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Maker-Education: Exploring Learning Through Exploration

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December 2023

Slides at:

bit.ly/crshortms2023

Introduction and Welcome
介绍与欢迎

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Background:
Blended and Personalized Learning,
Teacher Preparation,
Open Education

Makerspaces Defined

- A Concise Definition
  - Makerspaces are creative environments for hands-on learning.
- They are rooted in historical “making activities” with or without technology and leverage pedagogical principals to encourage learning.
- In this way, they are catalysts for experiential learning and student empowerment.

Makerspaces Defined, Again

- A More Complete Definition

- Makerspaces是促进创意活动、解决问题、协作学习以及深入探讨学科概念的体验式学习环境。这些空间通常支持积极、动手、高度参与的学习经历，促进学习者的主动性、自我调节和以产品为导向的学习。Makerspaces通常包括3D打印机、切割机、激光打印机、热压机、染料机和配备各种设计软件的计算机等技术。Makerspaces还包括一些较少技术含量的资源，例如一般的艺术和手工艺品材料。在教育环境中，Makerspaces通常设在图书馆或实验室、移动车辆或独立教室中；然而，Makerspaces也可以在社区的非正式学习空间，如图书馆和工作坊中找到(Short et al., 2023)

Makerspaces Defined, Again

- A More Complete Definition

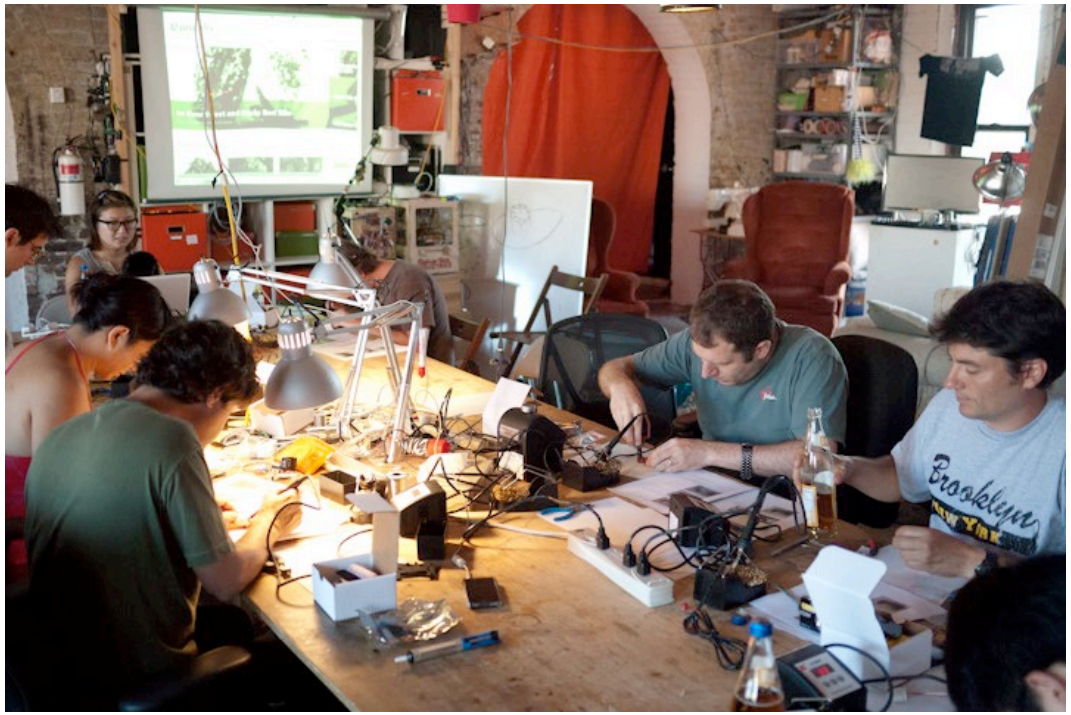
- Makerspaces are experiential learning environments that facilitate creative activities, problem solving, collaborative learning, and in-depth exploration of disciplinary concepts. These spaces generally support active, hands-on, highly engaging learning experiences that promote learner agency, self-regulation, and product-oriented learning. Makerspaces commonly include technology such as 3D printers, cutting machines, laser printers, heat presses, dyers, and computers with various design software. Makerspaces also include less technological resources such as general arts and crafts supplies. In educational settings, makerspaces are commonly housed in library or lab settings, mobile carts, or within individual classrooms; however, makerspaces can also be found in communities' informal learning spaces like libraries and workshops. (Short et al., 2023)

Moving Away From Tradition

Before the Printing Press (1233)

After the Printing Press (2016)

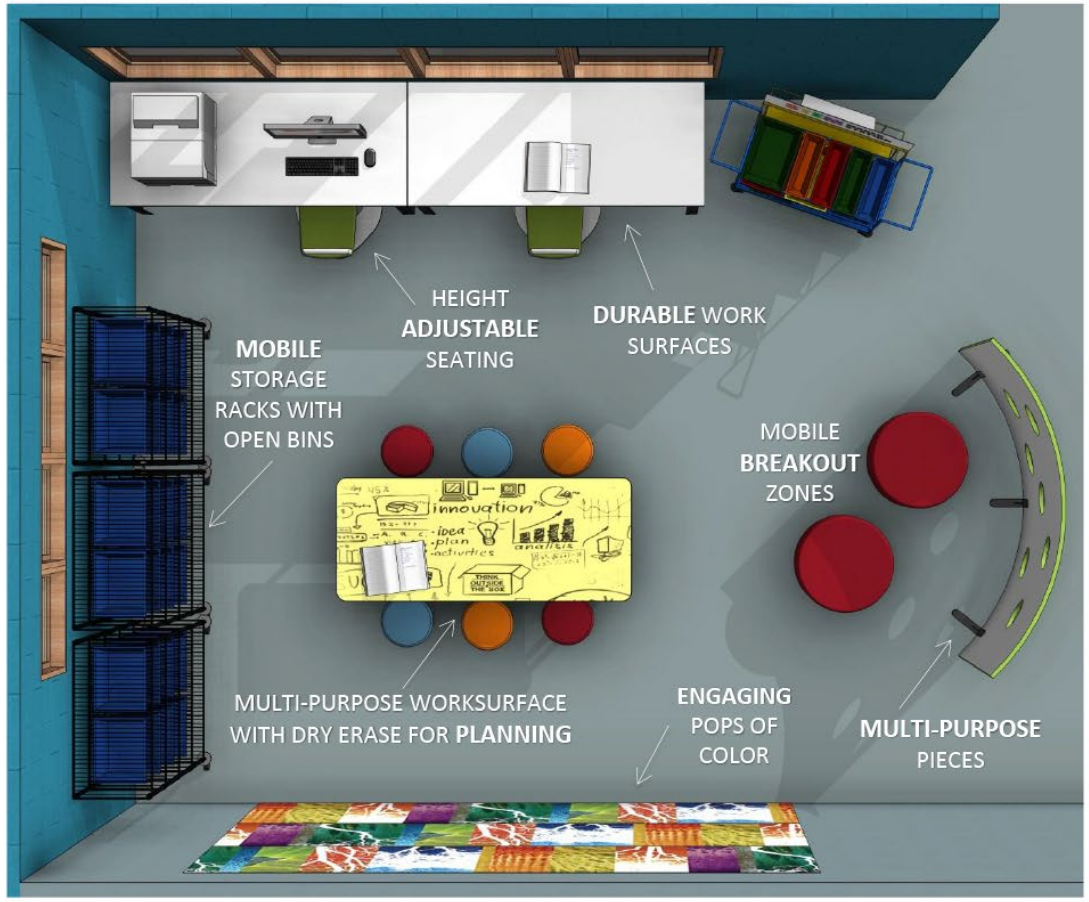
Makerspace Images



More Makerspace Images

Even More Makerspace Images

Last Makerspace Image?



My Local Makerspace

My Local Makerspace Recording/Printing

My Local Makerspace Cutting/Presses

My Local Makerspace Collaboration

Third Place Defined

- A place where people choose to go that is outside of their work/school or home.
- “The core role of the library as a place, the new normal for library buildings, is as a place of collaborative learning and community interaction . . . flexible spaces for collaborative work and in which [learners] can be part of a self-created community.” (Montgomery and Miller, 2011)
- A result of fiscal restraint and having to rethink library spaces in a digital world that provides library services to patrons at a distance, virtually, or electronically.

Montgomery, S. E., & Miller, J. (2011). The third place: The library as collaborative and community space in a time of fiscal restraint. *College & Undergraduate Libraries*, *18*(2-3), 228-238.

Third Place Characteristics

- Neutral
- Leveling
- Conversational
- Accessible and Accommodating
- Regular Attendees
- Low Profile
- Playful
- Home-Away-From-Home

Oldenburg, R. *The Great Good Place: Cafes, Coffee Shops, Community Centers, Beauty Parlors, General Stores, Bars, Hangouts and How They Get You through the Day*; Marlowe & Company: New York, NY, USA, 1997.

Third Places

1. 发现**真我**
2. **表达真我**
3. 创**造真我**
4. 设计**真我**
5. **描绘真我**
6. **探索真我**

https://www.chipublib.org/youmedia-teens/

Historical Foundations
历史基础

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The Beginning of Making

- **Historical Roots**: Making activities have existed throughout history, reflecting our innate human need to create.
- **Educational Roots**: Experiential learning spaces promote interaction between "an individual and objects and others" (Dewey, 1960, p. 86).
- **Contemporary Maker Movement**: The current maker movement has gained significant traction in the last ten years, after emerging in 2005.
- **Another Definition**: Encompasses people engaged in creative production, sharing processes, and products in both physical and digital forums.

Dewey, J. (1960). Experiencia y educación. Biblioteca Nueva.

Key Figures & Definitions

- **Papert (1980)**: Concerning his vision of the future after creating really early Makerspaces in the 1960s, “my vision of a new kind of learning environment demands free contact between children and computers.”
- **Chris Anderson’s (2012) Definition**: Describes the maker movement as a "new industrial revolution," emphasizing the use of digital desktop tools, online collaboration, and common design standards.
- **Mark Hatch's Manifesto**: Outlines key ideas, including making, sharing, learning, and tooling up, highlighting the importance of physical object construction.
- **Dale Dougherty's Universal Definition**: Views the term "maker" as universal and core to human identity, focusing on people associating with the ethos of making.

Papert, S. (1980). *Mindstorms: Children, computers, and powerful ideas*. Basic Books.

Makerspaces in China - Foundations

- **XinCheJian:** China's first hackspace, founded in 2010 in Shanghai.
- **2015 Expansion:** Over 100 makerspaces, 75% concentrated on the east coast.
- **Majority Activities:** Electronics and digital fabrication.
- **Survey Insights (Saunders and Kingsley, 2016):**
  - 75% work with digital fabrication machines.
  - 85% work with electronics equipment.
  - 32% work with fabrics, 20% with stone, clay, or ceramics.

Irie, N. R., Hsu, Y.-C., & Ching, Y.-H. (2019). Makerspaces in Diverse Places: A Comparative Analysis of Distinctive National Discourses Surrounding the Maker Movement and Education in Four Countries. *TechTrends: Linking Research & Practice to Improve Learning*, *63*(4), 397–407. https://doi-org.emporiastate.idm.oclc.org/10.1007/s11528-018-0355-9

Makerspaces in China - Users

- **Educational Focus**
  - 92% of surveyed makerspaces offer training
  - 66% offer classes
- **Demographic Focus**
  - 54% member are university students
  - 20% report the majority are school-aged children

Irie, N. R., Hsu, Y.-C., & Ching, Y.-H. (2019). Makerspaces in Diverse Places: A Comparative Analysis of Distinctive National Discourses Surrounding the Maker Movement and Education in Four Countries. *TechTrends: Linking Research & Practice to Improve Learning*, *63*(4), 397–407. https://doi-org.emporiastate.idm.oclc.org/10.1007/s11528-018-0355-9

Makerspace Core Principles

- **Experiential Learning:** Emphasis on learning through direct experience, trial, and error, constructionism - development through playing and building with authentic materials, student empowerment as changemakers in a malleable world, and using tools to construct and externalize knowledge within tangible artifacts are key pedagogical underpinnings of makerspaces.
- **Inclusivity:** Welcoming to all skill levels, backgrounds, and interests.
- **Community Collaboration:** Encouraging collaboration, knowledge-sharing, and peer learning.

Halverson, E. R., & Sheridan, K. M. (2014). The Maker Movement in Education. *Harvard Educational Review*, *84*(4), 495–504. https://doi-org.emporiastate.idm.oclc.org/10.17763/haer.84.4.34j1g68140382063

Sharing in Making

- **Socialization**: Emphasizes the accessibility of powerful computational and fabrication tools for everyone, enabling innovation and change.
- **Critiques**: Critiques about the maker movement's potential dominance by a specific demographic but highlights a more diverse and evolving landscape.
- **Problem-Solving**: A global demand for workforces fueled by innovation, created increased support for environments that could prepare learners to become creative problem-solvers (Hsu et al., 2017).

Hsu, Y. C., Baldwin, S., & Ching, Y. H. (2017). Learning through making and maker education. *TechTrends, 61*(6), 589–594. https://doi.org/10.1007/s11528-017-0172-6

Makerspace Growth

- Fleming (2015) captured how communities connect to the essence of a makerspace: “If you build it, they will come; and if you let them build it, they will learn.”
- The growth of do-it-yourself communities, the incorporation of 21st-century skills into traditional education, and the increased availability of digital fabrication technologies, tools to use when making, and research on makerspaces have contributed to a growing interest in makerspaces.

Fleming, L. (2015). *Worlds of making: Best practices for establishing a makerspace for your school.* Corwin.

Makerspace Support in China, pt. 1

1. **Make**
   - Identity reclamation and counteracting consumerism.
   - Government shift to "Designed in China."
2. **Support**
   - Government sees makers as drivers of innovation and economic growth.
   - China has the most incubators and makerspaces globally.
3. **Tool Up and Participate**
   - Focus on spaces for entrepreneurs and innovation.
   - Government-sponsored hackathons foster collaboration.

Irie, N. R., Hsu, Y.-C., & Ching, Y.-H. (2019). Makerspaces in Diverse Places: A Comparative Analysis of Distinctive National Discourses Surrounding the Maker Movement and Education in Four Countries. *TechTrends: Linking Research & Practice to Improve Learning*, *63*(4), 397–407. https://doi-org.emporiastate.idm.oclc.org/10.1007/s11528-018-0355-9

Makerspace Support in China, pt. 2

4. **Share**
   - Collaboration encouraged between makers and government/industry.
   - Nuanced approach to open source
5. **Learn and Play**
   - Makerspaces offer creative thinking opportunities, countering rote learning.
   - Concerns about overemphasis on technical skills in maker education.
6. **Change**
   - Maker movement seen as a chance for individual and national self-actualization.
   - Shift to "Designed in China" symbolizes broader national identity change.

Irie, N. R., Hsu, Y.-C., & Ching, Y.-H. (2019). Makerspaces in Diverse Places: A Comparative Analysis of Distinctive National Discourses Surrounding the Maker Movement and Education in Four Countries. *TechTrends: Linking Research & Practice to Improve Learning*, *63*(4), 397–407. https://doi-org.emporiastate.idm.oclc.org/10.1007/s11528-018-0355-9

Creating a Makerspace
创建一个创客空间

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Makerspace Physical Components

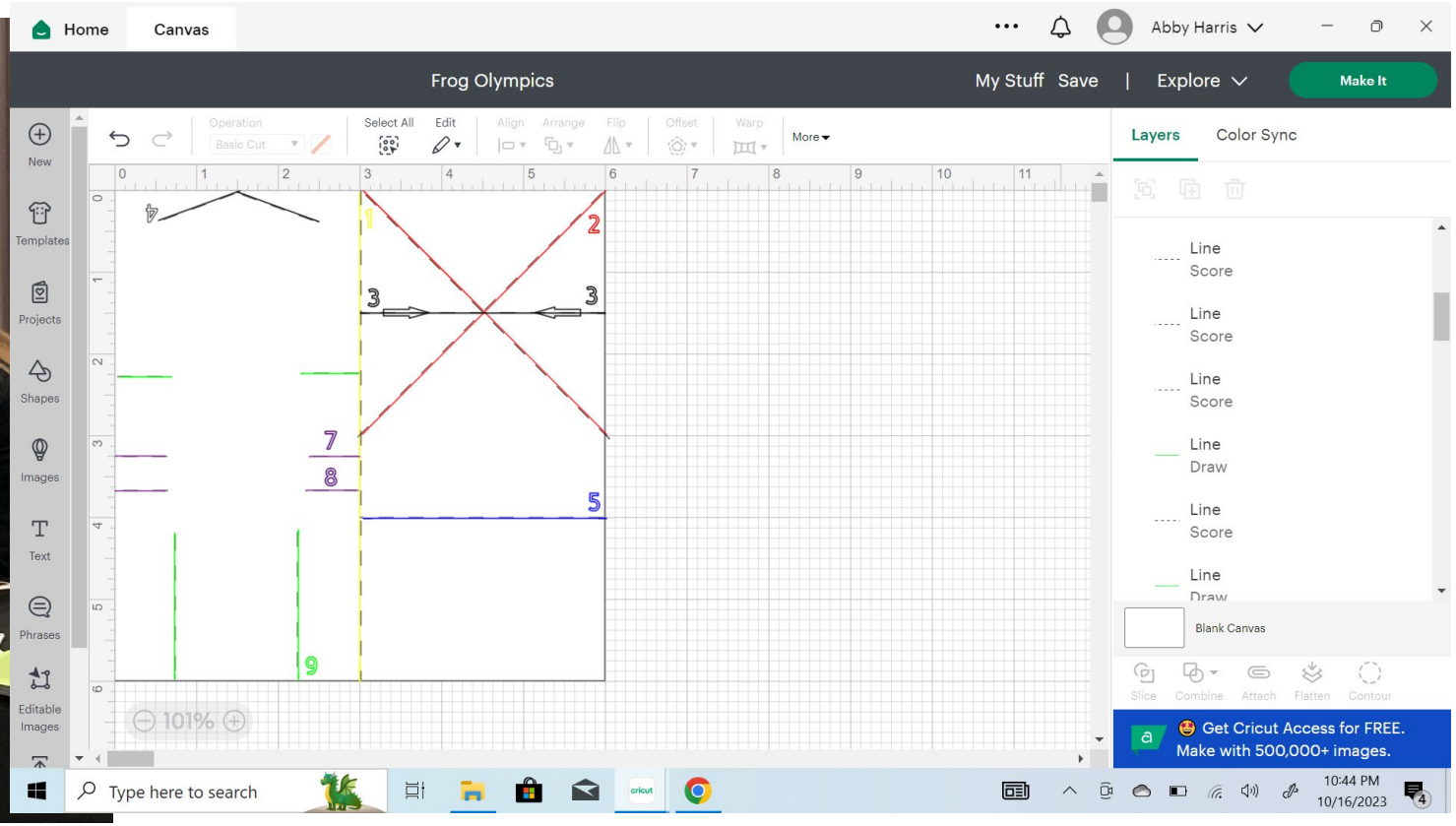
- **Physical Space**
  - **Open and Flexible Layout:** Encourages collaboration and adaptability.
  - **Tool Stations:** Equipped with a variety of tools catering to diverse projects
- **Technological Infrastructure**
  - **Digital Fabrication Tools:** 3D Printers, Laser Cutters, Computer Numerical Control (CNC) Machines
  - **Computational Tools:** Computers, Microcontrollers, Coding Bots, Design Software, Recording Software
- **Non-Technological Infrastructure**
  - **Tools:** Traditional Tool Sets, Fasteners, Table Saws, Sewing Machines, Handcraft Tools
  - **Building Materials:** Wood, Paper, Cloth, Metal

CNC Machines

- **CNC Machines** are automated tools that are controlled by computer programs. These machines use numerical data inputs to execute precise and repetitive tasks, such as cutting, milling, or 3D printing.

  - **Milling Machines**
  - **Lathes**
  - **Routers**
  - **Plasma Cutters**
  - **Laser Cutters**
  - **3D Printers**
  - **Cutting Machines with Blades**

CNC Machines Usage



Beyond The Physical Components

- **Community Engagement**
  - **Knowledge Exchange:** Platforms/forums/locations for sharing ideas, skills, and experiences.
  - **Inclusive Atmosphere:** Welcoming environment for diverse participants

- **Cross Curricular Exploration**
  - **Lab-Based Learning:** Classroom learning tends to get compartmentalized to physical and content-area spaces. Makerspaces encourage cross-curricular exploration and implementation.

Makerspaces in Education
教育中的创客空间

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Makerspaces in Education

- **Spread Across Institutions**: Makerspaces have expanded beyond independent organizations to museums, libraries, schools, and higher education institutions.
- **Progressive Educators and Making**: Progressive educators have long recognized the role of making in learning, aligning with constructionist theories.
- **Constructionism in Education**: Constructionism, rooted in the creation of shareable knowledge, finds expression in tools like Logo programming, LEGO Mindstorms, Scratch, and project-based learning approaches.

Learning Through Making

- **Artistic Practices**: Artists and arts educators contribute to learning through making across various art forms.
- **Blurring Formal and Informal Learning**: Making transcends formal and informal learning settings, fostering expansive views on where and how learning occurs.
- **Influence on Education**: The maker movement is influencing the education enterprise, bridging the formal/informal learning divide.

Constructionism in Makerspaces

- Externalism of learning stimulate higher cognitive functions
- Externalism may involve a range of media
- The goals, or initiative, of the learner is apparent in design.

Ackermann, E. (2001). Piaget's constructivism, Papert's constructionism: What's the difference. *Future of Learning Group Publication, 5* (3), 438.

Framework for Makerspace Learning, 1-2

1. Cognitive Domain

- Learning related to discipline-specific expertise.
- Advancement on projects leads to increased skills, knowledge, and understanding.
- Addresses specific phenomena with an expert's perspective through ongoing investigation.

2. Problem Solving

- Requires an overall view of a situation to break it into manageable parts.
- Projects begin with problems that demand practical skills, strategy, and organizational abilities.
- Assessment of whether the project meets the demands of the initial problem.

Morado, M. F., Melo, A. E., & Jarman, A. (2021). Learning by making: A framework to revisit practices in a constructionist learning environment. *British Journal of Educational Technology*, *52*(3), 1093-1115.

Framework for Makerspace Learning, 3-4

3. Critical Thinking

- Tests assumptions and theories for consistency throughout the project.
- Alternatives are considered, and decisions are made after careful contrast.
- Both the project's process and final result are subject to critical reflection.

4. Use of Tools and Materials

- Focuses on selecting and applying appropriate tools and materials.
- Tools can be digital or analogue, while materials are varied.
- Requires prior knowledge of tools and the ability to test their functionality safely.

Morado, M. F., Melo, A. E., & Jarman, A. (2021). Learning by making: A framework to revisit practices in a constructionist learning environment. *British Journal of Educational Technology*, *52*(3), 1093-1115.

Framework for Makerspace Learning, 5-6

5. Psychomotor Development

- Promotes specific motor skills from hand, wrist, and forearm muscles to the entire nervous system.
- Supports optimal psychomotricity and proprioception development.
- Involves automatic micro-adjustments through the interplay of tonic and kinetic activity.

6. Creativity

- Involves an individual, personal, and original response to a situation.
- Imagination of alternatives and testing of limits.

Morado, M. F., Melo, A. E., & Jarman, A. (2021). Learning by making: A framework to revisit practices in a constructionist learning environment. *British Journal of Educational Technology*, *52*(3), 1093-1115.

Framework for Makerspace Learning, 7-8

7. Intrapersonal Domain

- Involves abilities related to goal-setting and pursuit.
- Participants propose alternative ideas with confidence and respect.
- Persistent advancement of project objectives.

8. Interpersonal Domain

- Focuses on habits and skills required for collaborative work.
- Projects involve teamwork, agreements, active listening, and negotiation.
- Fosters shared responsibility, a balanced share of work, and a sense of belonging to a greater whole.

Morado, M. F., Melo, A. E., & Jarman, A. (2021). Learning by making: A framework to revisit practices in a constructionist learning environment. *British Journal of Educational Technology*, *52*(3), 1093-1115.

Developing Life Skills

研究发现，基于项目的学习增强了动力，使学生能够同时培养多种技能。

Educator Use of Makerspaces

- **“Objects-to-think-with”**: Educators can create manipulatives, games, and models that students can use to get hands on experiences as part of their learning.

Ackermann, E. (2001). Piaget's constructivism, Papert's constructionism: What's the difference. *Future of Learning Group Publication, 5* (3), 438.

Professional Development for Makerspaces
创客空间的专业发展

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Professional Development for “Making”

- Initial seminars should focus on the “Why” and “What” of learning through making.
- Educators question the importance and applicability of making in the classroom.
- Educators need to understand that making has a place in the classroom, moving beyond an after-school, enrichment activity.

Oliver, K. M. (2016). Professional development considerations for makerspace leaders, part one: Addressing “what?” and “why?”. *TechTrends*, *60*, 160-166.

Share History and Pedagogy

- **Answering "Why Make?":** Historical context from quilting societies to modern makerspaces.
- **Educational Theories Associated:** Piaget's constructivist learning theory, Papert's constructionist derivative.
- **Professional Development Activities:** Reiterate theories and research, explore experiential vs. traditional learning with hands-on activities.
- **Learning Forward Alignment:** Integrate theories, research, and models of human learning throughout the professional development.

Oliver, K. M. (2016). Professional development considerations for makerspace leaders, part one: Addressing "what?" and "why?". *TechTrends*, *60*, 160-166.

Look for Curriculum Alignment

- **Importance:** Making ties into various subject areas - humanities, arts, STEM.
- **Recommended Instructional Design:** Consider content, skills, available materials, design questions or problems.
- **Professional Development Activities:** Establishing communities among disciplinary and/or interdisciplinary teams, discussing curricular goals, linking making activities to authentic work or careers.

Curriculum Example

- Writing Robotics Programs
  - Mimic how DNA in cells creates specialized functions
  - Demonstrate organism interactions
  - Positive and Negative numbers for opposite directions
  - Variables change relationships with each other
  - Functions as rules and inputs
  - General reasoning with equations and inequalities
  - Importance of clear writing, methodical writing

How to Facilitate a Makerspace

- **Professional Development Focus:** Further development on facilitation and assessment strategies for open-ended, collaborative, and interest-driven maker projects.
- **Diversity of Learning Arrangements:** Individual, facilitated, small group, and collaborative arrangements identified in makerspaces.
- **Facilitators' Role:** Consider foundational skills and design prompts for independent student work.

Oliver, K. M. (2016). Professional development considerations for makerspace leaders, part two: Addressing "how?". *TechTrends*, *60*, 211-217.

Makerspace Learner-Led Design Process

- **Importance of Design Process:** Students encouraged to follow a structured design process.
- **Common Design Steps:** Identify a challenge, research it, ideate, prototype a solution, test, reflect, and share results.
- **Facilitator Strategies:** Utilize questioning, routines, and design meetings to guide students.
- **After-School Program Insights:** Challenges can occur in getting students to follow inquiry processes.

Oliver, K. M. (2016). Professional development considerations for makerspace leaders, part two: Addressing "how?". *TechTrends*, *60*, 211-217.

Collaboration Strategies

- **Community-Oriented Nature:** Makerspaces emphasize collaboration.
- **Encouraging Collaboration:** Group roles, modeling exchanges, debriefings, reporting conferences, and scientific concept usage.
- **Debriefing Models:** "Plussing" sessions where peers share and critique ideas constructively, “adding” to their peers’ work.
- **Collaborative Strategies:** Relay projects, musical chairs, and mashup projects to enhance collaboration.

Oliver, K. M. (2016). Professional development considerations for makerspace leaders, part two: Addressing “how?”. *TechTrends*, *60*, 211-217.

Assessment in Makerspaces

- Teachers have many core assessment values: intentionality, resilience, patience, perseverance, experiential learning, collaboration, communication, adaptation, independent curiosity, emotional, and physical well-being.
- These values can even be adapted to remote teaching.
- Overall emphasis on creative problem-solving, differentiation, perseverance, and creating relevant, meaningful connections.

Wardrip, P. S., Saplan, K., & Evancho, J. (2021). “Finding the Right Window Into What They’re Doing”: Assessment of Maker-based Learning Experiences Remotely. *TechTrends: Linking Research & Practice to Improve Learning*, *65*(6), 952–962. https://doi-org.emporiastate.idm.oclc.org/10.1007/s11528-021-00664-y

Makerspace Assessment At A Distance

- Digital assessment strategies were crucial.
- Students recorded videos, took pictures, or recorded audio for reflections and processes.
- Emphasis on observations, student reflections, and informal conversations for assessment.
- Use of FlipGrid, Google Classroom for digital documentation.

Wardrip, P. S., Saplan, K., & Evancho, J. (2021). “Finding the Right Window Into What They’re Doing”: Assessment of Maker-based Learning Experiences Remotely. *TechTrends: Linking Research & Practice to Improve Learning*, *65*(6), 952–962. https://doi-org.emporiastate.idm.oclc.org/10.1007/s11528-021-00664-y

Adapting Makerspace Projects to Distance Learning

- Shift to low-tech, cost-effective materials due to budget constraints and remote learning challenges.
- Students given more choice in materials to accommodate varied home environments.
- Unexpected benefits: discovering individual student quirks, building a virtual repository of student work for future learners and assessment.

Wardrip, P. S., Saplan, K., & Evancho, J. (2021). “Finding the Right Window Into What They’re Doing”: Assessment of Maker-based Learning Experiences Remotely. *TechTrends: Linking Research & Practice to Improve Learning*, *65*(6), 952–962. https://doi-org.emporiastate.idm.oclc.org/10.1007/s11528-021-00664-y

Criticisms of Makerspaces
创客空间的批评

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Cost

- Expensive to start
- Expensive to maintain
- Need lots of ongoing support and engagement

Low Equity

- Some research has found that makerspaces primarily serve learners who are:
  - White
  - Male
  - Affluent

Brahms, L., & Crowley, K. (2016). Learning to make in the museum: The role of maker educators. In K. Peppler, E. R. Halverson, & Y. B. Kafai (Eds.), *Makeology: Makerspaces as learning environments* (Vol. 1, pp. 15–29). Routledge.

Accessibility Importance

- In 2019, 40.7 million Americans (12% of the population) had a disability (US Census Bureau).
- Libraries strive to meet the needs of patrons and staff with disabilities but often overlook makerspaces.

ANDERSON, A. M., & PHILLIPS, A. L. (2022). Meeting Every Maker: Enhancing accessibility in makerspaces. *American Libraries*, *53*(5), 49

Accessibility Research

- Research conducted via focus groups with disability advocates and stakeholders, supported by the Institute of Museum and Library Services.
  - Makerspaces often lack initial accessibility design.
  - Librarians recognize the importance of accessibility but face challenges in retrofitting spaces.
  - Patrons with disabilities may not feel comfortable requesting help.

Barriers to Accessibility

- Furniture not adaptable; adjustable table heights are crucial.
- Building navigation challenges, especially in older facilities.
- Makerspaces often tucked away at the back of buildings or on upper floors.
- Tools are not made for those with disabilities and accessible tools are not available.

Accessibility Solutions

- Encourage groups to engage with their disabled community through comment cards, working groups, and/or focus groups. Stressing the importance of learning directly from patrons with disabilities to truly meet their needs.
- Accessibility improvements don't require major renovations.
- Universal Designs for Learning can be built in for all learners.
- Recommendations: movable tables and chairs, adaptable lighting, and accommodations for neurodivergent patrons

ANDERSON, A. M., & PHILLIPS, A. L. (2022). Meeting Every Maker: Enhancing accessibility in makerspaces. *American Libraries*, *53*(5), 49

Narrow Focus

- Some school-based makerspaces may be too narrow in their definitions of what constitutes making, ignoring:
  - Historical forms of making
  - Cultural forms of making
  - Variety in building, creating, and/or inquiry

Unclear Focus

- Makerspaces may differ in what they claim to focus on:
  - Building student engagement and interest
  - Promoting student agency
  - Entry point for STEM learning

Conclusion and Takeaways
结论与要点

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Definitions – Makerspaces and Third Places

- **Makerspaces**: Collaborative spaces emphasizing hands-on creation, fostering innovation, and providing access to tools.
- **Third Places**: Inclusive, conversational environments that serve as a "home away from home," fostering a sense of belonging.

Makerspace Foundations and Growth

- **United States of America**
  - **Origins:** Emerged from hacker and DIY communities around 2005, emphasizing a culture of sharing and collaboration.
  - **Evolution:** Shifted from niche communities to mainstream educational tools, impacting various sectors.
- **China**
  - **Rapid Growth:** China's makerspaces have experienced exponential growth since 2010, driven by grassroots making and government support.
  - **Government Involvement:** Premier Li Keqiang's visit and Mass Makerspace program showcased official endorsement and funding of the maker movement.

Creating Makerspaces

- **Essentials:** Consider space, tools, and community engagement for a successful makerspace.
- **Community Involvement:** Engage stakeholders, involve diverse voices, and foster a welcoming atmosphere.

Using Makerspaces in Education

- **Integration:** Makerspaces offer hands-on learning, fostering creativity, problem-solving, and collaborative skills.
- **Educational Impact:** From K-12 to higher education, makerspaces enhance STEM education and provide real-world applications for a wide range of subject areas and contents.

Providing Teacher Training for Makerspaces

- **Teacher Training**: Professional development is crucial for educators to effectively integrate makerspaces into curricula.
- **Continuous Learning**: PD should be ongoing, reflecting the evolving nature of technology and maker practices.

Criticisms of Makerspaces

- **Accessibility:** Concerns about equitable access and inclusivity in makerspaces is prevalent.
- **Focus on Tools:** Criticisms about prioritizing tools over educational outcomes must be overcome to show Makerspace value.
- **Addressing Critiques:** Continuous evaluation and adaptation is needed to address criticisms and enhance makerspace effectiveness.

Final Thoughts

- Makerspaces have bridged grassroots making and institutional support, evolving from niche communities to mainstream educational tools.
- Educational benefits from hands-on, collaborative learning in makerspaces impact diverse age groups and educational levels.
- Ongoing professional development is crucial for educators to maximize the potential of makerspaces in educational settings.
- While there are critiques, addressing issues of accessibility and maintaining a focus on educational outcomes can enhance the effectiveness of makerspaces.

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