How to Catch'em All: Designing Attractive Learning Activities for Girls in Computer Science: A Systematic Framework

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***Abstract*—To fight the underrepresentation of female students in Science, Technology, Engineering and Math (STEM), schools and universities should cooperate in communicating what skills and competencies are required and to what extent schools already help develop them. Universities need to communicate the necessary competencies and schools should encourage girls by an appropriate design of learning activities, exercises, and projects. They also need to emphasize the underlying competencies and how this will help in taking up STEM subjects at university, thereby raising the girls' self-esteem and self-efficacy. The key to transporting this message is an appropriate and systematic learning activity design based on a competency-based approach and appropriate teaching methods as well as a more female-responsive scope of tasks. This paper focuses on computer science and sets up a morphological analysis of dimensions to consider when designing learning activities for computer science lessons, taking into account what kind of subjects girls are interested in and what fosters their skills and their self-efficacy in STEM.**

***Keywords*—STEM subjects, women in STEM, learning activity design, competency-based education, teaching computer science**

I. Introduction

The underrepresentation of girls in STEM majors is a long-lasting, but more and more intensely researched phenomenon. One of the reasons is a lack of self-esteem, a feeling of not being sufficiently prepared for the universities' requirements, which during school time leads to a constantly diminishing number of girls interested in taking up STEM majors (a phenomenon also called "the leaky STEM pipeline") [1]. This can especially be observed in the field of computer science. In a study conducted by the IU International University of Applied Sciences, 777 school girls mostly between 16 and 20 were asked how much they agreed to the following question related to STEM subjects like engineering, computer science, math, biology, physics and chemistry: "With my prior knowledge and skills, I feel equipped to start a degree or apprenticeship in the following subject". For computer science, only 16.2% of all girls chose "fully agree" or "agree" [2].

So schools and universities need to make sure that female students gain a better knowledge about what universities expect from first-year students in computer science, thereby helping to overcome unsubstantiated fears. Matching the competency-based approaches of universities and schools based on common expectations might help give the girls a more realistic estimation on how well they're already equipped with the necessary knowledge and competencies, especially in those categories commonly associated with women's strengths and how these competencies can be an advantage when studying computer science.

Learning activities in computer science lessons at school should concentrate more on raising interest and providing a feeling of positive self-esteem and personal success also for female learners. Therefore, the lesson design has to take into account the girls' predisposition and their attitude to topics and types of exercises instead of providing female and male pupils with the same kind of subjects, which tend to be more aligned along the preferences of male students.

This paper introduces a multi-dimensional approach for designing tasks and learning activities for computer science lessons at school which on the one hand stimulate the girls' interest and on the other hand foster the required competencies of first-year students of the subject. Section II creates the scope for the framework, summarizing and combining related work in the fields of the competency-based education approach with female-responsive learning activity design and insights in strategies for teaching computer science. Section III describes the morphological analysis as the tool used in Section IV for creating a systematic framework. Section V derives the framework's dimensions and choices and shows two ways of using it in practice. It combines the relevant competencies with other dimensions to form interesting learning activities, and using hybrid tools and problem-solving techniques, thus providing a framework for teachers creating new learning concepts and effective instructional strategies. Section V gives further recommendations and a conclusion.

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II. Related Work

The suggested framework should include and integrate former research in the field of competency-based teaching, female-responsive school lesson design and successful patterns for teaching computer science in schools, making use of the broad range of insights from a pedagogical point of view.

A. Competency-Based Education

In the last years, Competency-Based Education (CBE) gained much attention in STEM education and teaching. This approach focuses on building up those qualities that a person needs to possess in order to perform in a job, role or task, i.e., the required competencies [3]. Universities pursuing a CBE have the objective that their students acquire the competencies that are required in order to execute their future roles and jobs. Regarding computer science, in 2020 the Association for Computing Machinery (ACM) and IEEE Computer Society (IEEE-CS) presented the Computing Curricula 2020. It supports universities by providing curricula guidelines for undergraduate programs in computer science related majors [3].

Given the perspective that competencies are gradually built up and further developed from school through university, the question arises which competencies first-year students must possess to successfully start a STEM major. Thurner *et al.* [4] and Zehetmaier *et al.* [5] described the competencies that were related to studying computer science and to what extent they were required from the start on and therefore had to be built up during a school career. The model of competencies developed contains self-competencies, practical and cognitive competencies, social competencies as well as technical competencies.

In their studies analyzing the competencies of first-year students (including a self-assessment of the students), Thurner *et al.* [4] and Zehetmaier *et al.* [5] identified a gap between the competencies expected from universities and the actual competencies leading to the problem that about two-third of the first-year students in STEM majors had difficulties to meet the study requirements. In addition to this real gap between actual and required competencies, many girls in STEM subjects struggle with a further "imagined" gap: Girls tend to underestimate their own competencies with respect to STEM, a problem which could be shown in various studies in the last 30 years [6]. In order to raise girls' self-efficacy with respect to STEM, i.e. their individual beliefs about their own capabilities regarding STEM, and to support them in a decision for a STEM major, STEM lessons in school have to provide the opportunity to students to develop the required technical and behavioral competencies. At the same time, teachers have to ensure that the students, especially the female students, too, are aware that they built up a certain competency.

A further concept relevant in this context is the concept of computational thinking, which was originally described by Seymour Papert in the 1980s and extended by Jeannette Wing in several publications since 2006 [7–10]. Computational thinking as discussed by Wing can be seen as "a lens and a set of categories for understanding the algorithmic fabric of today's world" [11] (p. 884). It states that enhancing the thinking process itself is technology-independent, that it should lead to a solution that can be implemented by a person and/or a computer and emphasize on divide-and-conquer strategies for problem analysis, abstraction, and generalization. So computational thinking represents a kind of meta-problem-solving strategy that can be applied to a variety of subjects and therefore should be taken into account when designing computer science lessons for girls [8, 10].

B. Female-Responsive Learning Activity Design for STEM Subjects

When trying to tailor the design of computer science lessons to the needs of female learners, it is important to consider the differences between boys and girls concerning learning and problem-solving. For example, boys can be found to quickly go for a first explorative solution without further investigating the problem or its detailed requirements [12]. On the other hand, girls tend to prefer working in teams and scrutinizing the problem thoroughly before designing a solution. In Gurski and Hammrich's study, girls demonstrated higher than average self-efficacy in teamwork, problem solving and critical thinking, but lower in mathematics and science [13]. Developing STEM courses for women that suit their interests is important to increase their willingness to engage in related fields and to balance the gender gap in STEM fields [14, 15].

In addition, Dancstep and Sindorf [16] introduced a "Female-Responsive Design Framework", based on four pedagogical strategies supporting learning processes in STEM subjects. These four strategies include:

- Enabling social interaction and collaboration,
- Creating a low-pressure setting,
- Providing meaningful connections and,
- Representing females and their interests.

The findings of Steffen *et al.* [17] could be aligned with this framework and confirm that such a design is perceived in a positive way by female high school students. Their analysis of female high school students' attitudes towards STEM subjects shows that girls perceive school lessons as positive when STEM teachers explain the topics in a comprehensible way and use everyday examples, thereby relating the topics to the girls' everyday lives. In addition, the girls in this study reported in a positive way on their teachers who used a mix of teaching methods for a certain topic, allowing students to learn related theory, gain practical experience and thereby develop a deeper understanding of the topic.

A completely different approach is taken by the I-STEM project [18]. Here, teachers use creative methods to help students learn about STEM subjects. Among the projects in Poland, the Netherlands, Ireland and Finland many involved the participation of artists, acting, role-playing, theatre scene setting, music or poetry. This might also appeal to competencies which are often associated with female interests and open up new perspectives on subjects that are otherwise perceived as abstract and arid.

C. Teaching Computer Science

Zendler [19] introduced 20 different (mostly classical) teaching methods in the field of computer science didactics, ranging from well-known approaches such as presentations or concept-mapping to more IT-related tools like computer simulation or learning by modelling. For each method, an example of a typical IT-related task is given, but no distinction is made as to whether a method is equally suitable for girls and boys. Nevertheless, it shows that teaching computer science does not necessarily have to be about coding.

Roth *et al*. [20, 21] gave a recent overview of how IT-based tools and concepts can be used to teach other STEM subjects such as chemistry and physics, e.g., using Augmented and Virtual Reality, Artificial Intelligence, etc., not for their self-purpose but to explain complex scientific topics. This is in line with the concept of computational thinking introduced in Section II. However, Roth *et al*. do not consider gender-specific aspects in their teaching methods.

A general scheme for classifying teaching methods was developed by Hilbert Meyer in 2002. He classifies teaching methods into three levels – micro, meso and macro – according to their scope [22]. On the macro level, elements regarding the basic organization of the lessons can be found, such as frontal teaching or project-based teaching. On the meso-level different social and organizational forms are described. The micro-level comprises concrete techniques such as demonstrating a certain aspect. Besides of this general classification scheme by Meyer, templates that are used when describing teaching methods such as in [22] provide a certain systematic. This template includes for example the social form, the duration, and the use of media. A different scheme is used by Zendler [23] based on Merriam *et al*. [24] and Woolfolk [25] to compare several learning theories. The criteria are as follows:

- Outcome of learning,
- Demands on didactic design,
- Principle of teaching, role of the teacher,
- Role of the learner,
- Role of the peers,
- Control of the learning path, and
- Control of the learning success.

D. Resulting Scope for the Framework

The question is then how to improve the cooperation between universities and schools in order to provide the necessary competencies and make girls aware of them. Teaching STEM-subjects in an appropriate way requires a framework for setting up learning elements that are better tailored to girls' needs, interests, and competencies. The goal of this paper is to provide such a framework, focusing on the intersection of these three research fields. Fig. 1 shows a graphical representation.

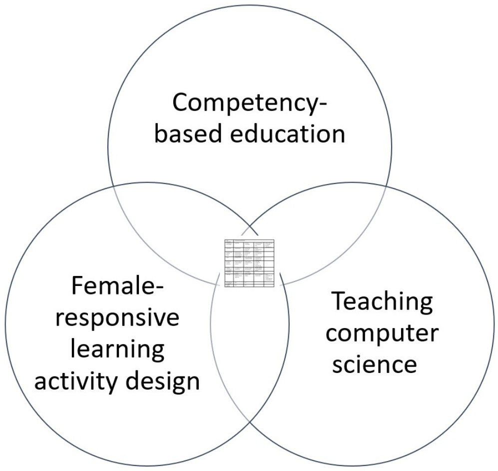

Fig. 1. Research focus for the framework.

III. Morphological Analysis

This paper uses the technique of the morphological analysis, a creative problem-solving technique developed by Fritz Zwicky, to develop a structure for designing tasks and exercises for computer science lessons at school. Following this approach by Zwicky, a problem or challenge is broken down into its component parts and then, the different ways in which those parts can be combined or modified are explored. As these components are typically presented in the form a matrix or a table, this approach is also known as the Zwicky-box. By examining the different possibilities, existing approaches can be systematically analyzed, or new solutions be created [26].

Having clearly defined the problem or the challenge to be analyzed, the technique comprises the following steps [26, 27]:

(1) Identify dimensions: Identify the relevant dimensions or components of the problem. Each dimension should represent a different aspect of the problem.
(2) Identify characteristics: For each dimension, describe the possible characteristics or choices. This can be done systematically, e.g., based on existing literature or by brainstorming. The dimensions and their respective characteristics are typically displayed as a matrix.
(3) Develop / Analyze solution variants: By combining the different possible characteristics / choices, different variants of the problem can be described, or an existing solution can be analyzed. In this step, the most promising combinations should be further examined, i.e., especially combinations that are novel, useful, and feasible.

IV. A Systematic Framework for Designing Female-Responsive Learning Activities in Computer Science Lessons

To provide a modular approach for the design of learning activities for computer science lessons that especially foster girls' self-efficacy, a morphological analysis is carried out. It is used to identify the necessary dimensions of such learning activities, their characteristics, and appropriate combinations. This results in a systematic multi-dimensional framework.

A. Framework Dimensions

The dimensions have been identified on the basis of a review of existing schemes for classifying teaching methods in STEM subjects as described in Section II and different settings of school lesson design used in studies on girls' learning performance in STEM subjects. Note that the dimensions do not refer to the content of the learning activity (except for the last one), but to the methodological way of working and learning. This ensures that the competencies needed for a successful study start in computer science are being fostered.

1) Competency

The first dimension is the competency itself, i.e., the competency that should be acquired by the students with the help of the defined learning activity. A subset of the competencies identified by Thurner *et al*. [4] and prioritized for first-year students by Zehetmeier *et al*. [5] is used in our morphological analysis. The focus was put on those competencies that are both expected from first-year students in computer science and that can directly be fostered by an appropriate design of the computer science lessons (and other STEM subjects) at school, like "thinking concretely", "analytic", "thinking in an abstract way", "being able to visualize", "thinking holistically".

These competencies basically reflect what is described by the concept of computational thinking (see Section II). Wing [9, 10] emphasized the importance of abstraction, which was represented in the competence model chosen as basis for this paper, as "thinking in an abstract way". Further key competencies that are discussed in the context of computational thinking refer to the ability to identify and clearly formulate the problem, to logical thinking as well as to developing and comparing different approaches and ultimately implementing a chosen solution [7]. These are reflected by the competencies "inventive" and "thinking concretely" in the Zwicky-box.

Note that "inventive" is not included in the list of prioritized competencies for first-year students by Zehetmeier *et al*. [5], but was added to the framework presented here due to its importance in the context of computational thinking and in working contexts in which humans and artificial intelligence work together (or even compete), In contrast, competencies like "being able to write/read" or "being eloquent" which need to be addressed in almost every school subject were not included.

It is important to note that this dimension can easily be extended to include further competencies, as there is no limit to the number of characteristics. Moreover, it is important to be aware that computational thinking is not only relevant for students who want to pursue a major in computer science. Instead, it is a fundamental skill for all science and engineering disciplines [9, 10].

2) Class organization

Another important choice is the class organization [7]. In addition to traditional frontal teaching, alternative approaches are well-known. Some learning activities can better be performed by a single learner alone (individual work); others require two partners to cooperate (working in pairs) or even a larger group or team setting up work packages (working in groups). Learning in pairs or groups allows learners to share their ideas about the task at hand and to discuss their opinions and intended approaches [12]. This style of social learning and interaction helps students to explore different perspectives as they need to evaluate and to integrate different, or even conflicting opinions. Fig. 2 shows the different possibilities.

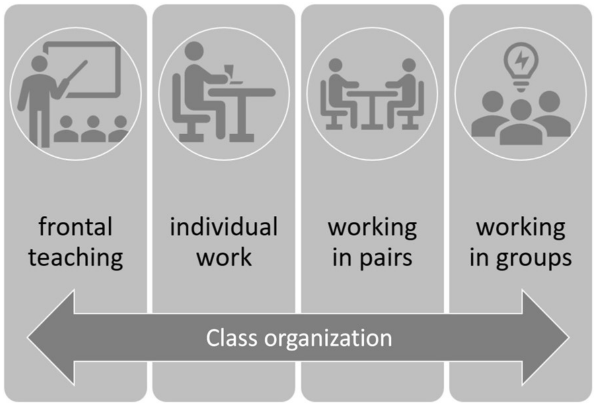

Fig. 2. Possibilities of class organization.

According to the pedagogical strategies compiled by Dancstep and Sindorf [16] in the Female-Responsive Design Framework, enabling social interaction and collaboration is especially important for females. Kulturel-Konak *et al*. [28] recommend a class organization that promotes collaborative learning rather than competition, as this is more likely to appeal to the social strengths of girls and women. Moreover, they emphasize that collaborative and cooperative learning environments are not only preferred by women, but are generally valued by students regardless of their gender.

In contrast to teamwork, single learner settings are preferred over pairs, groups or teams when "a computer science teacher wants to verify that all students are able to cope successfully with a given task or have acquired a specific skill" [7] (p. 203).

3) Gender pairing

When students should work together in pairs, teams or groups, different grouping strategies are possible. Various studies have shown that heterogeneous groups composed of students with different abilities and characteristics "can provide additional opportunities to learn from peers with different ability levels and backgrounds" [12] (p. 30). However, a certain aspect to be considered when designing learning activities for girls, is whether all-girls groups (single-gender) or mixed groups of girls and boys (mixed-gender) are formed.

Different studies analyzed girls' learning performance in single- vs. mixed-gender settings. As results differ with respect to the effects on girls' learning attitudes and engagement (see e.g., [12] for a discussion of several studies), the optimal grouping strategy must be selected for a certain task. Lin *et al*. [12] recommend based on the findings of their study, to form mixed-gender groups in the initial stages of problem solving because they tend to discuss more diverse opinions and develop more creative ideas. In later stages of problem solving, however, single-gender groups might be preferred because they appear to be more effective in implementing the solutions. In addition, when choosing mixed-gender groups, a rather balanced grouping should be considered as studies have shown that in majority-male groups, females tend to have problems that their opinions considered [29].

4) Duration

A further dimension is the duration, an aspect which is typically indicated in the overviews of teaching methods (see Section II). Learning activities can be designed to be solved in a single school lesson or require to be solved in subsequent lessons. They may also include homework. The more complex the learning activity, the more effort has to be spent on dividing it into working packages and coordinating their completion, a task which is well-known in project management. If teachers support students in identifying and organizing the single tasks, students have the possibility to build up competencies required for successfully working on projects.

5) Task type

There is a variety of typical tasks for computer science lessons that can be included in a learning activity in order to foster hand-on experiences. They often focus on algorithms and programming. However, topics can also be drawn from areas such as

- Human Computer Interaction (HCI) and interface design,
- Building and constructing switch boards or robots,
- Process modelling,
- Design and optimization,
- Game design and development.

Various studies analyzed the conditions under which a certain task is perceived as positive by girls and contributes in consequence to their interest in STEM and raises their self-efficacy. Corresponding to the female-responsive framework design presented in Section II, it seems to be important to choose a case study that matches girls' interests. Gomoll *et al*. [30], for instance, described the design of a learning activity with human-centered robotics. Note that the task type and the chosen case study can influence the time required, i.e., the duration of the learning activity.

6) Tools/Media

There are exercises that require software tools like programming, interface design, implementing machine-learning tasks, process modelling etc., others are focused on hands-on experience like building an electronic circuit or setting up a robot or simulating models with real-world objects. Both can be combined in larger projects.

7) Number of possible solutions

There are some problems for which there's only one correct solution to be found, e.g., a calculation result, an optimized algorithm etc. Other tasks, in contrast, allow for many different solutions that all deliver a correct result, such as different search or sorting algorithms or process variants. The more creative the task, the more likely it is that there will be an unlimited number of possible solutions, especially when it comes to things like interface design or any other design-related problem. When different solutions are possible, students need to learn to understand why certain solutions are more appropriate in a certain context than others.

8) Assessment

Depending on the learners' existing knowledge and certain characteristics of the learning activity, more or less interaction with teachers might be necessary in order to support the learning process. More complex tasks or tasks with many possible solutions will require more intensive and more frequent feedback from the teaching staff. Such an assessment differs from grading in the sense that an assessment has the objective to improve students' learning [7]. Grading, in contrast, has the objective to measure a person's knowledge and performance. According to Hazzan *et al*. [7], it is important that an assessment is fair and directly related to the expected learning outcomes. With the help of an assessment, students obtain feedback and should be motivated to reflect on their own learning process and their understanding of the learned topic.

The way how and how often feedback is provided is especially important for girls as Paechter [31] shows in their analysis of different studies. One problem is that girls are more sensitive to teacher feedback than boys. They tend to base the perception of their own competencies in STEM more on teachers' feedback than on their grades, even if they are high-performing. At the same time, girls obtain less feed-back and less attention in STEM lessons by teachers than boys [31, 32].

Feedback that empowers girls' self-efficacy in STEM subjects should contain both person-related and process-related feedback, applied in well-thought manner [31]. Teachers should give a girl an individual, person-related feedback, i.e., feedback on a girl's talent in STEM, her abilities or role models similar to her to raise her confidence. In addition, teachers should apply process-related feedback, i.e., feedback that focuses on the girl's learning process and the effort that she has taken, independent of her personal learner characteristics. This type of feedback helps to raise girls' self-efficacy beliefs. Fig. 3 shows the different types of feedback.

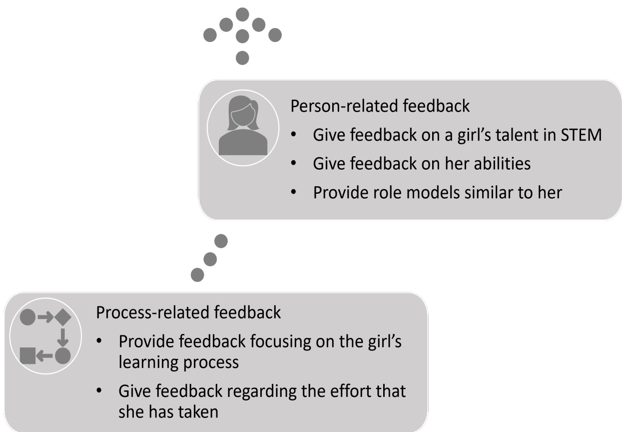

Fig. 3. Different types of feedback.

It is important to note that an assessment of student's work can take place during the process of creation, which is known as formative assessment. This type of assessment evaluates for example factors such as the quality of teamwork, creativity of solution approaches etc. On the other hand, for certain learning activities, only the final result is assessed, which is called summative assessment.

9) Documentation required

When it comes to more complex or more creative learning activities, it can be beneficial to require learners to create documentation about the solution or a user manual. Research has shown that generating such documentation can have positive effects on the learning process [20]. This is because the act of documenting the solution requires students to think more deeply about the topic. They have to think about the topic in a more abstract and generalized way. By documenting their solutions, students must organize their thoughts, clarify their understanding, and articulate their ideas clearly.

10) Grading

Knowing that their results will be graded can influence the learners' behavior and working mode. It should be kept in mind that not all types of learning activities are suitable for fair and objective grading, for example, some outcomes, such as a concept or user interface, may be difficult to grade in a quantitative way that reflects individual contributions in a fair manner. This is especially true when such outcomes are created by a team, where it can be challenging to evaluate each team member's individual contributions. In such cases, it may be more appropriate to use qualitative assessment methods, such as peer reviews or a jury's judgment, to assess the quality of the work produced. Alternatively, teachers may choose to grade the process of creating the outcome rather than the artefact itself, by evaluating factors such as team work, creativity, and problem-solving skills. And some learning activities like competitive games can be more fun if they are not graded at all. The intrinsic motivation to participate and/or win alone keeps the learners going.

B. Framework Dimensions and Choices

Table I shows the resulting set of dimensions and choices. It is open to more choices in the rightmost columns and can easily be extended, since in a morphological analysis not all dimensions need to have the same number of choices.

C. Using the Framework for Learning Activity Analysis and Design

The systematic framework presented in the previous section can be used by computer science teachers in (at least) two different ways. These scenarios are briefly described in the following.

1) Scenario 1: Analysis of an existing learning activity

First, the framework can be used to analyze an existing learning activity and to check to which extent it already includes a female-responsive design. Performing such an analysis means going step-by-step through the dimensions of the framework. For each dimension, it has to be identified which of the presented choices is actually realized in the learning activity at hand. It is recommended to reflect on alternative choices, especially choices that are more female-responsive. Doing this for all dimensions and systematically changing the characteristics results in a more female-responsive design.

2) Scenario 2: Designing new learning activities

If a teacher or trainer wants to create a new learning activity, the framework helps reflect important characteristics of female-responsive exercises and can raise awareness for communicating the ad-dressed competencies along with the school lessons. It also supports in detecting contradictions between dimensions. All in all, activity creation can be done in a more reflected way which over time will also change teacher awareness for the girls' preferences and needs.

TABLE I. FRAMEWORK FOR DESIGNING FEMALE-RESPONSIVE LEARNING ACTIVITIES IN COMPUTER SCIENCE

Learning Activity Dimension	**Characteristics/Choices**			
Competency	inventive	thinking concretely	analytic/ thinking in an abstract way	(others, *like able to visualize, thinking holistically* etc.)
Class organization	Single learner	partnership work, two learners	group- /teamwork 3–6 learners	–
Gender pairing	Single-gender	Mixed-gender	–	–
Duration	asynchronous during several lessons based on work packages	synchronous during one lesson	synchronous in more than one lesson	–
Task type	focus on programming an algorithm	focus on HCI-design	focus on physical construction	(other possibilities like process modelling/ design/ optimization)
Tools/ Media	Software tools	real-world tools, hardware-based	combination of hardware and software tools	–
Number of possible solutions:	there's only one correct sample solution	many sample solutions can be correct	unlimited number of correct solutions, e.g. creative artefact	–
Assessment (frequency)	no support, no interaction	Sporadic support during lessons	Regular support in and between lessons	–
Assessment (method)	formative during creation	summative when finished	–	–
Documentation required	yes	no		
Grading	yes	no		

V. RECOMMENDATIONS AND CONCLUSION

This framework is consistent with the requirements defined in the "Female-Responsive Design Framework" by Dancstep and Sindorf [16]. For example, the demand to "create a low-pressure setting" and to "enable social interaction and collaboration" fits well to learning activities that…

- Require creative solutions out of a huge number of variations, i.e., there is no need to match one single-solution,
- Are not directly graded, i.e., without explicit performance pressure,
- Can be solved in teams with a shared responsibility for the results,
- Range over a period of several lessons, i.e., there is no time-pressure, therefore enabling the girls to manage their own learning pace.

Accordingly, framework dimensions like *number of possible solutions, grading, working mode* and *duration* can all be trimmed to match the girls' specific needs.

Another important requirement of Dancstep and Sindorf [16] is "representing females and their interests". This can be fulfilled if the subjects of the learning activities cover topics that girls are usually interested in during certain phases of their development like animals, environmental issues, chances and risks of internet and social media usage etc. In addition, the topics should relate to real-life applications and practical examples because girls tend to be more successful when they understand the purpose and can see how the topic that they are learning influences the environment and our way of working and living [28]. This preference for "meaningful connections" [16] (p. 475) should lead to a change of mindset when it comes to choosing a topic for the learning activity. This could lead to teachers offering the same kind of learning activity with different variations reflecting a topic which is more likely to be chosen by each gender – thus giving them also a chance to "switch sides" just for curiosity.

The framework introduced in this paper integrates existing approaches to the design of female-responsive learning activities with a focus on computer science at school. It aims to foster competencies which are necessary for successfully taking up a major in computer science. At the same time, the girls should be made aware of their progress, so that they can build up more self-esteem and self-efficacy. The ability to solve complex problems through synchronous and asynchronous teamwork and communication is vital in STEM majors and business careers.

In order to group and organize the large amount of STEM learning activities that are targeted at girls during schooltime and outside school, this framework could also serve as a classification scheme, thus allowing for a broader overview. The result could be a catalogue or "map" from which girls (and their parents) can choose appropriate activities.

Future work in this field might lead to a database of computer science projects and activities, providing teachers and providers of female-responsive activities in computer science with ideas from which to choose. Since the dimensions are easily adaptable, the framework described in this paper might as well serve other STEM-subjects, too.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

Sibylle Kunz set up the morphological analysis and the scenarios. Claudia Hess conducted the literature research and related work. The article was written and approved by both authors.

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