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Conclusions

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Routledge
2020

Marsh , J , Blum-Ross , A & Kumpulainen , K 2020 , Conclusions . in A Blum-Ross , K Kumpulainen & J Marsh (eds) , Enhancing digital literacy and creativity : Makerspaces in the Early Years . Routledge , Abingdon, Oxon , pp. 182-191 . <https://doi.org/10.4324/9780429243264-12>

<http://hdl.handle.net/10138/329688>

<https://doi.org/10.4324/9780429243264-12>

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Citation information:

Marsh, J., Blum-Ross, A., & Kumpulainen, K. (2019). Conclusions. In A. Blum-Ross, K. Kumpulainen, & J. Marsh (Eds.), *Enhancing digital literacy and creativity: Makerspaces in the Early Years* (1st edition ed., Vol. 2019). London: Routledge.

12 Conclusion

Jackie Marsh, Alicia Blum-Ross and Kristiina Kumpulainen

As the chapters in this book indicate, the MakeY project has been successful in meeting its original aims, which were to identify the role and value of makerspaces for young children in both formal and non-formal settings. In this concluding chapter, we draw together the project's findings across the three levels of analysis outlined in the introduction: personal, relational and institutional. This is not to suggest that these three areas can be separated in a simple manner, given that they are interrelated. Nonetheless, this approach to analysis enables a close look at the micro-, meso- and macro-level factors at play in the provision of makerspaces for children aged under eight years.

Impact of makerspaces at the personal level

Identity plays a significant role in the ways in which children take up, or not, as the case may be, the opportunities offered by makerspaces. Given the links between makerspaces and STEM learning, it is worth considering some of the barriers to engagement. Whilst patterns of participation across post-compulsory STEM education, training and careers differ across the disciplines, some key trends are clear. Engagement by certain groups (girls, some Black, Asian and Minority Ethnic (BAME) groups and individuals from working-class families) in STEM is problematic, and research has identified that these patterns are evident in the choices made in subjects available to pupils in compulsory schooling in some countries (Archer et al., 2017), as well as in future educational and career choices (DeWitt et al., 2011). There are a number of reasons that have been identified for this situation, such as the stereotypes of scientists in society, who are often portrayed as White males, feelings of a lack of identification with the subject matter of STEM curricula, and a lack of family engagement in science subjects or pursuits, such as visits to science museums (Archer et al., 2012, 2013; Dabney, Tai and Scott, 2016). Given these challenges, makerspaces could offer a valuable means of providing more positive experiences for girls and for children from low socio-economic BAME communities. In many of the case studies outlined in this book, this was found to be the case. It was felt by many of the country project leaders that the development of a STEAM approach was more conducive to inclusive practice, as it enabled children to draw on their interests in non-STEM

subjects. This has been identified in other projects (Kang et al., 2012, although these studies have focused on older children. In addition, a STEAM approach aligns with established practice in early childhood education, in which topic-based approaches to the construction of the curriculum are common.

The MakeEY project was also found to have an impact in terms of ‘projective identities’ (Gee, 2003), in which individuals can imagine themselves otherwise. There were numerous cases across the studies in which children self-identified as makers, though they had not necessarily done so previously. Given the timescale of this project, it was not possible to determine whether or not this impact is long-standing in nature. If the practices established in makerspaces are not embedded in everyday curricula, then children will have limited opportunities to rehearse the maker identities developed within makerspaces. This is also the case in relation to the impact of the study on children with special educational needs. Whilst many of the practitioners involved discussed the way in which the project had benefited children who had cognitive, linguistic, and/or physical special needs, it remains to be seen if this impact continues beyond engagement with the MakeEY project.

In line with other analyses of makerspaces (Peppler, Halverson and Kafai, 2016), children across the case studies followed interest-driven pursuits. This was not always possible in those makerspaces that focused on specific outcomes, but even within those contexts, children spent longer on those activities that were of specific interest to them. It was not always the case, however, that makerspaces fostered engagement of all the children in the case studies. In those pre- and after-school settings in which the opportunity to choose whether or not to participate was available to children, some children did not want to engage, either partly or fully, as, for example, the Romanian case study indicates. Marsh, Wood, Chesworth, Nisha, Nutbrown and Olney (in press) point to the way in which ‘maker capital’ and ‘maker funds of knowledge’ (drawing on Moll et al.’s (1992) concept) impact on children’s engagement in makerspaces. Children’s previous experiences as makers impact on their levels of confidence and interest. Finally, in a consideration of the impact of the study at a personal level, a focus on children’s acquisition of digital skills and knowledge indicates that engagement in makerspaces can enhance children’s learning in numerous ways. Across the projects, children learned to operate and use a range of hardware and software, and they observed the use of equipment that was too complex for them to operate themselves, such as 3D printers and laser cutters. The makerspaces enabled children to learn how to code, how to create animations and films, and how to operate virtual reality (VR) tools, amongst other things. What was of value in this process was the way in which the acquisition of skills and knowledge was embedded in meaningful activities;

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children were not acquiring skills in isolation. In addition, makerspaces enabled the children to encounter playful approaches to the use of digital technologies, which is of value given the well-established relationship between play and learning (Vygotsky, 1938/67). It is important to note, however, that children did not simply acquire operational skills in the makerspaces; their cultural and critical skills and knowledge were also developed (Marsh, Arnseth and Kumpulainen, 2018). Further, it soon became clear that the project's original focus on digital literacy and creativity was too narrow; across the makerspaces, a rich range of skills and knowledge were developed across STEM and arts and humanities subjects.

It is important to note that when studying young children's creativity in makerspaces, there needs to be an acknowledgement that digital and non-digital practices are intimately related, and that practices will be fluid across domains. MakeEY was interested in digital making, but the team recognised that much of children's making takes non-digital forms, and they were interested in the creativity embedded in those practices, too. Rather than pose a false dichotomy between digital and non-digital making, the project explored young children's making in a range of forms and across physical and virtual domains, identifying the ways in which these domains were sometimes quite separate, and at other times merged, as in the Danish, German and UK case studies.

Impact of makerspaces at the relational level

Early childhood educational provision places great emphasis on the importance of providing space and time for children's social development. Given the significance of the early years in terms of, as the US National Scientific Council on the Developing Child terms it, 'Establishing a level foundation for life' (2012), and the evidence on the relation between social development and academic success (Denham and Brown, 2010), it is of little surprise that almost all early childhood curricula across the globe place emphasis on this aspect of development (Bertram and Pascal, 2002). Therefore, early-years practitioners foster values such as interacting with, and caring for, others. As Hatch's (2013) emphasis on 'sharing' indicates, makerspaces offer such opportunities. Petrich, Wilkinson and Bevan (2013: 53–54) argue that makerspaces foster solidarity with others, and David Gauntlett, in his book *Making is Connecting*, makes the point that 'acts of creativity usually involve, at some point, a social dimension and connect us with

other people' (2011 2). Thus, makerspaces offer children the potential to develop their social capacities.

Across the case studies, it was clear that social interactions were key to makerspace activities, with rich exchanges taking place not just between children, but between children and practitioners, older siblings, parents, grandparents and volunteer helpers, as was evident in the US case study, for example. Children provided support and scaffolding for other children's learning in the spaces, and listened to each other's ideas and reflections. It is important to note, however, that the nature of social interaction in the makerspaces was not always positive. Difference and conflict are embedded in daily social practices (Kumpulainen and Renshaw, 2007; Rajala and Sannino, 2015). Children did not always share the same thoughts about their work, and some found it difficult to share resources at times. Whilst not documented within the case studies outlined in this book, there were, occasionally, differences of opinion between some of the various professionals engaged in the study with regard to how to plan and conduct the makerspaces. This is, perhaps, unsurprising when one considers the different backgrounds and experience of the various professionals involved in the study. Rather than viewing this as problematic however, the team felt that this process enhanced the project, as it forced members to articulate the underlying principles and philosophies that shaped their practice, and it changed beliefs and practices in productive ways.

As outlined in the introductory chapter, the project team was also interested in understanding the ways in which the social and material resources of the makerspaces supported diverse children's joint engagement, digital learning and creativity. There were particular technical resources that supported collaborative work, such as tablets, given the affordances they have for this (such as touchscreen interfaces that enable more than one child to use them at the same time) (Burnett et al., 2017). However, even when resources appeared to preclude collaborative work, children still found opportunities to collaborate. For example, in the case studies in Germany and the UK, the use of VR equipment meant that only one child could wear a headset and experience the 3D environment at any time, but in fact in many of the activities, other children stood near the child wearing the headset, commenting on the VR drawing on the computer screen and talking with the VR artist about what they were doing.

The extent to which some of the makerspace activities fostered social relations was dependent on how they were organised by the practitioners. As the examples from Iceland, Norway and Romania indicate, for example, where a more open pedagogical approach was adopted, interaction and collaboration were encouraged, but even when a more closed pedagogical approach was adopted, joint activities were planned. Only in those maker activities which

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focused on individual tasks related to a specific skill were opportunities for collaboration fewer. In addition, how far an activity became a collaborative one was frequently shaped by the children themselves. At times, children engaged in activities that were set up to foster collaboration, but they worked in such a way that they deliberately excluded engagement with others. A key point to reflect on when considering this issue is that each makerspace is unique in the way in which it fosters, or closes down, social interaction, and much of that is shaped by the makerspace provider in addition to the types and tools of resources offered, but it is also the case that individual children's agentic actions can open up, or close down, opportunities for social interaction. Timely interventions by the pedagogue can ensure that these situations are managed effectively when necessary.

Impact of makerspaces at the institutional level

The project explored makerspaces across both formal and non-formal settings, and examined both temporary and permanent spaces. Given this level of heterogeneity, it is not possible to identify a singular institutional impact across these contexts. However, it was clear that there were some key principles that enabled makerspaces to flourish across this range of settings.

Firstly, having knowledgeable and committed individuals in institutions was key to ensuring that the legacy of MakeEY makerspaces was sustained beyond the project. In order to ensure this sustainability, a range of professional development opportunities were offered to participants in the study. Practitioners in some of the countries were able to participate in makerspaces prior to engaging in them with children, which developed their confidence and subject knowledge. The project as a whole developed a range of resources to support professional engagement in makerspaces.¹ Makers from independent Fab Labs and open-access makerspaces for the general public were brought into the project in some countries in order to share their expertise. Secondly, key to the sustainable nature of makerspaces is the ability to resource them, in terms of space, tools and resources. For some of the museums and libraries involved in the project, it was possible to set up permanent makerspaces, which enabled ongoing access to a range of tools and resources. Obviously, this was much more problematic for the early-years settings and schools, which in the main tended to set up pop-up makerspaces. In some cases, the nature of the makerspace shifted over the course of the project, from a pop-

¹ See: <http://makeeyproject.eu/resources/>

up one, in which practitioners could try out activities and approaches, to a more permanent space once the warrant for such provision was established.

The project also considered how far the makerspaces created equitable opportunities for children's learning and identity development and how this process operated at an institutional level. Whilst a number of claims have been made about how makerspaces can promote democratic participation in society (Anderson, 2012), the reality is rather different. The majority of makerspaces are located in urban spaces, which immediately excludes many people living in rural communities from participating. Further, Alper (2013: 1) reported a US survey that found that '8 in 10 makers are male, their median household income is \$106,000, and 80% have a post-graduate education'. This, indeed, was a major driver for setting up the MakeY project in the first instance. If makerspaces are going to be offered to young children in both formal and non-formal settings, then issues of equity are significant. In the preschool settings and schools involved in the project, equity of access to such provision is well-established in practice, and this was no different in relation to the makerspaces. Practitioners were attentive to the need to ensure inclusive practice and utilised a range of strategies to ensure such inclusivity, such as ensuring that topics were diverse and relevant to children's cultural backgrounds, that children in the early stages of acquiring the national language as a second language were given support in understanding key terms, and that the engagement of children who might not otherwise have participated was facilitated through mentoring arrangements.

In some of the libraries and museums involved in the study, inclusive practice was also possible because of public funding, as was the case in the US-based project. However, for some of the independent organisations and SMEs involved in the study, makerspaces could only be provided for children by requiring parents to pay for them, and this then restricted the opportunity for all children to participate. This situation could be addressed by the inclusion of such spaces in public-funded programmes that promote makerspaces in non-formal learning settings, a point that will be returned to later in the chapter.

At the institutional level, the MakeY project also considered the kinds of pedagogical and assessment practices that supported children's engagement in makerspaces. In general, it was found that more open pedagogical practices in which children could take an agentic role in planning and conducting their activities were productive in terms of children's engagement and learning, as discussed in the chapters written by the Danish, Icelandic and Norwegian teams. This is not to suggest that the makerspaces in which children had fewer choices about what to make were not successful, as the Finnish and UK case studies indicate. In those instances, even though the teachers wanted the children to meet specific learning objectives, which reduced

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the children's possibilities for agency in terms of the types of making, the children were fully engaged in the activities and gained a lot from them, as they were able to be creative and innovative. Therefore, it is clear that children gain different things from different kinds of makerspaces, and it is valuable for them to experience variety in terms of the set-up of makerspaces and the educational possibilities they offer.

Finally, the project examined the value of the partnership between academic and non-academic participants in creating makerspaces for young children. The project was highly successful in this regard, in that it enabled rich knowledge exchanges to take place. Early-years teachers acquired a range of technical skills and specialist maker knowledge from makerspace staff, who in turn became knowledgeable about the developmental needs of young children. Academics learned about exploratory approaches to creative production from artists, who themselves enjoyed extending their understanding to include approaches to undertaking research with young children and families. Library staff and museum educators taught others about the value of interest-driven learning, and they gained valuable knowledge about how to identify and capture the learning taking place in makerspaces. The project moved beyond simple knowledge exchange, however, to embody the key principles of co-constructed research, in which all parties contributed to knowledge creation, ensuring that, between them, new understandings were developed regarding the provision of makerspaces for children aged under eight. This project has also enabled learning across national boundaries, and it has fostered a conversation between different disciplines (education, media and communication, sociology, urban studies and planning) and across different sectors (SMEs, public services, third sector). Despite the challenges in this process, the value of such exchanges is inestimable. It is only through interdisciplinary and inter-sector work that some of the key challenges that face society in the years ahead can be addressed.

Implications of the project for research, policy and practice

The project has a number of implications for future research, policy and practice. In relation to research, whilst the project has identified the role and value of makerspaces in the early years, there is much more to explore with regard to this provision. Firstly, the longitudinal impact of children's engagement in makerspaces needs to be traced. It is to be hoped that, through positive engagement in innovative and creative approaches to STEM subjects in makerspaces

in early childhood, children will maintain their interest in these subjects throughout primary and secondary school, but this needs to be the subject of sustained study. Secondly, the relationship between the knowledge and skills gained in makerspaces, and the subject knowledge required when studying single disciplines, deserves further exploration. The interdisciplinary nature of learning within makerspaces means that, inevitably, the development of subject-level knowledge will be uneven in nature, and experiences may not map easily onto disciplinary expectations. This may not matter, if the main value of engaging children in making spaces is to excite them about subjects that they might not otherwise be attracted to. However, further sustained links between experiences in makerspaces and the curriculum would offer a more integrated educational experience for children. Finally, this project demonstrated that there is much synergy between the principles that underlie makerspaces and early childhood philosophy and practices, yet there are still some misunderstandings about the relation between them. As suggested in [Chapter 1](#), this means that some observers may query the need for makerspaces to be set up in early-years settings, arguing that this is everyday practice. This stance, we would argue, overlooks the fact that making in many preschool settings has traditionally focused on a relatively narrow set of tools and resources, and there is a need to broaden the sets of tools and resources made available if children are to become competent makers in the fourth industrial age. In addition, real-world applications of making, which are frequently seen in makerspaces, are not prevalent in early childhood education. Further research should be undertaken that examines the value of fostering authentic maker activities in preschool settings and primary schools, activities that can be linked to issues of citizenship and community action ([Marsh, Arnseth and Kumpulainen, 2018](#)).

The project also has a number of implications for policy. Given the rich range of learning that was observed across the case studies in this project, education ministries should carefully consider the need to fund the resourcing of makerspaces in early childhood and primary education, and in non-formal settings such as museums and libraries. It is clear that makerspaces can boost the kinds of skills and knowledge required to enable nation-states to compete globally in future employment markets, and so this investment will offer growth opportunities in later years. There is a particular need to support the provision of makerspaces in areas of high unemployment and deprivation, given that these are the areas most likely to be digitally excluded ([Helsper, 2012](#)). This is not to suggest that makerspaces are a panacea for poverty and a lack of equal opportunities; it would be foolish to suggest that through attendance at makerspaces, individuals will automatically develop the kinds of skills and knowledge that

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would provide entry to the job market. Nevertheless, such experiences can spark interest in the pursuit of further education and training in relevant areas. In addition, it may make employment in the creative and technical industries, or related future pathways, more accessible to a wider group of people, thus tackling the lack of diversity which is prevalent in these areas (O'Brien et al., 2017).

Finally, there are numerous implications for practice from this study. The project team has developed a wide range of resources for practitioners in early-years settings, schools, libraries and museums, and therefore we point readers to the project website, as detailed previously. In addition to these resources, which provide guidance on setting up and running makerspaces, the project has also identified implications for practice in open-access spaces and Fab Labs. In many communities, there is an appetite for attending makerspace activities aimed at young children, with some parents willing and able to pay for out-of-school makerspace workshops. We would encourage not-for-profit makerspaces and SMEs to consider this market, and to identify ways in which they may be more inclusive of this age group. This may lead to collaborations with early-years settings in primary schools in their vicinity.

Conclusions

This book has outlined the main findings from the MakeEY project, and it has considered the implications of these findings for research, policy and practice. The collaboration across different countries has been crucial to the success of the programme, as it has led to a more informed understanding of the way in which specific cultural contexts shape policy and practice with regard to the provision of makerspaces for young children. As the literature reviewed throughout this book identifies, there is a worldwide concern that our educational systems are outdated and failing to promote the necessary digital literacies that will adequately prepare our children for the future. One of the major concerns of educators is to ensure that every young person is equipped early on with adequate digital literacy skills and knowledge that will support their academic and civic engagement and lifelong, and lifewide, learning opportunities. In many countries the availability of technology is adequate, but the primary challenge to overcome is the lack of readiness for the pedagogically meaningful use of digital technologies and media to enhance young people's digital literacies in connection with other disciplinary and 21st-century skill sets. The MakeEY project, with its interest in understanding the potential

of makerspaces for enhancing young children's digital literacy and creativity across various settings, has made an important contribution to furthering understanding in this area.

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