Teaching 21st Century Skills in a Blended Learning Environment Using Desmos Activities

A Review of the Literature

By

Ashley L. Lee

Lamar University

February 1, 2024

**Introduction**

Society knows and feels that 21st century skills are critical for humanity and its growth, especially as 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 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).

Education must incorporate opportunities to acquire these skills and research confirms the idea that learners can acquire and develop 21st century skills in the educational setting using a blended learning environment. This literature review introduces what a blended learning environment is and explores 21st century skills in a blended learning environment to begin answering the question: in what ways do components of Desmos activities impact student growth in communication and collaboration?

**Review of the Literature**

**Definition of 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).

**Advantages of Using a Blended Learning Environment**

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). 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.

The National Academies of Sciences, Engineering, and Medicine (2018) highlights how technology can, if learner-centered, bring people together, 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). Blended learning environments 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).

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 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).

**Barriers to Implementing a Blended Learning Environment**

Initially, learners might resist the transition to a blended learning environment 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. Implementing and refining the new structures just requires consistency and time. As students experience a blended learning environment and the individualized support that comes with the authentic learning experience, they ultimately prefer blended learning environments (Alexander et al., 2019). There is also a 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.

Another barrier can be funding; an allocation of funds for the technological tools, including initial purchases of student and teacher devices, maintenance and repair costs, requires significant long-term district-level planning . With hardware and software technology rapidly changing, it can be hard to predict the appropriate budget required to meet the needs of creating, supporting, and maintaining a blended learning environment.

**21st Century Skills**

21st century skills include critical (analytical) thinking and reflection. Each of these crucial skills is developed and nurtured through the communication and collaboration inherent to a blended learning environment.

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). An 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).

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). This supports 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.

Reflection and critical thinking are interrelated, 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 as important as why something is right (Donovan et al., 2005).

**Communication and Collaboration**

Determining if a learner is developing these 21st century skills requires effective communication and collaboration, skills 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 as different modes or degrees of communication. 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). 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).

Being able to effectively articulate one’s thoughts, views, and perspectives on information is vital to overall success and blended learning environments can support communication growth. 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.” (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).

**Summary**

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. This literature review endorses the notion that learners can acquire and develop 21st century skills using a blended learning environment.

**This Review and the Field of Education**

The literature indicates that blended learning environments engage students and enhance authentic learning opportunities, typically referencing student engagement in specific subject curriculum without addressing the other characteristics and skills students learn through life experience. Additional literature supports the necessity for development of 21st century skills by formally defining these skills and what they might look like in the workplace. Explicitly connecting the two topics reinforces the need for education to change according to society’s evolution in the digital age, as most literature does not intentionally assess both simultaneously.

**Strengths and Weaknesses of this Body of Literature**

There is an abundance of literature that reaffirms the benefits of blended learning environments, moving away from the industrial model of education into the information age. The fundamental components of a blended learning environment have been consistent so as more literature is written, the accepted definitions of blended learning are reinforced. Also, understanding 21st century skills have been strengthened by literature spanning over the past four decades and continues to be widely analyzed and refined as we actually live in the 21st century. The literature covers a variety of contexts, maintaining a global understanding of the importance of acquiring and refining these skills.

What is incredibly weak about the literature is how tools can be explicitly used in a classroom to focus on development of 21st century skills and how to measure growth in these skills. Missing in the literature is how tools specific to a subject, such as Desmos activities, can be utilized in a blended learning environment beyond comprehension and retention of the subject matter. In fact, very little formal literature exists on how Desmos activities truly strengthen math instruction, beyond what Desmos publishes.

**Focus of the Current Study**

Although the literature does not exist yet on how Desmos activities can build 21st century skills and growth in communication and collaboration, the fundamental concepts of blended learning environments and 21st century skills have the potential to be identified and developed in the context of Desmos activities and their components. Beginning research by explicitly identifying in what ways do components of Desmos activities impact student growth in communication and collaboration will promote additional research to be done and literature to be written regarding this subject.

**References**

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.

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

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.

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

Jensen, M., Short, C. R., Guo, Q., & Keaton, W. (2022). *K-12 blended teaching: math edition*. <https://edtechbooks.org/k12blended_math>

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*. https://doi.org/10.13140/RG.2.1.2795.1841

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

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>

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., Robert, J., Muscanell, N., McCormack, M., Reeves, J., Arbino, N., Grajek, S., & Educause. (2023). *2023 EDUCAUSE horizon report, teaching and learning education*. Educause.

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>

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

*World economic forum future of jobs report*. (2023). https://www3.weforum.org/docs/WEF\_Future\_of\_Jobs\_2023.pdf