Success Factors of a Large-Scale In-Service Teacher Training in Computer Science

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Abstract. There is an increasingly strong demand for in-service teacher training, especially in computer science and digitalisation-related fields. However, such post-qualification programmes face significant challenges for both lecturers and participants: Heterogeneity regarding prior knowledge, differing individual timetables, workload of the primary job, and a wide geographic distribution of the participants require programmes that serve a high degree of flexibility. Since 2018, we have addressed these challenges with a blended learning, Bologna-compliant programme, which trains around 200 participants annually. Despite its high workload and comprehensive scope of content, it has a dropout rate of less than 2% and a very high overall satisfaction (94% were satisfied or very satisfied). In this paper, we introduce our programme, recount our lessons learned, and present an evaluation of 327 questionnaires former programme participants have answered. As a result, we identify 27 success factors for large-scale in-service teacher training in blended learning formats.

Keywords: In-Service Teacher Training · Post-Qualification Programme · Blended Learning · Success Factors.

1 Introduction

Experts agree that teaching IT skills in schools has to be given a much higher priority to meet challenges, such as shortages of skilled workers or an improvement in equal opportunities in terms of gender and socio-economic status [9,15]. In 2022, Germany was, however, among nine European countries that still need to implement mandatory computer science (CS) lessons in schools across the board [15]. Even though Germany offers only a minimal and heterogeneous range of CS lessons across the different school types and federal states, there is a tremendous need for many more computer science teachers.

The Standing Conference of the Ministers of Education and Cultural Affairs of the Länder in the Federal Republic of Germany demands that Germany needs to implement a compulsory CS subject for all learners in all schools with a scope of six hours distributed across the school career [14]. This pleasant change would triple the required number of computer science teachers [10], significantly increasing their shortage. The school system relies on approximately 360 computer science graduates annually, who aim to become teachers. However, this

number only covers the retiring teachers [10]. Subsequently, there is an essential need for in-service teacher training and post-qualification programmes.

This paper presents a large-scale in-service teacher training for computer science, which post-qualifies around 200 participants annually. The Bologna-compliant programme runs for an entire school year with a total workload of roughly 150 hours, equivalent to 5 ECTS. Of course, this scope is far from equivalent to a Bachelor's or Master's degree in computer science. Our program aims to effectively train future computer science teachers in the specific curriculum taught in schools. Combined with dedicated CS didactics training and the support and background of experienced CS teachers in their schools, the post-qualified teachers are meant to deliver high-quality CS lessons.

There are many challenges for such a programme: The subject-specific scope of its content is immense. This results in a high weekly workload, which must be compatible with professional and private commitments (for example, individual timetables or childcare responsibilities). It also has to serve the wide geographical spread of the participants and their significant heterogeneity, for example, in terms of prior education, affinity for CS, or different learning objectives due to different curricula at different school types. Moreover, the entire training must be designed for many participants at moderate costs.

Since 2018, we have been running a blended learning programme, which has been post-qualified more than 1,100 new computer science teachers. Despite the aforementioned challenges, the programme profits from a remarkably low dropout rate of less than 2% and very high overall satisfaction (94% were satisfied or even very satisfied with the training). With this in mind, this paper addresses the following research question: **Which factors contribute to the success of a large-scale in-service teacher training programme in computer science that faces the previously mentioned challenges?**

The contribution of this paper is twofold: First, we describe our training programme that may serve as a blueprint for similar programmes. Second, we present an evaluation of 327 questionnaires, which we conducted by reaching out to all former participants who now have one to four years of teaching experience in their new subject, computer science. Based on this evaluation and our experience, we recall our lessons learned and present 27 success factors for large-scale in-service teacher training in blended learning formats.

2 In-Service Teacher Training and their Success Factors

The demand for well-trained CS teachers is rising in Germany, Europe, and the world. For example, there is a clear trend in 37 European countries to introduce mandatory computer science education in schools [15]. Most countries meet the increasing need for CS teachers by offering in-service training. However, only a few of these training programmes are scientifically monitored, so we know little about their scope of content, quality and success factors.

Those programmes monitored and published vary widely in their design, including factors such as duration, scope, content, target group (primary or

secondary), number of participants, format (online, blended learning or face-to-face), monetary compensation, type of certificate and others. Programmes range, for example, from a 400-hour programme for Argentinian primary teachers [2] to Technoteach, an 18-day (120-hour) face-to-face programme for teachers in Wales [8], to smaller workshops for (non-specialist) computer science teachers [5]. Overviews of different programs and their design can be found, for example, in [6,7] for the USA or in [16] for Europe. Our selection is not exhaustive but is intended to illustrate the significant heterogeneity of the various approaches. The heterogeneity is evident not only in an international comparison but in many cases even within a single country, such as in Germany, where the existing post-qualification options vary significantly from one federal state to another [3,10].

Some of the existing programmes are more popular or successful than others. However, only a few publications describe or evaluate the success factors of their in-service teacher training programme. One example is the Welsh face-to-face teacher training [8]. As success factors, the authors mention, for example, that participants need to have an accredited qualification, need time off from teaching, and for the lecturer to understand the teaching profession. The Bavarian programmes stand out in Germany because they have monitored their programmes over many years and have derived and compared success factors for virtual-only, blended learning, and face-to-face trainings. Among many other factors published in [1,12,13], the authors emphasize the importance of financial compensation, support from tutors and the course team, and well-prepared materials for the specific target group. In a more recent publication [4], the authors identified several important factors from a survey of former participants in the Bavarian program. These include: - Monetary compensation - Course design featuring a combination of self-learning material and exercises with detailed feedback - Desire for intensive support - Opportunity to meet in face-to-face learning groups - Request for more support in applying their knowledge in the classroom through didactics, teaching materials, and practice.

Our paper aims to foster the knowledge of success factors of comprehensive, in-service teacher training in computer science in a blended learning format. We present an analysis of 327 questionnaires and derive 27 essential factors for a successful in-service teacher training programme.

3 Aim and Structure of our In-Service Teacher Training

We aim to educate around 200 participants annually to become qualified CS teachers. The program runs for one year and facilitates different types of schools at the same time. As discussed before, the primary challenge is that the programme must be compatible with the teachers' main jobs and private commitments. Another challenge is, that the participants have diverse backgrounds in terms of prior knowledge, proficiency level, and geographic location.

The scope of the content differs significantly from a Master of Education degree in CS. However, the participants already have an education degree, and general didactics and teaching are their daily work. Therefore, we focus primar-

ily on the subject-specific content. CS-specific didactic courses are – so far – offered after our programme by the Center for School Quality and Teacher Education Baden-Wuerttemberg. Our programme mainly focuses on the topics of the school's curriculum and therefore concentrates primarily on topics teachers will need in their daily work. We also go beyond that scope by introducing a few topics essential for a good understanding of computer science. Combined with a pool of carefully designed teaching materials, dedicated CS didactics training and the support and background of experienced CS teachers in their schools, the post-qualified teachers can facilitate excellent lessons.

3.1 Content, Workload, and Monetary Compensation

Our program covers the basics of coding, algorithms, computer architecture and networks, programming, database systems, and web development. A modular structure with different learning paths enables individualisation according to the school type. In total, we have developed 38 learning units. Depending on the type of school, around 22 units are compulsory for each participant[1] . Each unit covers a workload of 3-6 hours but can also be lower or significantly higher depending on previous knowledge and affinity. The structure of each unit considers the participants' heterogeneity. Easily accessible introductions and additional in-depth tasks or materials make learning units more adaptable for both strong and weak learners. To support participants in completing the program, they will retain their salary but are required to teach two hours less at school.

3.2 Studying in a Blended Learning Format

We designed our training programme using a **blended learning format** based on the previously mentioned challenges and the comprehensive scope of the content. Most teaching units are for self-study, which participants can watch, read, and interactively explore whenever convenient. They can recap complex parts or use additional links and material if they need more background.

A Moodle learning management platform provides the online **learning units**. We organise the units thematically, typically starting in the third week of the academic year and schedule breaks during holidays and particularly demanding school weeks, allowing for flexible pre- and post-holiday study sessions. A typical learning unit involves in-depth engagement with the material, followed by a **mandatory exercise, including programming tasks** ensuring that learners actively engage with the content. Close supervision and prompt feedback are integral to ensuring effective learning outcomes.

Besides the self-study material, we also offer **face-to-face meetings** during which we teach challenging topics such as programming, which can be difficult to learn independently. The meetings take place either at the university or in a digital setup using BigBlueButton as a conferencing tool. Before the Covid-19

[1] https://afww.uni.kn/weiterbildung-unterricht/kontaktstudium-imp/studienplan, last accessed 2024/09/16.

pandemic, we used to have only physical meetings. However, the digital setup proved to be quite convenient because it is much easier for participants to share their screen and discuss a proposed solution with other people. Additionally, working from home or school is a considerable time and money-saving advantage. Face-to-face meetings are organised in a **flipped classroom format**. Participants prepare at home, allowing for optimal classroom time for discussion and programming tasks. In the classroom, we are offering different learning formats for different learner types: *individual work*, *learning-homogeneous small group work* or *tutorials* (similar to an exercise-centred lecture).

We have a **course team** in place, all with the same mindset: Participants must be able to entirely focus on the content while the team organises the surrounding conditions as well as possible. We are fostering a sense of unity – the team and the participants are tackling the material together. Despite the virtual setting, we offer close and personal support, including a warm virtual welcome in the beginning and a two-day event at the university to enhance the learning experience and facilitate participants getting to know each other and the team. Our approach is service-oriented, treating everyone on an equal footing, and we prioritise very fast responses, even on weekends during critical phases. The team consists of a *scientific head* (providing strategic oversight, ensuring alignment with academic objectives and curricular standards), a *programme coordinator and lecturer* (creating teaching material, supporting the learning platform and all communication channels, contact person for all content-related and organisational matters, organisation and realisation of face-to-face meetings), *tutors*, mainly advanced teacher students (correction of exercises, individual and continuous learning support, contact persons for questions).

3.3 Legal Framework

As a microcredential with a certificate, the *Kontaktstudium IMP* is legally anchored in the Landeshochschulgesetz Baden-Württemberg as a Bologna-compliant continuing education format and leads to the acquisition of five credit points corresponding to the ECTS. As a result, it is integrated into the quality assurance processes of the University of Konstanz, both structurally and in terms of content [17]. The programme was developed and is conducted in a close collaboration with the Ministry of Education, Youth and Sports Baden-Wuerttemberg and the Center for School Quality and Teacher Education Baden-Wuerttemberg. The programme concludes with a two-hour written examination. In addition to the microcredential, participants acquire teaching license for the subject of CS. This approach ensures that participants obtain both a formal, systematically classifiable certificate and an extended teaching authorisation in coordination with the school administration.

4 Deriving Success Factors

We have already published an analysis of 1,281 questionnaires to derive an initial set of success factors [11]. The data for this initial analysis was provided

by the University of Konstanz's quality management, which evaluates our programme systematically and comparably across the years. In the beginning, the questionnaires ask for the participants' expectations, and after completing the programme, the questionnaires evaluate various aspects of the programme. A large part of the questionnaires are free-text responses, which we analysed qualitatively. Based on our experience and the aspects mentioned in the free-text fields, we identified 21 criteria that we considered success factors. We divided these criteria into four categories: *General conditions*, *communication & support*, *content & didactic implementation* and *design of teaching material & face-to-face meetings*. Next, we counted the number of free-form responses mentioning each of the criteria - independent of whether the connotation has been positive or negative. Although the frequency does not allow any quantifiable conclusions, it still showed a tendency about how many participants felt a certain criterion was important enough to mention it in the free text fields. However, this previous study does not rely on data explicitly asking about success factors. The study in this paper builds on the categories listed above and addresses its limitation.

4.1 Methodological Approach

We developed a new questionnaire based on the findings and feedback from the previous study. In addition to 18 personal questions, 29 questions and four free-text fields ask the survey participants about their evaluation of various aspects of our programme. We also extended the 21 criteria of the previous study to 27 criteria. For each criterion, we asked the participants *how critical this criterion was perceived for successful participation* in the programme, using a 5-point Likert scale. Free-text responses allowed the participants to provide feedback for all criteria. The following analysis mainly focuses on these 27 Likert-scale questions and their free-text responses to derive success factors. The language of the questionnaire and free-text responses is in the participants' mother tongue, German. Responses included in this paper have been translated to English.

We sent the online questionnaire to almost 1,000 former participants who had already completed the training programme and, therefore, had also put their training into practice. We received 327 completed questionnaires (overall response rate of 33.6%) from participants of all previous years (2018-2023).

4.2 Description of the Data

General Data. The general information about the survey participants again reveals the heterogeneity of the programme's participants in relation to age, school type, prior knowledge, and experience. Moreover, it mirrors the findings of our previous study [11]: Most participants are (very) satisfied with the programme and the achievement of the learning objectives.

Almost 76% of the survey participants are between the ages of 30 and 49; 9.7% are 29 and younger; and 14.5% are 50 and above. Former participants from all previous years answered the questionnaire, with 23% being from the

programme's first year in 2018/2019, 17.8% from 19/20, 15.2% from 20/21, 19% from 21/22, and 24.8% from 22/23. Furthermore, participants are from all major school types in Germany: 32.4% Allgemeinbildendes Gymnasium, 34.3% Realschule, 21.1% Berufliche Schulen and 12.2% others). 45.6% of the survey participants have already taught CS (respectively, the German subjects 'Wahlfach Informatik' or 'IMP') before the beginning of the programme without a formally certified qualification. 10.4% of the participants state that they have no experience or prior knowledge in CS at all, 5.5% state that they have comprehensive prior knowledge, and the other participants are normally distributed between no prior knowledge and comprehensive prior knowledge.

We asked several general questions using a 5-point Likert scale (1 = fully agree and 5 = fully disagree). We report the aggregated answers with their mean $\bar{x}$ and standard deviation *sd*. *My motivation during the training was always very high* ($\bar{x} = 2.05$, $sd = 0.87$). *After the programme, I feel that I do have enough knowledge in all topics covered by the programme* ($\bar{x} = 2.22$, $sd = 0.94$). And finally, the question *Looking back, I am satisfied with participating in the programme* was answered with a $\bar{x} = 1.48$ and $sd = 0.81$.

Data on Success Factors. Table 1 presents the results of all questions regarding success factors. For each criterion ($a_1 \cdots d_4$), the participants used a 5-point Likert scale to rate it between very important (= 1) and not important at all (= 5). We use gradient of blue colours to reflect the number of participants for each criterion and the Likert-scale option. A dark blue colour means many participants selected a particular answer. For example, 265 participants think that it is *very important* (=1) to get a *monetary compensation* (a_3) for our comprehensive training programme. We also computed the *mean* of all Likert-scale answers to get a better overview. Gradients of pink are used to indicate high and low mean values. Dark colours refer to a low mean value and, therefore, a large number of participants consider the criterion as (very) important. For example, for *monetary compensation* (a_3), the average response answer is 1.22.

We also computed a rank # for each criterion based on the mean. Dark green refers to the most important criteria. We want to point out that even the least important criterion *getting to know other participants* (a_6) has an mean of 2.64 – which is still reasonably important. Finally, we computed the standard deviation *sd* and used a bar to indicate it. A high *sd* with long bars show that the participants' opinions about the importance of certain criteria differ.

4.3 Discussion of Findings

General Conditions. Our survey participants consider *time flexibility* (a_4) and an *easy integration in the teachers' main jobs and private obligations* (a_2, a_4) as fundamental success factors. Participants, therefore, appreciate that the blended learning programme format is mainly independent of time and place. Face-to-face meetings and deadlines of compulsory exercises are adapted to the rhythm of the school year, and *deadline extensions* (a_5) can be received easily. All dates are announced well in advance to guarantee *plannability* (b_2), and participants

Categories		Criteria	#	mean	sd	1	2	3	4	5
General conditions	a_1	support of social environment (family, friends, ...)	24	2,22		109	97	60	36	16
	a_2	time off from school duties	2	1,18		275	38	9	1	0
	a_3	monetary compensation	3	1,22		265	45	12	1	0
	a_4	integration into the school's daily routine	8	1,28		240	71	8	1	0
	a_5	time flexibility & deadline extensions	12	1,46		217	75	23	6	2
	a_6	getting to know other participants	27	2,64		54	107	84	54	23
	a_7	collaborating with other participants	25	2,60		55	104	93	49	19
	a_8	suitable learning platform	9	1,30		236	76	10	0	0
Communication and support	b_1	distinct contact person for all questions	10	1,38		215	99	10	1	0
	b_2	predictability of academic calendar	1	1,17		271	47	4	0	0
	b_3	high quality answers to questions	6	1,27		244	74	7	0	0
	b_4	short response time to questions	13	1,46		192	118	15	0	0
	b_5	communication at eye level	14	1,48		202	94	22	4	1
	b_6	possibility to give feedback	21	2,11		88	139	67	17	7
	b_7	quick implementation of feedback	19	1,94		104	143	54	13	2
	b_8	getting to know the trainers and the team	23	2,14		100	121	64	24	11
Content and didactic implementation	c_1	content of teaching is new for participants	26	2,61		28	111	117	26	13
	c_2	content of teaching matches the curriculum	15	1,49		202	97	18	7	1
	c_3	various levels of difficulty	17	1,80		126	151	34	10	2
	c_4	computer science-specific didactics	11	1,43		221	79	14	9	1
	c_5	clear work instructions	5	1,23		253	67	3	0	0
	c_6	quality and didactics of material	7	1,28		248	62	13	1	0
	c_7	material matches prior knowledge of participants	18	1,83		128	131	50	7	3
Design of teaching material and face-to-face meetings	d_1	appropriate lecture format	16	1,52		173	128	16	2	0
	d_2	weekly exercises and grading	4	1,22		257	61	3	1	0
	d_3	different teaching methods at face-to-face meetings	20	1,98		112	119	46	21	6
	d_4	flipped classroom format for face-to-face meetings	22	2,14		91	104	72	21	6

Table 1. Four categories with 27 criteria. We asked the survey participants *how important each criterion is* using a 5-point Likert-scale (1 = very important, 5 = not important at all). We compute the *mean* and standard deviation *sd* of all Likert-scale answers. We rank # each criterion based on their mean. Colour gradients are used to better compare values: green for the rank, pink for the mean, and blue for the Likert-scale answers. The standard deviation is represented by the length of the bar.

can choose between several dates for the face-to-face meetings. Moreover, participants state that an *easy exemption from school duties for face-to-face meetings* (a_2) and *monetary compensation* (a_3) is essential. This is in line with the findings of [4, 8, 12, 13]. Furthermore, a *suitable learning platform* (a_8) on which materials and important organisational information are clearly arranged is rated as a success factor, which is also discussed in [12].

Communication & Support. Usually students can directly approach their lecturers after class. Blended learning formats do not offer this option. Therefore, our findings show the importance of high-quality support and communication. It is essential that *all participants have a distinct contact person* (b_1), that *answers are quick, at eye level, and of high quality* (b_3, b_4, b_5). Spohrer [12] also emphasises communication and compares Bavarian programmes that differ significantly regarding the scope of support. He describes that a central coordinator and contact person are essential, while a high level of supervision is generally beneficial but only essential for some learners. Engel & Michaeli [4] also confirms the desire for intensive support. Right from the start, we, therefore, make

a great effort to provide learners with *reliable, fast* (b_4) (sometimes within a few minutes) *and competent feedback* (b_3) via various communication channels (e-mail, chat, forum) to convey a feeling of comprehensive support, especially in the largely virtual setting. In our initial analysis [11], we found that 85% of participants stated that they considered individual support from student tutors important, and 92.3% of participants confirmed that they received good to very good support from the tutors. A factor that strongly favours this success is that all personnel, including the student tutors, must develop an understanding of everyday school life and communicate with learners *on an equal footing* (b_5).

Engel & Michaeli [4] and Spohrer [12] both describe that participants wish to meet each other face-to-face in study groups. Quite interestingly, our results show that *getting to know other participants*, *getting to know the team* or *collaborating with other participants* (a_6, a_7, b_8) does not seem to be of top priority among our participants. However, the comparably high distribution of the answers for these items shows that participants think differently about this topic. We conclude that different types of learners have different preferences.

Content & Didactic Implementation. *Clear work instructions* (c_5) and *quality of teaching material and didactic implementation* (c_6) are rated very high. Our data also shows that it is essential that the teaching material matches the specific requirements of the teachers's vocational area: The *material has to match the individual curriculum* (c_2) and has to *include computer science-specific didactics and ideas for its practical implementation* (c_4) at school. These results are in line with Engel & Michaeli [4], who confirm the strong wish of participants for more support regarding the practical implementation of their newly acquired knowledge in class (didactic skills and teaching material). Also, it replicates the findings of our previous study [11] that stressed that learning material has to be tailored to specific needs and has to bridge the gap from theory to application.

Another factor that promotes success is the *adaptability of the learning materials* (c_3). *Materials* should *match the prior knowledge of the participants* (c_7) to avoid time-consuming research and frustration so that the participants can fully concentrate on learning the new content. Due to the vast heterogeneity of the participants, the material and exercises should offer *various levels of difficulty* (c_3). Adaptability of the difficulty level is, for example, provided by optional materials for in-depth study. We also provide customised introductory materials for weaker participants. The importance of additional support for these participants is also highlighted by Engel & Michaeli [4]. They describe that additional support for non-mathematicians was highly valued. Although these two items are not top-ranked by our survey participants, we know from experience that they are critical factors in designing appropriate materials.

Design of Teaching Material & face-to-face Meetings. The *weekly exercises* (d_2), which aim to deepen and consolidate the content and to learn the practical implementation, are rated as very important while having only a small standard deviation. Mandatory graded exercises encourage participants to engage with the content more effectively, making it one of the critical success

factors. This result is astonishingly tough as the time commitment required to complete the exercises is significant. As mentioned above, *time flexibility* and *deadline extensions* (a_5) are also necessary due to weeks in which participants are very busy with their primary job. Furthermore, our previous study analysis revealed that providing detailed feedback on assignments along with sample solutions addressing common mistakes is highly valued. These findings are in line with [4] and [12].

To assess the effectiveness of the design of face-to-face meetings, we asked about the perceived importance of *different teaching methods at face-to-face meetings* (d_3) (individual work, small group work with a homogeneous learning environment or tutor-led groups). We also asked if the *flipped classroom format for face-to-face meetings* (d_4) is a good choice. A flipped classroom means that participants learn the theoretical backgrounds in advance in a self-study setting so that face-to-face time can be used more effectively. Both items are rated as essential but with a high standard deviation. Compared to other items, the responses are rather diverse. Different types of learners have different preferences for face-to-face meetings: Strong learners only sometimes see the need for face-to-face meetings in the first place. Weak learners often prefer more guidance during the self-study phase at home. The preparation for the face-to-face meetings and the meetings itself is very time-consuming. In particular, the self-study phase requires high self-motivation to try out different ideas and troubleshoot potential errors. On the other hand, an efficient solution is not always available, as learning programming is very time-consuming. Over the last two years, we have had very good experiences with interactive learning units - particularly for those new to programming and students who require additional support. These learning units include minimal step-by-step explanations with detailed videos, introducing new programming concepts and detailed examples of programming by a lecturer. Smaller theoretical and practical exercises are used to check learning progress. The unit's learning path can be adapted individually based on test results.

Finally, an appropriate choice of the *format of the learning material* (d_1) is rated as important. Our programme offers a combination of classical lecture recordings, screencasts, interactive teaching units and chapters to read. This question generated a lot of comment in the open text fields analysed in our previous study, and the opinions are very diverse. Some appreciate the vividness of lecture recordings, while others prefer text documents. However, others appreciate integrated exercises and the variety of interactive learning units to maintain their motivation. Most participants agree, however, that long screencasts are rather unsuitable for conveying complex subject matter. We conclude that different types of learners prefer different materials. Therefore, we use a mixture of materials to meet different preferences.

5 Conclusion

This paper described a large-scale, blended learning, in-service teacher training in computer science. Based on our experiences during the last six years, we

discussed the lessons we learned and analyzed 327 questionnaires from former participants in the programme. Based on the discussed challenges and the results of our analysis, we provided a set of 27 success factors, rated by their importance. We found that several success factors help facilitate a balance between primary job, private commitments and the workload of the training, e.g., by predictability of the academic calendar and blended learning specific flexibility regarding time and location. Other critical success factors include, for example, monetary compensation, high-quality support and communication, and adaptable, tailored, high-quality learning material, which includes computer science-related didactics and ideas for their practical implementation at school.

Our findings could serve as a blueprint for other training programmes. Our questionnaire's design and the derived success factors are based on our experience and a former qualitative analysis of free-text responses from 1,281 questionnaires (ex-ante and ex-post from all previous participants, see [11]). This design may lead to some methodological limitations. In particular, we highlight that there may be other success factors we should have considered in our questionnaire design. Moreover, the success factors may change for a different audience or subject or less comprehensive training and courses with more face-to-face meetings.

Many of our findings are in line with other publications. However, there are many other in-service teacher trainings that need to be scientifically monitored. Given the need for many well-trained computer science teachers, more scientific recording and evaluation of the different programme designs will help to improve and tailor new programme designs.

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