K-12 Makerspaces: Impacts and Implications For 21st Century Learning In The New Global Economy

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Makerspaces in Education are student-centered learning environments that provide a place for learners to cultivate their natural curiosity, and refine their 21st Century Skills. In a K-12 setting, a Makerspace is a physical place or mobile presence that allows learners to explore the nuances of the design process through iterative prototyping (NMC, 2017). The location, contents, and visitation schedule of a school's Makerspace can vary depending on budget, space, and time restraints. They can be located in: the classroom, Media Center, mobile carts, or in their own dedicated space. Just as location varies for Makerspaces so do the tools and materials for fabrication, which can include glue guns, recyclables, 3D printers, laser cutters, microprocessors, and coding and robotic components (Martin, 2015). The protocol for student use of the Makerspace can be fixed or flexible, reserved by class, or by Library Model which allows students to come during their free time or when classwork is completed (Redina, 2015).

Makerspaces embody the Constructivist and Constructionist pedagogical theories. The ideation and planning that is employed to develop the learner's idea reflects the Constructivist views. The prototyping and continuous improvement cycle lends support to Constructionist learning. In education, the goal of creating a finished product in the Makerspace is secondary to the ethos of a Maker Education, which at its core, provides an experience of learning, persevering, and improving (Maker Education Initiative, n.d.).

Makerspaces are proving to be a valuable tool to help students access a deeper understanding of information across different content areas. Makerspaces have been considered a channel for Science, Technology, Engineering the Arts, and Math (STEAM) subjects, but is evolving to also include all subjects (Spencer, 2017). Current trends indicate that when Makerspaces are integrated into the curriculum, they not only make learning more engaging, but tangible. The hands-on nature of the Makerspace provides practical experience while learning. Makerspaces

can be incubators of dynamic skill creation for the innovation required to maintain or elevate our rankings in the global economy.

Impacts of Makerspaces on the New Global Economy

The 20th century brought a transformational change to the role of the Education System in the United States. From one room school houses to extended formal learning institutions. The Education System was called to meet the demands of the Market by producing proficient laborers to power the Second Industrial Revolution (Christensen, Johnson, & Horn, 2016). With nearly one-quarter of the 21st Century behind us, the Market is demanding yet another transformational change of the Education System to power the Fourth Industrial Revolution. Future employers will require the inculcation of a precise skill-set highlighted by autonomous learning, analytical and critical thinking, creativity, and the initiative to channel all of these qualities into creating innovative solutions (Centre for the New Economy, & Society, 2018). This precise collection of skills are introduced and refined in a Makerspace.

The Fourth industrial revolution brings with it a shift in value from human production capital to creative intellectual capital (Schwab, 2016). On the shoulders of the Digital Revolution, global systems and processes in nearly every industry are evolving. The rate of change has compelled some countries to heavily invest in and promote the creation of Makerspaces in both community and school settings. With the goal of becoming Global Leaders of innovation and diminishing their role as a country of low-cost production, The People's Republic of China began investing in Makerspaces in response to a forecasted dramatic decrease in their population (Xiao, 2016). Likewise, the Governments of Australia, Canada (Atlantic Canada Opportunities Agency, 2015), India, Switzerland (Paranjape, 2018), and the United Kingdom (Department for

Digital, Culture, Media, & Sport, n.d.) have also invested in the innovative potential of Makerspaces by drafting financial Initiatives to fund their creation and operation.

Today's Makerspaces

Albemarle County Schools in Charlottesville, Virginia started up their first Makerspace in a single high school's library, creating a music studio. The idea was to have a space that was engaging and nurtured autonomous learning. The student's response to the music studio was immediate and encouraging. Administration reported significant improvements in academic achievement, behavior, attendance, and school culture (Albemarle County Public Schools, n.d.). Albemarle continues to highlight the idea that Makerspaces and classrooms are symbiotic by experimenting with one-room learning spaces. The one-room space includes k-5 students, studying together across all content areas. The making activities are integrated into the lessons that occur throughout the day (Madda, 2016). Albemarle now has 23 school makerspaces throughout the county, making it a Maker district.

Hillbrook School, an independent PreK-8 in Los Gatos, California facilitates making at the earliest levels of formal education. Hillbrook describes their iLab Makerspace as an agile classroom that not only includes the typical digital tools such as robots and microprocessors, but also woodworking, textiles and sewing tools. The iLab Makerspace is bolstered by a student-centered curriculum that carves out time devoted to the inculcation of a Maker's growth mindset in the lower grades, and independent study in the upper grades. During independent study time, personal projects are designed and produced by the students giving them agency to create something meaningful to them. The students are given training on the proper use of the tools and become certified, to mentor other students (Hillbrook School, n.d.).

Speculation on the impact of Makerspaces and 21st Century Learning

The Education Sector continues to have a primary function of preparing our youth to become contributing members of our society. Educators will seek effective tools and learning environments to nurture 21st century skills. The Makerspace environment and ethos will allow for the sharpening of the most abstract 21st Century skills of the computational and higher-order thinking. With these traits, Makerspaces are an exceptional vehicle to shift from our previous goal of producing efficient workers to inspiring proficient innovative thinkers and solution makers. As the Maker Education settles into the educational landscape, more cross-curricular concepts will emerge and make evident the practicality, and advantages Makerspace offers our Learners. Schools and Districts will appreciate the value of engaged motivated students invested in their own success.

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