

# State of Computer Science Education Research in Switzerland

Report of the WiPSCE'22 workshop in Morschach, November 2nd, 2022

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December 2, 2022

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## Executive Summary

On November 2nd, 2022, 27 Computer Science (CS) education researchers from all language regions in Switzerland met for an exchange of ideas regarding the current situation in computing education research in Switzerland.

After an introduction by Rolf Ingold about the Hasler Foundation's principles and goals, the workshop leaders presented a brief analysis of the situation of CS education research in Switzerland (which lags behind in some international comparisons) and of participants' responses to the pre-workshop survey, which revealed a broad range of perceived challenges and opportunities for CS education research. The participants' analysis of their situation reflected also some of the main statements in the conjectures of the Hasler Foundation.

The main part of the workshop was dedicated to the discussion of the seven conjectures put forth by the Hasler Foundation about the advancement of CS education research in Switzerland. Participants worked in 6 groups and in two rounds, with groups being mixed up in between.

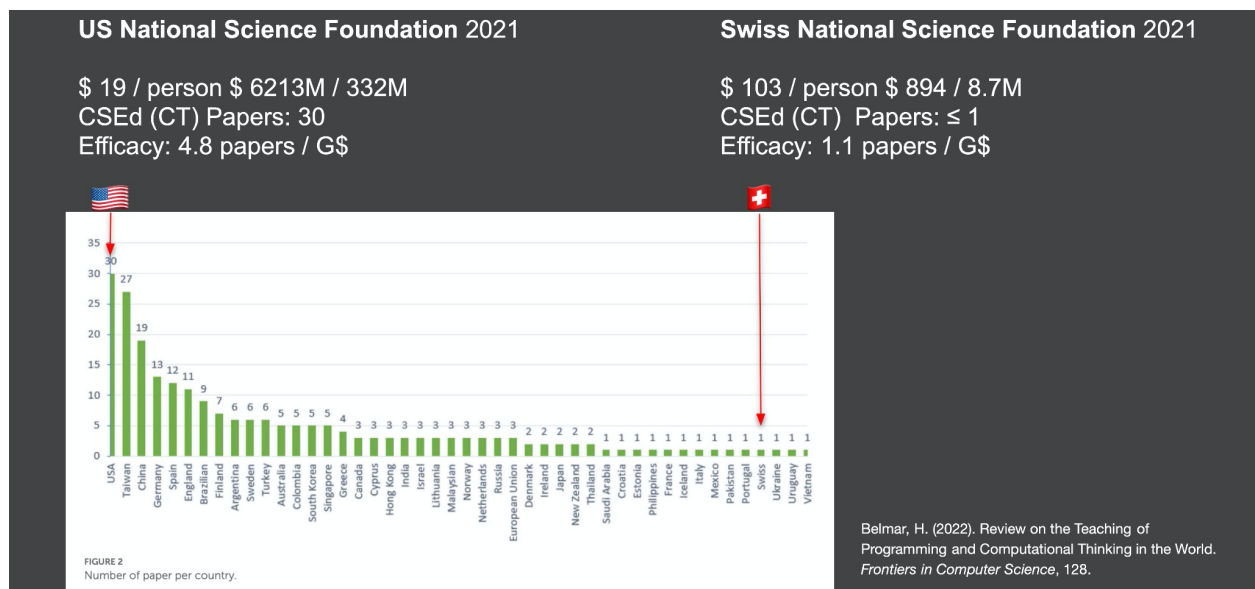
Participants engaged in group discussions on a self-selected conjecture from the list of seven conjectures. Participants went through two rounds of discussions, with groups being remixed between each round. The following points summarize the central outcomes of the discussions:

- CS education researchers in Switzerland need vessels such as doctoral schools or regular gatherings that advance the development of a strong research community.
- There is a clear need for improving the competencies of CS education researchers and educators in terms of CS knowledge, pedagogy, and research methods.
- Participants have identified multiple structural and recruitment challenges as barriers to the advancement of CS education research that can be addressed through concentrated efforts.
- The definition of research "at the level of excellence" needs to be broadened to ensure the inclusion of more practice-oriented, action-based research, such as replication research and design-based research.
- The Hasler Foundation could develop targeted programs that differ from existing funding mechanisms like SNF or InnoSuisse to address some of the highlighted issues.
- The financial mechanisms for developing competencies and promoting excellence research should start in parallel rather than sequentially, as originally proposed by the conjectures. Developing already strong research proposals now, even if small in number, could help accelerate the professionalization of the field. Furthermore, a three-year program is considered to be too short for the development of programs that target the build-up of talent.

# Introduction

The workshop on this report was initiated and financed by the Hasler Foundation and had the objective to bring together researchers in Computer Science Education in Switzerland to participate in an exchange of ideas on the research situation in Computer Science Education in Switzerland. During the workshop the participants were encouraged to discuss the specific research needs in the field of Computing Education, which of these research needs lack adequate financial resources and research programs and what a research program might look like that addresses these needs.

A brand new meta study (Belmar 2022)<sup>1</sup> exploring “the Teaching of Programming and Computational Thinking” internationally places Switzerland diametrically opposed to the US (Figure 1 below). Taking into account that the Swiss National Science Foundation spends more than five times more funds per capita compared to the US National Science Foundation, the efficacy of Computer Science education research in Switzerland is highly disappointing. In spite of the overall extremely large investment in research, the Swiss CSEd research efficacy, as measured by the number of top-tier publications in the field of Computer Science Education research (US > 4 x Switzerland), paints a clear and highly discouraging picture. Computer Science Education research has essentially not arrived in Switzerland.



**Figure 1:** Comparison of public research funding between the US and Switzerland in relation to research output in computing education research.

<sup>1</sup> Belmar, H. (2022). Review on the Teaching of Programming and Computational Thinking in the World. *Frontiers in Computer Science*, 128.

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Therefore, the workshop organizers were also very interested in seeing who exists in this community, what works and how and of course what can be improved. The intention was to develop concrete recommendations that would be useful to the Hasler Foundation when considering the launch of funding and research programmes in Switzerland.

## Workshop Setting

The workshop was held as a follow-up to the international computer science education research conference "The 17th Workshop in Primary and Secondary Computing Education" (WiPSCE '22). This facilitated participation for many people who were also present at the conference.

## Organizers

The workshop was organized by three professors who are currently receiving or have previously received funding from the Hasler Foundation:

- Engin Bumbacher (HEP Vaud)
- Mareen Grillenberger (PH Schwyz, PH Luzern, HSLU - Informatik)
- Alexander Repenning (PH FHNW)

## Participants

From the organizers' point of view, the workshop was well attended: 27 computer science education researchers from all over Switzerland met for the workshop (including the three organizers), and Rolf Ingold from the Hasler Foundation was also present:

- Rolf Ingold (Hasler Foundation)
- Barbara Amstalden (Gemeinde Glarus Nord Bildung)
- Ruedi Arnold (HSLU - Informatik)
- Dorit Assaf (PH FHNW)
- Engin Bumbacher (HEP Vaud)
- Adrian Degonda (PH Zürich)
- Mareen Grillenberger (PH Schwyz, PH Luzern, HSLU - Informatik)
- Beat Döbeli Honegger (PH Schwyz)
- Laila El-Hamamsy (EPFL)
- Tracy Ewen (ETH Zürich)
- Susan Grabowski (EPFL)
- Matthias Hauswirth (USI - Università della Svizzera italiana)
- Michael Hielscher (PH Schwyz)
- Dennis Komm (ETH Zürich)

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- Jakub Macina (ETH Zürich, ETH AI Center)
  - Larissa Meyer-Baron (PH Zürich)
  - Gabriel Parriaux (HEP Vaud)
  - Jean-Philippe Pellet (HEP Vaud)
  - Biljana Petreska von Ritter (HEP Vaud)
  - Alexander Repenning (PH FHNW)
  - Tobias M. Schifferle (PH Zürich / ETH Zürich)
  - Thomas Schmalfeldt (PH Zürich)
  - Bernadette Spieler (PH Zürich)
  - Sverrir Thorgeirsson (ETH Zürich)
  - Bettina Waldvogel (self-employed)
  - Patrick Wang (HEP Vaud)
  - Pascal Zaugg (PHBern)

## **Survey Data Prior to the Workshop**

In preparation for the workshop, all registered participants were asked to complete a short online survey prior to the workshop. The idea was to get a first impression of what opportunities and challenges the participants find in their respective institutions and what they perceive as unique opportunities and challenges to computing education research in Switzerland. The survey results are summarized in Figure 2.

## **Research Context and Topic**

Most of the workshop participants had at least a small part of their workload dedicated to research: Six participants spent less than 20% of their time on CS education research, five participants between 20 and 40%, three between 40 and 60%, and four more than 60%.

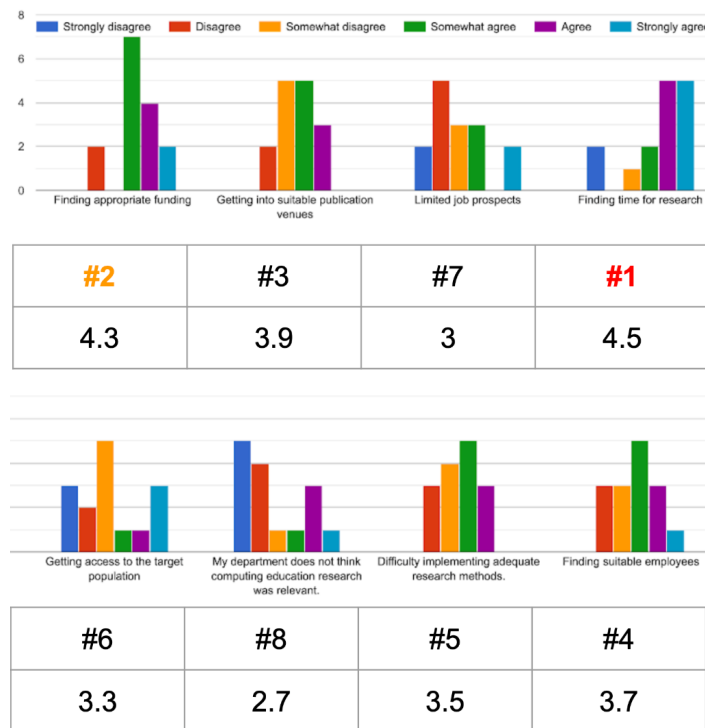
They reported being involved in a wide variety of research contexts and working on a broad range of research topics. Collectively, participants worked on every education stage from Kindergarten to university, and on informal schooling. The reported research methods ranged from qualitative approaches, involving focused group interviews and the like, to quantitative research methods, such as survey designs and statistical modeling, to design-based research and mixed methods approaches. Research topics included assessment, teaching methods, task and environment design, computational thinking, programming languages, robotics, CS perception, attitude and identity, and novel approaches to foster CS education, such as maker spaces or game-based learning.

## Perceived Obstacles to Computing Education Research

From a given list of potential obstacles, participants' main concern was about finding time for research, followed by finding appropriate funding. These issues were followed by the problem of being able to get accepted into suitable publication venues and finding suitable employees. Thus, apart from the first concern, participants' perception of barriers to computing education research reflects the conjectures developed by the Hasler Foundation.

The open responses further revealed a range of issues that participants identified as barriers to being sufficiently satisfied with their research situation (except for 4 candidates). These include the need for more financial and institutional support to conduct interdisciplinary work or to design novel learning materials and tools, to conduct large scale empirical research or research on "classical" computing education topics.

Research concerns that go beyond their personal research situation involved the difficulty accessing participants in the field, the lack of substantial cooperation between institutions and between departments within institutions, and the lack of validated and established research instruments. A couple of participants also mentioned the tension between media and computer science education as a challenge to advancing stronger research in CS education.



**Figure 2:** Breakdown of participant responses to the question "What kinds of obstacles do you experience to your desired kind of research?". The table shows the average score (1... Strongly disagree; 5... strongly agree) and the ranking of the given candidates for obstacles.

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## Discussion of Conjectures and Related Issues

Prior to the workshop, the Hasler Foundation prepared a thesis paper on the conception of measures regarding a programme to promote the subject didactics of computer science in Switzerland. The individual conjectures (C1-C7 below) and related issues were discussed during the workshop and the results of the discussions are summarized in this section.

### C1: Demands

*There is a proven need to support subject computing education research in Switzerland. The focus is on research-driven teaching-learning arrangements in computer science at all school levels with the aim of further developing teaching in an evidence-based manner.*

The participants did not put into question this foundational conjecture, however they commented on the need for a better understanding of the status quo of Computer Science (CS) education and CS education research in Switzerland. With the introduction of the Lehrplan21 (and the PER EduNum in the french part of Switzerland), the status of CS education in schools has changed significantly, but little is known about where teachers and schools currently stand in terms of the development of CS education in their classrooms. A group of participants also commented on the necessity to advance teachers' CS backgrounds through more targeted programs in initial and continued teacher training. Finally, participants agreed that more disciplinary education research in CS is needed in Switzerland, but that more exchange between researchers and educators is needed to address the question of what CS education research should look like in Switzerland.

### C2: Alignment of a Support Programme

*Excellence research is based on the criteria: 1) thematically relevant, future-oriented and original questions, 2) orientation towards internationally recognized scientific standards and 3) collaborative, ethically responsible work. In doing so, a) methodological pluralism, b) interdisciplinarity, c) grasping of the complexity of teaching, and d) high relevance for further development of computing education research should be implemented in teaching and practice.*

While there was general support of the overall aim for research at the level of excellence, participants expressed more caution with respect to some of the criteria of excellence. In particular, a main concern was that the set of criteria was not sufficiently conducive to excellent *applied and practice-oriented* research as opposed to fundamental research. They stressed the need for a definition of excellence research that also includes more practice-oriented research such as replication research or action research



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(e.g., design-based research). For example, replication research might not fit the criterion of “originality”, yet it is essential for advancing the field in order to achieve “d) high relevance for further development”, as replication is a central mechanism for developing generalizable knowledge and practices in education research. One group proposed to remove the requirement of “originality” to broaden the understanding of what could count as research at the level of excellence beyond more “traditional” understandings that are more aligned with fundamental research.

### **C3: Timing of the Programme**

*Research in the field of computing education research in Switzerland is under development. There are currently about 10 research groups that can successfully formulate proposals in research FD-Informatics on an excellence level according to conjecture C2. A program with a focus on excellence research with broad impact at the national level therefore comes too early.*

A central argument that emerged from the discussion was that the development of competencies and the promotion of excellence research should unfold in parallel rather than sequentially. In other words, there was a shared perception that good CS education research could already be funded now, even if the accepted projects would only be small in number. This would enable the continued support of the small group of researchers who already work at the level of excellence, while also increase the body of high-quality research that serves as the basis to advance the understanding in Switzerland of what counts as good CS education research, and to inspire future candidates to join the field of CS education research.

### **C4: Additional Gaps**

*In addition to the gap in computing education research, there is a gap in the development of competences for conducting computing education research at all target levels (especially for the transition from a computer science master's degree to a PhD or postdoc in computing education research).*

Participants identified structural challenges and issues with the development and recruitment of future researchers as key obstacles to conduct CS education research. This sentiment also resonates with the pre-workshop survey discussed in the chapter prior to this chapter. Participants suggested collaborations between teacher universities and regular universities to overcome some of these challenges. Another suggestion was the creation of a national-level graduate program involving organizations such as BeLearn (<https://belearn.swiss/>).

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- **Structural Challenges.** Only a minority of CS education instructors at teacher universities also conduct CS education research. Attracting PhD students to teacher universities is difficult. Some suggested solutions involving international universities. Others pointed out that a small number of teacher universities have started to create promising partnerships with regular universities, e.g., the PH FHNW with the University of Basel and the PHZH with the University of Zurich. However, at this point incentive structures are still somewhat unclear. Why would PhD students want to conduct their research at teacher universities?
  - **Personnel Challenges.** Recruitment of researchers with suitable Computer Science education background was considered to be difficult. Similarly, it is not clear how to further develop a pipeline of future Computer Science researchers. The Master Program Didactics of Media and Computer Science (PHSZ, UZH, PHLU, HSLU) is just one possible feeder of this pipeline. However, there is a significant concern that graduates of this program may lean more towards the Media, as opposed to the Computer Science aspect of this program.

## C5: Staging of Funding Programmes

*Aligned with conjecture C4, the first step is to foster the development of competences for computing education research and the second step is to promote computing education research itself through research projects at the level of excellence.*

While participants broadly agreed on the need for developing competences for computing education research, they were skeptical if explicit staging was an effective strategy to advance CS education research in Switzerland. One suggestion was to widen the scope of recruitment beyond the Didactics of Media and Computer Science Master Program. In other more successful countries such as the US, CS education PhD students generally do not emerge from CS education masters programs. As also mentioned in response to C4 above, another concern was also the perceived bias of some of the Master Program Didactics of Media and Computer Science to lean more towards Media rather than Computer Science research. In order to compete internationally, Computer Science Education researchers will have to be strongly focused on topics of computer science.

## C6: One-Time Development Program

*A one-time development program of the Hasler Foundation (project funding with matching funds) for the years 2023-2025 to strengthen the disciplinary competencies and structures supports the establishment of computing education research at the Swiss teacher universities.*

The workshop participants were unsure about how to interpret this conjecture: Is it meant to say that such a program is *sufficient* to develop the competencies?

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It was discussed if three years were enough to set up programs and bring about such a change with general agreement that this time period was probably too short to create new pathways; it was rather suggested to focus on the existing community (and the fringes) and strengthen their competencies and capacity - participants stressed again the structural problem that many competent people are too busy giving lectures and fulfilling other duties. This is also reflected in the answers to the pre-workshop survey, which has clearly shown that the majority of researchers can devote only a small percentage of their time to research (see Figure 2).

It was also discussed if the community could build on existing programs and synergies or if new offers had to be created. The groups realized that there is a large diversity of organizational structures at the different teacher universities and that it might already help if partnerships formed between those institutions to figure out e. g. which structural elements are conducive to research and to learn from each other. It was discussed if there are language barriers between the different regions that are hindering the process. One suggestion was to establish a Swiss conference on CS education research and this way to create a vessel that facilitates exchange between the different institutions and to also strengthen the voice vis-à-vis SNF. This is probably something that might be supported by the Hasler Foundation.

The participants among other things raised the important issue of strengthening partnerships between regular universities and teacher universities for research as well as the issue of strengthening awareness of CS education research at universities of teacher education. One group stressed the need for changing perception of teacher universities as research institutions to make them more attractive for researchers. However, it was unclear, what research means to different people at universities of teacher education, e. g. if the development of software, tools, teaching material etc. is considered research and if so, under what circumstances.

Overall, the participants in the workshop were rather skeptical as to whether a one-time development programme, limited to three years, could actually contribute to establishing the subject didactics of computer science at the teacher universities in Switzerland in the longer term.

## **C7: Grant Program at the Level of Excellence**

*A Hasler Foundation grant program for 2025-2028 to strengthen computing education research at the level of excellence supports evidence-based teaching and thus the effectiveness of computer science education from primary to high schools.*

As mentioned earlier, the reaction to the funding of research at the level of excellence was rather cautious, since many expressed the concern that this type of research was often equated with fundamental research. In line with the discussion of conjecture C2, participants suggested focusing more on practice-oriented research approaches that

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were internationally recognized as relevant to education research, yet which are not sufficiently recognized and supported by current Swiss funding mechanisms. This includes action research such as design-based research, research in service of developing teaching materials, or longitudinal studies.

We discussed how the Hasler program could differ from existing programs like SNF or InnoSuisse. One suggestion was to focus on specific methodologies or topics with a focus on practice-oriented research. Offering startup-like funding (similar to SNF Spark) but with lower requirements and shorter fuse was seen as another option. Another issue that came up was that the SNF lacks expertise in evaluating project proposals related to classroom teaching and computer science. Here, too, the Hasler Foundation can distinguish and position itself accordingly.

Again, it was stressed that the effectiveness of CS education in schools is related to a good research infrastructure. Trying out things in actual, representative, public school classrooms is essential but getting access to teachers and spaces is currently fairly cumbersome and challenging (depending on the canton and other circumstances).

As already mentioned in section “C5: Staging of Funding Programmes”, one group also expressed surprise about the time period of the planned funding and received general encouragement from the workshop participants: There are already projects worth funding now, so why wait until 2025 just because the number of submissions might be low? A development programme and an excellence research programme could run in parallel.

In sum, strengthening computing education research at the level of excellence was seen as supportive to evidence-based teaching from primary to high schools as long as the level of excellence is regarded as “high quality research” and not limited to fundamental research.

## **Building Competence**

There was agreement that many teacher universities lack the experience and competence to do proper research in CS education. In order to do good research, content knowledge, pedagogical knowledge and pedagogical content knowledge is required and practical experience is regarded as important. At the same time it is difficult to find all this in a single individual. Various ideas were discussed on what could be done to increase the competences for CS education research at the Swiss teacher universities and the teacher universities’ infrastructures were identified as a major problem.

Possible solutions to the identified problems might be to

- a) form competent teams (bridge between regular and teacher universities)

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- b) give potential PhD students funded time to acquire the relevant skills/competences (e. g. bridge year focused on content knowledge)
  - c) Provide structures that make collaborations between regular and teacher universities attractive for both sides (e. g. by making it a requirement to receive funding)

## Central Statements and Next Steps

In the final discussion of the workshop we collectively converged on three central points and suggestions for next steps for the CS education research community that the Hasler Foundation might be able to help with.

Appreciative of the workshop itself as a rare occasion to bring together CS education researchers from across the country, the majority of the group wanted to stress again the need for institutionalizing community building efforts. This should include but go way beyond the creation of a mailing list. Two ideas in which the Hasler Foundation could have some role were (1) the formation of a national doctoral school in Computing Education research that integrates different universities and institutions, and (2) the creation of a national CS education research conference that unlike similar existing gatherings focuses on computing education without media education, and that is indeed inclusive of all regions of Switzerland. The goal of the community building efforts is to fuel ongoing conversations around CS education at all levels of the educational system in Switzerland and the professionalization of computing education research.

The second issue that the workshop participants highlighted concerned the lack of adequate training in CS disciplinary and pedagogical content, and in research methods at all levels of the CS educators - teacher training, researcher training and teacher educator training. Stronger efforts are needed to improve the quality of training at these levels, which might be achieved among others through above-mentioned community building efforts.

For the final point, participants came back to their previously raised concerns with the core criteria for “research at the level of excellence” put forth in the conjectures. They stressed the need for broadening the definition of what counts as excellence research to ensure the inclusion of more practice-oriented, action-based research. In relation to this point participants also discussed the need for the development and strengthening of Research-Practice Partnerships (for more info: <https://rpp.wtgrantfoundation.org/>). Existing programs or associations like GymInf or SVIA might provide a good starting point, but targeted financing structures are needed to help amplify such endeavors.