**Assessment 3- Makerspaces: An Informal Learning Trend**

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**Introduction**

The desire to promote and enhance 21st-century learning and project-based learning has increased the need for interdisciplinary STEM activities and programs in schools nationwide. Jin et al. (2020) explain that authentically integrated STEM education incorporates "rich tasks" drawing on several STEM subject areas as a way of learning outside of the traditional classroom. With the economic, societal, and technological factors driving the need for STEM-based education, the maker movement initiated. Martinez (2019) explains that the maker movement values human passion, capability, and the ability to make things happen.

Schools that celebrate the process of design and making, which includes overcoming challenges, yield students to believe that they can solve any problem. The maker movement attracted more educators, students, parents, and stakeholders to bring "making" into education. Thus, the makerspace phenomenon's utilization began and provided opportunities for students to apply their subject knowledge and design STEM-related projects. Fleming (2015) describes makerspaces as physical spaces that are designed to support the maker in the creation, design, projects, and technologies. There has been strong advocacy for this type of teaching and learning, and policymakers must understand that the education system develops frameworks that move away from consumption and more towards creation in school settings (Jin et al., 2020). Makerspace is about turning knowledge into action and allows for a genuine opportunity to support personalized learning (Fleming, 2015).

**History**

Research indicates that over the 15 years of its foundation, Science, Technology, Engineering, and Mathematics (STEM) have been educated as separate subjects in schools (Blackley et al., 2017). However, the surge of interest in creating hands-on physical objects or creations utilizing digital tools through internet-shared plans and techniques initiated the maker movement (Burke, 2014). Some researchers claim that makerspaces have always existed. It is a part of human nature to plan and create things with our hands and tools. Anderson (2012) explains that makerspaces and the maker movement are vital parts of the third industrial revolution, where the variety of skills (relational and cognitive) are gained through collaboration and project completion, translated to workforce skills, and contributed to the creation of new jobs and industries, and promote innovation.

The hands-on approach also has precedents in education: project-based learning, Jean Piaget's constructivism, and Seymour Papert's constructionism (Martinez, 2019). These theories explain young makers' notable achievements and remind educators that every classroom needs to be a place where knowledge is a consequence of experience (Martinez, 2019). Burke (2014) explains that while some aspects of the maker movement, such as science fairs, have existed for ages, the Make Magazine launch in 2005, and its published information about maker-related projects gave the maker movement its start. The Make Magazine created "maker faires," a series of venues for makers to express themselves and share their creations (Burke, 2014). Since that time, makerspaces, maker faires, and other maker communities have emerged in various venues worldwide. In 2013, there were more than 100 maker faires and mini maker faires globally (Martinez, 2019).

In 2014, there were 135 recorded maker faires, with more than 800,000 attendees. Among these maker faires, the first white house maker faire took place, and a significant number of educators, students, and families attended (Sheridan et al., 2014). A year later, President Barack Obama declared June 12-18 "The Week of Making" and promoted a campaign called "Educate to Innovate." Similarly, in 2018, more than 150,000 children and adults gathered at the maker faire in San Mateo, California, over a weekend to make things, challenge one another, invent, solve problems, and inspire (Martinez, 2019). With the impact of these innovative efforts, museums, libraries, and schools began to embrace maker education that facilitates students to learn, build, create, and invent in new and creative ways (Sheridan et al., 2014).

**Makerspaces in Education**

A significant characteristic of makerspaces, which distinguishes it from previous versions of simply making things, is the influence of community-building and the collaboration of individuals working to make things within spaces (Burke, 2014). Peppler and Bender (2013) explain that the focus of makerspace is its do-it-yourself (or do-it-with-others) mindset that brings together stakeholders of different ages to make things happen. Makerspaces of all types are growing at an accelerated rate in the field of education. Dave et al. (2015) report that the search term "makerspace" in Google Trends has quadrupled in the past two years and is currently in its highest growth rate in search frequency. The New Media Consortium's Horizon Report: 2015 K-12 Edition shows that makerspaces are expected to be increasingly conducted in schools in one year or less to make use of mobile learning and cultivate environments where students take ownership by doing and creating. In the landscape of 21st-century education, creativity, design, and engineering are making their way to the forefront of educational considerations, such as robotics, 3D printers, and web-based 3D modeling applications, which are more readily accessible (Martinez, 2019).

The key to "making" is utilizing authentic tools to create meaningful projects. Krishnamurthi and Rennie (2013) identify makerspace opportunities as informal science programs and define them as less formal and intentionally different from traditional approaches. They assert that this type of learning should be student-centered and presented to provide choices for the learner, enabling them to explore and create as their interest increases. Thus, The Makerspace in STEM (MIS) project was crafted and centered on two theoretical, pedagogical pillars: experiential learning (trial-and-error, learning-by-doing, student-centered) and social constructivism (new knowledge is developed through collaboration, social interactions, and the use of language). As our society changes to meet our learners' needs, use of innovative technology programs and platforms have been created, such as design software (Krueger, 2018).

Once too complex for most learners, now software like cloud-based TinkerCAD and SketchUp place 3D design within students' reach. The ability to incorporate interactivity or intelligence into everyday objects, such as robotics, is another aspect of the maker trend (Krueger, 2018). Microcontrollers, such as Arduino, are utilized and allows the circuitry to be more transparent to the students and increases their understanding of the technologies. Lastly, computer programming, such as coding, is incorporated in makerspaces. The International Society for Technology in Education (ISTE) standards are closely linked with makerspaces. Its innovative framework in education helps teachers and education leaders globally prepare students through creativity, technology skills, and creating out-of-the-box ideas and inventions (ISTE, 2021).

**Conclusion**

Makerspaces are physical spaces designed to provide opportunities for participants of all ages and interests, from hobbyists, crafters, engineers, and students, to collaborate, explore, and create STEM-related activities and innovative technological inventions. Makerspace is about turning knowledge into action and allows for a genuine opportunity to support personalized learning (Fleming, 2015). The use of innovative technological programs in makerspaces are necessary as our society changes to meet our 21st-century learners (Krueger, 2018). Makerspaces are beginning to plant and take root within the educational soil of many institutions. While some research demonstrates the effectiveness and success of this global informal learning approach, more research is needed on the type of innovations that makerspaces will experience in the future.

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