Empowering people

Open Education and Open Source for Sustainable Economic Activity

Open education and open-source are essential foundations for enabling civic engagement with technologies and sustainable use. Makerspaces can lead the way for structural change through local learning and economic development.
By Maximilian Voigt

Resource-efficient living requires changes on numerous levels. These changes include, in particular, the use of technology, which is decisively shaped by individual skills, political framework conditions and the availability of open technologies and infrastructures. This is shown by juxtaposing the sustainability mantra of "reduce, reuse, recycle" with excerpts from the definition of "Open": "Open means anyone can freely access, use, modify, and share for any purpose." Without technical-technological competences, which at their core includes practical skills and systemic understanding that go beyond the application level, without open technologies such as open-source software and hardware, and without makerspaces that enable repair and self-learning by the general public, technology is always just a fast-moving consumer object that is difficult to adapt to new circumstances and to integrate into sustainable local cycles.

A need for open technology teaching

At the same time, competence development is not about disseminating in-depth engineering or IT skills more broadly. Rather, it is about understanding functional relationships that allow the assessment of technology, which is transferable to different concrete contexts. It is about basic craftsmanship, on a physical and digital level. And it is about the understanding and critical reflection of systemic contexts and political dimensions.

Current developments in education are at risk of falling short of these goals. Technology is equated with digital tools and skills that are largely limited to application. Skills that go beyond this are rarely in focus. What is therefore needed is teaching technologies openly, meaning methods that place the technical function at the centre and promote a self-determined approach to technology. Using a vacuum cleaner as an example, it is a matter of opening the plastic housing and understanding the mechanism behind it. Because only on this basis we can really make sustainable consumption decisions and repair to a certain degree by ourselves.

This is also about power. After all, in a society that is thoroughly permeated by technology, those who possess the knowledge of technologies can influence processes. This is not only evident in debates around the "Netzwerkdurchsetzungsgesetz" [Network Enforcement Act] or data retention, where an understanding of the subject matter is necessary to be able to evaluate arguments. It is also about framework conditions for the development of technology, for example with regard to the right to repair. This is where fundamental decisions on the repairability of objects are made. Should members of the public be able to obtain spare parts themselves, or only authorised dealers? Do spare parts have to be kept in stock at all? And should manufacturers design their equipment so that it is easy to repair? A broad response to these questions requires a basic understanding and awareness of technical issues.

Taking open-source into the mainstream

In addition to these individual competences, open technologies are also required. Thus, open technology development and repair is only feasible when the documentation of technical objects and software solutions are made available. This includes an open and modifiable design of technical devices. This also applies in particular to the sustainable development of technology. Open-source software and hardware solutions make it possible to re-use resources that have already been used, by collectively developing existing technology and improving faulty designs. A free licence ensures decentralised modification. It also enables integration into local cycles, as the technology can be easily adapted to needs and integrated into infrastructures. In order to ensure this, the basic rule with regard to design is that the application should be structured into a generic core with open interfaces. This covers cross-platform basic functions and enables adaptation to different requirements by facilitating the development of connectable applications.

While open-source is a widespread topic in the realm of software and enriches large parts of software development, open-source hardware is still in its infancy. Worse: Anyone who remembers the 50s and 60s knows that the circuit diagram was often an integral part of purchased devices. Nowadays, technical connections disappear more and more in sealed casings that are supposed to give as few reasons as possible for opening them – the technical documentation of the devices only pro-

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vides the bare minimum of information. This has to change and, at minimum, connections relevant to the repair must be documented.

It is clear that widespread implementation of open-source would have profound implications for the way our economy is creating value. It is therefore necessary to develop new business models that are not limited to the sale of proprietary knowledge and rights of use. Developments such as dual licensing, software-as-a-service, freemium, Patreon or Open Collective can be seen as starting point. One hardware example of dual licensing is demonstrated by Xyc Cargo bikes. These are based on a construction system developed by Xyz Spaceframe Vehicles, which makes stable frames possible solely by bolting together aluminium elements. A basic structure is documented and available under the constrained Creative Commons licence BY-NC-SA 3.0, which is restricted for commercial purposes. Further developments, especially variations in the form of other superstructures, are closed. This is not yet ideal, but knowledge of the core system facilitates repairability and allows modifications to be made.

While the consumer sector is still experimenting, the research sector is already little further along. Although it is the exception rather than the rule that publicly funded projects make their developed technologies available under a free licence and documented, this becomes more common. Dedicated funding guidelines should reverse this proportion. Separate documentation funding is one way of ensuring subsequent use. Beyond this, however, the number and use of technologies published as open hardware is increasing. Business models are regarded in the scientific context, especially in servicing the elaborate systems, for example by providing spare parts or custom-made products (Pearce 2017).

As already mentioned, open-source in the software sector has a big head start over hardware. Besides the obvious economic aspects, this goes hand in hand with challenges in terms of documentation. "The biggest problem is not writing documentation, but keeping that documentation up to date" (Austic et al. 2020). Hardware consists of numerous knowledge resources, which places special demands on tracking changes. It is therefore necessary to further develop dedicated versioning systems.

Another challenge is the question of when hardware is really documented for re-use. This is because reconstructing physical objects requires very different resources, such as technical drawings, parts lists or assembly plans. The DIN SPEC 3105 (Meyer 2020) and the OPEN! project provide initial answers, by developing frameworks and evaluation criteria.

Makerspaces

When seen through the magnifying glass of the pandemic, the decades-long failings in adapting the education system to the needs of the postmodern age are particularly evident. Teaching digital, technical and technological skills is still in its infancy. This, along with the division of labour, has also resulted in an intellectual decoupling from the technical infrastructure, which we as consumers are now blindly at the mercy of (Simondon 2012). This creates numerous problems, especially when it comes to resource-saving use. Technical-technological competences are an essential basis for leading a self-determined and resource-saving life. Fostering these and not putting undue strain on educational institutions requires open spaces where learners and teachers can engage with technology in a self-determined way, to develop their own approaches. Such access is provided by numerous extracurricular places of learning throughout Germany, such as makerspaces.

The character of a makerspace emerges when comparing it to a vocational training workshop. There, the focus is on concrete job profiles with a productive character. There are teachers who imbue trainees with knowledge or make them fit for a certain branch of work or a specific job profile. The goal is therefore a certain level of qualification. This stands in contrast to makerspaces. Such experts may also be on hand there, but they are not the centre of attention. Rather, it is about the mutual empowerment of equals. This does not have the primary aim of producing a qualification certificate, but is about the practical hands-on knowledge itself. Makerspaces bring together people who are interested in learning by doing, in passing on their experiences to others and in becoming a social community. This self-determined learning enables very individual access to technical objects and in this way also promotes the responsible use of technology in everyday life.

Interfaces for local learning and economic development

In addition to social and technical engagement, makerspaces are also learning spaces in which the sharing of knowledge, which is the fundamental practice behind open-source, becomes tangible. As hubs of regional learning networks, they can bring together numerous knowledge resources and promote exchange. In this way, innovations from civil society and extra-institutional contexts are transported into formal institutions and an open learning culture is established that focuses on collaboration and instils a culture of knowledge sharing.

Makerspaces also play a prominent role with regard to local economic spaces, such as circular systems. They enable customised one-offs or spare parts that are no longer available to be produced (rapid manufacturing), as well as the further development and repair of existing technologies. Typical equipment in addition to common hand tools, typical equipment includes a 3D printer, laser cutter and other CNC machines to process different materials and workpieces. True to the motto: make almost everything (Bergner 2017).

Visions for structural change

Embedded in local contexts, makerspaces are places for raising and spreading new ideas, for self-empowerment and participation in open-source. Emancipation from outmoded structures and the search for new ways of doing business are particularly important in rural areas. The context of makerspaces gives rise to a resilient civil society that is largely independent of global structures and taps into its own, local resources (Lange et al. 2016). Open-source hardware and software, solution-oriented action, infrastructures of mid-range technologies that improve independent experimentation and locally situated economies enable promising visions for a resource-efficient life.

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