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Measuring Creativity of Elementary School Students in the Context of a Coding and Storytelling Intervention

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Abstract

The presented study is a pilot to validate a test instrument in the context of an intervention in the areas of creativity and algorithmic thinking for elementary school children. The aim is to generate a test instrument that measures creativity and basic programming skills and also to check the feasibility and quality of the intervention created in order to achieve high-quality results in the future main study, which is to be carried out with a larger number of children from first to fourth grade. A total of 16 fourth graders from an elementary school in Germany participated as part of an out-of-school learning day. At the beginning of this day, they completed a pretest, after which they learned about the use of floor robots and basic algorithmic skills in a playful and creative way in an intervention lasting approximately 90 minutes. Finally, a post-test was administered to measure learning gains. The data collected shows that the algorithmic thinking test instrument measures algorithmic thinking adequately and shows significant learning gains for the children overall. It was also possible to classify the children into four groups according to their competencies with respect to convergent and divergent thinking, of which one group (with high scores in convergent and divergent thinking) can be classified as "the creative group". In addition, the data shows indications of connections between creativity and algorithmic thinking, although these can only be evaluated descriptively and need to be confirmed with a larger sample.

Keywords

Elementary School, Creativity, Algorithmic Thinking, Creativity Measurement, Floor Robots

1. Introduction

Our world is permeated by digital technologies. They accompany us every day and are all around us. As children explore and try to understand the world around them, it is important that they engage with digital technologies and also understand how they work and which principles are behind them. Further, creativity is regarded as a 21st century skill and likely to become increasingly important (Nakano & Wechsler, 2018; World Economic Forum, 2020). For instance, telling stories including designing new worlds using floor robots is a highly creative process: imagination and coding are used to create something that did not exist before. Hence, this combination addresses both: creativity and exploring basic principles behind digital technologies including algorithmic thinking.

Young children often approach problems playfully and openly on their own, which is why the influence of creativity in their learning processes is likely to be pronounced here. However, in order to be able to make a valid statement about this, their creativity must be made measurable. Numerous studies and research opportunities already exist in this area, on which this study builds. In line with the literature and current research creativity is defined here as the ability to think innovatively and appropriately (Bliersbach & Reiners, 2017; Sternberg & Lubart, 1998). Creativity is operationalized with respect to divergent and convergent thinking, both of which according to literature are highly developed characteristics in creative people (Brophy, 2006; Cropley, 2006; Garaigordobil, 2006; Landmann et al., 2014).

Designing new artifacts that solve any kind of problem is one core activity in computer science (CS). People in CS create software and/or hardware systems that are to solve some kind of real-world problem. Hence, creativity and innovation are also needed here. There are attempts to bring CS into elementary schools which focus on programming and basic algorithms (Tengler et al., 2022). Therefore, tests exist that approach these competencies empirically, such as the *Beginners Computational Thinking Test* (Zapata et al., 2021). Here, basics in programming such as navigating floor robots are included and children's skills can be assessed empirically.

This study is therefore dedicated to the development of test instruments for the creativity and algorithmic thinking of elementary school children. Additionally, it addresses the question of how these skills are related. Furthermore, an approximately 90 minutes intervention on the floor robot *BlueBot* was also carried out. The aim of this intervention is to introduce children to basic programming and to let them develop first algorithmic thinking skills.

2. Background

As outlined in the introduction, basic algorithmic thinking skills and creativity are two constructs that are interacting with each other and should therefore be considered together. The first questions to be answered here are whether, why and, if so, which CS skills should already be acquired in elementary school. The connection between creativity and basic algorithmic thinking skills in elementary school is then theoretically explained. Finally, a brief overview is given of the operationalization of creativity in this study and the studies used for this aim.

2.1. Computer Science and Creative Approach to Science in Elementary School in Germany

In Germany, the integration of CS into all school subjects and levels is crucial. While various approaches are dedicated to this topic (Chesterman, 2023; Kyriazopoulos et al., 2022; Mannila, 2023; Schmid et al., 2018), there is still no clear assignment to a specific subject in elementary school in Germany. As important skills for everyday life are addressed in science and social science education in elementary schools, called *Sachunterricht*, it seems appropriate to anchor CS education also in that subject. Science and social science education in German elementary schools include all natural and social sciences. CS content that should be addressed in elementary school can be found in the educational standards of the German Informatics Society (Gesellschaft für Informatik (GI) e. V., 2019). They distinguish between CS contents such as *algorithms* or *computing systems*, and processes such as *modeling and implementing* or *communicating and cooperating*. There, *modeling and implementation* is also described as a creative process. Accordingly, these skills can be found in the natural scientific and technical perspective in elementary education (Gesellschaft für Didaktik des Sachunterrichts, 2013). For example, Humbert et al. (2020) explain the creation of processes for controlling robots as a concrete activity that targets the competencies of the areas of modeling and implementation.

As described above and also confirmed in a survey of prospective teachers, it appears that technical and natural scientific education in particular seem to offer potential for promoting creativity on the one hand and making use of creative potential on the other (Holzapfel et al., 2022).

The existence of a large variety of learning material, especially for use in elementary school, opens up new spaces for the development of creative possibilities. Following Froebel's original ideas and his gifts for creative-playful learning, Zuckerman et al. (2005) refer to physical computing toolkits as digital Froebel gifts, as these are non-predefined materials for designing and modeling various real worlds (Brosterman & Togashi, 1997). These enable constructive and creative access to CS and interdisciplinary content, which is at the focus of the approach described here.

One approach to foster the acquisition of basic CS skills was chosen by Tengler et al. (2022), who implement storytelling with robots at elementary school level with the intention of bringing CS education into elementary school. They conclude that the combination of stories and robotics offers a suitable approach to CS in elementary school. Tzagkaraki et al. (2021) also emphasized in their literature review that floor robots have a positive effect on the learning process and also have an influence on the acquisition of basic CS skills and creativity. The use of floor robots that children can program on their own has therefore already proven to be positive in elementary school and may offer creative approaches to other learning topics that have not previously been the focus of research.

Based on this, a concept that was previously developed for a project in European kindergartens and which is intended to provide support for the development of creative processes (Dittert et al., 2021) was implemented in the project presented. While the original focus was on accompanying children on their way to free exploration, we now want to focus specifically on the creative processes of designing worlds, telling stories and algorithmizing. Following this idea, an approach for promoting and exploring the creativity of elementary school children was developed, in which the children learn the basics of programming and are given the opportunity to build on their creativity.

2.2. Theoretical Reflections on the Measurement of Creativity of Elementary School Children in Science Education

In order to make conclusions about children's creativity, a suitable test instrument is required. In line with current research discussions, this project began by considering how creativity can be operationalized (Holzapfel et al., 2022). The current discourse is quite clear: creativity appears to be a construct that is made up of divergent and convergent thinking and requires both equally (Brophy, 2006; Cropley, 2006; Garaigordobil, 2006; Runco, 2006). In other words, those who think creatively think innovatively and differently, but also in a solution-oriented and goal-oriented way (Sternberg & Lubart, 1998).

For the field of creativity research in science education, this is summed up by the definition of Bliersbach & Reiners (2017: p. 324):

> "Creativity describes the potential inherent in every human being to create something new and relevant for his or her environment with the help of various metacognitive strategies, breaking out of known structures and the recombination of knowledge, to create something new and relevant for their respective environment."

This definition is also easily transferable to technical education and thus to the presented study. All four sub-areas are addressed here: the *creative person*, the *creative process*, the *creative product* and the *creative environment* (Rhodes, 1961). These sub-areas all are relevant for teaching and thus also for learning basic algorithmic thinking skills. In this way, it is possible to focus on the creative person, teacher or student, the classroom (environment), the learning process or even the product that the learners develop. The study includes all of them, with a specific focus on the measurement of the creativity of the person in this article.

3. Research Questions

On the one hand, the current research shows that creative thinking can be operationalized as divergent and convergent thinking. On the other hand, it also appears that creative thinking can be helpful for basic algorithmic thinking skills.

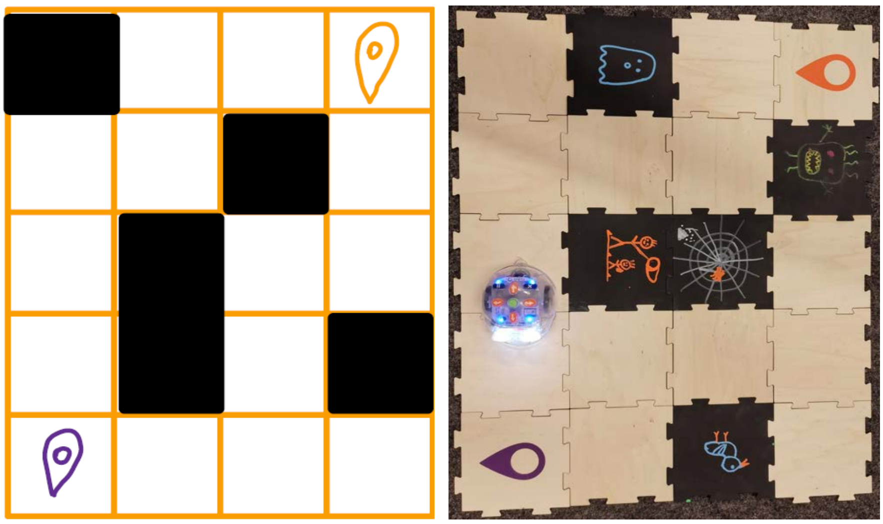
Therefore, in this study, a test instrument is examined that is intended to measure the two parts, divergent and convergent thinking, in relation to basic algorithmic skills. This leads to the following Research Questions:

RQ 1: How can creativity of elementary school students be measured with regard to the context of algorithmic thinking?

RQ 2: Is there a relation between creativity (i.e., divergent/convergent thinking) and algorithmic thinking, both with respect to learning gains and with respect to outcome scores?

4. Method

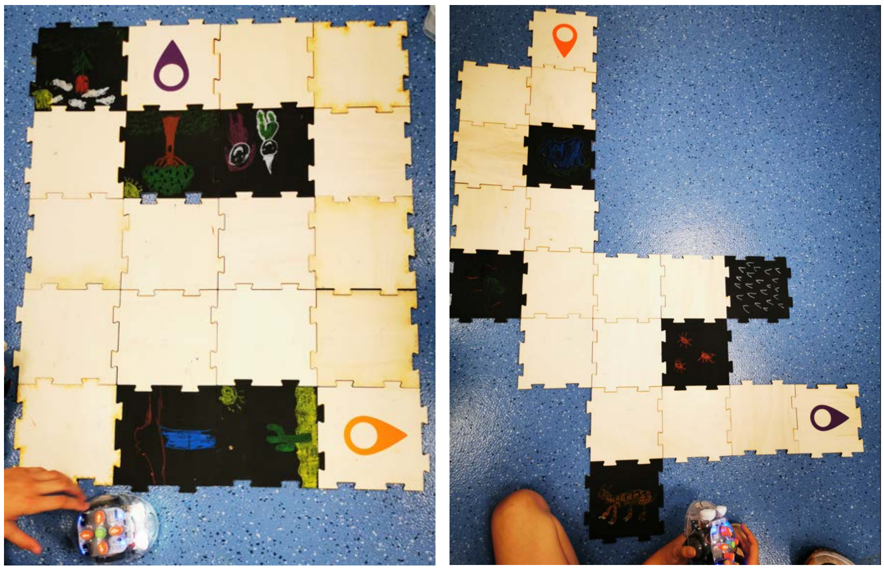
Data on algorithmic thinking, creative thinking, and a few demographic and control variables (age, gender, joy of learning, working with digital media, interest in technology) was collected by a paper-pencil-test as part of accompanying research of a pilot study for a larger-scale intervention study to promote algorithmic and creative thinking in elementary school children. In compliance with the theory and current research on creativity, the test for creative thinking was made up of scales for divergent thinking according to Torrance (1966) and a scale for convergent thinking according to Landmann et al. (2014). The test for algorithmic thinking was based on Zapata et al. (2021) and adapted to the present scenario.



(a) (b)

Figure 1. (a) Template for the task; (b) Example field designed by the tutors.

The intervention involves the children spending a morning in a teaching and learning laboratory at the University Oldenburg. First, there is a 45-minute pretest (algorithmic and creative thinking, age, gender, working with digital media, interest in technology). After a short break, the children spend almost 90 minutes learning basics of programming and how to use floor robots, with the *BlueBot* floor robot, which they program using the built-in buttons. The children design the field on which they control the *BlueBot* on their own in small groups beforehand. They are given the task of developing a short story on a topic of their choice with the field they have designed. For this purpose, they are given wooden puzzle tiles (see **Figure 1**): a start and a finish tile, 13 blank tiles for the *Blue Bot* to drive on, and five tiles sprayed with tabletop paint, which the children could design themselves to create the story (see **Figure 1(b)** and **Figure 2**). The initial tasks are: "Find out how the robot works! Program it so that it gets from the start to the finish without driving over the black tiles!" After exploring the basic functionality and fundamentals of programming the robot, children are asked to tell their own stories. The main task for the intervention is to "Think of a story that the robot experiences! Think about an environment for it and program the robot so that the story, the environment, and the robot fit together!" Finally, the children come together in a circle to talk about what they liked and what they didn't like before completing a 5-minute post-test (algorithmic thinking, joy of learning).



(a) (b)

Figure 2. Example fields designed by students (a) 4 × 5 design; (b) alternative field design.

4.1. Sample

A total of *N* = 16 fourth graders from the state of Lower Saxony in Germany were surveyed (Ø age ten; eight girls and eight boys, no binary/other). Participation was voluntary, and school authorities as well as all parents indicated their consent. The elementary school from which the children came is located in an urban area.

4.2. Test Instrument

The algorithmic thinking test is based on the *Beginners Computational Thinking* test (Zapata et al., 2021) and adapted to the present scenario. It consists of four single-choice items in which the children are asked to solve tasks relating to a robot on a coordinate field. They select the correct answer from four options. In addition, there is a task in which the children have to draw the robot's path to a given step sequence. This test is used slightly modified form pre and post, e.g. moving one step to the left instead of one step to the right.

The convergent thinking task was developed based on the *Compound Remote Associates Test* (*CRA*) according to Landmann et al. (2014). The participants are asked to complete word sequences. They are each given three words with a picture and asked to select and circle the matching picture from a box with eight. As a solution, three new compound words result from the three given words and the searched word. This test instrument was originally developed for young adults. In order to adapt it to the target group, simple series were selected from the long list of possible word series. In addition, the instrument was shortened and simplified in terms of language. Additionally, attention was paid to ensure that the word searched for is either always added at the front or always at the end. Also, each word is always presented with a picture, so that the reading skills of the children, which still vary in the fourth grade, should have less influence on the test result. The children are asked to complete a total of eight rows. Based on the *CRA*, they have one minute to complete each row.

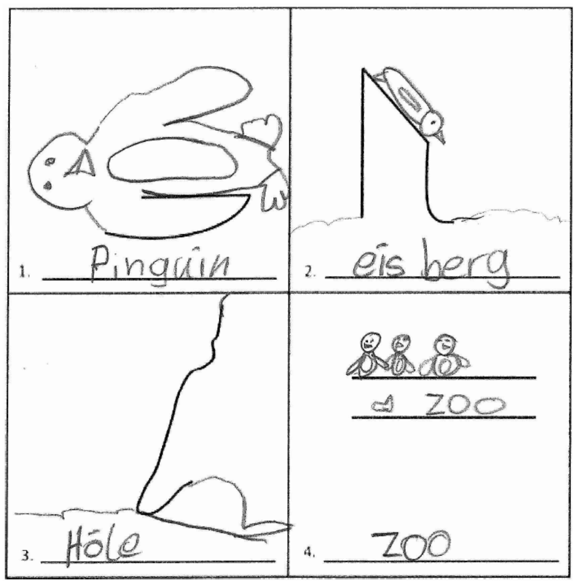


Figure 3. Example figural part 1: Picture story about a penguin (1), on an iceberg (2), in a cave (3), and in the zoo (4).

In accordance with the theory that creativity contains both a divergent and a convergent component, a test instrument was developed that takes both aspects into account. Three scales on divergent thinking were adapted from the *Torrance Test of Creative Thinking* (Torrance, 1966) and translated into German. There were two figural parts and one verbal part. In part one of the figural scale, participants are asked to complete four pictures according to their own imagination and, if possible, to label them (see **Figure 3**). In order to reduce the cognitive requirements for the children as much as possible, the instructions were also shortened and adapted to the target group in terms of language. In addition, the children are offered fewer circles (figural two) and lines (verbal) to complete so that there is not too much pressure to fill in more. In figural part two, the children are given 18 circles to draw as they wish (see **Figure 4**). In the verbal part, the children are requested to write down as many ideas as possible for using a tin can to a maximum of 50 lines (e.g., as a pencil box). In all parts they are asked to try to think of things that no one else will think of. The children have four minutes for the figural part one, six minutes for the figural part two and six minutes for the verbal part.

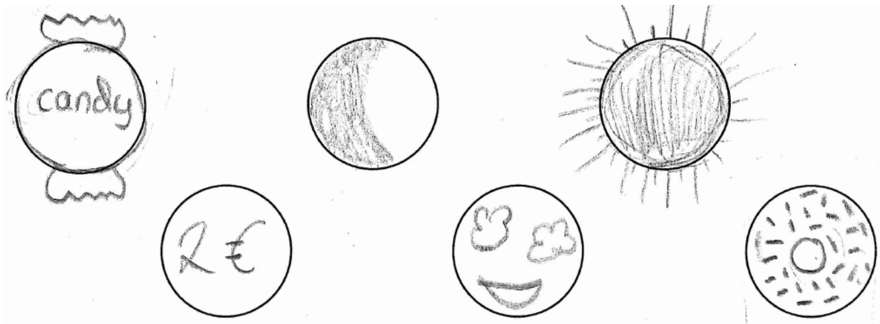


Figure 4. Excerpt (6 of 18 circles) from a test booklet for the Figural Part 2.

4.3. Coding

Coding of algorithmic thinking. With respect to the assessment of algorithmic thinking in pre- and post-test, correct solution steps were coded with one point, incorrect solution steps with zero points (no partial credit). The total number of correctly solved solution steps across all items was calculated, and the sum scores thus indicate the individual level of algorithmic thinking before and after the intervention, respectively (maximum score: 6, Cronbach's $a = 0.612$).

Coding of convergent thinking. With regards to the assessment of convergent thinking, each correctly solved item was coded with one point (maximum score: 8, Cronbach's $a = 0.856$). The sum score of correctly answered items across all 8 items was determined and z-standardized, indicating the individual level of convergent thinking. In order to be able to compare children with "high convergent thinking skills" and "low convergent thinking skills", a median split was performed, leading to a "high convergent thinking skills" group and a "low convergent thinking skills" group of (roughly) equal sample size.

Coding of divergent thinking. In relation to the three subscales addressing divergent thinking as described above, the following coding procedure was realized:

Transferring pictures into verbal descriptions. When coding the pictorial ideas of the participants (figural part one and two), the coders were advised to enter the most specific verbal phrase into the data set. Thus, for example, if a participant drew a "football", the coders entered "football" into the data set, and not just "ball". While, compared to a procedure where generic terms are coded, like for example "ball" for any type of ball, this procedure necessarily leads to a lower consensus between coders. Still, it ensures the most specific coding of ideas which is necessary for being able to code flexibility and originality in a straightforward way. In cases where the two raters used different verbal expressions but meant exactly the same thing (e.g., "letter D" vs. "D", or "high heels" vs. "stiletto heels"), the coders were advised to change one of their original codings in order to reach an agreement. In cases of disagreement between coders with respect to the meaning of the drawings, the issue was solved via discussion, and a final agreement was coded. In addition, the coders were advised to try to stick to the same verbal description throughout the whole coding process (e.g., coding "stiletto heels" for all drawings depicting high heels, stiletto heels, or pumps). With respect to the verbal ideas of the participants, the issue of the meaning of drawings did not appear, as the participants wrote down their answers verbally. Thus, in case of the third creative task, no measures to ensure inter-rater agreement needed to be taken.

4.4. Determining "Fluency"

According to Torrance (1966), fluency refers to the number of ideas generated by a person. As the three divergent thinking tasks used in the present study pose very different ways and opportunities to come to different solutions, fluency scores were determined for each part separately, by determining the number of ideas generated by a person (e.g., "3" for figural task one). For each part, these scores were z-standardized, and a combined fluency score (across all divergent thinking parts) was obtained via adding up and again z-standardizing the z-scores of the three creative tasks.

4.5. Determining "Flexibility"

Following Torrance (1966), flexibility refers to the number of different ideas generated by a person. Thus, for each divergent thinking task, it was counted how many different ideas were mentioned (again, separately for the three tasks). In this respect, as always, the most specific interpretation was coded, a person mentioning a "football" and a "volleyball" was coded having two different ideas, while a person drawing a "ball" two times was coded as mentioning one idea. For this purpose, duplicates were removed and the remaining number of entries was counted. Again, the scores for the three tasks were z-standardized and added up to obtain a combined flexibility score, which, ultimately, was also z-standardized.

4.6. Determining "Originality"

According to Torrance (1966), originality is a measure reflecting the rarity of an idea in the total sample. Thus, for each code in the data set it was determined how many other persons had obtained the same code at least once (for figural part one: separately for the four figures; for figural part two: across all circles; for verbal part: across all lines). In the data set, it was first entered how often an idea occurred in total (i.e., one means that only one person mentioned this idea, while a large number means that many others had the same idea); missing answers were not taken into account. At this stage, a high value indicates low originality and vice versa. In consequence, for each idea, the reciprocal value was calculated by dividing one by the total number of mentions of that idea. Following this procedure ensures that high values represent high originality. Again, separately, these three scores were z-standardized and added up and again z-standardized to obtain a combined originality score.

4.7. Total Divergent Thinking Score

After computing the three separate divergent thinking scores, namely *fluency*, *flexibility*, and *originality*, a combined total divergent thinking score was computed by adding up the three z-standardized single scores; the result was again z-standardized. In order to be able to compare children with low or with high divergent thinking, a median split was performed, leading to a "high divergent thinking skills" sub-sample and a "low divergent thinking skills" sub-sample of (roughly) equal sample size.

4.8. Formation of Sub-Groups

Using the results of the total convergent and divergent thinking scores, four different groups can be distinguished, namely 1) Low level of convergent and low level of divergent thinking skills ($n = 2$); 2) Low level of convergent and high level of divergent thinking skills ($n = 4$); 3) High level of convergent and low level of divergent thinking skills ($n = 6$); 4) High level of convergent and high level of divergent thinking skills ($n = 4$), respectively. Following the theory outlined above, the fourth group is called "creative".

5. Results

With respect to the coding of the figural items, a high interrater reliability was achieved: For the first figural part (four items), two independent raters coded 89.5% of the drawings with the same meanings. With respect to the second figural part (18 items), both raters coded the same meaning for 82.8% of the drawings. Disagreements were resolved via discussion.

With respect to the divergent, convergent, and algorithmic thinking scores, descriptive results and correlations are shown in **Table 1**. Except for the correlation between algorithmic thinking before and after the intervention, no significant correlations between creativity and algorithmic thinking scores were obtained; however, the small sample size should be considered when interpreting these results.

A comparison between the algorithmic thinking scores before and after the intervention revealed a significant learning gain, $t(15) = -2.70$, $p = 0.016$, Cohen's $d = -0.675$, indicating that the intervention successfully fostered the acquisition of basic algorithmic thinking skills.

As outlined above, the convergent and divergent thinking scores were categorized via median split as low or high, and accordingly, four groups were distinguished.

Table 2 shows descriptive results separately for these four groups, respectively.

Table 1. Descriptive results and correlations with respect to creativity and algorithmic thinking scores.

	M (*SD*)	2	3	4	5
1) Convergent thinking	0.00 (1.00)	−0.18 (0.498)	−0.10 (0.71)	−0.19 (0.491)	−0.16 (0.558)
2) Divergent thinking	0.00 (1.00)		−0.16 (0.545)	−0.01 (0.986)	0.11 (0.692)
3) Algorithmic thinking (pre-test)	0.56 (0.96)			0.59 (0.017)	0.03 (0.918)
4) Algorithmic thinking (post-test)	1.50 (1.71)				0.83 (<0.001)
5) Algorithmic thinking (learning gain)	0.94 (1.39)				

Table 2. Means (and standard deviations) of creative and algorithmic thinking scores.

	Convergent thinking	Divergent thinking	Algorithmic thinking (pre-test)	Algorithmic thinking (post-test)	Algorithmic thinking (learning gain)
Low level of convergent and low level of divergent thinking skills (*n* = 2)	−1.90 (0.88)	−0.05 (0.35)	1.50 (0.71)	2.00 (1.41)	0.50 (0.71)
Low level of convergent and high level of divergent thinking skills (*n* = 4)	−0.65 (0.54)	0.76 (0.76)	0.00 (0.00)	1.50 (1.91)	1.50 (1.91)
High level of convergent and low level of divergent thinking skills (*n* = 6)	0.74 (0.17)	−0.88 (0.93)	1.00 (1.27)	1.83 (2.04)	0.83 (1.33)
High level of convergent and high level of divergent thinking skills (*n* = 4)	0.49 (0.21)	0.58 (0.45)	0.00 (0.00)	0.75 (1.50)	0.75 (1.50)

Comparing participants with low versus with high divergent thinking skills revealed substantial (albeit statistically not significant) differences with respect to their algorithmic thinking learning gain ($M = 0.75$, $SD = 1.16$ versus $M = 1.13$, $SD = 1.64$, respectively; $F(1, 14) = 0.278$, $p = 0.607$, $\eta_p^2 = 0.019$), indicating that students with higher levels of divergent thinking skills outperformed those with low levels with respect to their learning gains in the intervention phase. On the contrary, however, comparing participants with low versus with high convergent thinking skills revealed contrary (statistically not significant) results with respect to their algorithmic thinking learning gain ($M = 1.17$, $SD = 1.60$, versus $M = 0.80$, $SD = 1.32$, respectively; $F(1, 14) = 0.504$, $p = 0.626$, $\eta_p^2 = 0.017$), indicating that lower levels of convergent thinking skills were associated with higher learning gains in the intervention phase.

With respect to gender, the girls showed significantly higher levels of convergent thinking skills compared to the boys (girls: $M = 0.55$, $SD = 0.44$, boys: $M = -0.55$, $SD = 1.13$, $F(1, 14) = 6.499$, $p = 0.023$, $\eta_p^2 = 0.317$). Concerning divergent thinking, the girls achieved descriptively higher scores compared to the boys; however, this effect did not reach the level of significance (girls: $M = 0.23$, $SD = 0.96$, boys: $M = -0.23$, $SD = 1.05$, $F(1, 14) = 0.870$, $p = 0.367$, $\eta_p^2 = 0.058$).

While the girls showed descriptively higher pretest scores in algorithmic thinking ($M = 0.75$, $SD = 1.17$) compared to the boys ($M = 0.38$, $SD = 0.74$; effect not significant, $F(1, 14) = 0.589$, $p = 0.456$, $\eta_p^2 = 0.040$), both groups achieved the same post-test scores ($M = 1.50$ for both groups, $SD = 2.07$ for the girls, $SD = 1.41$ for the boys, respectively); thus, learning gains were substantially and statistically significantly higher for the boys compared to the girls (girls: $M = 0.75$, $SD = 1.49$; boys; $M = 1.13$, $SD = 1.36$, respectively; $F(1, 14) = 6.499$, $p = 0.023$, $\eta_p^2 = 0.317$).

6. Discussion

With regard to the **first research question**, it can be stated that it is possible to operationalize children's creativity on the basis of convergent and divergent thinking. Following Torrance (1966) and Landmann et al. (2014), divergent and convergent thinking can be operationalized respectively. This study therefore provides an opportunity to classify sub-samples as potentially more creative and less creative. With this division into sub-samples, the influence of creativity, for example on algorithmic thinking, can be investigated in the future. Unfortunately, due to the small sample size, the statistical analyses presented here should be interpreted cautiously and need to be validated with a larger sample.

Regarding **research question two**, the present study shows that the students surveyed had only little prior knowledge in the area of algorithmic thinking, surprisingly the girls had higher prior knowledge compared to the boys. The overall very low level of prior knowledge shows once again how important it is to address this topic in elementary school. It is to note that the students had significant learning gains as a result of the intervention, with the boys showing a significantly higher learning gain than the girls. Overall, the mean values achieved show that there is still room for improvement with respect to algorithmic thinking learning outcomes. What is interesting is that the present data suggests that there are links between convergent and divergent thinking and learning gains with respect to algorithmic thinking. For example, a high level of divergent thinking performance appears to be beneficial for learning algorithmic skills, whereas a high level of convergent thinking appears to be a constraint. Accordingly, the highest learning gains were achieved by the group with a high level of divergent thinking and a low level of convergent thinking. The group that can be described as creative based on the literature (i.e., high scores in both convergent and divergent thinking), achieved a lower learning gain in comparison, which was less to be expected. However, based on the small sample size the results need to be interpreted cautiously and validation studies are needed.

7. Conclusion

The study presented suggests that there are links between children's creativity and their learning success in algorithmic thinking, and in particular shows a considerable benefit of divergent thinking skills. However, it raises the question for the upcoming larger study as to whether a high level of convergent thinking has an influence on the acquisition of basic algorithmic skills. Based on the present results it can be assumed that thinking differently can be advantageous, while at the same time, goal-oriented thinking could be a barrier. Future studies that are focused on relations between different forms of creativity and algorithmic skills are needed in order to shed light on connections between creativity and the acquisition of CS skills. As the study presented is based on a small and very specific sample, the results should be interpreted accordingly. A larger-scale study with children of different ages and from different regions is needed in order to verify the results. Moreover, this is a very short intervention, so it can be assumed that the learning effect will be correspondingly higher if the learning time is increased. In order to achieve those higher effects, an intervention lasting several days could be designed. In addition, the material could be adapted to include supportive learning instructions. With regard to cognitive requirements, it should be taken into account that these are very young children whose attention span is correspondingly short.

In completion, a qualitative study of the learning process should be carried out. For example, the interaction between the children or between the children and the technology when creating the story or programming could be recorded on video or through structured observation protocols.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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