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Validity of figural creativity model development based on robotic learning concept

Figures contain non-English texts!!
Data of all graphs must be provided.
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ABSTRACT

The teaching and learning process is not only related to student learning outcomes but must also be able to stimulate student skills such as creativity skills, problem-solving skills, collaboration skills, communication skills, etc. Creativity skill is one of the skills students need to have in facing the era of the industrial revolution 4.0, so applying the right learning model is very important in achieving the expected learning goals. The purpose of this study is to test the validity of the learning model based on the concept of robotics technology, where the learning model is designed to stimulate students' figural creativity skills. At present there are several learning models that have been validated and are able to improve the ability to think creatively. However, in this study, the validity testing of this robotics-based learning model was carried out even further, to the building blocks of figural creativity skill. The validity aspects of the figural creativity model based on robot learning were investigated on the 4 elements of figural creativity namely: Fluency, flexibility, originality, elaboration, and validity, and were assessed by 2 psychologists and 2 education experts. The results showed that the concept of robotic learning was able to fulfill the valid criteria. Based on the validator's evaluation, the cleavage model fulfilled the content validity with an Aiken's V value>0.92. Learning process by applying figural creativity development models based on robotic learning concepts can improve students' figural creativity skills in all the building blocks of figural creativity.

1. Introduction

The study regarding the model of learning has become an important aspect of the learning process. In the sphere of education, model or method of learning is one of the influential factors in the learning process. Learning success depends heavily on the ability of teachers' learning process. The achievement of learning success is greatly influenced by the teachers' applied learning models. A learning model is a step by step procedure that leads to specific learning outcomes (Eliza et al., 2019). Thus, the learning model plays an important role, because it will direct the learning process to achieving the learning objectives. One of the goals of implementing the learning process is to let students get experiences that can be used to construct their own knowledge, skills and abilities. But, some of the learning models focus only on the development of knowledge, while the development of skills receives less attention. Thus, one of the important skills students need to have is a figural creativity. Figural creativity is the ability of students to create something new (Gunawan et al., 2018). Therefore, the learning model that can develop figural creativity of students is very important.

Some studies have shown that a learning model can stimulate creativity. Problem-based learning (PBL) online effectively improves both the creativity and critical thinking of physics students (Sulaiman, 2013; Khoiriyah and Husamah, 2018). Problem-based learning with spiral model positively influenced learning outcomes along with learners' higher-order thinking skills, such as creative thinking and problem-solving of junior high school students (Khoiriyah and Husamah, 2018).

Although, few studies have been carried out on how learning model can stimulate creativity, however, there is a limitation in the availability of literature on the development of learning models based on artificial intelligence technology such as

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robotics. The new education strategy also needs freedom in learning and teaching, coupled with an active mode of learning influences on innovative personality development, which creates something unique and turns it into an entrepreneurial activity (Radovic-markovic, 2012). The purpose of this study was to determine the aspects of the validity of figural creativity models based on the concept of robotics learning in elementary school students. Validity is an attempt to evaluate the usefulness and feasibility of learning models based on robotics concepts to improve the figural creativity of students.

2. Materials and methods

This section gives vivid explanations about the participants, instrument and data analysis technique.

2.1. Participant

Our respondents were from a private Elementary School in Padang, Indonesia. Total sample in this research were 23 students, ages ranging from 10 to 11 years old.

2.2. Instrument

2.2.1. Figural creativity instrument

Figural creativity of the students was measured using the Figural Creativity Test (Hendrik et al., 2018; 2020; Gunawan et al., 2018). Regarding the measurement of creativity, the most widely used test is the figural creativity test developed by Torrance known as Torrance Tests of Creative Thinking (TTCT) (Ayob et al., 2012; Rababah et al., 2013), TTCT in the form of tests which involves completing a picture (i.e., drawing completions test), referred to as the Wartegg test (Hendrik et al., 2019).

2.2.2. Validity test instrument

Quantitative data for the validity of the robotics-based learning model was obtained from the results of the expertise assessment sheet by experts. The validity aspects of the figural creativity model based on robot learning were investigated in the 4 elements of figural creativity namely: Fluency, flexibility, originality, and elaboration. The validity was assessed by 2 psychologists and 2 education experts. In this study, the content validity coefficient is Aiken's V.

2.3. Procedure

2.3.1. Figural creativity model development based on robotic learning concept

This study is a research and development based study which refers to the Model Plomp (Plomp and Nieveen, 2010). Plomp models are considered more flexible, because at every phase, activity can be tailored to the characteristics of the research (ArianatasariI and Hakim, 2018). This study consisted of three stages, namely the preliminary stage, prototyping stage and the assessment stage.

2.3.2. Data analysis technique for validity test

Content validity was estimated through testing the validity of the appropriateness or relevance of the content of the test via rational analysis by experts. The validity of the content ensured that measurements incorporate an adequate set of items and representations that reveals the concept. The more increase in the item scale reflecting the region or the concept being measured, the greater the content validity (Hendryadi, 2017). The validity content is the illustration of need and newness (Pandiangan et al., 2017). In this study of figural creativity, the validity c[Provide reference]nt model is based on robotic learning concept using the Content validity coefficient, the Aiken's V.

Aiken (1985) formulated Aiken's V formula to calculate content-validity coefficient, based on the results of the assessment of an expert panel of n people against an item in terms of the extent to which these items represent the construct being measured (Hendryadi, 2017). Aiken Formula:

$$v = \sum \frac{s}{[n(c-1)]} \quad (1)$$

3. Results and discussion

3.1. Preliminary stage

The preliminary stages involved testing the level of the figural creativity of students by conducting a figural creativity test (pre-test) using the instrument TKF (Hendrik et al., 2018; 2020; Gunawan et al., 2018).

Based on the pre-test data from 23 students as a sample, 26.1% had low average figural creativity, 65.2% had average figural creativity, while 8.7% had high average figural creativity.

Results of the data analysis indicates that only 8.7% of students had a high average figural creativity, thus the application of high technology such as robotics in learning models is needed to improve the figural creativity in elementary school students (Fig. 1).

3.2. Prototyping stage

3.2.1. First prototype syntax

The learning model with the aim to increase students' figural creativity was designed with the syntax as shown in Table 1.

In the first prototype syntax, robotics technologies used included various types of robots, such as the use of a robot arm, mobile robot, Lego Mind storms, quad copter and humanoid robot to stimulate all the variable's figural creativity (fluency, flexibility, elaboration, originality) (Masril et al., 2019).

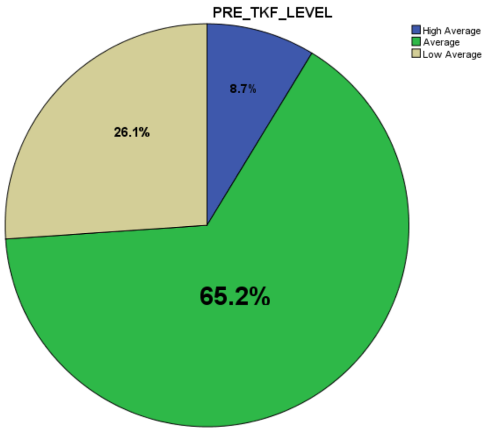


Fig. 1: Figural creativity (pre-test) result

Table 1: First prototype syntax of figural creativity model based on robotic

No	Syntax
1	Phase 1: Introduction (Presenting, understanding robotic technology)
2	Phase 2: Preparation (Organize students according to individuals or groups)
3	Phase 3: Project Robot (Create a new robot, making solution with robot)
4	Phase 4: Competition (Some exercise on robotic technology that were given to the students were intended to produce works that can be able to create competition)
5	Phase 5: Evaluation (evaluating the learning process and outcomes)

3.2.2. Revision

Based on the experts' advice, the syntax of figural creativity prototype based on robotic models were classified by four variables of figural creativity and were thus split into four second prototype syntaxes.

3.2.3. Second prototype syntax

Second prototype syntax figural creativity based on robotic models were divided into 4 syntax and were based on the objective to stimulate the creativity of each variable figural fluency, flexibility, elaboration, originality. To stimulate fluency abilities, a humanoid robot type was used, which is the second prototype of the syntax of the physical creativity model based on robotic, as shown in Table 2.

Table 2: Prototype syntax of figural creativity model based on robotic to stimulate fluency

No	Syntax
1	Phase 1: Introduction (Presenting, understanding fluency activities)
2	Phase 2: Preparation (Organize students according to individuals or groups)
3	Phase 3: Imagination (the students were asked how to design and create a robot from the imagined object)
4	Phase 4: Discussion (the teacher provided several explanations hinged to opportunities for discussion)
5	Phase 5: Competition (Some exercise on robotic technology that were given to the students were intended to produce works that can be able to create competition)
6	Phase 6: Evaluation (evaluating the learning process and outcomes)

To stimulate the flexibility ability, the robot arm was used, which is the second prototype of the figural creativity model syntax based on robotics (Table 3).

Table 3: Prototype syntax of figural creativity model based on robotic to stimulate flexibility

No	Syntax
1	Phase 1: Introduction (Presenting, understanding flexibility activities)
2	Phase 2: Preparation (Organize students according to individuals or groups)
3	Phase 3: Modification (students were asked to make modifications to the robot provided by the teacher)
4	Phase 4: Negation (The students are supposed to negate and make new ideas about an object)
5	Phase 5: Evaluation (evaluating the learning process and outcomes)

To stimulate elaboration ability, mobile robots and Lego Mind storms robots were used, which is the second prototype syntax of the figural creativity models based on robotics (Table 4).

Table 4: Prototype syntax of figural creativity model based on robotic to stimulate elaboration

No	Syntax
1	Phase 1: Introduction (Presenting, understanding elaboration activities)
2	Phase 2: Preparation (Organize students according to individuals or groups)
3	Phase 3: Making Stories (Present in front of the teacher and other students about their robot design)
4	Phase 4: Concretizing (Describe detail idea of robots)
5	Phase 5: Evaluation (evaluating the learning process and outcomes)

To stimulate the originality ability, the Lego Mind storms robot was used, which is the second prototype of the figural creativity model syntax based on robotics (Table 5).

Table 5: Prototype syntax of figural creativity model based on robotic to stimulate originality

No	Syntax
1	Phase 1: Introduction (Presenting, understanding originality activities)
2	Phase 2: Preparation (Organize students according to individuals or groups)
3	Phase 3: New Creation (Design a robot that has never existed or differ from the design of other students)
4	Phase 4: Different Answer (Design a robot that can solve the problem, and students were expected to have different answers from that of other students)
5	Phase 5: Evaluation (evaluating the learning process and outcomes)

3.3. Assessment stage

Expert were asked to assess if the learning activities were designed in a robotics-based learning model, and if they were able to meet the objectives in every element figural creativity. After designing the activities and objectives of the activity described clearly, there was a further validity by experts. Data were analysed by using the results of the validity coefficient Aiken's V. To obtain the content validity, it is necessary to conduct a rational analysis of experts in the field-those who developed the instruments, or obtain professional judgment by using a formula Aiken (Yamtinah et al., 2016).

Aiken's V validity analysis techniques, "Aiken's V formula is used to calculate the Content Validity Coefficient based on the assessment of an expert panel of n people on the item regarding the extent to which these items represent the construct being measured" (Hendryadi, 2017). In the robotics class that was designed, there was a request for the ratings of 4 experts, where two people were experts in the field of education and the other two were experts in the field of psychology. Furthermore, the average score was sought with the following steps:

a. Scoring answer with a number between 1 (not verily represented or totally irrelevant) until number 5 (verily represented or very relevant) on any question.
b. Summing the scores of each validator for all indicators, the validity of the robotic class design to improve the ability of figural creativity in 4 elements (fluency, flexibility, elaboration, originality).
c. Validity percentage was calculated with the formula (1)

The average expert score of figural creativity model in all variable (Table 6).

Table 6: Expert assessment element of figural creativity model

All variable of figural creativity	Average rating score	Validity Aiken's V
Fluency	0.92	Valid
Flexibility	0.91	Valid
Originality	0.91	Valid
Elaboration	0.93	Valid

The validity value of Aiken's V of fluency=0.92; the validity value of Aiken's V of flexibility=0.91; the validity value of Aiken's V of originality=0.91; the validity value of Aiken's V of elaboration=0.93; hence, the Aiken's V validity coefficient for all element variables is 0.92.

Based on the test results of the expert judgment, Aiken's validity coefficient V of the items assessed is 0.92, meaning that the value is in the range of 0.60 up to 1.0, asserting it to be very valid. Thus, the validity coefficients of these experts can qualify as a valid instrument and can be used in this study.

Based on the syntax of figural creativity based on robotic models, robotics-based learning interventions were conducted on extracurricular activities of elementary school students. After the intervention process was completed, phases of post-tests were conducted to find out the figural creativity of students.

4. Descriptive statistic of figural creativity

To determine the effect of figural creativity learning models based on robotics against the figural creativity of students, a figural creativity test (post-test) was carried out using TKF.

Based on data from the post-test of 23 students, 21.7% had figural creativity Average level; 21.7% had figural creativity High Average level; 26.1% had figural creativity Superior level; while 30.4% had very superior figural creativity level.

From the results of the pre-test and post-test data analysis, it can be stated that in the post-test results there were no students who had low average figural creativity level, however there were students with superior and very superior figural creativity after the intervention and hence the application of high technology such as robotics in learning models can improve figural creativity in elementary school students (Fig. 2).

The next stage was the comparison of the pre-test and post-test students on each variable's figural creativity. Comparison of the pre-test to post-test on the variable fluency of the whole sample can be seen in Fig. 3. The first line shows the results of the post-test, the second line shows the results of the pre-test, and the third line shows the differences or the increase of variable fluency in the post-test result.

With reference to Table 7, the descriptive statistic of variable fluency in the pre-test result is min value=5, max value=14, mean value=9.52, while the post-test result is min value=8, max value=20, mean value=13.74. The mean value of the pre-test to post-test variable fluency increased by 44.32%.

Table 7: Descriptive statistics of fluency

	N	Min	Max	Mean	Std. Deviation
Pre_Flue	23	5	14	9.52	2.644
Post_Flue	23	8	20	13.74	3.506

Comparison of the pre-test to post-test as regarding the variable flexibility of the whole sample can be seen in Fig. 4. The first line shows the results of the post-test, the second line shows the results of the pre-test, and the third line shows the differences or the increase of variable flexibility in the post-tests result.

With reference to Table 8, the descriptive statistic of variable flexibility in the pre-test result is min value=5, max value=14, mean value=10.17, while the post-test result is min value=9, max value=19, mean value=13.78. The mean pre-test to the post-test variable flexibility increased by 35.49%.

Table 8: Descriptive statistics of flexibility

	N	Min	Max	Mean	Std. Deviation
Pre_Flex	23	5	14	10.17	3.099
Post_Flex	23	9	19	13.78	2.999

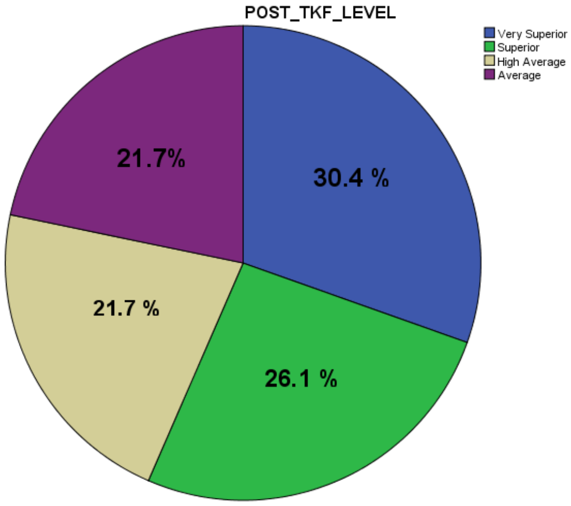


Fig. 2: Figural creativity test (post-test) result

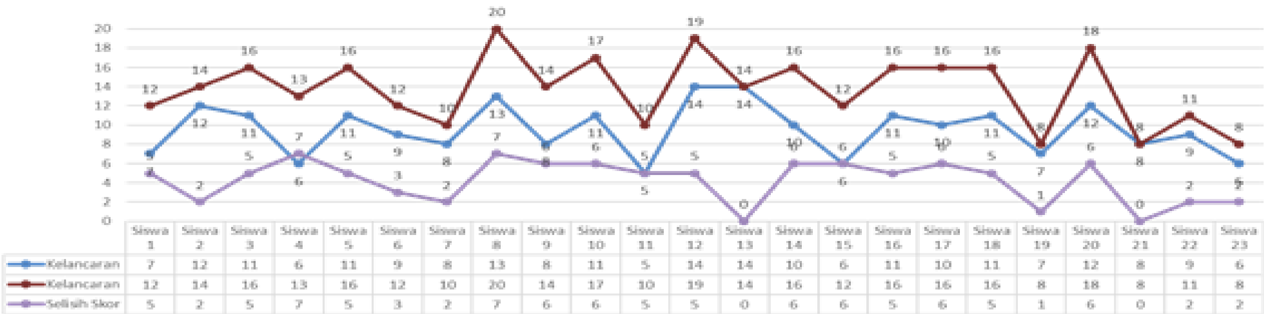


Fig. 3: Comparison of the pre-test to post-test on variable fluency

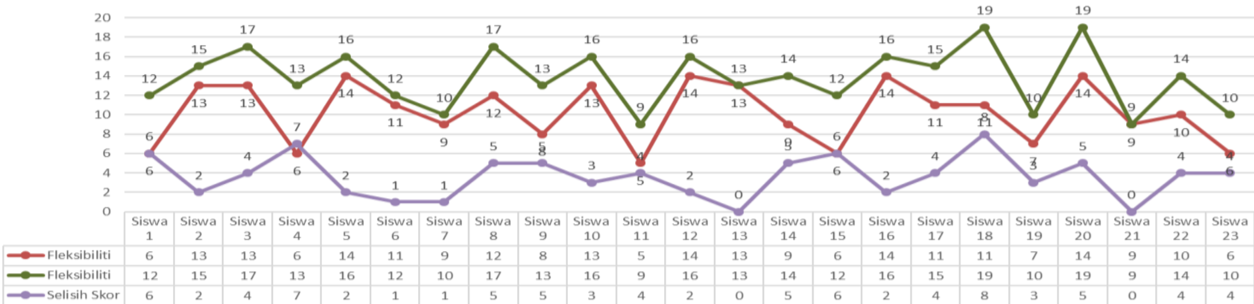


Fig. 4: Comparison of the pre-test to post-test on variable flexibility

Comparison of the pre-test to post-test on the variable originality of the whole sample can be seen in Fig. 5. The first line shows the results of the post-tests, the second line shows the results of the pre-test, and the third line shows the differences or the increase of variable originality in the post-tests result.

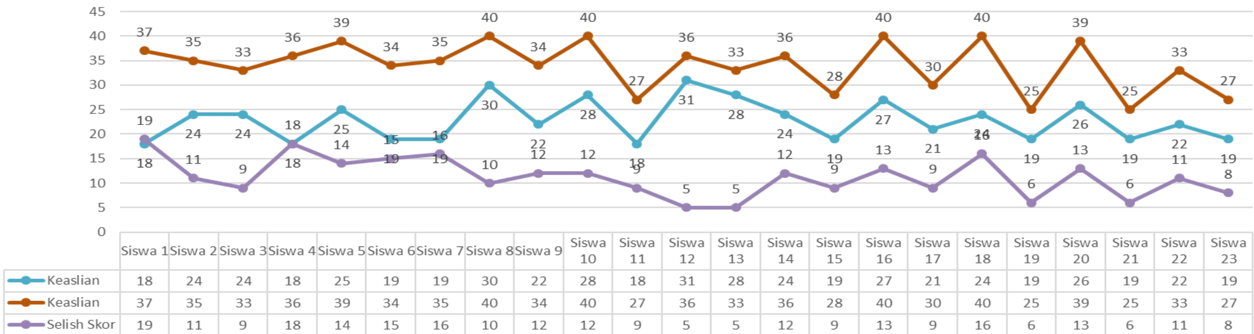


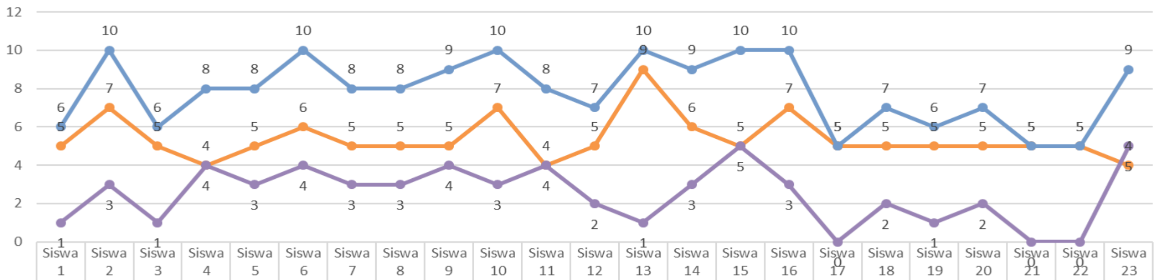
Fig. 5: Comparison of the pre-test to post-test on variable originality

With reference to Table 9, the descriptive statistics of the originality variable in the pre-test result is min value=18, max value=31, mean value=22.78, while the post-test result is min value=25, max value=40, mean value=34.00. The mean pre-test to the post-test of the variable originality increased by 49.25%.

Table 9. Descriptive statistics of originality

	N	Min	Max	Mean	Std. Deviation
Pre_Ori	23	18	31	22.78	4.112
Post_Ori	23	25	40	34.00	4.918

Comparison of the pre-test to post-test on the variable elaboration of the whole sample can be seen in Fig. 6. The first line shows the results of the post-tests, the second line shows the results of the pre-test, and the third line shows the differences or the increase of the variable elaboration in the post-tests result.



	Siswa 1	Siswa 2	Siswa 3	Siswa 4	Siswa 5	Siswa 6	Siswa 7	Siswa 8	Siswa 9	Siswa 10	Siswa 11	Siswa 12	Siswa 13	Siswa 14	Siswa 15	Siswa 16	Siswa 17	Siswa 18	Siswa 19	Siswa 20	Siswa 21	Siswa 22	Siswa 23
Penghuraian	5	7	5	4	5	6	5	5	5	7	4	5	9	6	5	7	5	5	5	5	5	5	4
Penghuraian	6	10	6	8	8	10	8	8	9	10	8	7	10	9	10	10	5	7	6	7	5	5	9
Selisih Skor	1	3	1	4	3	4	3	3	4	3	4	2	1	3	5	3	0	2	1	2	0	0	5

Fig. 6: Comparison of the pre-test to post-test on variable elaboration

With reference to Table 10, the descriptive statistics of the elaboration variable in the pre-test result is min value=4, max value=9, mean value=5.39, while the post-test result is min value=5, max value=10, mean value=7.87. The mean pre-test to the post-test variable elaboration increased by 46.01%.

Table 10. Descriptive statistics of elaboration

	N	Min	Max	Mean	Std. Deviation
Pre_Ela	23	4	9	5.39	1.158
Post_Ela	23	5	10	7.87	1.766

5. Discussion

The application of learning models to improve student skills is very important, of course before applying the learning model must be validated by experts. There are several developments of learning models to enhance creativity skills, such as the Collaborative Creativity (CC) Model that has been validated and can be stated that the CC learning model to teach skills of scientific creativity and scientific collaborative (Astutik et al., 2016). Mathematics Learning Model of Open Problem Solving to Develop Students' Creativity (PMT Model) was validated by 3 experts and it was stated that the PMT Model can develop student's creativity (Suastika, 2017). Another research, Creative exploration, Creative elaboration, Creative modeling, Practice scientific creativity, Discussion and Reflection (C3PDR) learning model is a valid model that specifically developed to improve the students' scientific creativity of Junior high school (Kirana et al., 2020). However, in this study, the learning model is designed to stimulate every variable that builds creativity, namely fluency, flexibility, originality, elaboration, and has been validated by experts on each variable, not just overall creativity skill.

Figural creativity development models based on robotic learning concepts have passed the content validity test by several experts and have been declared valid on all figural creativity variables. Furthermore, the application of this model in extracurricular activities has proven to be able to stimulate the improvement of all students' figural creativity variables, namely fluency, flexibility, elaboration, and originality.

The results of this study is in accordance with previous studies that the use of robotics as an educational tool on Extracurricular activities in the United Emirates Arab can stimulate creative thought and encourage critical thinking (Afari and Khine, 2017). Educational robotics are used as an extracurricular activity for the development of the 21st century skills such as collaboration, problem solving, creativity, critical thinking and computational thinking (Komis et al., 2017; Masril et al., 2019). Robotic extracurricular program stimulates the creative efforts of teacher and students (Yusuf et al., 2018). Robotic workshops are aimed at introducing gifted primary school students to computer programming and robotics, teach them some basic programming and mechanics skills, and develop their algorithmic thinking, problem solving and creativity (Jagust et al., 2018).

6. Data availability

The Descriptive Statistics data used to support this study are included in the bottom of each figure Comparison of the pre-test to post-test, and the Expert assessment element of figural creativity model data of xlsx files used to support the findings of this study is available from the corresponding author upon request.

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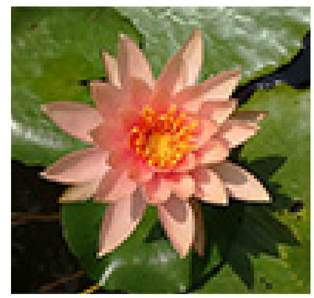

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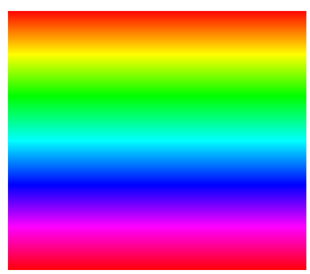

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