Making STEAM Tangible: The Rural Makerspace Initiative *"Technik für Kinder Vulkanland"* in Austria

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***Abstract* — While makerspaces have gained attention as environments for exploratory and interest-driven learning, comparatively less is known about how maker education can be organized as a permanent, community-based, and regionally embedded learning environment in rural contexts. This paper addresses this gap through the case of *Technik für Kinder Vulkanland (TfKV)*, a permanent makerspace for children and adolescents aged 7 to 14/15 in rural southeastern Austria. *TfKV* combines traditional craftsmanship and material practices with digital technologies and connects these learning opportunities with regional mentors, local expertise, educational actors, and community partners. Using a descriptive case study approach, the paper examines the organizational structure, pedagogical design, mentoring model, participation structure, regional partnerships, and implementation of the initiative. These descriptions are complemented by exploratory evaluation data from the initial implementation phase, including a parent survey (n = 33) and two reflective mentor interviews. The findings indicate high levels of parent-reported engagement and highlight process-oriented learning, experimentation, and intergenerational mentoring as central characteristics of the learning environment. At the same time, they reveal tensions between openness and structure, guidance and autonomy, as well as challenges related to age heterogeneity, gender imbalance, organizational capacity, and the resource-intensive nature of sustained makerspace provision. Parents also reported perceived behavioral changes associated with perseverance, patience, and confidence in dealing with mistakes and failure; however, these observations were not assessed using standardized measures and should not be interpreted as evidence of competence development. Based on the case, the paper conceptualizes regionally embedded maker education as an approach that connects material engagement, technological exploration, social and intergenerational learning, and regional knowledge and resources within a sustained learning infrastructure. The paper contributes to maker education research by providing initial empirical and practice-based insights into how a permanent rural makerspace can be organized, embedded within its region, and sustained as a community-based learning environment.**

***Keywords* — Maker Movement, Maker Education, Makerspace, STEM Education, Rural Education, Intergenerational Mentoring**

I. INTRODUCTION

Technological change and digitalisation are reshaping occupational structures and skill requirements, increasing the relevance of digital skills across a wide range of professional contexts [1]. At the same time, craft-related expertise remains relevant in the context of digital and sustainability transformations, while craft practices themselves are increasingly intertwined with digital technologies [3, 4]. This intersection is also relevant from an educational perspective. Craftsmanship involves the integration of thinking and making, practical experience, judgement, and skilled engagement with materials [2]. Related research on tacit knowledge highlights forms of knowledge that are acquired through practice and social participation and cannot always be fully articulated or formalised [5]. The future relevance of craft-related expertise therefore lies not in an opposition between the digital and the material, but increasingly in their interaction. This raises an educational question: *how can children and adolescents meaningfully experience the interplay between digital technologies, materials, practical knowledge, and real-world problem solving?* Learning takes place across both formal school and informal out-of-school contexts; however, research has pointed to a persistent lack of connection between these contexts and has emphasized the need for approaches that bridge formal and informal learning environments [6]. Informal learning organizations can complement and extend learning opportunities for children and youth and, when connected with schools and other educational organizations, form part of a broader regional educational ecology [7]. This question is particularly relevant in rural regions, where access to STEM learning opportunities is uneven. Research has documented geographically linked structural barriers affecting rural and small-town students, including more limited opportunities to learn in STEM [8]. Rural students have also been found to participate less frequently in after-school science clubs despite expressing substantial interest in such opportunities [9]. More recent research similarly points to reduced access to advanced STEM coursework, extracurricular STEM activities, informal STEM learning opportunities such as museums and summer camps, and STEM role models among students attending rural schools [10]. At the same time, rurality should not be understood solely through a deficit perspective. Rural communities provide distinctive forms of local knowledge, community resources, and place-based learning opportunities that can serve as resources for science and technology education [11]. Place-based approaches can connect learning with local environments, community knowledge, hands-on experiences, and real-world problem solving, thereby creating educational opportunities that are closely embedded in learners' everyday contexts [11]. From this perspective, establishing sustainable learning environments in rural regions is not simply a matter of transferring urban educational models to rural settings, but of building on local actors, knowledge, resources, and networks. In this paper, this perspective is referred to as regionally embedded maker education: an approach that connects technological and

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material learning with local knowledge, regional expertise, community actors, and place-based practices while providing sustained opportunities for hands-on experimentation and collaborative learning. Community-based makerspaces represent one possible environment in which such regionally embedded learning can be realised. By providing access to tools, materials, technologies, and collaborative environments, makerspaces can create opportunities for hands-on experimentation and learning across traditional boundaries between digital and material practices. Existing maker education research highlights the potential of makerspaces to support problem solving, iterative design, skill development, collaboration, technological exploration, and interest-driven learning [12, 13, 18, 20]. At the same time, participation in a makerspace should not be assumed to automatically produce positive developmental outcomes. Such outcomes may depend on factors including facilitation and scaffolding, participants' age and gender, and the duration and intensity of participation [13]. In the German-speaking context, the *MAKER DAYS for kids* provide a well-documented example of maker education for children and adolescents. Implemented as open digital workshops and pop-up makerspaces, these initiatives combine digital fabrication, coding, physical computing, robotics, electrical engineering, crafts, and arts within intensive multi-day formats [12, 14, 18]. While this research provides valuable insights into the pedagogical design and implementation of temporary and institutionally situated maker activities [12, 14], comparatively less attention has been paid to maker education organized as a permanent, community-based learning environment for children and adolescents in rural regions. Existing research has addressed individual aspects such as rural maker education and community partnerships [15], mentoring and longitudinal participation in rural maker programs [16], and makerspace sustainability and continuance [17]. However, the combination of these dimensions within a permanent and regionally embedded rural makerspace remains less well understood. In particular, questions remain regarding how continuity, regional embedding, mentoring structures, organizational sustainability, and sustained participation can be brought together within such an environment. Therefore, the present paper examines ***how maker education can be organised as a permanent, regionally embedded learning environment in a rural context***. It presents *Technik für Kinder Vulkanland (TfKV)* as a practice-based case and examines its organisational structure, pedagogical approach, mentoring model, material environment, regional partnerships, and participation structure. In addition, exploratory evaluation data provide initial insights into how this model translates into practice.

II. TECHNIK FÜR KINDER VULKANLAND

A. Context and Setting

Technik für Kinder Vulkanland (TfKV) is located in the Styrian Vulkanland, a rural region in southeastern Austria characterized by strong traditions in craftsmanship and small-scale industry (see Fig. 1).



Fig. 1 Location of Technik für Kinder Vulkanland (*TfKV*)

The initiative was established as a non-profit association in March 2024 in response to the limited availability of hands-on STEAM learning opportunities in the region. The initiative was established with the aim of creating a technology house as a permanent, professionally equipped learning environment for children and adolescents aged 7 to 14/15 (see Fig. 2).



Fig. 2. Exterior View of the Technology House

The technology house provides 24 workstations (see Fig. 3), a dedicated machine room with tools such as saws and sanding machines, and a wide range of materials, including wood, metal, and electronic components.


Fig. 3 Interior view of the Technology House workshop

In addition, participants have access to digital elements such as LEDs, sensors, and simple automation systems. A shared social space complements the workshop and supports exchange, collaboration, and informal learning processes.

B. Conceptual Design/Pedagogical Approach

TfKV deliberately combines traditional tools and materials with digitally supported practices. The aim is to create a learning environment in which technology is experienced as embedded in real-world objects and processes. This design reflects the concept of regionally embedded maker education

introduced above: rather than treating making as an isolated technological activity, *TfKV* connects material and technological exploration with practical contexts, local expertise, and community-based learning opportunities. Pedagogically, the technology house follows an open, project-based approach without a fixed curriculum or predefined learning pathways. Participants develop their own ideas, experiment with tools and materials, and refine projects through trial and error. Such processes are consistent with previous maker education research emphasizing problem identification, iterative design, experimentation, skill development, interest-driven and self-organized learning, and learning with and from others [18, 20].

C. Learning Processes and Session Structure

Each club session follows a recognizable internal structure that provides orientation without imposing rigid sequences. A typical club session can be described as a sequence of loosely defined phases [19] (see Fig. 4). Before the participants arrive, the lead mentor and mentors prepare the workshop and organize the materials. When the children and adolescents arrive, they check in, receive their name badges, and take part in a short, moderated group introduction during which project ideas are discussed. Afterwards, they either work on suggested activities proposed by the mentors or continue with their own self-initiated projects. Tools and materials are available throughout the sessions under mentor supervision. The session ends with a collective clean-up and a brief reflection among the mentors.

Time	Activity
14:00 – 14:50	Preparation of the workshop by the lead mentor and mentors
14:50 – 15:05	Arrival and distribution of name badges
15:05 – 17:00	Group introduction and project work led/supported by the lead mentor and mentors
17:00 – 17:30	Completion of workshop activities and joint clean-up
17:30 – 18:00	Debriefing and reflection between lead mentor and mentors (no children and adolescents)

Fig. 4. A typical club session

This structure provides orientation while maintaining flexibility within the project-based format. The regular club format takes place weekly from Monday to Thursday during the school year, from September to June/July. Each session lasts approximately 2.5 hours.

D. Participation

The weekly club sessions address children and adolescents aged approximately 7 to 14/15. Participants mainly come from the rural region of southeastern Styria, particularly the Styrian Vulkanland and surrounding municipalities. The target group includes children with different levels of prior experience in craft, technology, and making. Participation requires prior registration by a legal guardian. For the regular weekly club format between Monday and Thursday, children enrol for a fixed day per week aligned with the school year. Each club session is limited to a maximum of 24 participants. Due to limited capacity, places are allocated based on availability, and waiting lists may emerge when demand exceeds the number of available places. The regular club program has been in operation since January 2025. Since its launch, a total of 105 children and adolescents have participated in the weekly club sessions. During the summer semester of 2026, 64 children were enrolled across four weekly club sessions, with group sizes ranging from 12 to 18 children per day. Although the initiative is open to all children, participation showed a pronounced gender imbalance in the summer semester 2026, with 86% boys and 14% girls. Anecdotal observations from the first project phase suggest that girls may be more likely to participate when personally invited or when attending together with a friend, sibling, or another girl. This imbalance represents an important challenge for future recruitment and program development.

E. Mentorship

Previous research emphasizes the strongly social character of makerspace learning and the importance of knowledge sharing, collaboration, and facilitation [20]. During the summer semester 2026, participants were supported by a team of 20 mentors, of whom 17 were regularly involved in weekly club sessions and three served as substitutes. The average mentor-to-participant ratio was approximately 1:4, comparable to the ratio reported as suitable for the *MAKER DAYS for kids* [12, 14]. Such relatively intensive support reflects the heterogeneous learning processes and levels of prior knowledge characteristic of open makerspace environments [12, 14]. Beyond this organizational function, mentoring constitutes an important mechanism of regional embedding at *TfKV*. Mentors bring practical and locally situated expertise into the learning environment while supporting participants in their individual projects. Their role therefore combines regional knowledge with pedagogical facilitation and requires a careful balance between guidance and learner autonomy. Consistent with previous maker education research, mentors are expected to support participants when needed without taking over the making process [18].

F. Regional Reach and Demand

The geographical distribution of participants (see Fig. 5) shows that children travel from a wide surrounding area, with many covering approximately 10 to 20 kilometres to attend the weekly club format. This geographical reach suggests that *TfKV* functions as a regional learning hub and indicates that families are willing to travel considerable distances to access the program.

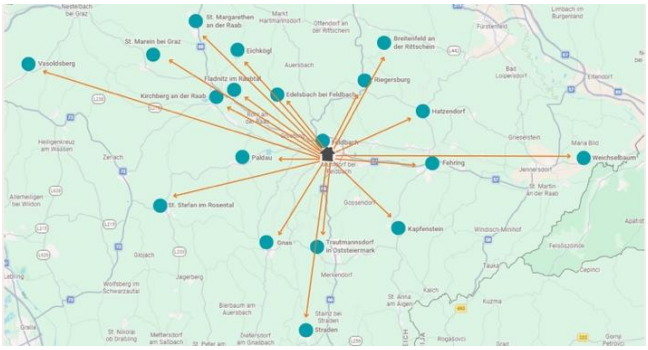


Fig. 5. Geographical distribution of participants
(Source: *TfKV*, 2026; visualization by Eva Maria Michelic)

G. Activities

The core offering is the weekly club format in which children work on craft- and technology-based projects. Activities include woodworking, electronics, soldering, drawing, free crafting, and hybrid projects combining analog materials with digital or electronic components. Beyond the regular club activities, *TfKV* offers additional educational formats, including holiday workshops in cooperation with local municipalities and project-based collaborations with schools. These activities extend the initiative beyond the weekly club format and strengthen connections between informal learning, schools, and regional stakeholders.

H. Funding and Partnerships

Participation in the weekly club format is fee-based (€ 20 per child per month in 2025 and € 25 in 2026) and calculated over a ten-month school-year period. *TfKV* operates through a mixed funding model combining participation fees, regional partnerships, company contributions, public funding, and in-kind support. Regional SMEs, banks, and organizations such as the Austrian Economic Chamber (WKO) typically provide annual sponsorship contributions ranging from €500 to €10,000. Public funding includes programs such as Erasmus+ Small-Scale Partnerships and LEADER. Partnerships also extend beyond financial support. Local companies and regional actors contribute materials, expertise, mentoring, networking, and visibility, while schools and other educational institutions participate primarily through non-commercial educational collaborations. Together with the mentoring model, these partnerships operationalize the regional embedding of *TfKV* by connecting the makerspace with regional expertise, material resources, educational institutions, and economic actors.

III. Initial Insights from Implementation

To better understand how the conceptual design of *TfKV* translates into practice, this section presents initial insights from the first implementation phase between February and July 2025, based on an exploratory evaluation combining parent survey data with qualitative mentor perspectives.

The evaluation [19] combined a parent post-survey (n = 33) with two open-ended reflective interviews with the lead mentor and one regular mentor. The survey was sent to parents of children participating in the weekly club format between February and July 2025 (n = 51; 47 boys and 4 girls). The mentor interviews were conducted without a predefined interview guide and served as an exploratory source of practitioner perspectives. No formal qualitative coding procedure was applied; instead, the material was descriptively reviewed to identify recurring or contrasting observations concerning session organization, mentoring practices, openness and structure, age heterogeneity, and perceived learning processes. Given the exploratory design and small number of interviews, these observations are used to contextualize the parent survey findings rather than as generalizable qualitative findings.

Parents consistently reported high levels of enthusiasm and engagement among participants, particularly in relation to working with real tools, creating tangible artefacts, and pursuing their own ideas. As one parent described, *"it is a unique opportunity for our children to learn a craft without stress or school pressure and to really dive into topics they are interested in"*. Children were frequently described as proud of their self-made projects and increasingly interested in technical domains such as electronics or the combination of craftsmanship and scientific concepts. A central pattern across the data concerns the process-oriented nature of learning in the technology house. Rather than focusing on completed products, learning was described as emerging through experimentation, trial and error, and iterative engagement with materials. This is reflected in statements such as: *"It is not important that a finished product is completed every week - the doing, the intermediate steps, trial and error, that is where the real learning happens"*. Such perspectives also highlight a shift from initially outcome-oriented expectations toward more process-oriented learning practices, which emerged as a characteristic of the learning environment during the initial implementation phase. Beyond motivation and engagement, parents reported perceived behavioral changes, including greater perseverance, patience, and confidence when dealing with mistakes. As no standardized measures of these or related constructs were employed, these observations should not be interpreted as evidence of competence development. According to parental reports, some children appeared more willing to engage in complex tasks and to tolerate mistakes and failure as part of the learning process. In some cases, parents also observed improvements in fine motor skills and technical understanding, for example when children explained self-built electrical circuits at home. The intergenerational mentoring model emerged as a central element shaping the learning experience. Mentors were widely described as supportive, patient, and encouraging. One parent compared the interaction to *"grandparents working with their grandchildren"*, highlighting the relational and affective dimension of the learning environment. At the same time, the data reveal inherent tensions within this model. Some parents observed that mentors occasionally intervened too quickly or completed tasks themselves, thereby limiting opportunities for independent problem-solving. As one parent critically noted, mentors sometimes *"help too much and finish parts themselves"*. This tension is further reflected in the two mentor interviews, which point to differing pedagogical orientations. While one mentor emphasized the importance of a more structured, tool-oriented approach with systematic introduction and repeated practice, the lead mentor highlighted a project-based approach in which tool skills are acquired implicitly through meaningful making activities. This indicates an underlying tension between structure and openness in the design of learning processes. Another recurring theme concerns age heterogeneity within the participant group. While younger children were generally well engaged in basic activities, older participants expressed a desire for more complex tasks and advanced tools. Parents suggested that differentiated learning pathways or age-specific grouping could help better address these varying needs. In addition, mentors highlighted organizational challenges, including the need for clearer planning structures, improved time management, and more differentiated tasks to accommodate different levels of experience.

IV. Conclusion

This paper contributes to maker education research by conceptualising *TfKV* as a permanent, regionally embedded, community-based makerspace in a rural context. The case extends existing research on temporary and institutionally situated maker activities by examining how maker education can be organised as a sustained learning environment that connects material engagement, technological exploration, intergenerational learning, and regional resources.

The exploratory findings provide initial insights into how this model translates into practice. They indicate high levels of parent-reported engagement and highlight process-oriented learning, experimentation, and intergenerational mentoring as central characteristics of the learning environment. At the same time, the findings point to tensions between openness and structure as well as between guidance and learner autonomy. While makerspaces are often conceptualised as open and self-directed learning environments, the present case, consistent with previous research [12, 14, 18], suggests that openness requires appropriate structures, facilitation, and low-threshold entry points to support participation without imposing rigid learning pathways. Sustaining such an environment is also resource-intensive, requiring sufficient mentoring capacity, pedagogical coordination, appropriate infrastructure, and continuous access to materials.

A central conceptual contribution of the case concerns regional embedding. The case suggests that regional embedding is not merely a geographical characteristic but an organizational and educational principle through which local expertise, community actors, material resources, and educational institutions become part of the learning environment. In *TfKV*, intergenerational mentoring is particularly relevant in this regard, as it connects children's project-based activities with practical experience and locally situated knowledge. This creates opportunities for tacit knowledge, material practices, technological exploration, and social learning to interact within a sustained learning environment. Such an interplay may provide conditions for future-oriented learning that bridges digital and material practices rather than treating them as separate domains.

At the same time, the participation data illustrate that open access alone does not necessarily result in balanced participation. Despite being open to all children, *TfKV* currently shows a pronounced gender imbalance. Girls remain substantially underrepresented. This suggests that inclusive participation needs to be actively supported rather than assumed to emerge from open access alone. Measures currently planned or considered include targeted outreach through schools and regional partner organizations, low-threshold trial sessions and introductory workshops for girls, opportunities to participate together with a friend or sibling, greater visibility and recruitment of female mentors and technical role models, more gender-sensitive communication and visual representation, and a broader range of project contexts linking technology and craftsmanship with design, sustainability, creativity, and everyday problem-solving. Future evaluation should examine not only overall participation rates but also whether such measures affect recruitment, retention, and experiences of belonging among girls and other underrepresented groups.

Several limitations must be considered. First, the study is based on a single case and an exploratory design with a relatively small sample. Second, the evaluation relies primarily on parent-reported perceptions and two open-ended mentor interviews that were not subjected to a formal qualitative coding procedure. Third, constructs such as perseverance, patience, and confidence when dealing with mistakes and failure were not assessed using validated instruments; consequently, the findings cannot demonstrate measurable development in these areas. Fourth, the short observation period does not allow conclusions about long-term learning trajectories or causal effects of participation. The pronounced gender imbalance further limits the extent to which the findings represent the experiences of girls participating in the makerspace. Finally, the first author's involvement in the initiative represents a potential source of researcher bias that should be considered when interpreting the findings.

The findings should therefore be interpreted as preliminary rather than conclusive. Nevertheless, the case provides initial empirical and practice-based insights into how a permanent rural makerspace can be organised and embedded within its region. It suggests that the potential of such environments lies not only in providing access to tools and technologies, but in creating sustained connections between making, practical knowledge, social interaction, and regional resources. In this sense, regionally embedded maker education offers a perspective for understanding how community-based learning infrastructures can complement formal education and create sustained opportunities for hands-on, context-sensitive learning in rural regions.

Conflict of Interest

The first author was actively involved in the development and implementation of *TfKV* and served as project lead until December 2025. This dual role provided substantial contextual knowledge but may also have influenced the interpretation of the initiative and its evaluation.

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