Teaching 21st-Century Skills in a Blended Learning Environment Literature Review

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The President of the American Federation of Teachers, Albert Shanker, delivered a speech and brought in the philosophical questioning of British management expert Charles Handy, which addresses comparisons between the workspace and school. One should consider a stereotypical, successful office job and how one might describe the structure, organization, and culture. Then, one should consider how absurd it would be if executives were to run businesses like schools: workers would sit in their cubicles, all working on similar tasks using similar methods, all rotating to a new manager every 45 minutes. The few authentic interactions with colleagues would be at the proverbial water cooler or in the elevator to and from the office floor working in company-sanctioned teams or groups. One imagines the tedious cycle ending after a full eight hours, repeating the cycle day after day as a present-day corporate Sisyphus. This hypothetical school-like business structure would severely restrict the opportunity to explore new ideas, build relationships with diverse peers, and develop and test new patterns based on the real-world data collected in practice. Handy sharply shifts focus to education, stating "We don't consider students workers; we consider them inanimate objects being moved along an assembly line" (Shanker, 1989).

According to Shanker (1989), taking risks is a part of trying something different, changing habits, and reflecting on progress. Educators have seemingly not heeded the call to action. The aforementioned speech was delivered in 1989, and prior to it, U.S. Secretary of Education Terrel Bell suggested the nation consider new skills goals for our evolving technological society to be attained by the beginning of the 21st century (Raizen, 1982). Rather than embrace this call, we maintain a factory-model, assembly line educational system. Decades later, we have more opportunity and reason than ever to finally break the bonds of 20th century

education practices and, by implementing a blended learning environment using the station rotation model, transform our classrooms into greater alignments with the possibilities presented by the 21st century and the future.

Society knows and feels that 21st-century skills are critical for humanity and its growth. Education must incorporate opportunities to acquire these skills and research supports the benefits of acquiring these skills in an educational setting, transitioning from the past and present state of education to the future. Research confirms the idea that learners can acquire and develop 21st-century skills in the educational setting using a blended learning environment and the station rotation model. This literature review examines the history and future of educational practices and progress, introduces blended learning environments, and explores 21st century skills in a blended learning environment.

History and Future of Education

Education of the Past

Understanding the impact of blended learning environments requires analysis of our past educational system, a system that according to Harapnuik et al. (2018) is functioning just as intended and should not be considered broken. The system's current structure was partly established by Adolphe Quetelet in the 19th century by imposing astronomy's "method of averages" to people. Unfortunately, this factory-model, assembly line system, while effective in the mass-creation of everything from coffee pots to automobiles, dictates the least effective way to teach actual human children: a passive process in which teachers talk and students listen (Everybody Counts: A Report to the Nation on the Future of Mathematics Education: Summary, 1989). This experience is what most learners have been engrained to expect from education, that they acquire a set of steps and repeat those exact steps to validate the knowledge transfer

(Harapnuik et al., 2018) so naturally the approach rolls forward into generation after generation, as old system's students eventually become the same system's caretakers. Horn et al. (2017) also addresses that there is hesitation for change because the perception of risk in reputation and professional assets is great, especially in highly ranked schools.

Education of the Present and Future

Hesitation to transition from the past into the future of education only dissipates when the future structure produces superior results compared to the coveted traditional system (Horn et al., 2017). The current educational system is a mixture of factory-model, assembly line system classrooms and innovative environments, creating hybrids that incorporate both worlds in the attempt to maximize comfort and effectiveness. Harapnuik et al. (2018) compared the traditional teacher-centered classrooms with student-centered classrooms. Teacher-centered classrooms put the teacher at the center of attention, presenting an inherently specific approach to content and limiting the learner's voice, choice, and ownership. Student-centered classrooms put the learner at the focus, identifying the learners' needs and building structures to promote choice and voice, and ultimately ownership, in an authentic learning environment. The challenge, of course, is knowing what will and will not work to produce the latter results (Horn et al., 2017). Thankfully, any educational approach that starts with the learner at focus produces positive results (Harapnuik et al., 2018). According to *Everybody Counts: A Report to the Nation on the Future of Mathematics Education: Summary* (1989), when we compare our current system's stagnant factory-model, assembly line system to a potential system-wide shift to a learner-centered approach, there is no other option but to make immediate strides to facilitate change. Recent decades have illustrated that society cannot afford to be complacent and expect these innovations

to occur naturally (Horn et al., 2017); local leaders must respond to the decades of research that have only been partly heeded.

Education and Standardized Testing

According to Gallup (Inc, 2022), Americans have never been less satisfied with the nation's education system. Americans are dissatisfied for three overlapping reasons: 65% believe there are problems with the curriculum or educational approach, 15% believe the curriculum is poor and/or outdated and 9% believe students are not learning adequate life skills. The American public seems what many administrators and other stakeholders do not. They see that now is the time to shift from the present average methods that produce average students with average results to innovative environments that prepare students for a relentlessly adaptive future (Harapnuik et al., 2018). The current data shows that the current educational approach is not generating growth or superb results.

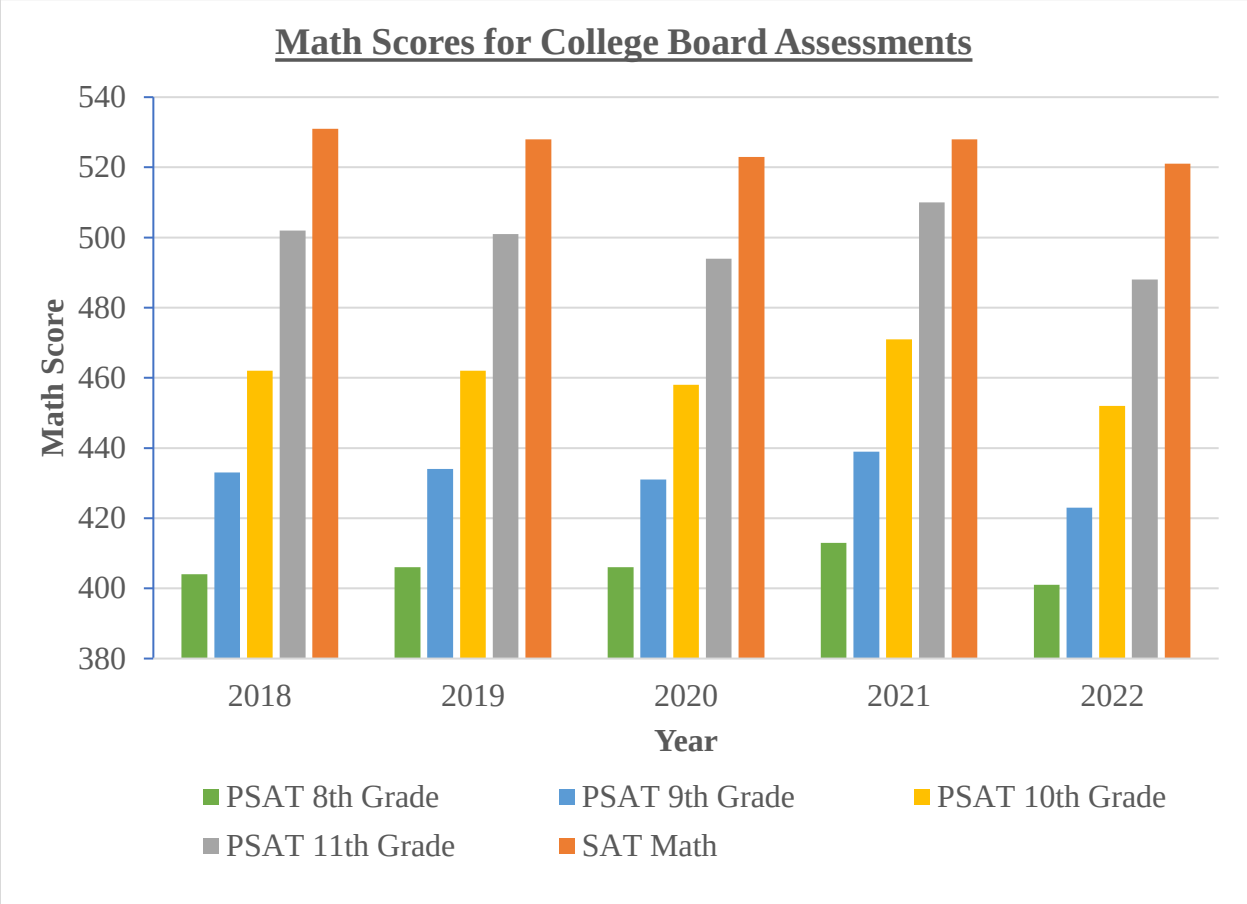
According to the National Assessment of Educational Progress (NAEP), while there was no substantial overall change for average seniors scores between the years 2015 and 2019, the gap between higher and lower performing students widened (*NAEP Mathematics: National Average Scores*, n.d.). This downward trend is likely to continue in both mathematics and English. The NAEP reports a decrease in fourth-grade mathematics scores in forty-one states and a decrease in eighth-grade mathematics scores in all states except Utah, which produced no change (*NAEP Mathematics: Mathematics Highlights 2022*, 2022). For English, NAEP reports declines in scores over the past three years in thirty states for fourth-graders, thirty-three states for eighth graders (*NAEP Reading: Reading Highlights 2022*, 2022). In fact, the NAEP reports score declines across all demographics in 2023. Absenteeism is also on the rise, with more than a

quarter of students missing more than three days of school per month (*NAEP Long-Term Trend Assessment Results: Reading and Mathematics*, n.d.).

National standardized testing scores, such as the SAT, have been on the decline for the past five years (*SAT Suite of Assessments Annual Report*, 2018-2022). 2021 does seem to show some growth, but it is necessary to consider how the educational system operated during the school year. A majority of schools were operating under pandemic guidelines, including precautionary steps for social distancing, and this meant standardized testing environments needed to meet the same requirements. There were no digital options available and numerous universities, including all the ivy leagues, dropped the SAT score requirement for application and admission (Jaschik, 2020). Because of these circumstances, amongst others, the number of test-takers dropped by about 50%. It is likely that those still able to test were in affluent communities with access to the resources to navigate the pandemic's precautions and regulations more safely.

Figure 1

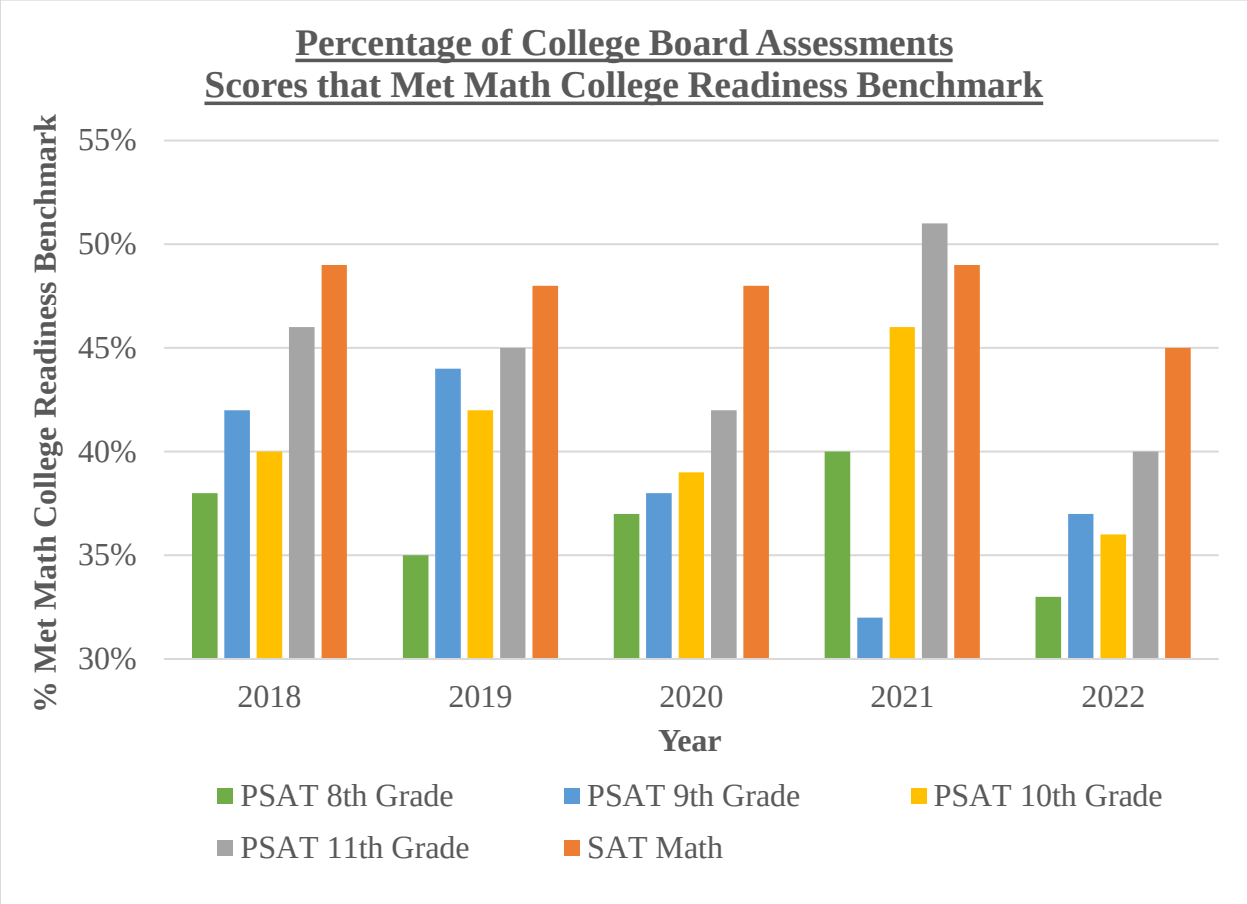
Math Scores for College Board Assessments



Note. Tabular data can be found in References Table 1.

Figure 2

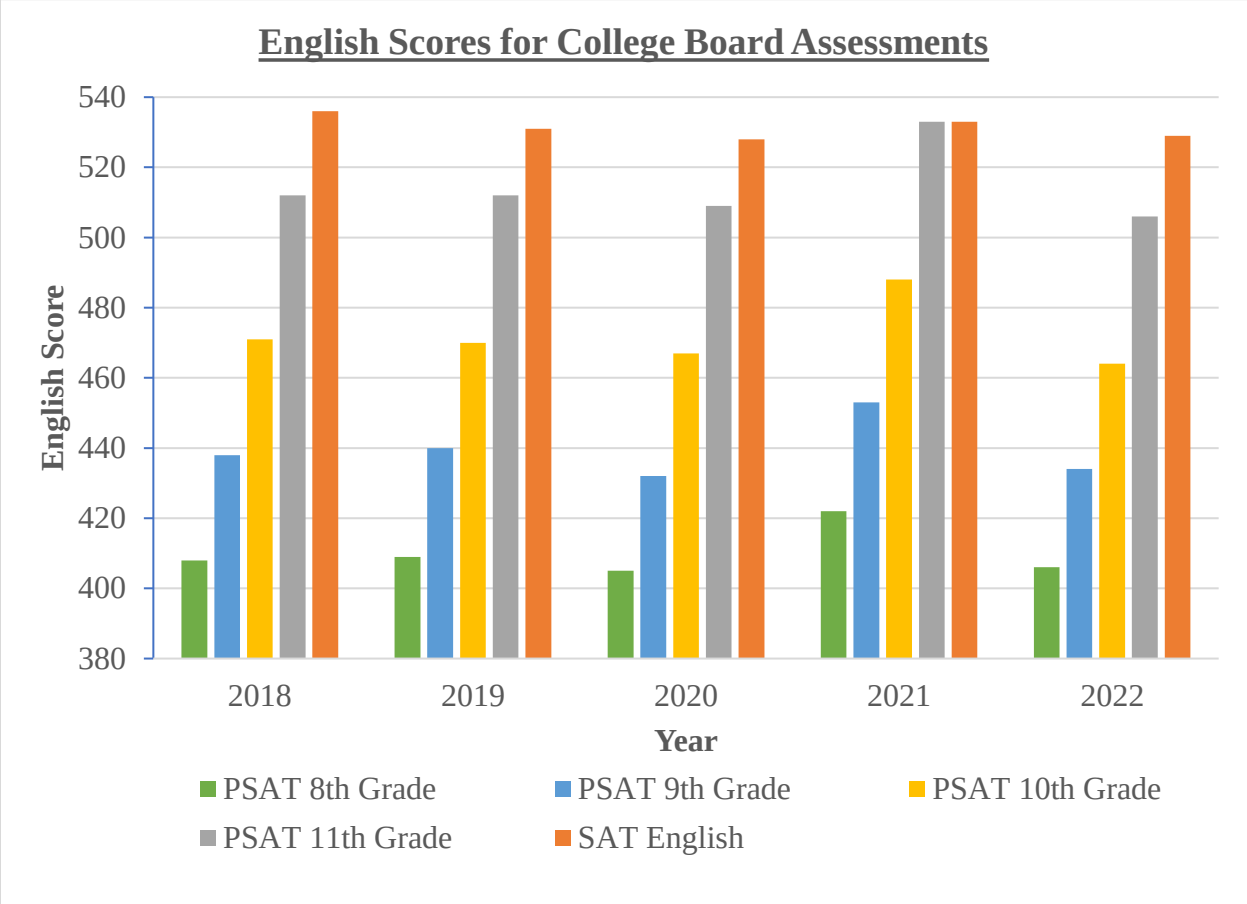
Percentage of College Board Assessments Scores that Met Math College Readiness Benchmark



Note. Tabular data can be found in References Table 1.

Figure 3

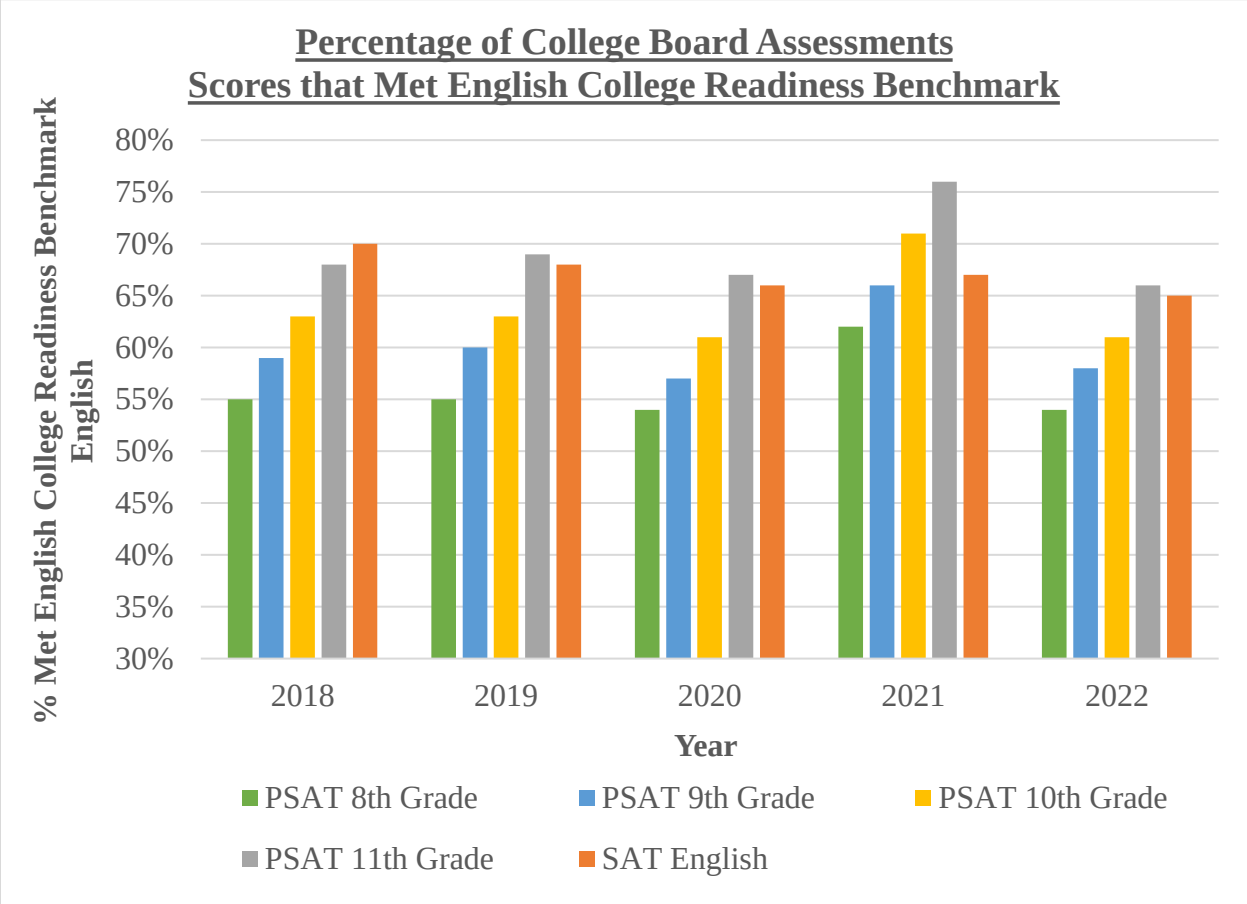
English Scores for College Board Assessments



Note. Tabular data can be found in References Table 2.

Figure 4

Percentage of College Board Assessments Scores that Met English College Readiness Benchmark



Note. Tabular data can be found in References Table 2.

The College Board is making significant changes in its testing procedures. The PSAT will be an online, adaptive test in fall 2023 and the SAT will follow suit in spring 2024. It may seem as though the assessment's adaptive nature means progress towards assessing individuals, the tests still group students into categories, labeling their ability to learn and grow with a stagnant, singular grade. Meanwhile, there is a missed opportunity to engage students in ways that do not simply prepare them for standardized tests that keep the door open to college. There are missed opportunities to give them the tools and skills to stay in higher education until they

choose to leave, as labeling them from the outset with a single number that very likely has little to do with the skills that truly matter in college and career. When learners get to engage in genuine assessment, one that meaningfully connects knowledge, analysis, and creativity, they create solutions to actual problems in the world into which they soon graduate (Harapnuik et al., 2018).

Education and the Workplace

There is more to education than academic knowledge; students should learn characteristics and skills that make them positive contributors to society and the workplace. The National Research Council (2006) found that employers seek employees with 21st-century skills and lament the current disconnect between their needs and the quality of potential workers produced by the traditional educational system. Additionally, as the workplace changes and specialized vocational skills rapidly cycle from critical to obsolete, employees must actively seek opportunities to maintain relevance. The education system needs to foster an independent workforce comfortable with self-directed, lifelong learning.

According to Horn et al. (2017) the factory-model, assembly line system restricts learner growth in developing these requisite 21st-century skills. These skills in the current and future workplace are necessary because work has become more mentally stimulating and taxing, more technologically driven, more communicative, and more diverse (*Everybody Counts: A Report to the Nation on the Future of Mathematics Education: Summary*, 1989). Caroline B. Lacampgne from the U.S. Department of Education said jobs exist now that did not when workers were in school, and education should not simply cope or react to, but participate in change (Mathematical Preparation of the Technical Work Force, 1995). As businesses transform due to rapid technology shifts, education needs to follow suit (*World Economic Forum Future of Jobs Report*,

2023). However, according to Raizen (1982) and Powell et al. (2015) the educational system still tries to prepare learners for the future without actively incorporating the methods of the future workplace. Because the price of not adequately preparing the next generation for the technological world is grave and enduring, educators must look outside the current perspectives of their field and create new innovative ideas, processes, and solutions, while incorporating technology as a tool to accomplish this goal (*The Role of Applications in the Undergraduate Mathematics Curriculum*, 1979).

Intentionally incorporating real-world applications beyond predictable, formulaic textbook word problems will prepare learners for life beyond the classroom as they begin to interact with information and build connections, developing skills that will transfer to innovative workplace environments (Harapnuik et al., 2018). Deborah A. Zopf from Henry Ford Community College mentions that a new learning environment must bridge academic and work worlds, incorporating technology and understanding how the technology performs (Mathematical Preparation of the Technical Work Force, 1995). Conveniently, these innovative structures provide authentic application of content, deliberately integrating technological tools to enhance the blended learning environment and aligning with the global industries that utilize technology for collaboration and communication on a global scale (Pelletier et al., 2021).

There are some who call for different entry points into highly skilled careers other than a college degree. As the number of workers with traditional college degrees decrease and powerful technological companies, such as Google, Apple, and Tesla, remove the college degree requirement, the secondary classroom is the only opportunity for learners to obtain the 21st-century skills prior to high school graduation. Developing these skills will allow employees to actively engage in a company’s micro-credentialing programs that introduce and strengthen an

employee's projected professional abilities and business standards (Pelletier et al., 2022). Moreover, as the life expectancy increases, learners are staying in the workforce longer, so learning will have to continue in later life to either maintain the current employment or be attractive to potential new employers (Pelletier et al., 2023).

Blended Learning Environment

Blended learning environments embrace the variety of technological tools available in education to construct authentic learning opportunities. These opportunities require student control over timing, place, pathways, and/or pacing (with online components), empowering the educator to accomplish more with this structure as they assist students not only with what to know but also what to do and how to participate in society (Horn et al., 2017). Alexander et al. (2019) explained that technology and digital integration through several accessible modalities must be leveraged in the learning design to support all learners in critical thinking and complex problem solving. The purpose of educational technology is to drive learners towards accomplishing desired outcomes, and the goal of a blended learning environment, according to Harapnuik et al. (2018), is to create a space that is "learner-centered, engaging, motivational, contextual, experiential, and authentic" (p. 62).

The station rotation model is a blended learning environment structure that incorporates three main stations: teacher-led instruction, online instruction, and collaborative activities and groups (Horn et al., 2017). The station rotation model creates a blended learning environment that develops a learner's comprehension of the traditional academic content in a conceptual context that has a variety of representations (Donovan et al., 2005). Initially, learners might resist this transition because, according to Harapnuik et al. (2018), they find comfort in the traditional classroom where the teachers are lecturers and expect students to simply regurgitate content, but

as they experience a blended learning environment and the individualized support that comes with the authentic learning experience, students ultimately prefer blended learning environments (Alexander et al., 2019). According to the National Academies of Sciences, Engineering, and Medicine (2018) there is evidence to support that when provided meaningful opportunity, simply having a chance for learners to choose any of these opportunities builds autonomy, learning, and achievement.

There is another misconception that technology will replace educators. Horn et al. (2017) addresses the feelings of those naysayers, suggesting they are dissatisfied and detached, negatively affecting the learners' environment. We have an opportunity to build blended learning environments that allow learners to reach their full capacity as the relationships between ideas become real and applicable to their lives outside of the classroom (National Research Council et al., 1998). According to the National Research Council (2006), learning must progress beyond collecting and memorizing surface-level knowledge and venturing into exploring and connecting interdisciplinary knowledge and concepts.

Every Learner Everywhere, Digital Promise, and Tyton Partners conducted a survey in 2020 after the unexpected transition to remote learning. The survey found that learners felt increased satisfaction when the conventional aspects they were comfortable with were incorporated into digital learning (Pelletier et al., 2021). Blended learning environments and the station rotation model involve both components of in-person and online learning opportunities. The past few years have demonstrated that when diverse modalities are intentionally integrated in the blended learning classroom, education cannot only grow the framework and approach to teaching, but also expand the resources available to properly implement these modalities (Pelletier et al., 2022).

When Horn et al. (2017) examined the implementation of a blended learning environment across an entire campus, they found that the most impactful environment occurred when small groups of learners received the "lecture" from the teacher; the small-group instruction allowed teachers to respond to questions and facilitate collaborative dialogue. This came from student choice, as all students had the opportunity to attend the lectures, but a majority chose other modalities, such as collaborative groups and online-instruction platforms, making the learning active and no longer passive. Blended learning environments create personalized paths that both deliver choice regarding how, what, and where learners obtain knowledge and build connections and that enable student voice (Powell et al., 2015). Eliminating the suppositions of an educator's role and actions according to the factory-model, assembly line system is vital to creating this blended learning environment success and effectiveness (Horn et al., 2017).

Blended learning environments can also develop connections between content and skills. According to the National Academies of Sciences, Engineering, and Medicine (2018) learning is promoted by variable learning and interleaving, occasions when a learner practices skills using various methods within a mixture of activities. Stations that are successful at incorporating tasks that provide learners with the ability to control learning elements (Kershner et al., 2010) while integrating structures within the resources to comprehend and connect complex concepts (Means et al., 2015). Collaborative activities built within the station rotation model also give learners the chance to articulate their learning using multiple representations, further building on the success of the blended learning environment (Tarchi et al., 2013). Learners who interact with the real world will start to appreciate the multiple facets of the world and society while understanding that learning cannot be compartmentalized because it is about connections (National Research Council et al., 1998). Through these approaches, education can start to reduce and eliminate the

prominence of fact regurgitation, thus increasing and embracing the interconnection between different academic disciplines and 21st-century skills (Raizen, 1982).

The online components of blended learning environments and the station rotation model's online instruction components are not technology for technology's sake. As personal computers become nearly ubiquitous Raizen (1982) defined what blended learning is not: online textbooks. Online textbooks – a simple transfer of the physical paper versions to digital form - are not what enhance learning; how textbooks are used to engage learners is what matters. The National Academies of Sciences, Engineering, and Medicine (2018) highlights how technology can, if applied in a learner-centered approach, bring people together and out of isolation, enriching social connections in a blended learning environment. Online tools can also provide opportunities to introduce more advanced concepts in a safe environment that encourages exploring and analyzing with less time spent by the teacher developing those enrichment lessons (National Research Council et al., 1998). According to Patrick & Sturgis (2015)

> "Technology has dramatically changed the potential of how [educators] can deliver instruction and assess learning, allowing [educators] to rethink our methods of providing highly effective instruction at any time and any place, opening up opportunities to personalize education and enabling [educators] to stretch learning [for students] beyond the classroom and school day" (p. 5).

A part of technological integration must be continuous evaluation of the effectiveness of the tools to improve and adapt to achieve ideal results (National Academies of Sciences, Engineering, and Medicine, 2018).

Blended learning environments and the station rotation model can be designed to engage learners in a variety of manners, address a diverse learner population, and align with academic

objectives and goals while also removing barriers on the breadth and depth of learning (Pelletier et al., 2023). They also move away from retaining information in short-term memory to get through a unit assessment and more towards competency learning, continuing to work on problems until achieving success, regardless of the timeframe (Horn et al., 2017). Blended learning environments allow for education to really develop 21st-century skills in the context of academic domains.

21st-Century Skills

21st-century skills include creativity, curiosity, flexibility, critical and analytical thinking, metacognition, reflection, motivation, and self-awareness. Each of these critical skills is developed and nurtured through the communication and collaboration inherent to a blended learning environment.

Creativity

Creativity, or creative thinking, ranks at the top of the *World Economic Forum Future of Jobs Report* for 2023 as a core skill and can be formally defined as producing ideas to solve problems or improve situations (Marr, 2022). The factory-model, assembly line educational system currently incorporates a rigid, closed-minded mechanism for acquiring and applying knowledge, as teachers tend to explain the process that is most efficient or reasonable to them, closing off the exploration and creativity that can come with applying prior knowledge in deeper ways (Horn et al., 2017). According to E. M. Forster, “spoon feeding in the long run teaches us nothing but the shape of the spoon” (Forster, 1951). To develop learner capability and openness to being creative, a blended learning environment must be provided that incorporates challenging problems in new context, nudging the growth of learners’ creativity as they apply and adapt the academic knowledge and relationships they have already discovered and learned (Patrick &

Sturgis, 2015). When they learn how to react to trials in the form of new, unfamiliar problems through significant, meaningful learning environments, they will develop a skill set that will transfer to occupational situations (Pellegrino & National Research Council Committee On Defining Deeper Learning And 21t Century Skills, 2012).

Curiosity

Curiosity enhances creativity. The *World Economic Forum Future of Jobs Report* (2023) includes curiosity and lifelong learning as the fourth skill in their top ten list of skills employers seek and will continue to seek over the next five years. Having curiosity embodies the mindset that learning does not stop after formal schooling; moreover, curiosity allows students to meet their full potential, embracing and enhancing all the other 21st-century skills to continue to learn and grow (Marr, 2022).

When implementing blending learning, learners can practice utilizing tools they will undoubtedly need and find useful in college and career. Blended learning environments, especially the station rotation model, forces learners into a variety of situations where their individual and collective curiosity can be nourished. Structures that push for exploration and questioning provide learners the opportunity to see their current boundaries and then work beyond those boundaries, expanding their personal and community perspective of what can be accomplished now and what has not been accomplished yet but is still possible for the future. This goes hand in hand with communication and collaboration; if a learner can share their ideas and hear those of others, the connections they make strengthen their personal point of view, bending and flexing to incorporate the new ideas of others they had yet to consider and build a stronger voice and purpose for continuing the learning.

Gradually, the blended learning environment can adapt to one where learners identify and interact with the modalities that meet their needs. The choice of modality brings power to curiosity and learning; it assists them in recognizing that after exploring different learning modalities and being curious about others, they have the metacognitive ability to determine and advocate for the modality that best empowers their growth (Harapnuik et al., 2018). This can be transferred to the workplace; according to Horn et al. (2017), becoming a lifelong learner provides learners the skills to adapt to a rapidly changing world where specific knowledge and skills become outdated quickly and are replaced with new technological advancements and better understanding of our world.

Additionally, as society transitions from considering college as the only viable option to obtain a lucrative job, microcredentials are becoming more popular, especially because more than 75% of the workforce does not hold bachelor's degrees but many jobs require technical competency (*Mathematical Preparation of the Technical Work Force*, 1995). To be successful at these microcredential programs, lifelong learning must be engrained in one's nature. This alongside curiosity can be taught within a blended learning environment. When we provide blended learning environments in the classroom, Pelletier et al. (2022) says we are providing exposure to the similar commercial learning platforms companies are turning to for micro-credentialing.

Curiosity and lifelong learning will also assist in adapting to changes in life expectancy and retirement age forecasts. According to Pelletier et al. (2023), as life expectancy extends, so do work lives, and rapid advancements within the workplace intensify requirements and demands for lifelong learning. The transient nature of the workforce, where workers are seeking more influence, representation, collaboration, and independence (Freeman et al., 2006), also

incentivizes companies to meet the employees' wants and needs within the working environment by providing learning opportunities that align with the company's vision but also with the individual's goals (Pelletier et al., 2023). In education, there are requirements that need to be met to obtain a diploma, but there is flexibility for learners to choose specific courses that capture their interest. Teachers, using blended learning environments, can also provide this flexibility to engage learners in personal curiosities and lifelong learning.

Flexibility

Being open to change, having resilience, and fixing one's focus onto learning opportunities and not perceiving struggle as an obstacle (Marr, 2022) are examples of demonstrating flexibility; flexibility is in the top five skills identified by Fortune as a necessary skill in the 21st-century workplace (World Economic Forum Future of Jobs Report, 2023; Thier, 2023).

Flexibility comes in many forms. Perhaps most meaningfully, flexibility interacts with creativity and curiosity because analyzing and critiquing a new idea or perspective requires flexibility to adapt and develop a new voice. This means that restricted, inflexible mindsets suppress creative, curious approaches to novel circumstances. Learners benefit from learning how to be flexible when unforeseen circumstances arise, especially when initial solutions are no longer viable. Because technology itself is constantly changing, a blended learning environment, one that incorporates the station rotation model, for example, creates opportunities for teachers to incorporate flexibility in student choice, teach flexibility by using a variety of different platforms and hardware, and give students choice and ownership when technology does not necessarily work as the student or teacher intended.

Flexibility also creates capacity for perseverance. When purposeful struggle is intentionally incorporated into the blended learning environment through tasks or problems that are demanding yet not inhibiting, learners use their flexibility to rethink, readjust, and adapt within trial and error (Donovan et al., 2005). The expectation to use mistakes and setbacks as the learning opportunities exemplify this diligence. This also requires teachers to have flexibility to meet learners where they are and adapt the questioning and structure to provide a more engaging, authentic opportunity for the learner to really learn and grow. Learners who have internalized a fixed, inflexible mindset tend to shut down because of the fear of failure or their perceived inability to not build connections between the present and prior knowledge. A growth mindset which would allow the learner to exhibit grit and work through the struggle. As learners study to identify that the process of learning is more than the product, they become more prepared for the real world and the workplace. According to Harapnuik et al. (2018) “Ownership of learning is all about building the adaptability, confidence, character, grit, and a growth and learners’ mindset that is required for our learners to address the problems and challenges of the complex world in which we live" (p. 84).

A traditional classroom finds value in checking off a unit being finished, but more time and flexibility are necessary to foster deep authentic learning and understanding (National Research Council et al., 1998). These frequent opportunities through blended learning to truly make sense of the concepts and patterns build flexibility and perseverance (Kilpatrick & Swafford, 2002). Once learners move past the resistance and discomfort of a new blended learning environment that counters their past experiences of a factory-model, assembly line system, the flexibility they learned in the station rotation model transfers to future educational

opportunities because according to Pelletier et al. (2023), they want more flexibility and convenience in the delivery of education.

Critical and Analytical Thinking

According to Marr (2022), critical thinking means analyzing problems and circumstances based on evidence while questioning the legitimacy of the information. Analytical thinking is ranked as the most essential skill employers need employees to have when entering the workforce (*World Economic Forum Future of Jobs Report*, 2023). Part of critical and analytical thinking is the determination of what information is benefiting one's learning and what information deters from building connections (Harapnuik et al., 2018). Blended learning environments and the station rotation model allow teachers to establish routines and strategies that encourage learners to make personal conclusions and learn how to critically think to incorporate in other areas of their life, especially in the workplace.

Another aspect of critical thinking is justifying one's perspective or answer, a process which both requires and fosters effective communication. When a learner can explain and justify their reasoning, they are able to critically think and consider the logical patterns of the context's language. If the logic is sound and effectively communicated, then the deeper authentic learning is nurtured and available for future thinking (Kilpatrick & Swafford, 2002).

When blended learning environments are implemented, especially the station rotation model, teachers can provide a variety of modalities for students to incorporate critical thinking. Critical thinking applies to the technology utilized in the various stations and can potentially connect to other academic content areas outside the class's required content. Through choice and ownership of learning, students can develop a personalized process of analyzing information and unique ways to express their own-built information and knowledge base, which will prepare

them for future opportunities as adults in society (Pellegrino & National Research Council Committee On Defining Deeper Learning And 21st-Century Skills, 2012). As learners develop a sense of what is appropriate or not when applying technology, they can leverage technology's power to perform the more mundane tasks and open their minds to the deeper authentic learning (National Research Council et al., 1998).

Analytical thinking is a component of problem solving. Analysis and synthesis of knowledge also incorporates other skills, such as creativity and flexibility, because as the problems change and transform with new information or new success criteria, students must think critically and consider how the change in parameters requires a change in perspective and allows different connections (National Academies of Sciences, Engineering, and Medicine, 2018).

In a blended learning environment, technology should not do the problem solving explicitly, but it should certainly be used to nurture and extend problem solving and analytical thinking. Technology can be used to perform more basic processes involved in problem solving but determining whether or not the output is valid requires critical thinking. Students must know how to use the tools and analyze the results, as well as use those results to build bigger conclusions, new perspectives, and richer connections (National Research Council, 2006). As the new thoughts and results are collected, they open the opportunity for problems to have more than one correct solution or more than one path to get to a particular set of solutions (National Research Council et al., 1998). Critical thinking can also develop by analyzing the results of others' efforts; perhaps a station in the rotation could require collaborative discussion or access to a technology platform that expresses the ideas of others.

Critical and analytical thinking are developed over a significant period, so blended learning environments build time to visit the different modalities and learn what works and what does not. Learning to distinguish between thinking that is inaccurate and thinking that is accurate allows students to develop a voice they can use to express their ideas, and teachers can use blended learning environments to create opportunities to facilitate this discourse so that learners can express their ideas and analyze and address misconceptions (National Research Council et al., 1998).

Metacognition, Reflection, and Feedback

Metacognition, reflection, and feedback are 21st-century skills that portray a person's ability and awareness to self-regulate their actions and behaviors (National Academies of Sciences, Engineering, and Medicine, 2018). When learners embrace thinking about thinking, they personally control their learning because they establish their goal, follow, monitor, and adjust their progress towards that goal (Pellegrino & National Research Council Committee On Defining Deeper Learning And 21st-Century Skills, 2012). This transitions learners from the classroom to the real world, as it establishes a progression from external to internal, from the extrinsic rewards of grades and accolades to the intrinsic rewards of growth and purpose (Donovan et al., 2005). They also see the relationship their perspective has on the world and how their impact can be a positive contribution to society. According to the National Academies of Sciences, Engineering, and Medicine (2018) learners demonstrate the most success when they exhibit mindfulness and sustain their learning beyond the classroom.

Pellegrion & National Research Council Committee On Defining Deeper Learning And 21st-Century Skills (2012) posit that metacognition can be clearly taught by exposing learners to mental devices that address self-monitoring, self-regulation, and self-correcting, which are

desirable for learners as long as they are explicitly connected to academic content (Harapnuik et al., 2018). While this ability to think about thinking naturally develops over time (Karmiloff-Smith, 1979), there is always opportunity to allow students to reflect on their learning and the feedback they receive from peers and teachers which will promote and sustain changes in behavior that build 21st-century skills (National Research Council et al., 1998).

Reflection and critical thinking go hand in hand, especially when considering sequence of thinking and finding flaws in one's understanding and connections. As students reflect on the different strategies they have utilized in their work, they maintain engagement in the learning and consider how to make minor adjustments in reasoning for more complete comprehension and efficiency. There are instances when multiple creative ideas arise to solve a problem or answer a question; analyzing the advantages and disadvantages and reflecting on the perspectives from which these disparate ideas come is something employers are looking for. Understanding why something is wrong is equally as important as why something is right (Donovan et al., 2005). Metacognition introduces self-regulation, and according to the National Academies of Science, Engineering, and Medicine (2018) "Self-regulation allows them to more effectively direct their cognitive activity by voluntarily setting learning goals, identifying methods for achieving them, actively pursuing those methods, and tracking progress toward the goals" (p. 72). The learner will obtain knowledge and connections between their knowledge and prior understandings and experiences more speedily than if they were never to receive feedback at all (Pellegrino & National Research Council Committee On Defining Deeper Learning And 21st-Century Skills, 2012).

This self-regulation comes from self-reflecting not only on student thinking, but also the impact of actions and emotions on themselves and others. According to Patrick & Sturgis (2015)

teachers must assist learners in managing their emotions by promoting strong relationships and a culture in which learners are actively engaged in all aspects and feedback can play a crucial role in the depth of reflection. When a teacher provides feedback, the teacher is actively engaging the learner in metacognition. According to Jensen et al. (2022), to be effective, feedback should be provided quickly at intentional points of the learning cycle, respectfully emphasizing strengths and areas needing improvement, all in the context of the learner's personal progression and in a supportive, motivating manner (National Academies of Sciences, Engineering, and Medicine, 2018). According to Horn et al. (2017) feedback that cannot be acted on by learners has a negative impact on overall learning, but being intentional about explaining to learners the purpose of the feedback leads them to becoming self-assessing and actively seeking feedback from others (Donovan et al., 2005). This also means that learners providing feedback to each other must be supported with resources, like rubrics. As learners become more proficient with providing feedback, they will create almost an infinite loop of reflecting on the feedback they give and receive, creating a community that supports each other and takes ownership of their personal learning and the learning of others (Jensen et al., 2022).

In a blended learning environment, according to Donvan et al. (2005), providing learners opportunities to experiment with their ideas and determine the validity of their perspective, as well as supporting self-assessments through written and oral discussion, helps the individual deepen their understanding and voice. They have increased their ability to think about their thinking and how it progresses through the learning process, using data and reflection, which then leads to success in the workplace (Brown et al., 2020). As this metacognitive perspective strengthens and adapts, learners can start asking their own questions in relation to their prior knowledge to build on that thinking and insight, developing new insights for themselves and

others (National Research Council et al., 1998). Blended learning environments can aid in metacognition, reflection, and feedback because the online interactions between the learner and other learners, their teacher, and society broaden a student's perspective (Jensen et al., 2022). This makes the teacher more of a facilitator, shifting away from the lecture model to one in which the blended learning environment's connection to the world through the internet at a specific station can provide equally valid and impactful feedback (Pellegrino & National Research Council Committee On Defining Deeper Learning And 21st-Century Skills, 2012).

Motivation and Self-Awareness

Two 21st-century skills that are a part of *World Economic Forum Future of Jobs Report* (2023) top ten skills – motivation and self-awareness - are not commonly associated with the other skills mentioned. Society might consider that motivation and self-awareness are inalterable aspects of a person's personality and self, but they both come from experience and are enriched by the reflective process. According to Horn et al. (2017) a survey conducted in 2013 found that teachers rank student motivation as the biggest challenge in the classroom. The focus on what motivation looks like to each individual and having the self-awareness of one's motivation and the motivations of others gets people beyond understanding what they do, and how they do it, but the root of why they do what they do (Harapnuik et al., 2018). When learners do not engage in the why, they miss a critical part of the authentic learning that happens because they are not taking personal ownership but rather relying on the reasoning of others that it must be important for some reason. Horn et al. (2017) says learners desire to feel success and enjoy life. The blended learning environment removes a potential barrier the factory model of education presented, the barrier of feeling failure and lacking joy, by tapping into students' genuine motivations and building student self-awareness to identifying these motivations.

The National Academies of Sciences, Engineering, and Medicine (2018) says that social acceptance takes priority as a motivator during adolescence, but teachers can explicitly introduce motivating lessons through a blended learning environment and the station rotation model. When students have choices and can authentically connect with the lessons, they are indirectly learning what personal, academic motivation feels like and then finding that motivation as they learn and connect with more content (National Research Council et al., 1998). This builds their capacity to bring this motivation and self-awareness into the workplace and its development in a blended learning environment will determine how much and how well they continue lifelong learning in new scenarios. Teachers support learners' motivation by meeting individualized student needs in a blended learning environment where they feel protected and valued (National Academies of Sciences, Engineering, and Medicine, 2018).

Communication and Collaboration

The only way to determine if a learner is developing these 21st-century skills is through effective communication, another skill necessary for learners to face the challenges of tomorrow and become people who can reach their full potential (Pellegrino & National Research Council Committee On Defining Deeper Learning And 21st-Century Skills, 2012). Communication can be embedded in a blended learning environment and the station rotation model, as different modes of communication can occur at different stations and the degrees of communication can also be developed. The roles learners have in conversations are also developed by these processes, giving them choice, ownership, and voice in the authentic learning environment, and helping them to improve self-monitoring and metacognition (Donovan et al., 2005). As learners communicate their ideas and reflections, they engage in the community to reveal their individual strengths and areas of improvement (Harapnuik et al., 2018). They are also reconnecting with

their motivations of feeling successful and building positive healthy relationships (Horn et al., 2017). As learners build on their prior knowledge, they bring their perspective and experience to a new task and communicate their findings, further cementing the perception of their understanding (National Research Council et al., 1998).

Blended learning environments can provide whole group discussions during teacher-led instruction that transition from the teacher leading with questioning and cues to one where students facilitate the conversation. According to Horn et al. (2017) learners become teachers as the classroom community learns how to learn and teaches how to teach. Empowering learners through whole group discussion gives them deepened understanding while developing a sense of purpose on how their view is significant to the blended learning environment (Harapnuik et al., 2018). This connects with the workforce, where the smaller groups inside companies have different perspectives that can impact the overall company's success. Being able to effectively articulate one's thoughts, views, and perspectives on information is vital to overall success.

Blended learning environments can also support smaller group communication. While there is valid concern that discussions could be incorrect or at times off topic, Kober (2015) calls on research that even if learners initially do not know a correct answer to a problem, the active communication learners engage in leads to better comprehension and retention than if the teacher were to do the thinking and explaining. The National Research Council et al. (1998) articulates that learners need time to explore questions and wrestle with some degree of uncertainty to develop a variety of representations that communicate their reasoning. Teachers can also assess a learner's prior knowledge and experiences to further enhance the discussions by incorporating new perspectives and addressing misconceptions. Specific to math blended learning environments, Donovan et al. (2005) states

> "One important way to make students' thinking visible is through math talk—talking about mathematical thinking. … Instead, students and teachers actively discuss how they approached various problems and why. Such communication about mathematical thinking can help everyone in the classroom understand a given concept or method because it elucidates contrasting approaches, some of which are wrong—but often for interesting reasons. Furthermore, communicating about one's thinking is an important goal in itself that also facilitates other sorts of learning" (p. 228).

The online components of blended learning environments also broaden the opportunities learners have to build their communication skills. To build appropriate communication skills in an online setting, teachers must initiate the communication parameters and facilitate the conversation. As learners engage with the teacher and other learners, the teacher can strategically withdraw from the debates and evaluate how much teacher voice is required to maintain appropriate and relevant communication between learners. According to Jensen et al. (2022) too much teach voice becomes overpowering and diminishes the learners' communication quality and quantity, but too little removes a sense of security and feeling heard. The ratio of teacher to student voice adapts as the learning progresses and students develop their own voice. Technology is utilized to facilitate the communication of reasoning with multiple representations that oral discussions cannot, including symbolically, graphically, and with models (National Research Council et al., 1998) and nurturing a blended learning environment that intentionally incorporates these tools cultivates learner agency and responsibility, two other characteristics desirable to have in the workplace (Powell et al., 2015).

Other aspects of 21st-century skills build on inter-personal skills, especially the ability to collaborate in pursuit of a mutual goal (Ponz, 2001). According to Marr (2022), collaboration

must be with people from numerous places and shared spaces. Authentic learning environments cannot be authentic without the collaboration opportunities (Mathematical Preparation of the Technical Work Force, 1995). The National Academies of Sciences, Engineering, and Medicine (2018) compiled several research studies that recognize learning is most beneficial in complex collaborative tasks. Blending learning environments can incorporate various structures to facilitate these tasks and allow learners to have choice on their problem-solving approach, ownership of their learning through dividing responsibilities and reflecting on progress, and voice when communicating their ideas. Additionally, collaboration can also bring out leadership qualities, two highly ranked qualities employers look for in their future employees (Marr, 2022; World Economic Forum Future of Jobs Report, 2023; Pellegrino & National Research Council Committee On Defining Deeper Learning And 21st-Century Skills, 2012).

Technological Literacy

The *World Economic Forum Future of Jobs Report* (2023) includes general technological literacy, also called digital fluency, digital and data literacy, and information literacy, in their top ten skills employers will continue to seek (Pellegrino & National Research Council Committee On Defining Deeper Learning And 21st-Century Skills, 2012). According to Alexander et al. (2019) “Digital fluency is the ability to leverage digital tools and platforms to communicate critically, design creatively, make informed decisions, and solve wicked problems while anticipating new ones” (p. 14). Marr (2022) supports this definition, as Forbes states technological literacy is about one’s ability to use these tools confidently and carefully by critiquing and obtaining meaning in data as well as effectively communicating it to others collaboratively.

Blended learning environments, such as the station rotation model, intentionally provide opportunities to build technological literary with a variety of platforms and devices. To counter the misconception that students should know how to use technology because of their abilities to use cell phones and play video games (Raizen, 1982), teachers must educate learners how to use the device and create accessibility to even more learning (Alexander et al., 2019). Using a variety of technological tools not only builds literacy, but it also incorporates differentiation to meet learner needs, such as learning preferences and paces, resulting in a transition from knowledge transmission to learning stimulation (Everybody Counts: A Report to the Nation on the Future of Mathematics Education: Summary, 1989). As a whole, technology should not be used solely because it exists, but be intentionally incorporated to enhance the blended learning environment and extend reach of academic content (Everybody Counts: A Report to the Nation on the Future of Mathematics Education: Summary, 1989).

There is a balance within technological literacy: one must determine what is effective and valid without contributing to an overload of superfluous information. Teachers must provide learners with the structure to make appropriate choices about what will develop their understanding (Harapnuik et al., 2018). A blended learning environment using the station rotation model provides that structure as stations can incorporate the foundation of choice while also giving learners an opportunity to express their voices on what choices do and do not work to meet their needs. Learners can also reflect on the different resources' effectiveness, developing a sense of a tool's appropriateness for individuals and the collective group. Through a blended learning environment, learners acquire technological literacy, becoming assets in the workforce where technical competency, including reading, writing, and analyzing technical documents, is

required more often than a formal education (Mathematical Preparation of the Technical Work Force, 1995).

Conclusion

Society recognizes and deems 21st-century skills as critical for humanity's advancement so secondary education must integrate opportunities to obtain and refine these skills. Research reinforces the advantages of acquiring these skills in an educational setting, shifting from the current conditions of education to the future profound possibilities. This literature review endorses the notion that learners can acquire and develop 21st-century skills using a blended learning environment.

References

2018 SAT Suite of Assessments Annual Report. (2018). College Board. https://reports.collegeboard.org/media/pdf/2018-total-group-sat-suite-assessments-annual-report.pdf

2019 SAT Suite of Assessments Annual Report. (2019). College Board. https://reports.collegeboard.org/media/pdf/2019-total-group-sat-suite-assessments-annual-report.pdf

2020 SAT Suite of Assessments Annual Report. (2020). College Board. https://reports.collegeboard.org/media/pdf/2020-total-group-sat-suite-assessments-annual-report.pdf

2021 SAT Suite of Assessments Annual Report. (2021). College Board. https://reports.collegeboard.org/media/2022-04/2021-total-group-sat-suite-of-assessments-annual-report%20%281%29.pdf

2022 SAT Suite of Assessments Annual Report. (2022). College Board. https://reports.collegeboard.org/media/pdf/2022-total-group-sat-suite-of-assessments-annual-report.pdf

Alexander, B., Ashford-Rowe, K., Barajas-Murphy, N., Dobbin, G., Knott, J., Mccormack, M., Pomerantz, J., Seilhamer, R., & Weber, N. (2019). *Educause Horizon Report : 2019 Higher Education edition.* Educause.

Brown, M., Mccormack, M., Reeves, J., D Christopher Brooks, Grajek, S., & Educause. (2020). *2020 EDUCAUSE Horizon Report: Teaching and Learning Edition*. Educause.

Donovan, S., Bransford, J., & Council, R. (2005). *How students learn : history, mathematics, and science in the classroom*. National Academies Press.

Everybody Counts: A Report to the Nation on the Future of Mathematics Education: Summary. (1989). https://doi.org/10.17226/19079

Forster, E. M. (1951, October 7). Sayings of the Week. *The Observer*, 6.

Freeman, R. B., Rogers, J., & Russell Sage Foundation. (2006). *What workers want*. Ilr Press ; New York.

Harapnuik, D., Thibodeaux, T., & Cummings, C. (2018). *Choice, Ownership, and Voice through Authentic Learning*. Creative Commons License.

Horn, M. B., Staker, H., & Christensen, C. M. (2017). *Blended : using disruptive innovation to improve schools*. Jossey-Bass.

Inc, G. (2022, September 1). *Americans' Satisfaction With K-12 Education on Low Side*. Gallup.com. https://news.gallup.com/poll/399731/americans-satisfaction-education-low-side.aspx

Jaschik, S. (2020, June 22). *Harvard, Princeton and Stanford Join Test-Optional Colleges, for a Year*. Inside Higher Ed. https://www.insidehighered.com/admissions/article/2020/06/22/harvard-princeton-and-stanford-go-test-optional

Jensen, M., Short, C. R., Guo, Q., & Keaton, W. (2022). *K-12 Blended Teaching: Math Edition*. https://edtechbooks.org/k12blended_math

Kershner, R., Mercer, N., Warwick, P., & Kleine Staarman, J. (2010). Can the interactive whiteboard support young children's collaborative communication and thinking in classroom science activities? *International Journal of Computer-Supported Collaborative Learning*, *5*(4), 359–383. https://doi.org/10.1007/s11412-010-9096-2

Kilpatrick, J., & Swafford, J. (Eds.). (2002). *Helping Children Learn Mathematics*. National

Academies Press. https://doi.org/10.17226/10434

Kober, N. (2015). *Reaching Students: What Research Says About Effective Instruction in Undergraduate Science and Engineering*. https://doi.org/10.17226/18687

Marr, B. (2022, August 22). *The Top 10 Most In-Demand Skills For The Next 10 Years*. Forbes. https://www.forbes.com/sites/bernardmarr/2022/08/22/the-top-10-most-in-demand-skills-for-the-next-10-years/?sh=4c49a68417be

Mathematical Preparation of the Technical Work Force. (1995). https://doi.org/10.17226/9066

Means, B., Shear, L., & Roschelle, J. (2015). *Using Technology and Evidence to Promote Cultures of Educational Innovation: The Example of Science and Mathematics Education Instructional Coaching for Tech-Enhanced Approaches in Mathematics View project Center for Innovative Learning Technologies (CILT) View project Jeremy Roschelle Digital Promise Global*. https://doi.org/10.13140/RG.2.1.2795.1841

NAEP Long-Term Trend Assessment Results: Reading and Mathematics. (n.d.). www.nationsreportcard.gov. Retrieved June 21, 2023, from https://www.nationsreportcard.gov/highlights/ltt/2023/

NAEP Mathematics: Mathematics Highlights 2022. (2022). Www.nationsreportcard.gov. https://www.nationsreportcard.gov/highlights/mathematics/2022/

NAEP Mathematics: National Average Scores. (n.d.). Www.nationsreportcard.gov. https://www.nationsreportcard.gov/mathematics/nation/scores/?grade=12

NAEP Reading: Reading Highlights 2022. (2022). Www.nationsreportcard.gov. https://www.nationsreportcard.gov/highlights/reading/2022/

National Academies of Sciences, Engineering, and Medicine. (2018). *How people learn. II : Learners, Contexts, and Cultures*. The National Academies Press.

National Research Council. (2006). *Learning to Think Spatially*. National Academies Press. https://doi.org/10.17226/11019

National Research Council, Phillips, E., Akst, G., Norman, M. O., Zbiek, R. M., Confrey, J., & Resek, D. (1998). *The Nature and Role of Algebra in the K-14 Curriculum*. https://doi.org/10.17226/6286

Patrick, S., & Sturgis, C. (2015). *Maximizing Competency Education and Blended Learning: Insights from Experts Issue Brief*. http://www.aurora-institute.org/wp-content/uploads/CompetencyWorks-Maximizing-Competency-Education-and-Blended-Learning.pdf

Pellegrino, J. W., & National Research Council Committee On Defining Deeper Learning And 21st-Century Skills. (2012). *Education for life and work developing transferable knowledge and skills in the 21st-century*. Washington, Dc National Academies Press.

Pelletier, K., Brown, M., D Christopher Brooks, Mccormack, M., Reeves, J., Arbino, N., & Educause. (2021). *2021 EDUCAUSE Horizon Report: Teaching and Learning Edition*. Educause.

Pelletier, K., McCormack, M., Reeves, J., Robert, J., Arbino, N., & Educause. (2022). *2022 EDUCAUSE Horizon Report, Teaching and Learning Education*. Educause.

Pelletier, K., Robert, J., Muscanell, N., McCormack, M., Reeves, J., Arbino, N., Grajek, S., & Educause. (2023). *2023 EDUCAUSE Horizon Report, Teaching and Learning Education*. Educause.

Ponz, B. (2001). *COMPETENCIES FOR THE KNOWLEDGE ECONOMY*. OECD. https://www.oecd.org/innovation/research/1842070.pdf

Powell, A., Watson, J., Staley, P., Patrick, S., Horn, M., Fetzer, L., Hibbard, L., Oglesby, J., &

Verma, S. (2015). *Blending Learning: The Evolution of Online and Face-to-Face Education from 2008-2015 UPDATES WRITTEN BY: PROMISING PRACTICES IN BLENDED AND ONLINE LEARNING*. https://files.eric.ed.gov/fulltext/ED560788.pdf

Raizen, S. A. (1982). *Science and Mathematics in the Schools*. National Research Council. https://doi.org/10.17226/19568

Raizen, S. A., & Jones, L. V. (Eds.). (1985). *Indicators of Precollege Education in Science and Mathematics*. The National Academies Press. https://doi.org/10.17226/238

Shanker, A. (1989). *THE REVOLUTION THAT IS OVERDUE FROM INFORMATION FACTORY TO LEARNING AND TEACHING IN RESTRUCTURING SCHOOLS*. https://reuther.wayne.edu/files/64.62.pdf

Tarchi, C., Chuy, M., Donoahue, Z., Stephenson, C., Messina, R., & Scardamalia, M. (2013). Knowledge Building and Knowledge Forum: Getting Started With Pedagogy and Technology. *LEARNing Landscapes*, *6*(2), 385–407. https://doi.org/10.36510/learnland.v6i2.623

The Role of Applications in the Undergraduate Mathematics Curriculum. (1979). National Academy of Sciences. https://doi.org/10.17226/19835

Thier, J. (2023, May 1). *The skills gap is so big that nearly half of workers will need to retrain this decade*. Fortune. https://fortune.com/2023/05/01/most-important-skills-employers-want/

World Economic Forum Future of Jobs Report. (2023). https://www3.weforum.org/docs/WEF_Future_of_Jobs_2023.pdf

Tables

Table 1

College Board Standardizing Testing Data from 2018-2022, Mathematics

Year	2018	2019	2020	2021	2022
SAT Math Mean Score	531	528	523	528	521
% Met Math SAT College Readiness Benchmark	49%	48%	48%	49%	45%
PSAT 11th Grade Math Mean Score	502	501	494	510	488
% Met Math PSAT 11th Grade College Readiness Benchmark	46%	45%	42%	51%	40%
PSAT 10th Grade Math Mean Score	462	462	458	471	452
% Met Math PSAT 10th Grade College Readiness Benchmark	40%	42%	39%	46%	36%
PSAT 9th Grade Math Mean Score	433	434	431	439	423
% Met Math PSAT 9th Grade College Readiness Benchmark	42%	44%	38%	32%	37%
PSAT 8th Grade Math Mean Score	404	406	406	413	401
% Met Math PSAT 8th Grade College Readiness Benchmark	38%	35%	37%	40%	33%

(*SAT Suite of Assessments Annual Report*, 2018-2022)

Table 2

College Board Standardizing Testing Data from 2018-2022, English

Year	2018	2019	2020	2021	2022
SAT English Mean Score	536	531	528	533	529
% Met English SAT College Readiness Benchmark	70%	68%	66%	67%	65%
PSAT 11th Grade English Mean Score	512	512	509	533	506
% Met English PSAT 11th Grade College Readiness Benchmark	68%	69%	67%	76%	66%
PSAT 10th Grade English Mean Score	471	470	467	488	464
% Met English PSAT 10th Grade College Readiness Benchmark	63%	63%	61%	71%	61%
PSAT 9th Grade English Mean Score	438	440	432	453	434
% Met English PSAT 9th Grade College Readiness Benchmark	59%	60%	57%	66%	58%
PSAT 8th Grade English Mean Score	408	409	405	422	406
% Met English PSAT 8th Grade College Readiness Benchmark	55%	55%	54%	62%	54%

(*SAT Suite of Assessments Annual Report*, 2018-2022)