Profiles of Mathematics Giftedness

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Introduction

National Association for Gifted Children (NAGC) defines gifted students as those who demonstrate "outstanding levels of aptitude or competence in one or more domains" (NAGC, 2008; see Subotnik, Olszewski-Kubilius, & Worrell, 2011, for a review of definitions). Within the domain of mathematics, researchers consider students to be mathematically gifted if they score high on standardized mathematics achievement tests (Lubinski & Benbow, 2006), if they demonstrate superior higher-level thinking such as metacognition (i.e., knowledge and regulation of one's thinking; see Cheng, 1993), or if they excel in accelerated mathematics courses (e.g., Young, Worrell, & Gabelko, in press). In schools, it is left up to individual school districts to determine how gifted students are identified. Overall, there is no unified process for identifying mathematically gifted students. This study attempted to further understand mathematics giftedness by asking the following questions: *Are there different profiles of mathematics giftedness? Are some students more mathematically gifted than others?*

Method

Participants

Participants were 17 California public school students (age 12 – 16) who demonstrated outstanding (A-level) mathematics achievement in their home school classrooms and completed an accelerated mathematics course at a summer program for academically talented middle and high school students. Participants were 71% female and represented a range of socioeconomic statuses.

Measures

	Description	Coding	
		High	Low
California Standards Test (CST)	Criterion-referenced test measuring level of achievement on the California state mathematics standards	Advanced Range	Proficient Range Basic Range Below Basic Range Far Below Basic Range
Mathematics Diagnostic Test (MDT)	Mathematics readiness test used by California public schools to determine preparedness for subsequent mathematics courses	80% Accuracy or Higher	Below 80% Accuracy
Accelerated Course Success (ACS)	ACS determined by final grade in summer program accelerated mathematics course	A+, A, A-	B+, B, B-, Pass, No Pass
Metacognition (MC)	MC measured through mathematics problem solving interviews (see Young, 2010)	Demonstration of metacognition when necessary to solve mathematics problem	Absence of metacognition when necessary to solve mathematics problem

Procedure

Data pertaining to students' CST, MDT, and ACS were gathered from the summer program database. Problem-solving interviews were conducted concurrently with the summer session and interview transcripts were analyzed to determined students' MC. Finally, student groupings were formed based on students' CST, MDT, ACS, and MC levels.

Results

When grouped according to CST, MDT, ACS, and MC levels, five distinct profiles were identified. A comparison of these profiles suggests a developmental trajectory of mathematics ability beginning at Level 1 and continuing through Level 5.

At **Level 1**, students perform well in their home school mathematics courses and receive A's in mathematics, but lack both standards-based and non-standards-based mathematics content. These students also struggle in accelerated mathematics courses and fail to engage in metacognitive thinking during mathematics problem solving tasks.
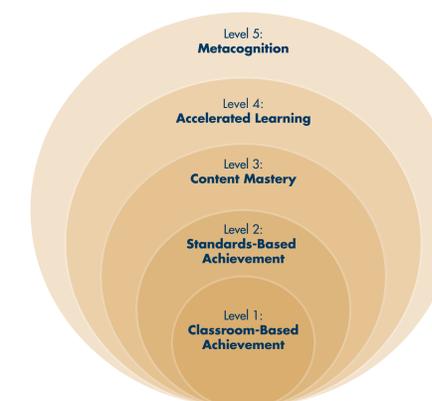
At **Level 2**, students perform well in their home school mathematics courses and display mastery of standards-based mathematics skills taught in California public schools. Despite this standards-based mastery, they lack proficiency in additional mathematics content as evidenced by low MDT scores. Similar to students in Level 1, these students also struggle in accelerated mathematics courses and fail to engage in metacognitive thinking during mathematics problem solving tasks.

At **Level 3**, students perform well in their home school mathematics courses and demonstrate strong mathematics content mastery (both standards-based and non-standards-based). However, despite this content mastery, they struggle in accelerated mathematics courses and fail to engage in metacognitive thinking during mathematics problem solving tasks.

At **Level 4**, students perform well in their home school mathematics courses, demonstrate strong mathematics content mastery, and perform well in accelerated mathematics courses. However, these students exhibit difficulty engaging in metacognitive thinking during mathematics problem solving tasks.

At **Level 5**, students perform well on all measures of mathematics achievement.

	n (%)	CST	MDT	ACS	MC
Level 1	1 (6%)	Low	Low	Low	Low
Level 2	3 (18%)	High	Low	Low	Low
Level 3	6 (35%)	High	High	Low	Low
Level 4	3 (18%)	High	High	High	Low
Level 5	4 (24%)	High	High	High	High

Level 5: Metacognition
Level 4: Accelerated Learning
Level 3: Content Mastery
Level 2: Standards-Based Achievement
Level 1: Classroom-Based Achievement

Discussion

Students displayed different profiles of mathematics giftedness based on their levels of achievement as measured by the California Standards Test in mathematics, the Mathematics Diagnostic Test, their success in an accelerated summer mathematics course, and their use of metacognitive thinking during mathematics problem solving tasks. The pattern of these profiles suggests the following developmental trajectory of mathematics giftedness: success in home school mathematics courses → success on standards-based mathematics assessments → success in non-standards-based assessments → success in accelerated mathematics courses → successful application of metacognition during mathematics problem solving tasks. Results of this study indicate that it may be beneficial for students, parents and teachers to assess students' levels of mathematics giftedness to determine how to focus their mathematics studies. For example, a student who demonstrates a Level 2 profile may benefit from focusing on mastering non-standards-based mathematics skills and knowledge before attempting an accelerated mathematics course. Results of this study are limited by the small sample size and may only be generalized to California public school students due to the variables examined. Further research is needed to replicate these findings within larger samples and to examine profiles of giftedness based on the measures used to assess mathematics ability in other states.

References

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