Understanding assessment while developing equitable teaching practices

By: Tyrette Carter, Kerri Richardson, and Nakeshia Williams

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Abstract:

Our research focuses on a growth model of teachers' ability to assess student learning as a result of creating equitable instruction for students in informal school settings. We describe data collected as part of a study examining the mathematical reasoning of Grades 3–5 students. Our research context took place in six elementary schools from rural and urban settings. Here, we focus on one of the schools by describing how a teacher began her instruction and over time, how she developed her assessment strategies to ensure that students obtained access to and support for algebraic reasoning, mathematical content, and discourse.

Keywords: assessment | elementary school students | mathematics education

Article:

***Note: Full text of article below**

UNDERSTANDING ASSESSMENT WHILE DEVELOPING EQUITABLE TEACHING PRACTICES

Tyrette Carter
North Carolina A & T State University
tscarte1@ncat.edu

Kerri Richardson
University of North Carolina at Greensboro
kdricha2@uncg.edu

Nakeshia Williams
North Carolina A & T State University
nnwilliams1@ncat.edu

Our research focuses on a growth model of teachers' ability to assess student learning as a result of creating equitable instruction for students in informal school settings. We describe data collected as part of a study examining the mathematical reasoning of Grades 3–5 students. Our research context took place in six elementary schools from rural and urban settings. Here, we focus on one of the schools by describing how a teacher began her instruction and over time, how she developed her assessment strategies to ensure that students obtained access to and support for algebraic reasoning, mathematical content, and discourse.

Equity research in mathematics education has attracted considerable attention in recent years (e.g, D'Ambrosio et al., 2013). Equity can be broken into multiple perspectives such as: cultural content, social organization, and cognitive resources (Brenner, 1998). While our foci may include all three, we study equitable practice in mathematics classrooms that centers on a growth model which highlights how teachers can progress in their disposition toward mathematical content and discourse. The research question in this study is how does equitable teaching affect teachers' assessment and instructional practices.

Related Literature

Research on Equity

Equitable instruction or practice in the mathematics classroom is defined as "those teaching practices that create fair distribution of opportunities to learn mathematics among students, with special emphasis on the learning of students who are members of ethnic and social groups currently 'underperforming' in mathematics, and those students who depend on schools for their primary access to learning" (Goffney, 2010, p. 7). Banks (2001) also states that equity is utilizing various teaching strategies and creating a classroom environment that helps students from diverse racial, ethnic, and cultural groups attain the knowledge, skills, and dispositions needed to function effectively within society. Goffney (2010) and Banks (2001), among many researchers, argue against deficit models in equity research, aligning with our beliefs and experiences in mathematics classrooms.

Research on Assessment as Related to Equity

Assessment is a way to evaluate whether students and teachers meet a target goal or learning outcome. Not only does an assessment determine the outcome of an event, it also informs a teacher of two items: 1) what a student can do on a particular problem, concept, or task, and 2) how does what the student knows affect instruction. The assessments in this study are formative assessments that inform teaching and learning versus a summative assessment to assign a score to determine one's performance.

The On Track-Learn Math research project provided a unique space for teachers to examine their assessment and instructional practices because the teachers taught in a nontraditional setting, an after school program. Teachers could experiment with non-routine problems and utilize different assessments to determine student learning which allowed them to begin to adjust their instructional practices. The research team utilized the Structure of Observed Learning Outcome (SOLO) taxonomy (Biggs & Collis, 1982) to examine what teachers and students could do (process, conceptual, and discourse) on a task, which led the teachers to develop equitable practices over time.

Theoretical Framework

Many researchers have found that the quality of instruction is directly related to teacher knowledge and student achievement (Darling-Hammond, 1999; Ingersoll, 2002; Whitehurst, 2002). However, culture plays an important role in the academic development of students. Culture can be conceptualized as the "combination of norms, values, beliefs, expectations, and conventional actions of a group" (Phalen, Davidson, & Cao, 1991). Culture is a dynamic construct which influences how and what knowledge is produced while also defining important differences among learners (Grimberg & Gummer, 2012). Also, students make gains when they have a quality teacher (Hill, Rowan, & Ball, 2005) – one who can successfully choose a task, provide rich instruction, and orchestrate meaningful discourse. However, there exists a paradox of accessible, equitable and successful teaching, learning, and assessment outcomes for all students. Here, we posit a possible way to address such a paradox by using a sociotransformative constructivist perspective.

This study uses sociotransformative constructivism as the theoretical lens to guide inservice teachers' use of assessing diverse and multicultural students in an after-school program. Sociotransformative constructivism (Rodriguez, 1998, 2010, 2015) merges

multicultural education and social constructivist theoretical frameworks as a theory for learning and teaching. Rodriguez (1998) describes the four components of sociotransformative constructivism: (a) dialogic conversation (b) authentic activity (c) metacognition (Idol & West, 1991) and (d) reflexivity. These components are meaningful interactions that evolve organically and are facilitated by teachers. Sociotransformative constructivism assists teachers in becoming more aware of how issues of power, gender, and equity influence who has access to education, and the influence each has over what and how subject matter is taught and assessed.

The Structure of the Observed Learning Outcome (Biggs & Collis, 1982) is a taxonomy for assessing students' understanding of a given task. The SOLO taxonomy was designed to empower teachers to apply theoretically based knowledge of student thinking and learning so their teaching practices would maximize student achievement. SOLO also merges well with the sociotransformative theoretical framework because it provides transitional movement for students and teachers to deepen their level of thinking through a cultural and equitable lens. The SOLO taxonomy approaches assessment as an ongoing process by informing instruction using the prestructural, unistructural, multistructural, relational, and extended abstract stages (see Table 1). The stages in the taxonomy take students from knowing one point about a problem to knowing multiple points about a problem and describing their thinking and finding patterns, to finding multiple solutions or strategies and rules.

Table 1

The SOLO Taxonomy

Pre-structural	The task is not attacked appropriately; the student hasn't really understood the point and uses too simple a way of going about it.
Uni-structural	The student's response only focuses on one relevant aspect.
Multi-structural	The student's response focuses on several relevant aspects but they are treated independently and additively. Assessment of this level is primarily quantitative.
Relational	The different aspects have become integrated into a coherent whole. This level is what is normally meant by an adequate understanding of some topic.
Extended abstract	The previous integrated whole may be conceptualized at a higher level of abstraction and generalized to a new topic or area.

In the On Track project, a type of question asked was, "If 100 square tables can seat 202 people, how many people will be able to sit at 101 tables?" The purpose of this type of question was to deepen the student's understanding regarding the total number of square tiles at a particular phase. The highest level of the SOLO (deep understanding and extending) in this example would ask the question, can you develop a rule? As tasks become richer in nature, the idea is that discussion from students deepens and the understanding between teachers and students also deepens. This also aligns with the elements of the sociotransformative constructivism framework.

Here, our research focuses on how one teacher increased her understanding of assessment as she developed equitable teaching practices over time. We describe how one teacher began her mathematical instruction and how she varied/increased her assessment strategies through growth in her practices to ensure that students obtained access to the algebraic reasoning, mathematical content, and discourse. It is also our intent to bring to the forefront how classroom instruction that balances the structures found in the sociotransformative framework and elements of the SOLO taxonomy to assess student learning and produce equitable teaching and assessment practices.

Methodology

Design and Subjects

The On Track project included students in grades 3, 4, and 5 and took place in six elementary schools (some Title 1) located in both rural and urban settings in the eastern part of the United States over the course of two years (4 semesters). Children attended 10 sessions per semester, lasting two hours per day, twice a week. Professional development sessions were held at the beginning of each semester for one lead teacher and one assistant teacher per school. Ongoing and real-time professional development was offered by the research team as needed during the filming of sessions. Each session took place directly after school in classrooms of the lead teacher. However, in this study we investigate one teacher in one of the schools from the larger data set and refer to each semester as a cycle.

Task and Instruction

Students, mostly in grade 3, sat in groups of four for this study, and the tasks given

included a series of algebraic reasoning questions centering on functions. For example, "This machine has a rule that makes new numbers. Your job is to guess the rule." The question goes on to show an input of 1, output of 1; input of 2, output of 4; input of 3, output of 9. Each student had a copy of the problem to write on; however, students were encouraged to discuss, share ideas (even work together). As they worked the problems, the lead teacher and supporting teacher circulated around the classroom offering assistance as needed. For more information about the tasks themselves, Store (2013) details the nature of such tasks.

Evidence and Analysis

The SOLO taxonomy was used to examine one teacher's (Ms. Pearson, a pseudonym, also referred to as the Lead Teacher) equitable assessment practices over the course of four cycles of problem solving in an after-school program of students mostly in Grade 3 for this analysis. Unlike other taxonomies, the SOLO taxonomy was chosen because it was designed to measure the level of what students are able to do or "learn (to do)" (Brabrand & Dahl, 2009). Data collected included video, student work samples, observations, and interviews. Video data was viewed separately by each researcher, analyzed, and viewed again together - all using the SOLO taxonomy during the process. Attention was given to the types of questions the lead teacher asked the students during her work with the tasks. We coded the questions asked by the teacher using the phases of the framework (prestructural, unistructural, multistructural, relational, and the extended abstract).

We also performed content validity through selecting algebraic tasks that have been measured valid and reliable from experts. The results from the tasks were triangulated through the authentic work samples, observations, and interviews. Furthermore, the researchers implemented the problems with the teacher participants and determined their level of understanding through the SOLO taxonomy, and had discussion with the teacher to validate the results. Then, the teacher utilized the same content with Grade 3, 4, and 5 students in the after-school program, and these data were collected and analyzed.

When we first started the lessons, the teacher was given a script to follow to allow her time to become comfortable with the algebraic content. Our intent was for all the teachers in the project to veer off the script once they became use to the types of tasks and the style of student engagement in the tasks. During the first cycle, Ms. Pearson followed the script verbatim. She asked a question, waited for an answer, and then moved on to the next question. For example,

Ms. Pearson first started the initial set of tasks with unistructural questioning like, "How many sides does it take to make one table?" She did grow to multistructural questions like, "How many sides are needed for each of the tables pictured?" but her assessment of the students' answers was underdeveloped. If a child gave an incorrect answer, she moved on to someone who had the correct answer without inquiring about the processes of either child's thinking.

At the second cycle we began to notice a significant change. Ms. Pearson engaged students in both large group and small group discussions. We found this to be an equitable teaching and assessment practice in conjunction with the more advanced phases of the SOLO framework. For example, she posed a relational question to the entire group, then she and her assistant teacher circulated around the room, spending 10-15 minutes with small groups allowing them to process and describe their strategies. She prompted the assistant teacher to attend to their pictorial representations and verbal descriptions. As if compiling data, she would then bring the class together as a whole, and allow them to present their solutions using the document camera. If a student had everything worked accurately, she would hold off on allowing them to share first to allow mistakes to be a part of every task given. In the act of sharing, many students stood at the front of the classroom and self-corrected their mistakes simply because they were allowed the space to do so.

As the project continued into the third and fourth cycles, Ms. Pearson often used relational questioning at thoughtful times *during* their presentations, as well. For example, when one student described their work with the pentagonal tables, she followed up by asking, "If 2 tables include 9 sides, how many sides will 10 tables include?" This challenging yet engaging style of questioning got the students excited because they were already invested in the problem. She assessed on the spot that the child was ready for a more sophisticated line of thinking about that problem.

Results and Discussion

All four phases of the SOLO taxonomy are reported during most of the teaching cycles in the On Track project along with equitable teaching and assessment practices. These, as we predicted, are difficult to separate due to the nature of a learning environment that creates opportunities for all students to make sense of the mathematical content. The very structure of the On Track project began with scripted lessons and a narrow focus, which we were concerned the teachers may not want to drift away from. One reason we scripted so much at

first was because we observed Ms. Pearson and other teachers in the project using a lot of direct instruction in their regular classrooms. We wanted to start them out with a familiar format for the project. However, as Ms. Pearson met with us (after the second session was completed) for professional development, she started bringing in ideas about how the students were approaching the task. We showed video examples of reform-based classrooms and this inspired her to make changes for the third session as described in the above analysis.

Through our analysis of the On Track data over, we found that Ms. Pearson grew in her confidence, her ability and her content knowledge. Providing targeted professional development and allowing teachers to practice the learned strategies in a non-threatening environment supports the growth and success of teachers. Ms. Pearson also commented on how she began taking the formative assessment strategies back into her regular classroom to really analyze student thinking and understanding of the concepts. She believed these experiences were beneficial to the mathematical growth of her students that were not necessarily in the after school program. The research allowed the teachers to connect rich mathematical tasks to targeted learning outcomes, while teachers were able to strengthen their assessment strategies and utilize the knowledge they learned about the students' thinking for the following learning episodes, in this case the next after school session. It is difficult to capture how teachers assess student learning and utilize this in their teaching; however, Ms. Pearson demonstrates this ability, as she increased her questioning skills, the level of discourse in the classroom, and her ease and understanding of each of the tasks. Ms. Pearson began to think on a more global scale of how to transform the learning of her students with respect to the levels of formative assessment found in the SOLO taxonomy.

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