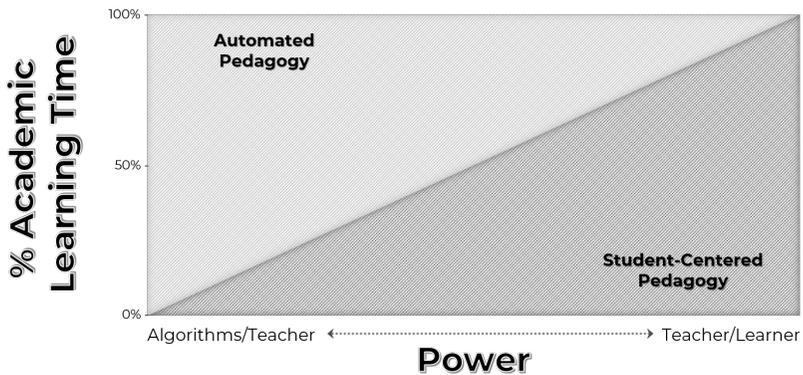
Decision making power and agency in the classroom are critical to any discussion of personalized learning. Agency is an individual's capacity to make and act on choices that affect their life (Martin, 2004). The individual's ability to enact agency is dependent on their use of self-regulatory behaviors including planning, strategizing, control of physical actions, and self-monitoring (Schunk & Zimmerman, 1997). Under typical circumstances, individual agency develops over time, but is influenced by the surrounding social environment (Bandura, 2006; Schunk & Zimmerman, 1997). In the classroom environment, learner ability to enact agency is enhanced when the teacher and peers provide guidance and feedback on self-regulatory behaviors that the learner displays. Social cognitive theorists suggest that a classroom be well-equipped for learning and practicing self-regulatory behaviors. As such, student-centered pedagogies in the classroom support the

development of learner capacity for self-regulation through opportunity to enact agency, whereas teacher-centered pedagogies support learner agency only through teacher-modeled behaviors (Martin, 2004).

A learner's capacity for agency is not equivalent to the power evident in the classroom, and an investigation of power structures in each personalized learning environment may reveal variation in power distribution as the norm. To analyze power distribution in schools one must investigate three areas: who determined the norms and values expressed in the everyday classroom interactions; who controls what constitutes knowledge in the classroom, or the intended curriculum; and who plans, organizes, and evaluates school activity (Apple, 2004). Experts argue that some models, which depend heavily on automated pedagogies such as adaptive learning software, restrict opportunities for learners to enact agency beyond agreement to engage with software, where to engage with the software, and possibly when to engage with the software (Boniger et al., 2019). Alternatively, models that employ more student-centered pedagogies may require learners to enact agency in order for initial curricular decisions to be made and learning to progress. Yet, many models of personalized learning may offer combinations of automated and student-centered pedagogies that complicate an analysis of power distribution. Essentially, similar issues of power that occur within various learning theories are likely to extend toward their scaled customization applications in personalized learning as well.

### **THE PERSONALIZED LEARNING CONTINUUM FRAMEWORK**

Considering the variation in the models of personalized learning, a new and universal root model is needed using the conceptualizations of automated and student-centered pedagogies. Different schools and classrooms personalizing instruction will demonstrate variation in the amounts of automated pedagogies and student-centered pedagogies employed. Some models employed by online schools may only focus on automated pedagogies, while progressive models like Montessori education may only employ student-centered pedagogies (Boniger et al., 2019; Watson & Watson, 2016). We argue that the shift from the traditional factory model to personalized learning is the complementary advancement of both pedagogical traditions towards mass customization and a redistribution of some or all of the curriculum decision power from the teacher toward computer algorithms and the student. While one might assume teacher-centered and automated pedagogies would present in direct contrast with student-centered pedagogies (Mascolo, 2019), we argue that in many personalized learning models these philosophically-opposed approaches are likely used in some unique combination best suited for the context and the individual learner resulting in a scaled custom educational experience. To illustrate this framework, we designed the Personalized Learning Continuum Framework (PLCF).



**Figure 1.** The Personalized Learning Continuum Framework.

Using the PLCF as a new conceptualization of personalized learning, researchers can sort and compare various models of personalized learning thereby allowing description of varying models in common terms, including:

- Percent ALT on automated pedagogy
- Types of automated pedagogies
- Percent ALT on student-centered pedagogy
- Types of student-centered pedagogies
- Distribution of power, agency, and agents

Here are some examples. On the far left of the continuum, a personalized learning model that devotes 100% of ALT to the automated pedagogy of adaptive learning tools may distribute more power to the software and algorithm developers. In a teacher-curated or teacher-created blended learning model, for example, the teacher may develop and assign content without the aid of an algorithm, therefore enacting agency over learning decisions. In contrast, personalized learning models that fall to the far right of the continuum may distribute power between the teacher and learner in varied ways. These models on the far-right side will likely require abundant learner agency and well-practiced self-regulation behaviors, otherwise the teacher may be required to orchestrate significant portions of individualized student-centered activity. Still, many models of personalized learning will fall between these two extremes on the continuum and employ unique combinations of automated and student-centered pedagogies resulting in complex and changing distributions of power between teacher, computer algorithms, and learner. Yet, using the PLCF, any researcher, practitioner, or stakeholder could more readily explore the nature of power in a personalized learning model.

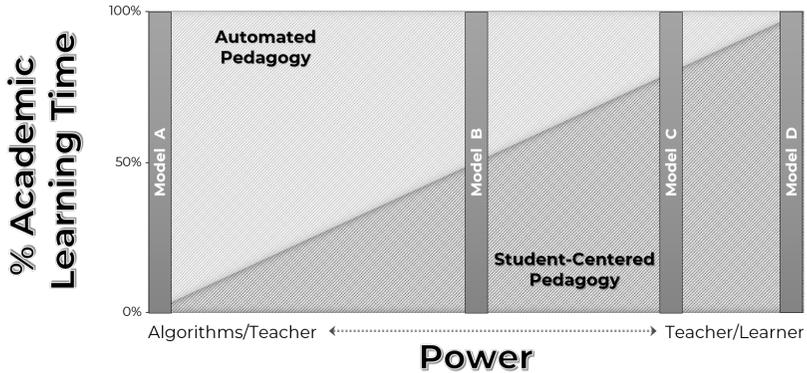
### Application of the PLCF

Researchers and practitioners have agreed that the confusion around personalized learning makes it difficult to translate into practice (Bingham et al, 2018; Gross & DeArmond, 2018; Watson & Watson, 2016). Educators and educational leaders seeking to design a personalized learning model for their unique setting may use the PLCF to help guide that process. They may first analyze and articulate (1) available financial and technical resources to serve automated pedagogies, (2) capacity of available teaching force to provide student-centered pedagogy, (2) learner capacity to enact agency, and (4) epistemological values held within the school community to identify the area of the continuum that may provide the best models to consider for their environment. Then communicating with other educators who are personalizing their classrooms using the language of the PLCF may help educators find school with models worth emulating in their school communities. Otherwise, confusion about how personalized learning can translate into classroom practice may perpetuate and continue to make implementation planning overwhelming. For illustration purposes Table 3 shows how four different fictitious personalized learning models might be described and compared.

**Table 3**  
Fictitious personalized learning models for purposes of PLCF illustration

	Model A	Model B	Model C	Model D
Percent ALT on automated pedagogies	100%	50%	20%	0%
Types of automated pedagogies	Online adaptive learning platform	Flipped content delivery	Classroom center with adaptive learning platform	N/A
Percent ALT on student-centered pedagogies	0%	50%	80%	100%
Types of student-centered pedagogies	NA	Project-based and small group instruction	Small group instruction, project-based, and collaborative	Co-planning, small-group, and project-based learning
Distribution of power	Computer Algorithms	Teacher and student	Teacher and student	Teacher and student

The models presented in Table 3, represent variability among models present in the personalized learning movement. These models can be charted on the PLCF as shown in Figure 2.



**Figure 2.** Fictitious Models Mapped on the Personalized Learning Continuum Framework.

To claim that Model C should be stopped, since Model A has prohibitory challenges is a dangerous line of assumptions and reactions. Schools can use the PLCF to begin designing their own models, but also to identify viable comparators and collaborators, which fall close to their intended models on the PLCF. In the future, researchers should investigate the value of the PLCF in guiding the development of personalized learning models.

It is important to point out that although a school or teacher may plan, or intend, for a certain distribution of automated pedagogy and/or student-centered pedagogy, each learner will experience ALT differently as they work toward mastery. Any point plotted on the PLCF should be considered developmental, changing, and likely to shift any given day for any specific classroom or learner; however, we find the discussion and analysis of specific instances along this continuum valuable in relating models of personalized learning to one another.

### Implications of the PLCF

Research in personalized learning can be difficult to design without a conceptual foundation and common understanding of the construct. Recently the National Educational Policy Center (NEPC) aimed at providing a critique of “the contemporary personalized learning movement” (Boniger et al., 2019, p. 13). This critique focused primarily on the Bill and Melinda Gates Foundation definition of personalized learning and the resulting technocentric models that employ programmed instruction. In response, the PLCF addresses this critique by highlighting how programmed instruction

is only a limited sub-component of personalized learning under our proposed term *automated pedagogies*, and consequently is not the entirety of personalized learning. Therefore, the analysis by Boniger et al., would only apply to specific models near the far-left side of the PLCF, and could not be generalized to all possible models that scale customization of learning.

Models of personalization are as diverse as the students and teachers engaged within them. Arguably one of the most challenging aspects of scaling personalized learning is encountering these seemingly infinite examples and trying to find one that fits a context just right. Analyses like the one presented by the NEPC, should specify the model on which their critique focuses, describe its relationship to other models (possibly using the PLCF), and avoid generalizing their conclusions to an entire movement. By calling for a pause in efforts towards personalized learning (Boniger et al., 2019), they devalue the models being invented and iterated by under-funded and passionate classroom teachers and school leaders who seek to provide for the unique needs of their learners. It is unhelpful to lump all models of personalized learning together as either effective or ineffective. Rather, as personalized learning calls for, treat each individual case as its own unique set of characteristics and potentials. Moving forward, researchers will need to avoid the binary and broad claims of experimental effectiveness studies, and instead dive into investigations of individual models to understand the complexities inherent within them and how they relate to other models in practice.

## CONCLUSION

The personalized learning movement has garnered significant attention and funding, which warrants research and iteration, but researchers and practitioners alike require a common conceptual understanding from which to begin this work. To support these efforts, we have provided an inclusive definition supplemented by the PLCF, which was informed and rationalized by the surrounding bodies of literature. The potential held in personalized learning is felt deeply by educators, even when difficult to articulate. Still, we are cautious with our terminology. Up to this point, many actors, including the present authors, have thrown around the claim of a “paradigm shift.” However, without revisiting the purpose of schooling or variable outcomes of schooling, we withhold any claim of personalized learning in K-12, as it stands today, to be a true paradigm shift. We can acknowledge that the evolution towards customization is not unprecedented in other fields, and education is likely following the same shift seen in medicine, entertainment, and manufacturing.

Mass production in schooling has for decades overproduced similarly credentialed individuals, which has challenged the relevancy and legitimacy of our system of schooling (Apple, 2012). If schools continue to prepare all learners with common outcomes, we prepare no one to fulfill any particular role well. Currently, a K-12 education in the context of the United States whether personalized or not, still aims to prepare students for college entrance and/or career activity. It still involves a high school transcript built on Carnegie units that speak to learning in the distinct areas of language, math, science, and the humanities. Until the personalized learning movement begins to challenge these fundamental beliefs about schooling allowing custom end goals and custom means to those goals, we see personalized learning as a movement towards systemic advancement in modern system efficiencies and learner satisfaction. Moving forward, we must engage in more discourse about what a custom education entails to expand and build on the PLCF. Perhaps the movement will grow to include goals and outcomes of schooling that are as diverse as the learners themselves and reject the lock-step structure that ascribes all learners to the same eventual outcome. Once that is accomplished, then a true paradigm shift can be realized.

The future of personalized learning will inevitably bring changes to the movement, what it includes, and how we continuously reconceptualize it. Rapid iteration is perhaps the best prescription for the currently stagnated educational ecosystem and is required for true personalization to take root. We anticipate that specific models will prove more effective with certain subgroups of learners, likely challenging our conception of equal opportunity. Just as in the earliest iterations of other personalized industries, the PLCF will need to continue to evolve as advancing technology and artificial intelligence advances. In the future, if learners are permitted to design their own educational programs and outcomes, automated pedagogies may need to be reconceptualized to continue to serve learners at scale offering unlimited options. Other fields that are moving toward personalization, such as medicine or entertainment, may find unique ways to interact with a personalized system of schools. We can anticipate that the personalized learning movement is too new to announce generalities or to make calls for it to be stopped, nor is it likely that student-focused educators would heed such a call at this point. At this stage of infancy, personalized learning is ripe with opportunity, and a hope for a better system of schooling drives learners and educators alike to determine their own path and endeavor forward.

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