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Mathematical Creative Thinking Ability in REACT Learning Assisted by Dynamic Assessment in Terms of Student Learning Independence

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Abstract

Creative and critical thinking abilities and self-directed learning are critical components of mathematical education. This study aimed to ascertain students' capacity to think creatively and mathematically while learning the REACT paradigm through dynamic assessments. This study used a mixed-method approach in conjunction with a sequential explanatory design. The research population consists of students in the seventh grade at SMP Negeri 8 Semarang. The instruments employed are assessments of mathematical creativity, surveys on learning independence, and interview procedures. The findings indicated that (1) students' mathematical creative thinking abilities improved significantly when REACT learning was supported by dynamic assessments; (2) the average mathematical creative thinking ability of students in REACT learning enabled by dynamic assessments is superior to that of students in REACT learning; (3) there is a positive correlation between learning independence and mathematical creative thinking ability; and (4) the description of mathematical creative thinking ability is accurate. Students who demonstrate high learning independence perform admirably on all mathematical creative thinking abilities indicators. Students who have a moderate level of learning independence perform pretty well on the indicators of mathematical creativity. Students with a low level of learning independence demonstrate only one of the three indicators of mathematical creativity.

1. Introduction

Mathematical creative thinking is the capacity to generate new ideas or methods of producing products or resolving problems. Creative thinking ability is the highest level of a person's thinking ability. (Krulik & Rudnick in Siswono, 2007). Mathematical creative thinking ability is a critical mathematical ability that students studying mathematics must master and develop (Hendriana et al., 2017).

The underlying concept that the ability to think creatively and mathematically is critical for mathematics learning is contained in the Law of the Republic of Indonesia Number 20 of 2003 on the National Education System, which states that one of the functions of national education is to develop students into creative human beings. Additionally, Minister of Education and Culture of the Republic of Indonesia Law No. 36 of 2018 states that one of the 2013 curriculum's objectives is to prepare Indonesians to be creative individuals.

Although the ability to think mathematically creatively is critical and is included in educational functions and objectives, the capacity for mathematical creativity remains limited. The Organization demonstrates this for Economic Cooperation and Development's (OECD) results through the Program for International Student Assessment (PISA), which placed Indonesia 74th out of 79 countries with an average score of 379. This fact was also confirmed during an interview with one of the teachers at SMP Negeri 8

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Semarang, who stated that students were so focused on the examples and problem solving provided by the teacher. So that the students became confused when confronted with varied questions.

Affective components of creative thinking include sensitivity to a problem and an ability to see opportunities, accept uncertainty, an open mind, courage to take risks, confidence, control emotions, a high level of curiosity, and an ongoing desire to learn (Hendriana et al., 2017). From an affective standpoint, it is consistent with indicators of independence development, specifical independence from others, self-confidence, discipline, responsibility, acting on their initiative, and the ability to exercise self-control (Nurzaman in Hendirana et al., 2017). Thus, independent learning enables students to develop their mathematical creative thinking abilities. Additionally, the initial capital in creative mathematical thinking is the students' active participation in the learning process.

Learning the REACT model is one alternative designed to engage students' active participation during the learning process. REACT is a model of contextual learning (Purnamasari et al., 2016) The Center for Occupational Research and Development (CORD) introduced a five-step process that consists of relating, experiencing, applying, cooperating, and transferring. According to Crawford (2001), the purpose of the Relating process is for students to connect concepts to their prior knowledge to generate valuable ideas for developing students' fundamental skills. Experiential learning, in which students can explore and discover on their own; Applying, that is, students are expected to be able to apply what they have learned in their daily lives; Cooperating, in which students work in groups to exchange ideas about a problem, until the Transferring stage, in which students with pre-existing knowledge and abilities can solve the problems they face.

Prior to engaging in classroom learning activities, a learning plan with specific learning objectives is required. Learning planning entails determining how the learning process can most effectively accomplish learning objectives. A learning assessment is required to determine whether learning activities are aligned with the objectives, whether students can master the material presented, and whether the learning process is carried out effectively and efficiently. Assessment of learning is obtaining data in various forms that can be used to judge students (Poerwanti, 2015).

The issue with assessment arises when it is viewed as an instrument that causes anxiety in students. It is as if the student's future is contingent upon the outcome of the Assessment or Assessment. Numerous countries, including Indonesia, require students to pass national exams. A national exam that requires students to achieve specific standards to pass is inconsistent with the assessment's objectives. Because the primary goal of assessment is to assist students in mastering relevant knowledge, it is preferable to focus on student learning processes rather than outcomes. Dynamic assessment developed as an assessment process centered on student skill development. Vygotsky coined the term "dynamic assessment" because he believed that the initial stages of understanding occur through interactions with other people. Dynamic assessment is guided by ZPD, which serves as the approach's focal point. Through interaction between students and mediators, dynamic assessment aims to optimize the process of student development (Khaghaninejad, 2015).

According to the explanation above, researchers are interested in researching mathematical creative thinking skills associated with learning the REACT model using dynamic assessment to increase student learning independence. The following questions are posed in this research: (1) Is students' mathematical creative thinking ability improves when learning the REACT model assisted by dynamic assessments? (2) Is students in REACT learning assisted by dynamic assessments have a higher average mathematical creative thinking ability than students in REACT learning? (3) Does learning independence affect students' mathematical creative thinking abilities? Moreover, (4) How does the REACT model learning assisted by dynamic assessment describe students' mathematical creative thinking abilities regarding student learning independence?.

2. Methods

This study employed a mixed-methods approach with a sequential explanatory design. Mixed methods research employs a combination or integration of quantitative and qualitative techniques. The sequential explanatory design method is defined as collecting and analyzing quantitative data in the first stage, followed by collecting and analyzing qualitative data in the second stage to improve the quantitative research results in the first stage (Lestari & Yudhanegara, 2015).

SMP Negeri 8 Semarang is located at Jl. Cinde Raya No. 18, Jomblang, Candisari District, Semarang City, Central Java. This research was conducted during the odd semester of the academic year 2021/2022, specifically November – December 2021. The population for this study was comprised of all seventh-grade students at SMP Negeri 8 Semarang during the academic year 2021/2022. At the same time, class VII B was used as the experimental class and class VII E as the control class in this study. Cluster random sampling was used in this study. The following chart illustrates the steps involved in the sequential explanatory design.

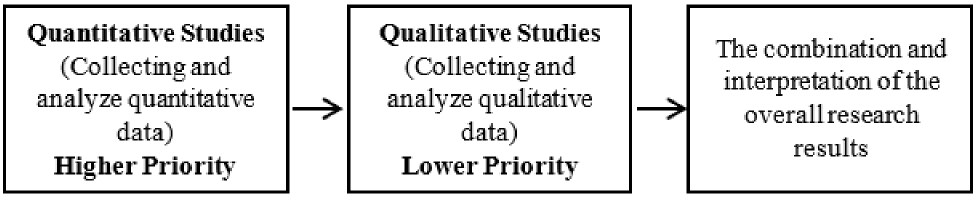

Figure 1. Sequential Explanatory Design

This study used two data collection techniques: test and non-test techniques. The test technique is a mathematical creative thinking ability test. The non-test technique is a questionnaire, interview guide, observation, and documentation of learning independence. Prior to and during the research, observations and documentation were made. The interview was conducted following the creative thinking ability test and completion of the questionnaire on student learning independence.

The Nonequivalent Pretest-Posttest Control Group Design was used in this quantitative study. The samples for both the experimental and control groups were not chosen at random in this design. Both groups took a preliminary test of their mathematical creative thinking ability (O) before the research to ascertain their initial state. The experimental group received treatment (X), namely learning treatment using the REACT model aided by Dynamic Assessment. In contrast, the control group received learning treatment using the REACT model. Additionally, both classes were given a final test of mathematical creative thinking ability (O) after the assessment to ascertain the results.

Table 1. The Nonequivalent Pretest-Posttest Control Group Design

Group	Pretest	Treatment	Posttest
Experiment Class	O_1	X	O_2
Control Class	O_1	Y	O_2

Explanation:

O_1 : Pre-test to measure early mathematical creative thinking skills
X : Learning with the REACT model assisted by Dynamic Assessment
Y : Learning with the REACT model
O_2 : Final test to measure the final ability of creative mathematical thinking

The qualitative method described this study's mathematical creative thinking abilities regarding student learning autonomy. After obtaining quantitative data from the posttest in the form of the results of the mathematical creative thinking ability test, the next step is to ascertain each student's level of learning independence by distributing learning independence questionnaires to be completed by students. Additionally, the researchers analyzed the students' completed learning independence questionnaires and classified them into three categories: (1) high learning independence, (2) moderate learning independence, and (3) low learning independence.

Two students from each category of learning independence were selected as research subjects from the experimental class. Then interviews and an analysis of the students' descriptions of their creative thinking ability were conducted.

Using a Likert scale, create a questionnaire to assess learning independence. Prior to administering the creative thinking ability test and the questionnaire on learning independence to the experimental and control classes, a trial was conducted in the trial class. The trial was conducted to ascertain the research instrument's validity, reliability, discriminatory power, and degree of difficulty. As a result, the research instrument is declared feasible to assess students' ability to think creatively and independently.

The mathematical creative thinking ability test was conducted to determine the test instrument's feasibility by analyzing the items' validity, reliability, discriminating power, and difficulty level of the questions. The following conclusions can be drawn from the test results for the mathematical creative thinking ability test questions. All ten of the testing questions are feasible to use. All questions have a high level of validity, with a reliability value of 0.872. Mathematical creative thinking ability test questions range in difficulty from Easy to Medium. Each question also meets enough's criteria for distinguishing upper- and lower-class students.

The learning independence questionnaire trial aims to determine the questionnaire instrument's feasibility through an analysis of its validity and reliability. The questionnaire under examination contained 28 statement items. Each statement of self-efficacy is derived from indicators of learning independence. The following table summarizes the findings from the test results of the learning independence questionnaire. All 28 statement items in the learning independence questionnaire tested were feasible to use. All items have a high level of validity, with reliability of 0.948. All statement items in the learning independence questionnaire can be used to determine a student's level of learning independence and can be administered to the experimental research class.

3. Results & Discussions

3.1. Study Mastery Test

The completion of learning is categorized into individual and classical completeness. The criteria for complete learning is to meet both categories. From this research results such as the results of the Patimah and Saniah (2020) study which stated that the increase in mathematical creative thinking skills of students who used REACT learning was better than students who received conventional learning.

3.1.1 Individual Completion Test

This test is used to determine whether the average mathematical creative thinking ability in the learning of the REACT model helps dynamic assessments more than or equal to 65. Testing is done using T statistic. Based on calculations obtained value of $\mathrm{t_{count}}$ is 4.88. To a significant degree (α) 5% and degree of freedom 32 obtained value $\mathrm{t}_{(0,95)(32)}$ is 1.696. Since $4.88 > 1.696$, students' average mathematical creative thinking ability on the learning of reacting model-assisted dynamic assessment is more than or equal to 65. Students' mathematical creative thinking skills in learning react models assisted by dynamic assessments have achieved individual learning completion.

3.1.2 Classic Completeness Test

A classical completeness test was used to determine whether or not the REACT model was learned classically with the assistance of a dynamic assessment of students' mathematical creative thinking skills. Complete learning occurs when the percentage of students who achieve individual mastery reaches at least 75% of the total number of students. The one-sided proportion test (left) is used in conjunction with the z test. Based on the calculation obtained value of $\mathrm{z_{count}}$ is 0.906. To a significant degree (α) 5% obtained value $\mathrm{z}_{(0,45)}$ is 0.164. Since $z_{count} = 0.9057 > -z_{table} = -1.64$ then H_0 is accepted. This means that the percentage of students who earn a 65 after learning the REACT model through Dynamic Assessment reaches 75%. (having achieved classical completeness).

3.2. Two Average Sample Test

The average two-sample test was used to determine whether the average mathematical creative thinking ability of students participating in REACT model learning assisted by dynamic assessment was superior to the average mathematical creative thinking ability of students participating in REACT model learning alone. This test is conducted using a similarity test between two averages or a t-test. Based on the calculation obtained value of $\mathrm{t_{count}}$ is 2.048. To a significant degree (α) 5% obtained value $\mathrm{t}_{(0,95)(64)}$ is 1.669. Since $2.048 > 1.669$, Then, on average, the mathematical creative thinking ability of students in the experimental class exceeds that of the control class. This means that students who receive REACT learning assisted by dynamic assessment have a higher level of creative mathematical thinking than students who do not receive

REACT learning. The results of this study are similar to the research of Aisyah (2013) which shows that the thinking ability of students who receive mathematics learning with REACT learning is significantly higher than students with conventional learning and get positive student attitudes towards REACT learning.

3.5 Regression Determination Coefficient Test

This experiment was designed to determine how learning independence influenced students' mathematical creative thinking abilities. According to the summary model table generated by SPSS 20.0, the value of R = 0.924, indicates that student learning independence positively affects students' mathematical creative thinking abilities when learning the REACT model assisted by Dynamic Assessment. R square = 0.854 is the coefficient of determination of student learning independence in terms of mathematical creative thinking skills. This means that student learning independence has an 85.4 percent effect on students' mathematical creative thinking skills when learning the REACT model assisted by Dynamic Assessment. In comparison, the remaining 14.6 percent is due to other factors.

3.6 Analysis of Students' Mathematical Creative Skills Based on Student Learning Independence

The indicator of learning independence used consists of six indicators: independence from others, self-confidence, disciplined behaviour, a sense of responsibility, self-initiative, and self-control. Additionally, the questionnaire was distributed to the experimental class (VII B). The students' scores were then classified into three levels of learning independence, namely high, medium, and low. The following table summarizes the results of the student learning independence questionnaire.

Table 2. Students By Learning Independence Category

Category	Number of Student	Percentage
High	11	33.3%
Medium	15	45.5%
Low	7	21.2%
Total	**33**	**100%**

As can be seen from the table above, 11 students in class VII B fall into high learning independence, 15 students fall into medium learning independence, and seven students fall into low learning independence. Two students chose research subjects to conduct an in-depth analysis of their mathematical creative thinking abilities during the learning process. Each selected research subject was then coded based on the results of the learning independence questionnaire in order to facilitate the presentation of mathematical creative thinking ability data. The following table details the coding of the research subjects.

Table 3. Qualitative Research Subject Code

Learning Independence Categories	Research Subject Code	Mathematical Creative Thinking Ability Test Scores
High	E-5	95.56
	E-13	97.78
Medium	E-1	71.11
	E-16	73.33
Low	E-18	57.78
	E-31	60

3.7 Analysis of Students' Mathematical Creative Thinking Ability with High Learning Independence

Two research subjects with subject codes E-5 and E-13 demonstrated a high level of learning independence. Both subjects possess exceptional abilities in mathematics and creative thinking. According to the final test of mathematical creative thinking abilities, the two subjects were not significantly different in meeting the three indicators of mathematical creative thinking ability. Subjects E-5 and E-13 scored 95.56 and 97.78 on the mathematical creative thinking ability test.

Students who have a high level of learning independence have few difficulties completing the questions. According to research, the average student who possesses a high level of learning independence can completely write down the known information and answer the questions. Additionally, students can approach questions in a structured manner with a distinct thought pattern. Both subjects developed strategies for answering questions on other sheets before transferring them to the answer sheet.

The analysis's findings indicate that the two subjects with a high level of learning independence performed admirably on the three indicators of mathematical creative thinking skills, namely fluency, flexibility, and novelty.

3.8 Analysis of Students' Mathematical Creative Thinking Ability with Medium Independent Learning

Two subjects with a Medium level of learning independence were chosen for the study: E-1 and E-16. Both subjects require a high level of mathematical creativity. According to the final test of mathematical creative thinking abilities, the two subjects were not significantly different in meeting the three indicators of mathematical creative thinking ability. Subjects E-1 and E-16 scored 71.11 and 73.33 on the mathematical creative thinking ability test.

Students with a Moderate level of learning independence occasionally encounter obstacles when attempting to solve problems. According to the research, the average student with moderate learning independence jotted down pertinent information and asked complete questions. Students with a Medium level of independence can solve problems correctly, even if some students are less thorough or have an unstructured way of thinking.

While subject E-1 Enough satisfies all three indicators of mathematical creative thinking ability, subject E-1 outperforms the flexibility indicator, indicating that students can propose multiple solutions to a problem or problem. The medium subject E-16 outperforms the novelty indicator, indicating that students can develop novel solutions to problems.

According to the analysis's findings, the two subjects with Medium learning independence meet the three indicators of mathematical creative thinking ability: fluency, flexibility, and novelty.

3.9 Analysis of Students' Mathematical Creative Thinking Ability with Low Learning Independence

Two research subjects with a low level of learning independence were chosen using the subject codes E-18 and E-31. Subjects E-18 and E-31 scored 57.78, and 60 on the mathematical creative thinking ability test.

Students with a low level of learning independence frequently encounter obstacles when attempting to solve problems, both in understanding the meaning of the questions and understanding the material surrounding the questions. According to the research, nearly all students with a low level of learning independence failed the final assessment of mathematical creative thinking abilities. Additionally, students who fall into the category of Low independence are less focused on providing answers.

The analysis's findings indicate that the two subjects with moderate learning independence are sufficient in terms of meeting the three indicators of mathematical creative thinking ability, namely fluency, flexibility, and novelty.

4. Conclusion

The study's findings indicate that (1) students' mathematical creative thinking ability improves when learning the REACT model assisted by dynamic assessments; (2) students in REACT learning assisted by dynamic assessments have a higher average mathematical creative thinking ability than students in REACT learning; and (3) there is a positive correlation between learning independence and students' mathematical creative thinking ability. (4) A description of mathematical creative thinking ability in terms of student learning independence, namely: (1) Students with a high level of learning independence are capable of exceedingly well meeting all indicators of mathematical creative thinking ability, namely fluency, flexibility, and novelty; (2) Students with a medium level of learning independence are capable of exceedingly well meeting all indicators of mathematical creative thinking ability, namely fluency, flexibility, and novelty.

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