Developing Creative Thinking Skills Through Philosophy for Children (P4C) in Middle School Mathematics Classes

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Abstract

The purpose of this research is to examine the effect of Philosophy for Children (P4C)-based instruction applied in middle school mathematics courses on students' mathematical creativity levels, specifically focusing on fluency, elaboration, and originality. An embedded mixed-methods design was adopted in the study. The quantitative phase utilized a quasi-experimental design with a pre-test and post-test control group, while the qualitative phase employed a case study design. The study group consisted of 40 fifth-grade students studying at a public school in Hatay, Turkey. Over an 8-week implementation period, the experimental group engaged in mathematics activities integrated with the P4C “Community of Inquiry” model, whereas the control group followed the standard mathematics curriculum. Data were collected using the Torrance Tests of Creative Thinking Figural Form B, a researcher-developed Mathematical Creative Thinking Skills Test, semi-structured interviews, and observation forms. Quantitative data were analyzed using Mixed-Design ANOVA, and qualitative data were analyzed via content analysis. The quantitative findings revealed a statistically significant increase in the mathematical creativity scores (fluency, originality, resistance to premature closure, and emotional expressiveness) of the experimental group compared to the control group. Qualitative findings supported these results, showing that P4C transformed the classroom into an active community of inquiry where students could freely express their thoughts, draw inspiration from peer ideas, and generate multiple alternative solutions in a safe environment. Consequently, the P4C approach proved to be a highly effective pedagogical tool for enhancing mathematical creativity.

Keywords: philosophy for children, mathematical creativity, mathematics education, middle school, creative thinking

Introduction

The pedagogical transformation in mathematics education emphasizes shifting students from passive recipients of knowledge to active constructors who can solve complex problems and develop alternative thinking pathways. However, the traditional perception of mathematics, which often focuses on finding a single correct answer, limits students' capacity to approach problems in an original, flexible, and fluent manner. Mathematical creativity requires students to overcome mental blocks when faced with a problem, utilizing mental flexibility to produce multiple, previously non-existent solutions based on fluency, originality, and elaboration.

The Philosophy for Children (P4C) approach aims to develop students' critical, creative, caring, and collaborative thinking skills through the "Community of Inquiry" model. The safe atmosphere of P4C, which eliminates the fear of judgment, reduces speaking anxiety and supports self-confidence, empathy, and the ability to generate alternative hypotheses. In this context, this study examines the effects of the P4C approach on middle school students' mathematical creativity to contribute to the cultivation of generations who think critically and go beyond conventional patterns rather than merely memorizing formulas.

Furthermore, there is a direct cognitive link between the philosophical inquiry steps of P4C and the cognitive dimensions of mathematical creativity. According to Lipman's constructivist philosophical framework, continuous questioning and brainstorming practices directly increase students' volume of idea generation, which corresponds to the "fluency" dimension of creativity. Similarly, the "Community of Inquiry" encourages students to examine alternative hypotheses and listen to different perspectives, thereby breaking mental rigidities and fostering "flexibility" and "originality." Despite these theoretical links, experimental studies examining the direct effect of the P4C approach on mathematical creativity remain quite limited in the international literature. While existing research predominantly focuses on critical thinking, problem-solving, mathematical reasoning, and general academic achievement, studies centering specifically on the fluency, flexibility, and originality dimensions of mathematical creativity are relatively scarce. Therefore, this study aims to fill this theoretical gap by concretizing the conceptual connection between philosophical inquiry processes and mathematical reasoning.

Methodology

This research was conducted using an embedded mixed-methods design, which integrates quantitative and qualitative data. In this design, qualitative data were embedded within a quantitative quasi-experimental design (pre-test and post-test control group) to deeply understand the mechanism of the experience and the participants' processes. The study group consisted of 40 fifth-grade students attending a public middle school in Hatay, Turkey. Existing intact classes were randomly assigned to the groups, resulting in 20 students in the experimental group (10 girls, 10 boys) and 20 students in the control group (10 girls, 10 boys).

The research process was structured in four main stages: preparation, pre-test, experimental implementation, and post-test. Initially, the Torrance Tests of Creative Thinking Figural Form B and the researcher-developed Mathematical Creative Thinking Skills Test were administered as pre-tests. During the 8-week experimental procedure, mathematics topics (Fractions, Decimal Notation, and Data Processing) were taught in the experimental group using the P4C "Community of Inquiry" model. This involved presenting philosophical stimuli (e.g., excerpts from children's literature, math-themed stories), generating questions, and conducting collaborative dialogues in a circular seating arrangement. Conversely, the control group received traditional instruction based on teacher-centered explanations and routine problem-solving according to the existing curriculum.

At the end of the 8 weeks, the same tests were administered as post-tests. In addition, semi-structured interviews were conducted with 10 students from the experimental group. Furthermore, student behaviors were continuously assessed using observation forms evaluated by two independent experts. Quantitative data were analyzed utilizing Mixed-Design ANOVA to determine the main and interaction effects, while qualitative data obtained from interviews and observations were subjected to systematic content analysis.

Results and Discussion

Quantitative Findings

The Mixed-Design ANOVA results for the Torrance Tests of Creative Thinking revealed statistically significant interaction effects favoring the experimental group in multiple dimensions. While the fluency pre-test mean score of the experimental group was 7.05, it significantly increased to 11.68 in the post-test [$F(1, 38) = 5.019$, $p = .031$]. Similarly, the experimental group's originality score rose from 5.45 to 14.95, indicating a remarkable improvement compared to the control group [$F(1, 38) = 11.230$, $p = .002$]. Significant interaction effects favoring the experimental group were also observed in the dimensions of resistance to premature closure [$F(1, 38) = 11.701$, $p = .002$] and emotional expressiveness [$F(1, 38) = 26.796$, $p < .001$]. However, the interaction effect for the elaboration dimension was not statistically significant [$F(1, 38) = 0.362$, $p = .551$].

The Mathematical Creative Thinking Skills Test results further confirmed these improvements. The experimental group showed a highly significant increase in general creativity scores, yielding a very large effect size ($\eta^2 = .827$) [$F(1, 36) = 171.676$, $p < .001$]. Specifically, mathematical fluency scores increased from 2.48 to 3.55 in the experimental group, while the control group only shifted from 2.14 to 2.28 [$F(1, 36) = 98.302$, $p < .001$]. In the mathematical originality dimension, the experimental group's scores jumped from 2.33 to 3.48, compared to a minimal increase (2.17 to 2.42) in the control group [$F(1, 36) = 41.386$, $p < .001$]. Even in the mathematical elaboration dimension, where the Torrance Test showed no significant difference, the experimental group demonstrated a substantial increase (from 2.33 to 3.50) compared to the control group (from 2.11 to 2.14), revealing that P4C effectively fosters elaboration in mathematical contexts [$F(1, 36) = 156.203$, $p < .001$].

Qualitative Findings

The content analysis of the semi-structured interviews and observations revealed that students' development clustered around four main themes: “Fluency,” “Flexibility,” “Originality,” and “Elaboration.” Observation data indicated that at the beginning of the process, students mostly relied on standard algorithms and avoided complex multi-step problems. However, starting from the fourth week, as the philosophical dialogues deepened, the experimental group reached peak performance levels (2.90–3.00 out of 3.00) in generating independent solutions and viewing mistakes as learning opportunities.

Student interviews provided concrete evidence of this transformation. For instance, in the originality dimension, Student 20 (Ö20) initially provided a standard, restrictive answer to an alternative mathematics system question during the pre-test. Following the P4C interventions, the same student successfully constructed an unconventional, unique rule system in the post-test. Similarly, in the elaboration dimension, Student 17 (Ö17) initially provided very brief, result-oriented answers. However, during the post-test, the student expanded their reasoning step-by-step, providing strong justifications and enriching their mathematical arguments with detailed scenarios. These findings indicate that the "Community of Inquiry" effectively removes the pressure of finding a single correct answer, encouraging students to freely express and elaborate on their original thoughts.

Conclusion

The findings indicate that P4C-based mathematics instruction is a highly effective pedagogical tool for enhancing students' mathematical creativity compared to traditional teaching methods. The P4C process successfully transformed the classroom from a routine calculation environment into an active, democratic "mathematical community of inquiry." By eliminating the pressure of finding a single correct answer, the intervention supported students in generating alternative solution strategies, questioning assumptions, and constructing their own cognitive processes. This research provides a practical and integrable "mathematical philosophical inquiry" model for curriculum designers and mathematics educators to foster creative thinking in middle school classrooms.

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Declaration of Generative AI and AI-Assisted Technologies in the Writing Process

I declare that Gemini, an AI-assisted tool, was used in translating the manuscript into English and refining the language. The usage was limited to translation, correcting grammatical and spelling errors, and rephrasing statements for accuracy and clarity in English. I further declare that, apart from this, no other AI or AI-assisted technologies have been used to generate content in writing the manuscript. The ideas, design, procedures, findings, analyses, and discussion are originally written and derived from my careful and systematic conduct of the research.

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