Imagine Yourself as a Media and Computer Science Teacher

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ABSTRACT

In order to investigate pre-service primary teachers' mental images and beliefs about Media and Computer Science teaching, the Draw-A-Science-Teacher-Test Checklist (DASTT-C) was adapted for the field of Media and Computer Science. For this explorative study, 78 student teachers were asked to imagine themselves as Media and Computer Science teacher before and after a methods seminar. Using a qualitative research approach and building upon the ideas of the Draw-A-Science-Teacher-Test Checklist, the drawings before and after the course were coded. A coding scheme was developed, resulting in the Draw-A-Media-And-Computer-Science-Teacher Repository (DMECS-R). Subsequently, the results of the coding were analysed and evaluated with a mixed-method approach. Quantitative comparison of the number of recategorizations of the drawings after the methods course, comparison of 'average' images, visualization with multidimensional scaling and qualitative observations of minimum and maximum individual changes have led the authors to three conclusions: (1) After the method course it is less likely that student teachers draw individual work of students. (2) After the course, student teachers were less likely to draw children working on closely guided assignments. Post-course, more student teachers draw pupils working on own projects and tasks. (3) After the method course, it is less likely that student teachers draw themselves in a conventional, classically furnished classroom with only chalkboard and neatly arranged tables and chairs. Taking a dialogic and constructivist approach of learning into account, this research shows that the methods course expanded the student teachers' repertoire of teaching methods for Media and Computer Science lessons. For following studies in computer science education, the results should be verified by accompanying interviews and subsequently find their way into pedagogical training.

CCS CONCEPTS

• **Social and professional topics → Computing education**.

KEYWORDS

teacher beliefs, mental models, primary education, DASTT-C

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1 INTRODUCTION

Media and Computer Science has been a subject in the Swiss curriculum for primary schools since 2018. In this subject, media education and computer science education are linked and combined. Since it is a new subject, current student teachers have no experience in relation to this subject when they were pupils. Beliefs hold influence on teachers' judgment and perception [19]. Therefore, it is important to make visible the beliefs of student teachers in relation to this new subject. In order to investigate student teachers' beliefs about Media and Computer Science lessons, we used drawings and adapted the methodology Draw-a-Science-Teacher-Test Checklist (DASTT-C) [24]. Thus, we chose a method that has hardly been used in computer science education research so far and open a new approach to teacher beliefs in this field.

An explorative study was conducted to dive into drawings of student teachers in their second or third year of study at a large university of teacher education in Switzerland. Inspired by the work of Hirsch [9] and Markic et al. [14], who conducted an exploratory study in which they asked prospective teachers to draw their mental models for teaching home economics or science and to code the drawings with a repository, we examine data from Media and Computer Science lessons obtained through a variation of the DASTT-C prompt. An exploratory approach was taken by recategorizing the data rather than using an existing checklist [24] or scale [14]. To the best of our knowledge, a drawing task was rarely used to evaluate beliefs of student teachers teaching Media and Computer Science in primary schools. Simply inferring information from existing studies seems not appropriate as there is evidence that beliefs are tied to specific subjects, e.g. different specifications between biology, physics and chemistry teachers on a scale between teacher-centered and student-centered [15]. The goal of this paper and this study is to introduce drawing tasks to the broader computer science community and to explore drawings with a range of different approaches to find out whether and how drawings differ before and after the methods course. The course followed the dialogic learning paradigm [13, 22, 23] to develop subject-specific, didactics of computer science specific and media pedagogical competences. To capture and describe the diversity of the drawings, a repository along the following research questions was developed:

(1) Which shared or distinct beliefs do pre-service teachers have about media and computer science lessons at the beginning of the methods course?
(2) How do pre-service teachers' beliefs change after completing a ten-week media and computer science methods course?

2 INVESTIGATING BELIEFS IN TEACHER EDUCATION WITH DRAWINGS

This research followed the definition of beliefs as stated by Richardson [21]. Beliefs are "psychologically held understandings, premises, or propositions about the world that are felt to be true". Based on the work of Pajares [18] and Richardson [20], beliefs about teaching were specified as psychologically held understandings, premises or propositions about teaching that are felt to be true. We define beliefs about teaching as beliefs about teachers, students, the environment, and the interactions between those three categories. Pajares notes that beliefs cannot be "directly observed or measured but must be inferred from what people say, intend, and do" [18]. We define mental images as an expression of beliefs. Mental images are conceived as the inner images which are revealed when pre-service teachers draw a picture of a Media and Computer Science lesson. A mental image and its realization are produced in a constructive, cognitive, partly conscious and partly unconscious process by negotiating different beliefs about teaching in the current context of the task.

Researchers have been looking at students' drawings for about 70 years to study their perceptions of science or scientists [6]. Most of these research projects focus on the perception of children and young people. However, there are scientific indications that the method of drawing is also particularly suitable for pre-service teachers [12]. Drawings can capture teachers' unconscious, implicit perceptions, interior understandings, which are difficult to access using traditional methods [27]. Another advantage is that misunderstandings between researcher and respondent are reduced because the picture gives more concrete and holistic insight into the idea than oral or written statements [8]. Based on Vygotsky's theory of the Zone of Proximal Development it has been shown, that culturally bound "tools and signs" that are drawn provide information about the inner beliefs of a prospective teacher and, while drawing these signs and tools, stimulate the teacher to deep reflection, to learning [1]. It goes without saying that the socio-cultural context has a strong influence on these drawings made by teachers. Furthermore, it is stated that the combination of narrative and drawing in particular provides a comprehensive insight into the teacher students' self-perception [1].

By perceiving teaching as a complex and multi-faceted process with several actors and circumstances in which teachers have to constantly take reasonable actions upon the situation presented [19], drawing seems to be a good way to investigate beliefs about "the setting, the arrangement of objects in physical space, and interactions" [17]. Although teachers naturally take their actions in sequence, they do so in constant deliberation and interaction with the parallel actions of their students. A drawing task is closer to the situation pre-service teachers encounter in their (future) classes and their mental models about this situation. For this reason, a handful of researchers use and modify the DASTT-C approach of Thomas et al. [24] in teaching-related research projects. The most common version of the DASTT-C is the one evaluated by Thomas et al. [24]. After setting a writing and drawing task (prompt) the authors evaluated the results with a 13-item dichotomous checklist. Another popular version along the DASTT-C is a recoded and extended version by Markic et al. [14]. They extended the prompt with two more questions and developed three main categories "beliefs of classroom organization", "beliefs of teaching objectives" and "epistemological beliefs" each with a scale from -2 to 2. There are multiple adaptions using different statistics (e.g. dependent t-test to compare means in pre- and post-test [2], independent t-test to compare groups or McNamar's-test [17] to compare each item in pre- and post-survey), leaving out items of the checklist [5] or adapting the prompt.

3 METHOD

This investigation was inspired by the DASTT-C and adaptations of it [9, 14, 24]. Building on the research of the DASTT-C, three main categories were established in the construction of our checklist: Teacher(s), students, and environment. We wanted students to focus on those three and defined teaching as the complex interaction between those three categories. We define environment as the part that cannot be directly associated with teacher(s) and students but is in the vicinity for interaction for teacher(s) and students. Since the teacher students were already in their sixth semester and therefore had a high level prior pedagogical knowledge, we wanted to differentiate the categories of the DASTT-C even more in order to obtain a more detailed information.

After a pre-test, the final version of the Draw-A-Media-And-Computer-Science-Teacher prompt (DMECS-P) was developed as follows: "Imagine a specific situation in your media and computer science class. Draw your imagination. What are you doing in your drawing? What are your students doing? What does your environment look like? Draw yourself, your students and the environment in this situation on a white A4 paper in landscape format (or a digital format with the same aspect ratio).". The main prompt was followed by a set of bullet points: if students have never taught Media and Computer Science, they should just imagine it; students can draw stick figures; students should draw a situation and not create a mind map. Students were asked to use 45 minutes for the task.

We took a mixed method approach to analyze different parts of our data. First, we analyzed the text and picture in a quantitative way by comparing the number of texts and the number of drawn objects in pre and post surveys. Second, we developed a categorization of the drawings and the accompanying texts about the students, teacher(s) and the learning environment with a thematic qualitative data analysis [11]. In order to define the codes, we mixed concept-driven and data-driven approaches with a strong reference to the research questions. As a first step, we derived the main categories from our prompt: students, teacher(s) and learning environment. Afterwards, we developed codes along the data. Those developed codes were diversified into different characterizations. We developed indicators for each characterization to reach an acceptable inter-rater reliability. To represent our data as well as possible, we used a mix between a maximum variation and a minimum difference approach along criteria of changes between pre- and post-survey.

After a pilot course in autumn semester of 2020, we launched the study in spring 2021. The course "Media and Computer Science 2" aims at preparing teacher students for teaching Media and Computer Science in primary school (4 to 12 year old children) in Switzerland. Each researcher was responsible for two study groups of around 20 students (78 total). The methods course Media and Computer Science is listed at the end of the Bachelor's program in the sixth semester. Most of the pre-service teachers are about to receive their teacher's diploma for the Bachelor of Pre-primary and Primary Education. More precisely, 14% of students were in their second year, 86% in their third or fourth year and 38% would finish their studies at the end of the current semester. Due to the flexibilization of the teacher training program and the covid-19-pandemic, students came to the course with different previous experiences, but they had all learned several teaching and learning methods in general didactic and subject didactic courses in mathematics, sports, science, foreign languages and more. Some of them had already worked as teachers in classes or were registered in official mentoring programs at schools. The course series was a 2 ECTS (60 hours of work) learning opportunity over ten weeks with three hours of joint working time per week. Main topics were specified by the Media and Computer Science section of the swiss school curriculum Lehrplan21 [4], with a tendency to the computer science section. The curriculum related to computer science states three content areas: data and their structures, algorithms and technology/information systems. Gender, socioeconomic status, and other demographic information were not collected because they did not contribute to answering the research question.

Students received an e-mail with the drawing task two weeks before the course started. Post survey was conducted after the last teaching event. The task was mandatory but not rated.

The methods course was conducted online, in a partly synchronous, partly asynchronous mode. The aim of the seminar was developing subject-specific and subject-didactic competences. The students focused on data structures, algorithms, computer science systems and the social impact of digitality and how these topics can be taught to different age groups. The content of the course was based on topics of the school curriculum [4]. Teaching methods played a role related to the learning subject. The course was designed according to the dialogic learning cycle (see figure 1) and the ICH-DU-WIR-principle of dialogic learning by Ruf & Gallin [13, 22, 23]. "ICH" (German for "I" or "Me") means that students deal with the topic or idea themselves. They document and reflect on their thoughts by keeping a written learning diary. "DU" (German for "You") means that the students exchange thoughts with another person and thereby expand their own concept. "WIR" (German for "We" or "Together") means that students and teacher(s) come to an agreement together and develop the regular insights of the theory with the insights achieved in the dialogue into a concept. The dialogic learning cycle is composed of four phases interchanging between reception of ideas and their production. Starting with a core idea (left part of the cycle), capturing the central but personal core of the current subject, the teacher creates an assignment (lower part of the cycle). Students write their ideas of this into a written learning diary (right part of the cycle). Teacher(s) and/or other students give feedback (upper part of the cycle). Teachers adapt their core ideas along the ideas of students and create a new assignment. The cycle restarts. The dialogue as the central element of learning is divided into dialogue of students with the content (ICH) and dialogue between students about the content (DU). During the assignment, learners deal with the subject content openly. They have the opportunity to approach a topic with their previous experiences, cognitions and feelings and to gain an individual, singular approach to the assignment. Learners record their thoughts in writing. Afterwards, in dialogue with other learners, there is an examination of other people's approaches, based on which the question of the "regular" arises and the learner wants to know what it is really like, which is clarified in dialogue with the teacher (WIR). While using this approach, each week we set a new open assignment, which we created based on the students' previous work and ideas documented in the learning diary articles.

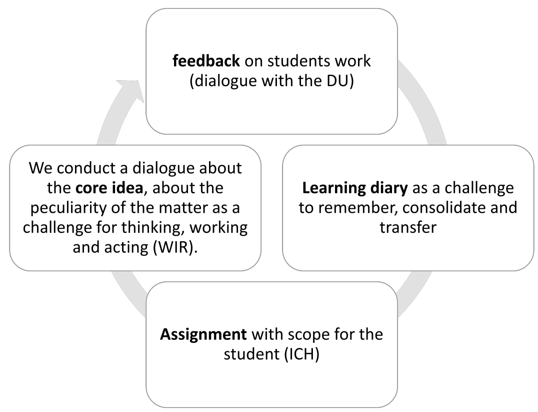
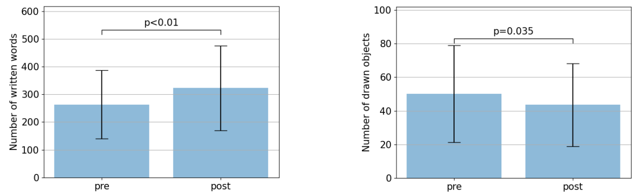


Figure 1: The cycle of the dialogic learning arrangement.

4 RESEARCH APPROACHES AND RESULTS

First, we conducted a quantitative analysis of the number of objects and the number of written words. To count the number of words, the written data was copied to a plain text file. While copying the data, all phrases and questions from the prompt, which some students had copied into their answers, were removed. We observed that the number of words significantly increased ($p<0.01$) and the number of objects significantly decreased ($p<0.05$) in a two-sided t-test for depended variables (see Figure 2a and 2b).

Second, we categorized the images and accompanying texts with a mixed approach. Derived from our initial prompt, we defined teacher(s), students, and environment as main categories and then inductively applied the methods of thematic qualitative data analysis proposed by Kuckartz [11]. Unlike others [9] we did not take the size of drawn elements into account but studied their position to each other as we were focusing on interactions. We also did not consider the emotions expressed by the drawn characters [12]. A collection of similar sentences, pictures, groups of objects and their position in relation to each other was created so that similar codes could be clearly identified. These descriptions are called indicators. Furthermore, we assumed that in many cases similar beliefs are drawn in a similar symbolic way but that its symbolic



(a) Written text. **(b) Drawn objects.**

Figure 2: Comparison of written text and drawn objects in pre and post survey.

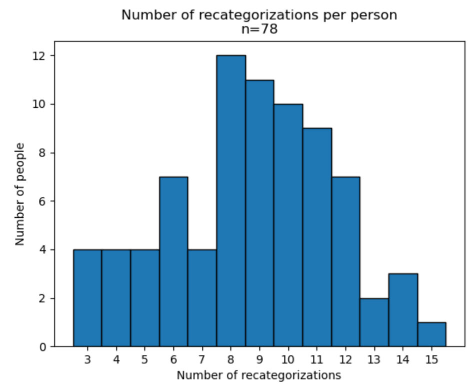


Figure 3: Recategorizations per person. Difference between pre and post survey.

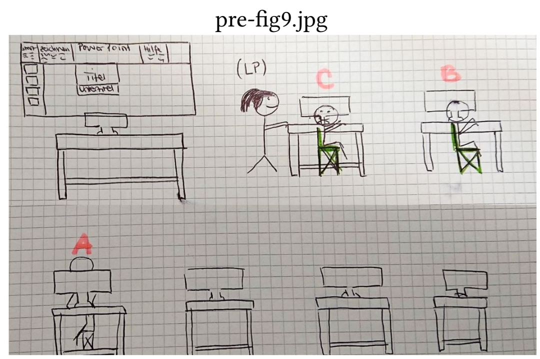


Figure 4: "Average" drawing of pre data collection with two deviations from standard values.

meaning always needs to be analyzed in context of the full drawing: Whereas an illustration of a teacher standing in front of the class may indicate a more instructional approach it also may be that students asked the teacher to do a short presentation or that the teacher is making a short introduction to an otherwise open and student-centered task. A repository aiming at a diverse set of mental images and beliefs has therefore to take careful consideration to not lose this context. Along the process, we developed multiple categories for each main category, inductively. Each category was divided again into characteristics. To each characteristic, we added a description and some typical indicators (anchoring example).

The complete Draw-A-Media-And-Computer-Science-Teacher repository (DMECS-R) consists of sixteen categories. Four categories for teacher (see Table 1), five categories for students (see Table 2), six categories for environment (see Table 3). Each category is divided into characteristics. Each characteristic includes an "Undecidable / Not enough information" characteristic. Unclear characteristics are not displayed in the tables.

We calculated an interrater reliability of 83.9% of raw agreement and interrater-reliability with Cohens Kappa of 0.75. This is a moderate agreement [16] that we deemed acceptable value for this exploratory study.

4.1 Changes in the beliefs after the course

The resulting categorizations were evaluated quantitatively. Therefore, we investigated the recategorizations, compared "average" pictures, made a multidimensional scaling, and compared the minimum and the maximum changes.

4.1.1 Recategorizations. We calculated the number of overall recategorizations of each individual student from pre to post survey. For this purpose, we compared the drawings of each participant by counting how often the characterization in the categories changed after the course. The results show that many students' drawings were recategorized between eight to eleven times (see Figure 3).

Based on this result, we cannot make any statements about the direction in which the beliefs changed. However, it can be shown that the beliefs have changed.

4.1.2 Comparing "average" pictures. To visualize the average change between pre and post survey, we calculated and selected an "average" picture before and after the methods course. We set the characteristic with the most categorized images as the standard value. Then we calculated which images had the least deviation from this standard value: For the pre survey, the drawing in Figure 4 is closest to the "average" drawing. It shows a classroom where students are following an instruction, working alone, not interacting with each other and sitting apart from other. The teacher moves around, gives advice to a student and waits for students to ask questions or observes students until actively give hints. The environment is simple, there is individual material, the teacher displays information over a device. Figure 5 shows a drawing where students follow their own ideas. They work in the classroom, in groups as well as individually. They support each other in their respective tasks. They all do different things around the same task. The teacher supports a student, waits if a student has questions or looks for students who need help. The environment is diverse and there is some individual material. The teacher communicates with students through an overhead projector and elements on the walls. There are computers for everyone and no additional devices.

This change towards more interaction can also be seen when plotting the categories with the most changes from one category to another. Pre-service students more often draw pupils interacting with each other (see k3.3 in Figure 6a), moving around or sitting or standing in different places (see k4.2, 4.3 in Figure 6b). From this part of the analysis we conclude that student activities that

Table 1: Categories and characteristics of the teacher.

Category	Characteristics	Indicators
Movement in environment	Stationary	Teacher sits at his desk. Students visit the teacher if they have questions.
	Currently stationary	Teacher talks to a student or a group of students but will likely move away afterwards.
	Moving around	Teacher moves around. Teacher stands in the classroom but not directly with a student.
Direction of communication with (some) students	One-way	Teacher holds a lecture. Teacher makes an introduction. Teacher explains something.
	Two-way	Teacher asks students about their progress. Teacher supports students.
	No communication	The teacher does not currently communicate directly with students.
Position to students on drawing	Group setting	Teacher sits with a group. Teacher talks to more than one student at the same time.
	With individual student	Teacher talks to an individual student. Teacher stands with an individual student.
	In a lecture setting	Teacher talks to the whole class.
	With nobody	Teacher talks to nobody.
Initiative of engagement	Passive	Teacher talks when asked by students.
	Active	Teacher actively seeks the initiative. Teacher holds a lecture.
	Mixed	Passive and active engagement is described.

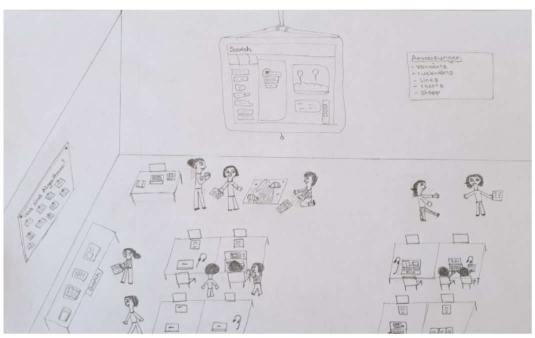
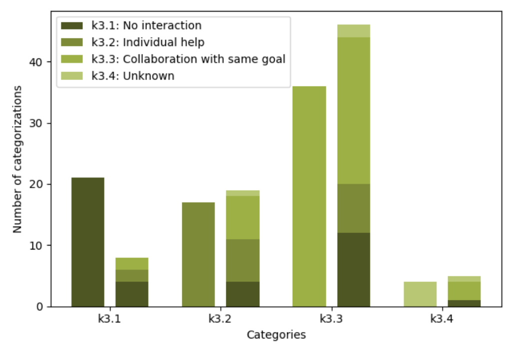
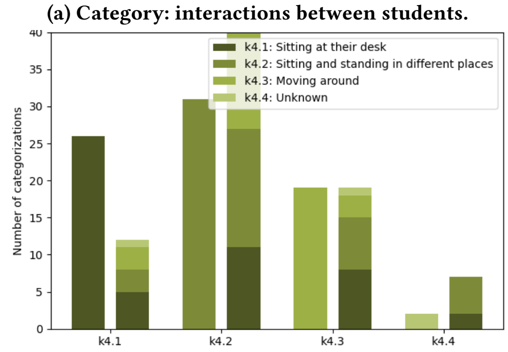


Figure 5: "Average" drawing of post data collection with two deviations from standard values.



(a) Category: interactions between students.



(b) Category: freedom of movement.

Figure 6: Changes in categories from pre to post survey.

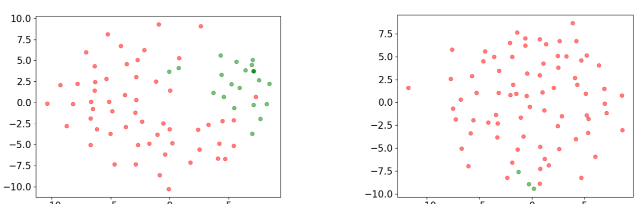
are presented in drawings after the methods course were more interactive, cooperative and dynamic.

4.1.3 Multidimensional scaling. To further investigate and visualize our data we calculated the number of deviations of each drawing to all other drawings. Then, we used multidimensional scaling (MDS) [3] to investigate and visualize the data. We did this with the pre and the post dataset. This allows for a comparison to observe groups in pre- and post-survey, however, the exact position of a specific point in the visualization is not comparable over pre and post dataset.

In figure 7a one can recognize a distinct group on the top right corner. This group consists of pre-service teachers drawing teacher-centered images where the learning process is closed and students are sitting at their desk. In many cases the teacher stands lecturing in front of the class while students sit in rows in front of their computer looking in the direction of the teacher (e.g. Figure 8).

Table 2: Categories and characteristics of the students.

Category	Characteristics	Indicators
Openness of the learning process	Working on a closely crafted task follow an assignment get an introduction	Tasks indicated and numbered on a chalkboard. Assignments are mentioned.
	Bring in own ideas or follow own projects	Own projects are clearly mentioned. Inputs of own thoughts are explicitly mentioned.
Types of collaboration groups	Working alone / individual work	Drawn students sit alone / divided from each other in front of their desk.
	Partly individual work partly partner or group work	Some students work together and some of them work alone. Students stand together in groups and / or individually in the room. Places or time for group and for individual work are mentioned.
	Working in groups	No individual work is mentioned or drawn. All students work together in groups on a common task.
Interactions between students	No interaction	All students work or stand alone. No conversations between students are visible.
	Interactions to help each other with their individual goal or work	Conversations at a special Helpers' table are visible. The possibility to help each other is mentioned.
	Collaboration together with same goal or work	All or some students are organized in groups and work collaborative. All group members work towards the same goal and divide the tasks among themselves.
Freedom of movement in the room	Sit on their own places / at their desk	Every student sits at his or her own place. There is no indication that they will leave their place.
	Sit and stand in different places	The students are in different places in the room and change these places. There are free tables that can be used.
	Move around	Students are forced to move around because of the task. Students move around during the task.
Diversity of activities	Same activity / same task	Students do the same task more or less in the same pace. Students listen. Students follow teacher's small-step instructions.
	Activity around the same topic	Students work on the same task or under the same topic, but the certain action may be different.
	Not topic connected activities	Students work on different topics.



(a) Pre survey (b) Post survey

Figure 7: Number of differences in categorizations between each subject for pre and post survey. Reduced to two dimensions with MDS-algorithm. Pre-service teachers with their drawings categorized as showing a closed learning process and students are sitting at their desk emphasized in green.

Such a group cannot be recognized in the post-survey data (see figure 7b).

4.1.4 Maximum and minimum changes. For this part of the analysis, we followed a maximum variation and minimum difference approach inspired by the grounded theory [7]. Therefore, we looked at the pictures with the maximum and minimum changes from pre to post data collection.

We could find one drawing with fifteen changes (see Figure 9 and 10). In this case, all but one of the categories changed from pre (see Figure 9) to post drawing (see Figure 10). The pre-survey drawing shows students that follow a closely crafted task, they do not interact with each other and sit alone at their desks in front of their computer. They all have the same task. The teacher stands in one place at the front of the classroom and explains what the students have to do. The environment is reduced to the most important. There is some individual material to use. The teacher uses the environment to bring information to the students and each student has a computer. There are no additional devices like robots or cameras. In post drawing children follow their own ideas, they cooperate in groups, they sit and stand in different places, they do different things but follow an overall theme. The teacher

Table 3: Categories and characteristics of the environment.

Category	Characteristics	Indicators
Flexibility	Fixed, stationary, restricted	The learning environment cannot be redesigned. There is no indication that corridors are also used for the projects.
	Movable furniture, mobile chattels	The learning environment can be redesigned/furnished differently.
Versatility	Monotonous, classic facilitated	Uniform arrangement of tables, chairs, blackboard.
	Versatile facilitated	There are different sized tables. Students can work at different tables or in different corners.
Equipment / additional material	No or almost no material is provided	Booklets or papers, such as instructions, are not drawn or mentioned.
	Individual additional material for the task is provided	Instructions, fact sheets or booklets for the specific task are mentioned /drawn.
	Versatile material for the task and for cross-thematic projects is provided	A library is drawn. Versatile paper-based materials for a wide range of projects have been mentioned.
Communication via elements of the learning environment	Teacher communicates via the learning environment	Teacher writes information or tasks on the blackboard/whiteboard. The teacher uses the beamer to project content onto the screen. Teacher makes notes on the wall with rules, information or tasks.
	Teacher uses students' material for communication via learning environment	Teacher uses a video which was produced by a student for information or introduction. Students' products are pinned on a board for visualizing several results and discussing.
	Students themselves use the learning environment to communicate with each other	Students share and visualize their intermediate products for helping each other. Students create tasks by their own and write them on a whiteboard.
Technology (Computers, tablets, etc.)	No technology	No computer or tablet is mentioned or drawn.
	Some technology	Some students (e.g. every second) have a computer or tablet. There are tables without tablets or computers.
	1:1 computing	Every student has a computer or tablet.
Additional technological devices (robots, cameras etc.)	No technological equipment	There is no robot or camera or other things drawn.
	Some technological devices	Some students have a device. Some cameras or robots could be used in a corner.
	1:1 equipped with technological devices	Every student has a robot or camera.

currently helps a group. Either the teacher waits for the students to ask questions and speak up, or the teacher approaches the students. The room is open and divided into multiple rooms, the students communicate, mediated through the teacher, over the environment by presenting each other results. Some students use computers.

We could find four drawings with only three recategorizations. We selected one student in this group randomly (see Figures 11 and 12). All three changes happen in the students main category. The students can, different to the pre-survey, follow their own ideas, they partly work together and cooperate in groups, when creating an algorithm of their own. This change cannot be revealed by the picture but only in the accompanied narrative. In the pre-survey, the students were drawn in a situation where they had to follow instructions (see table 4. In the post-survey drawing, students were given more space to create their own algorithms (see table 5).

Table 4: Accompanying text in pre survey in German and English

German (original)	English (translation)
Die SuS geben die von mir gegebenen Befehle in das Tool XLogo Online ein.	Students type commands, presented by me, into the tool XLogo Online.

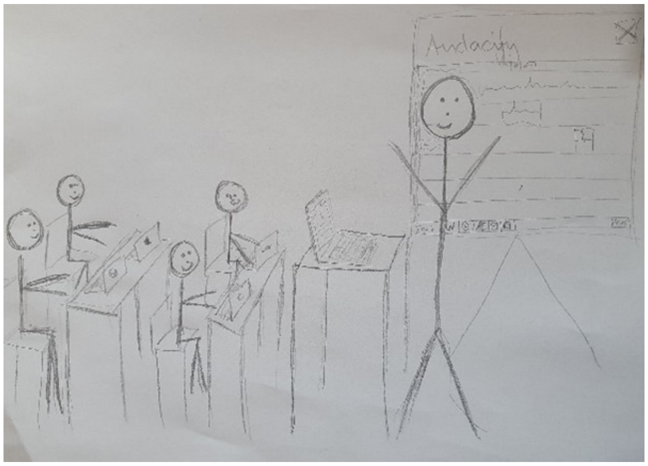


Figure 8: A teacher-centered drawing in pre-survey.

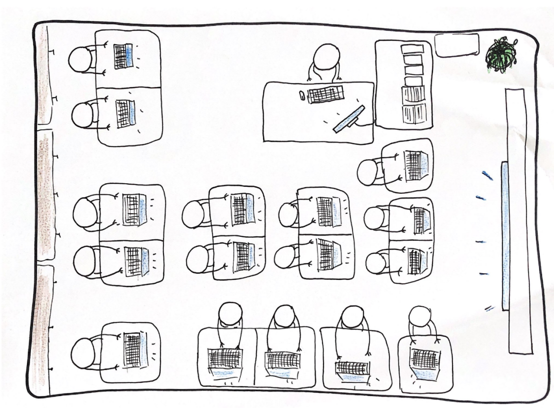


Figure 9: Drawing from pre-survey.

Table 5: Accompanying text in post survey in German and English

German (original)	English (translation)
Zu zweit erfinden die SuS einen Algorithmus und stellen ihn der Klasse vor.	Students invent, in groups of two, an algorithm and present it to the class.

5 CONCLUSION

5.1 Research question 1

Which shared or distinct beliefs do pre-service teachers have about Media and Computer Science lessons at the beginning of the methods course?

In our results, we could see a shared teacher-centered belief in a group of student teachers. With our repository and the following analysis, we were able to recognize this tendency. Thomas et

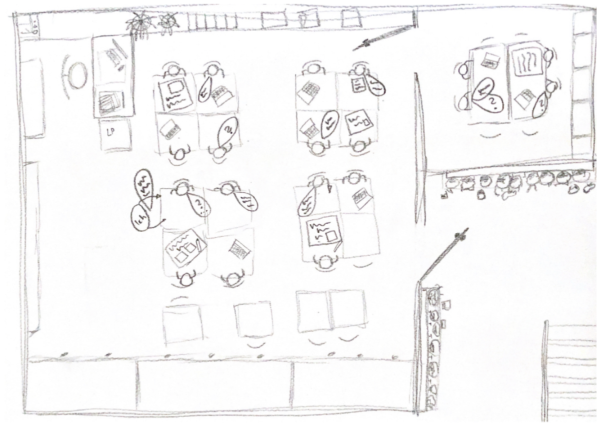


Figure 10: Post survey drawing of the same student like Figure 9 with fifteen changes from pre- to post-survey (maximum).

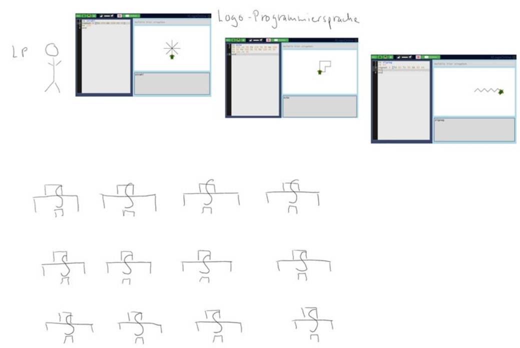


Figure 11: Pre-survey drawing.

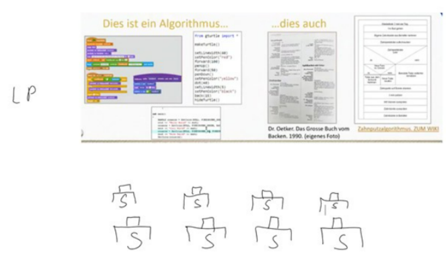


Figure 12: Post-survey drawing of same teacher student like in 11 with only three changes to pre-survey.

al. [24] report in their study as well that they observed that "student illustrations can be organized into two fairly distinct groups – teacher-centered (7-13 points) and student centered (0-4 points)". Considering our participants of the study, this particular group is noteworthy because all students in our group had already taken several methods courses in other subjects and general teaching methods courses. For this reason, we would argue that the changes in computer science and media teaching specific beliefs are specifically due to the methods course experienced.

All other beliefs observed through our repository seem to be evenly distributed. We could also see that the student teacher groups provided a wide range of drawings and thus brought a wide range of mental images to the course. In our eyes, this diversity should be interpreted as an opportunity for discussion within method courses.

5.2 Research question 2

How do pre-service teachers' beliefs change after completing a ten-week media and computer science methods course?

The quantitative analysis of texts showed that students can write more about what they have drawn in post-survey even though they draw slightly less. They seem to be able to describe their mental image of teaching computer science and media education better.

Comparing the "average" drawings, we were able to show that the they had changed from before the semester with individual work, quiet and seated students to the "average drawing" with more collaboration, movement and talking to each other. When comparing the picture with the maximum changes from one category to the other, we showed that it had changed from a teacher-centered, closely seated and individually working drawing to a drawing that uses multiple spaces, includes collaboration between students and where the teacher supports and helps students. We have shown that the comparison of students' drawings with minimal changes has shown changes especially in the main category students, which is supported by looking at the overall change in the students main category. Both the quantitative as well as qualitative evaluations show similar changes. This leads us to conclude that the changes observed when looking at the number of recategorizations show a qualitative change towards more student interactions and are not just noise in data, for example, because the pre- and post-survey prospective teachers select different situations at different stages of their learning process. Similar to others [10] we could only find very few examples with teachers and children outside of the classroom and we could not find any situation where more than one teacher was present in the classroom.

Based on our research we make three main conclusions:

(1) After the method course it was less likely that student teachers draw individual work of students.
(2) After the course, student teachers were less likely to draw children working on closely guided assignments. Post-course, more student teachers draw pupils working on their own projects and tasks.
(3) After the method course, it is less likely that student teachers draw themselves in a conventional, classically furnished classroom with only chalkboard and neatly arranged tables and chairs.

This leads us to the overall conclusion that taking a dialogic and constructivist approach of learning into account, the methods course has expanded the student teachers' repertoire of teaching methods for Media and Computer Science lessons.

6 DISCUSSION

Taking into account the previous conclusions and the whole research process, we recommend conducting future research using the DASTT-C and DMECS-P method in the field of computer science education.

Based on this study, we are able to describe implications and recommendations for teaching didactics in media and computer sciences for primary teachers, for future research and for future research with the DASTT-C in the field of computer science education.

6.1 Recommendations for actions in teaching didactics

First, it is important to note that the categories do not represent better or worse characterizations. Next to collaborative open learning arrangements, instructional teaching is an important and effective method. All teachers should have various methods in their toolbox. Students should learn to work individually as well as in cooperation.

Nevertheless, by taking a constructivist approach of learning into account, our research shows that the methods course has expanded the repertoire of teaching methods for media and computer science lessons. The post course drawings show a high diversity of teaching methods, which is particularly evident in the stronger focus on collaboration and open, individual projects. The learning environment has also become more diverse. To be able to adequately implement this versatility, co-teaching might be appropriate. Even though co-teaching is quite common in Switzerland we could not find any drawing that depicted another adult present in the drawings. We could not find any research with the DASTT-C that reported multiple teachers or other adults on the drawings. Furthermore, involving external experts in the lessons and teaching at extracurricular places of learning would also be a possibility to enable versatility. However, this is also not to be found in any of the drawings. Consequently, it can be stated that in subject didactic training, too, there should be a stronger focus on the extracurricular places of learning and versatile possibilities including external experts. In the sense of a didactic double decker, this should then also be reflected in drawings.

6.2 Recommendations for future research

In our study, there were few candidates who maintained a strongly teacher-centered image of themselves as teachers. Our study did not ask about the reason why students had changed their beliefs. It would be interesting to examine why students maintain their beliefs.

6.3 Recommendations for the DASTT-C and its adaptations

In research with pre and post-survey the DASTT-C is mostly applied to small groups. We hope that in future uses of the DASTT-C more researchers with small groups take the long way to explore the diversity of students teachers' beliefs by recategorizing and expanding upon the prompt of the DASTT-C. We hope that our contribution inspires this recategorization and analysis.

In the light of the widespread use of the DASTT-C prompt and variations of the DASTT-C in multiple disciplines such as math [25], engineering [26], primary school [24] and science [14] we hope that researchers will include and report more drawings that were either placed in the center of the group or were difficult to score. We hope that by doing this there will be strong incentive to further develop this valuable instrument.

Different from others we were able to collect a rich collection of written data. We attribute this to several circumstances which we cannot fully verify. First, the time set to draw the pictures and write their narrative was 45 minutes. Second, written reflective tasks are common at the university where this study took place. Third, the written task was set in a digital setting. Forth, each part of the prompt was asked to be filled out separately. We hope that future research will build upon a more comprehensive set of texts as, combined with the drawing, it is a rich source of information.

7 LIMITATIONS

The repository was developed using the same data that was analyzed afterwards. This could lead to bias because it is not generic enough. As we were interested in the development of the group and followed an exploratory approach, this is acceptable, but in further research the repository should be evaluated against an independent data set. Furthermore, we took several precautions to mitigate this effect: First, although we derived the categories inductively, we embedded them in the larger research corpora using the previous work around DASTT-C and beliefs about teaching. Second, after an initial draft of the repository, we had several meetings with an expert in qualitative research at our university to discuss our draft.

Since we conducted the research with students in our courses, the results and analysis are vulnerable to personal bias. We mitigated this by carefully drafting and describing our categories with examples and inclusion and exclusion criteria. We categorized the drawings together in several sessions. We reviewed results by categorizing 10% of the examples in the pre- and post-surveys twice.

It should be remembered that we intentionally asked students to draw a specific situation. Pre-service teachers were asked to draw a picture about a realistic situation - not an ideal one. This consciously biases the drawings to create mental images that students perceive as realistic. Asking them to draw an ideal situation might lead to different results.

As other authors have mentioned [17], it is unclear whether students transfer the effect shown to their lessons. This should be part of further studies in this area.

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