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CONCEPTUALISING THE SCIENCE KITCHEN AS A MAKERSPACE

Jaana Taar, Kristi Paas, & Tiina Vänt
School on Natural Sciences and Health, Tallinn University (Estonia)

Abstract

The Science Kitchen, a newly launched learning environment at Tallinn University in Estonia, seeks to connect the everyday knowledge and practical activities of home economics with scientific content. With its emphasis on STEAM (science, technology, engineering, arts, and mathematics) learning and hands-on experiences, the makerspace concept offers a promising approach to enhance the development of the concept of The Science Kitchen. Makerspaces have gained significant attention as learning environments that foster the development of twenty-first-century skills. These spaces provide diverse opportunities for learners of different ages to engage in hands-on learning and solve tasks as creators rather than as consumers. Although the concept is used in various formal and informal educational settings, there are variations in its definitions and dimensions. This article explores the definitions and nature of makerspaces by relying on scientific studies. A systematic literature review was conducted to identify relevant themes, limiting the search to makerspaces in formal learning. A qualitative content analysis was performed for eighteen relevant articles to systematically categorise and interpret the descriptions and meanings of the makerspace concept. The results reflect the key terms (e.g. *doing* and *tools*) used concerning makerspace learning environments, opening up various aspects associated with makerspaces. On the basis of the results, The Science Kitchen concept is defined as a makerspace, which could be used to develop meaningful STEAM-oriented activities in a given learning environment.

Keywords: *Makerspace, science kitchen, learning environment, home economics, STEAM.*

1. Introduction

The Cambridge Dictionary defines makerspace as a ‘place where people can come together to create or invent things, either using traditional crafts or technology’. Relying on this definition, the elements necessary for the environment to be classified as a makerspace are difficult to describe. Initially, the term makerspace was applied in 2005 when the Maker Movement applied the DIY (Do It Yourself) approach to computers and electronics, among others (Dougherty, 2012), relating it closely to new technologies and digital tools. However, as the makerspace concept became more widespread, it no longer necessitates a predefined set of tools; instead, it now emphasises providing a publicly accessible creative environment that supports exploration, making, and tinkering (Rosa, Ferretti, Guimarães Pereira, Panella, & Wanner, 2017).

Makerspaces initially originated in universities (Taylor, Hurley, & Connolly, 2016) or started as self-organised community-driven organisations. However, today, the adoption of this innovation by educational institutions, libraries, museums, and even industrial estates is rapidly increasing, leading to the emergence of a new category of institutionalised makerspaces. Depending on the mission, values, and culture of their host institutions, such makerspaces differ in their aims and organisations. For example, Özkil, Jensen, and Hansen (2020) introduced makerspaces that function as student-run facilities focused on self-initiated learning, as opposed to makerspaces that act as an integrated part of a certain curriculum. Likewise, alternative and/or slightly different concepts are used in parallel, including FabLabs (Gershenfeld, 2008), hackerspaces (Moilanen, 2012), and creative workshops (Saorín et al., 2017). Vuorikari, Ferrari, and Punia (2019) divide makerspaces into four types according to intentions and space for learning. On the vertical axes, they divide makerspaces into whether or not learning is intentional (as defined through learning outcomes). On the horizontal axes, they divide makerspaces as physical spaces with a range of fabrication tools devoted to making or spaces where making activities are carried out in an ad hoc environment, such as a mobile cart or a ‘pop-up’ kit. Our study focuses on intended learning in a set physical learning environment.

Makerspaces are utilised for interdisciplinary applications to help learners coordinate different disciplines. These environments are promising in terms of enriching learners with integrated knowledge in STEAM (science, technology, engineering, arts, and mathematics). By contrast, STEAM invites learners to think and learn through experience (Soomro, Casakin, Nanjappan, & Georgiev, 2023). In addition, makerspaces help learners develop twenty-first-century skills (critical thinking, creativity, communication, collaboration, and problem-solving) by fostering creative processes using active and collaborative learning through various tools (Rosa et al., 2017).

At this point, we rely on the promising positive impacts of makerspaces and focus on the definitions and characteristics that make academic, learner-centred makerspaces. So far, we have not managed to access any report on makerspaces concerning home economics or the food education context. However, home economics content (International Federation of Home Economics, 2008) fits well with ‘a creative and uniquely adaptable learning environment with tools and materials, which can be physical and/or virtual, where students have an opportunity to explore, design, play, tinker, collaborate, enquire, solve problems and invent’ (Loertscher, Preddy, & Derry, 2013). Home economics functions as an intermediary between STEAM practices and the makerspace learning environment, offering authentic, real-world contexts for learning. The Science Kitchen, a newly launched learning environment at Tallinn University in Estonia, seeks to connect the everyday knowledge and practical activities of home economics with scientific content. Its main goal is to enable learners to apply the knowledge and skills they acquire to real-life situations. With its emphasis on STEAM learning and hands-on experiences, the makerspace concept offers a promising approach to enhance the development of The Science Kitchen concept.

2. Methods

This paper shares the results of a systematic literature review of scientific peer-reviewed articles, including research and review articles, to identify topical content. An online literature search was conducted using e-databases available for registered library users at Tallinn University. The search terms ‘makerspace’ AND ‘learning environment’, ‘makerspace’ AND ‘cooking’, and ‘makerspace’ AND ‘food’ were used in two databases. Overall, 112 scientific articles were available with full access on the Web of Science and EBSCO Host e-databases, and 18 relevant papers remained eligible for inclusion after careful readings (coded as A1, A2, etc.). Articles focused only on virtual learning environments, libraries, or museum makerspaces, or on early childhood education were excluded from the analysis. In addition, the chosen articles were limited to makerspaces in formal learning contexts.

Qualitative content analysis (Schreier, 2012) was used to systematically categorise and interpret the descriptions and meanings of the makerspace concept in the topical articles from learners’ and educators’ points of view. The analysis was performed using inductive reasoning, by which themes emerged from the data through careful examination and constant comparison. The data were coded under named themes and divided into categories, if needed. As the aim of this study was to gain a broad understanding of different aspects of makerspaces, the themes and categories were revealed on a descriptive level rather than the proportions of the elements in more detail.

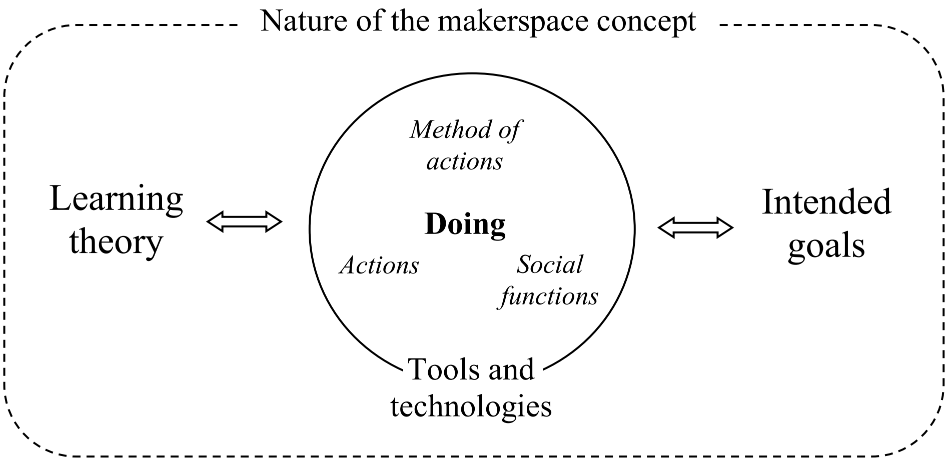
3. Results

The analysed articles represent various learning stages, from elementary and primary schools to colleges and universities. Moreover, the teacher’s and learner’s perspectives were revealed. Various aspects of makerspaces have been studied in the analysed articles, which focused largely on twenty-first-century skills or, more specifically, on creativity and collaboration. From the teacher’s perspective, professional development aspects and student assessment became visible. Typical of the makerspace concept, we see a majority of craft-, information technology-, and engineering-specific articles, although a drama-focused makerspace activity could also be named as a counterbalance. We present the results of the analysis in Figure 1, which shows the key components of a makerspace and their interactions.

The analysis revealed that makerspace was defined in only half of the articles. In some articles, the essence of the environment was described only in the Introduction section. However, the *nature of the makerspace concept* was identified in all articles. Mainly, makerspaces were identified as learning environments and, in one article, as teaching venues. In addition to the formal educational viewpoint, makerspaces are viewed as open-access workshops in an informal setting. In all the articles, makerspaces were defined as physical, multifunctional, and creative environments. Moreover, the social aspect of makerspaces as collaborative workspaces was highlighted.

The *learning theory* behind makerspaces creates a framework for the environment setup and actions performed in that environment. In the articles, the learning theory emphasises learners’ active participation and knowledge construction. From the descriptions, it can be seen that both constructivism and constructionism have been associated with such learning environments. Two articles take learning on a social level, prioritising 'social tools, and the dialectical relationship between self and the environment' (A18). Thereby, social constructivism and the sociocultural learning approach have also been highlighted. In addition, not all articles reflected the learning theory associated with the activities that take place in makerspace environments.

Figure 1. Schematic overview of the results.



The activities in the makerspaces were described in more detail. All aspects of the activities formed the theme of *doing* (see Figure 1), which included three categories: *action*, *method of action*, and *social functions*. Makerspace *actions* include learners' experimentation and exploration, both at the action and idea levels. These are the basis for idea generation and knowledge creation. Makerspaces expect learners to participate in designing, creating, building, tinkering, and iterating with materials in some other ways. Often, this includes prototyping and testing. Learners apply their skills and knowledge in makerspaces. In specific makerspaces, they play, hack, and perform other digital activities.

The descriptions of the *method of action* reflect the development of twenty-first-century skills. In makerspaces, problem-solving tasks are central. Learners develop their projects or engage in project-based learning. Creative ways of working with knowledge and tools are expected, and critical thinking is practiced by learners. The makerspace concept is quite often associated with STEM pedagogy. Eight articles described how STEM (and one, how STEAM) was implemented in the activities by integrating various subjects. The *social functions* in the makerspace activities become visible through the collaborative nature of the actions. Teamwork, shared work, and collaboration are mentioned as the means of working in makerspaces. Learners share their ideas, brainstorm, discuss possibilities and obstacles, listen to each other, and reflect.

Lists of available *tools and technologies* in makerspaces were discussed briefly. Most articles identified various digital tools, such as computers, three-dimensional printers, and digital fabrication technologies, as a necessary part of their makerspaces. Other machines, such as laser cutters, sewing machines, manufacturing tools, and general power tools, were mentioned significantly less. Materials and crafting tools were listed only in a few articles that focused more on craft content. In addition to the lists of needed tools and technologies, the makerspace environment must be flexible for users. For example, one article (A14) suggested that furniture must have wheels to enable easy reorganisation of the environment. In addition to physical tools, the makerspace environment also expects well-phrased guides and work instructions for learners. Learning challenges, thinking strategies, and concepts supported learners' actions and discussions throughout the tasks.

The *intended goals* of the makerspaces were discussed on various levels. In some articles, broad expectations were identified as the aims or impact of learning in a given makerspace, such as promoting twenty-first-century skills, working with complex real-world problems, increasing learners' motivation, and deepening learners' understanding of the basic concepts and principles. Makerspaces are intended to support the development of transferable knowledge and skills, cultivate the exchange of ideas, and focus on collaborative problem-solving. In other articles, more specific goals were phrased, including time management or supporting an understanding of the operating principles of technology. In any case, makerspaces promote innovation in education, both by raising learning to a new level and by supporting innovative solutions and outcomes.

4. Discussion

With our gained knowledge on the various natures of the makerspaces described in the analysed articles, we found that the commonality of and key insight into these natures are that learning in such environments is deeply embedded in the act of making. Rather than functioning as adjuncts to formal instruction, these environments promote experiential, embodied learning where knowledge is constructed through iterative design, experimentation, and reflection, as described by, for example, Loertscher et al. (2013). Makerspaces cultivate a learning culture that embraces failure, encourages help seeking, and fosters curiosity. Furthermore, these provide opportunities for participants to engage in generative and iterative problem-solving, with sometimes even never-before-considered materials and collaborators. This makes makerspaces unique environments where something new is always learned. This aligns with Dougherty's (2012) view of maker learning as rooted in a growth mindset—one that tolerates failure and embraces uncertainty, in contrast to fixed, risk-averse learning models. The collaborative, open-ended nature of making also exposes learners to novel materials and perspectives, enabling generative problem-solving across disciplinary boundaries and empowering learners to develop transferable competencies.

Some school subjects, such as home economics, may serve as natural bridges between traditional instruction and makerspace-style learning. As a largely practical subject with a less rigid structure compared with other school subjects, home economics offers an ideal springboard for integrating real-life tasks with opportunities for exploration and knowledge building. Similarly, in The Science Kitchen, we aim to turn the regular home economics kitchen into a makerspace, depending on learners' and lessons' needs. Thereby, in accordance with the model of Vuorikari et al. (2019), The Science Kitchen, as a makerspace, is a multifunctional physical environment with various tools and where learning is linked with the intended learning outcomes defined, for example, as part of a curriculum (e.g. for students) or qualification programme (e.g. for in-service teachers). We view it as a key site for pedagogical innovation that aligns well with the maker ethos. The most critical aspect lies in the methods (including the well-phrased instructions, given concepts, and thinking strategies) used to support learners' abilities to act, notice, analyse, and construct knowledge while fully empowering the educational potential of the makerspace environment. Without intentional pedagogical strategies, the transformative possibilities of makerspaces may remain underutilised.

In summary, makerspaces represent more than physical environments for crafting, as they are dynamic learning ecosystems that promote creativity, agency, and future-ready skills (including twenty-first-century skills) through hands-on, enquiry-driven experiences. In doing so, makerspaces offer a compelling model for preparing learners to navigate complex, evolving futures.

5. Conclusion

Although we did not manage to find a makerspace similar to The Science Kitchen from the literature, we gained confidence that a kitchen as an environment and home economics as a content fit well with the aims of makerspaces. With supportive measures, such as a learning approach and written and physical tools, a learning environment that supports learners' engagement in experimentation and knowledge construction can be created.

When used as a makerspace, The Science Kitchen acts as a multifunctional learning environment where social constructivism is applied to design STEAM-related experimentations and explorations that expect scientific observations and applying previous knowledge and skills for creating knowledge in a given learning situation. Learners in The Science Kitchen apply critical thinking when dealing with real-life-related problems and tasks. The given tasks encourage collaboration, sharing of experiences and ideas, discussions, and interactions with tools, in addition to people. The Science Kitchen has basic classroom and study kitchen equipment. It also has laboratory equipment, such as a microscope, sensors, and a thermal camera. In addition to physical tools, predefined STEAM learning tasks bring together interdisciplinary content to support knowledge construction. Thereby, The Science Kitchen, as a makerspace, adopts a new methodology of integrated learning by bridging home economics and STEAM.

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