

Chapter 10

Synthesis

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As a general answer to our question, ‘*Which digital technologies contribute to enhancing (dual) vocational education?*’, we proposed the Erfahrungsraum model, which can be described as a circular, iterative and incremental flow of learning activities, based on digitally captured experience, circulating across learning places (workplaces and school). Of course, a model always constitutes a simplification of reality: sometimes the VET system does not involve two spaces but a single one (e.g. when professional workshops are organised in schools) and, more often, three locations (i.e., the company, the school and the branch courses). Another simplification of our model is that professional experience is easier to capture in professions that produce artefacts (carpenters, florists, cooks) than when the core of the daily practices is a relationship with customers (salespersons, nurses, for example). On the one hand, those simplifications constitute the strength or even purpose of a model: they make the Erfahrungsraum a tool to be manipulated as a ‘tool to think with’. Some simplifications can indeed be viewed as particularly helpful given the complexity of the Swiss VET system.

On the other hand, simplifications have as a corollary that mapping the model to real situations is less straightforward. This is why we presented several learning technologies stories in various professions: chefs, bakers, beauticians, clothing designers, logisticians, carpenters, painters and gardeners. The learning technologies developed across these contexts are grounded in the same conceptual model but end up being very different precisely because implementing a conceptual model in a specific context is not a simple application process. It is a creative design process inspired by a conceptual framework. We conclude this book by highlighting four concepts that guide the design process of a VET learning environment.

- **To bridge.** Our main hypothesis in this endeavour has been that technologies can address the misalignment between the two legs of a dual system, the school and the workplace. By talking to teachers, apprentices and workplace supervisors, we quickly realised that there exists a ‘skills gap’ between these two places: what apprentices learn at school is not necessarily perceived by them as useful for their workplace activities and what they do in the workplace does not allow them to give meaning to what is taught at school. At the same time, we also realised that the articulation between the learning locations is a powerful opportunity for deep learning and professionals’ development. With the Erfahrungsraum (see Chapters 2 and 3) we tried to develop a pedagogically valuable model to better articulate the rich experiences apprentices live in both learning contexts by means of digital tools. The Erfahrungsraum is the VET-specific tool teachers and instructors can use to design technology-enhanced learning activities to put this principle into action.
- **To network.** As mentioned several times, the Swiss VET system is not simply dual, it is far more complex. We detailed this complexity in Chapter 1, as well as the tensions this might generate between the different persons who interact with apprentices: teachers, branch courses instructors and in-company trainers. The Swiss VET system relies upon a complex network of professional, geographic and linguistic sub-networks. Since digital technologies are intrinsically communication technologies, one of their obvious affordances is to network VET stakeholders, that is, to support rich interactions and fluid information flows among all the individuals involved in the training of an apprentice. VET networks are different from the well-known social networks, first because members have very different roles and duties and, second, they are clustered into rather hermetic sub-networks (communities) with their own strong professional identities. Chapter 4 explored the needs and solutions for networking all actors involved in the VET training of a ‘common’ apprentice.
- **To manipulate.** One specific feature of VET schools as compared to general high schools is that many of the learning activities in these curricula share the need to manipulate physical objects or to perform professional gestures, which is more

rarely the case in general high schools. These VET curricula benefit from digital technologies in which apprentices have the opportunity to manipulate, physically or at least virtually realistic professional objects. When we started in 2006, the interactions between a learner and a learning environment were mostly limited to a mouse and a keyboard, at least in daily practice. To enrich learning with more physical interactions, we pioneered the development of tangible interfaces and AR systems (see Chapter 6 and 7). Nowadays, with the growth of the Internet of Things and the ubiquity of additive manufacturing, the continuity between digital and physical aspects does not need to be demonstrated anymore to the actors of the VET system.

- **To monitor.** The fourth hypothesis is a corollary of the second one. As we anticipated in the introduction, the more complex a system is, the more efforts need to be made to monitor the way it functions. Nowadays, not only machines like our cars or airplanes, but also social structures like the educational system, are equipped with inner and outer sensors that are used to regulate them. Technology can improve these regulation mechanisms, making them faster, and sustaining more informed, evidence-based decisions that can make them more adaptive and flexible systems that are closer to the world of work. Chapter 9 explained how the learning analytics developed for VET education are much broader than those developed for general education as they model processes that go way beyond the classroom, involving all stakeholders of the apprentices' paths but, even beyond the VET systems, the evolution of the labour market, such as the emergence of new skills needs in companies.

Down the road, the contribution of this book has not been to prove that there is a magic technological solution to address the needs of the VET systems. These 16 years of experiments in schools are paved with many success stories and as many failures. As stated in the introduction, technologies have no intrinsic effect. Their effects depend upon the quality of the learning activities that apprentices and their educators will have to do while interacting with technologies. We provided the latter with a pedagogical model to design rich learning activities, integrating technologies of several different types and in several different ways, and we recursively and iteratively tested many of these possibilities in a continuous interaction between researchers and practitioners. We produced research, technological tools and applications, lesson plans and sets of learning activities. We introduced a pedagogical model and disseminated it in formal and informal training activities. We put apprentices' experiences at its core and learnt that the *Erfahrraum* can work with different kinds of experiences, from authentic to simulated, from mine to others'. We realised that this situated approach is also well aligned with and complementary to the official model used for VET teacher education in Switzerland (see Cattaneo & Boldrini, 2022). Together with the model, we also produced evidence of its results, on apprentices, on teachers, on the digital transformation of schools, and on the VET system and its connectivity across actors and learning locations.

Although our model is working well already, it can, of course, be improved, and it leaves room for further investigation and many questions that are still open, ranging from those related to the sustainability of the tools we produced, to the scalability of our approach, to the generative interplay between research, practice and politics. But we can summarise all this wonderful richness with one simple slogan: ***Design matters***. We co-designed technologies; we co-designed learning activities with teachers; we realised that combining technologies is sometimes better than focusing on some of them. Through these interactions, we somehow also redesigned the relations among VET stakeholders. Thereby, we modestly contributed to shaping the culture of VET when trying to exploit the affordances of digital technologies. We sought to summarise and share this 16-year-long journey in this book. We hope it will inspire the rich variety of learning activities that can be devised considering the digital tools available today.