WHITE PAPER

Differentiating Mathematics Instruction So EVERYONE Learns

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Differentiated mathematics instruction is powerful way to ensure that all students learn. Teaching to the middle and hoping that our instruction reaches all students are no longer acceptable because at any given time some students already know the material and other students are not ready for the material. Clearly, teach-to-the-middle instruction is an inequitable, out-dated practice. All students are entitled to classroom environments and learning situations that appropriately challenge and support their active and accurate development of mathematics knowledge. Not just those students who happen to be "in the middle."

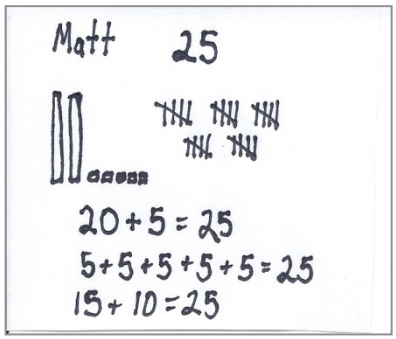
The Common Core State Standards (2010) offer renewed goals of focus and coherence with the underlying purpose of students learning, instead of teachers "covering" mathematics. There are now fewer, clearer, and higher mathematics standards that are directly aligned with college and career expectations. At no other time in our history have we needed differentiated mathematics instruction more. If students need to learn mathematics in a deeper, more thorough way, we have to teach them in a more meaningful manner. Essentially, the mathematical content and practice standards are better-quality and so our instruction must be, as well. Differentiated mathematics instruction guided by formative assessment, flexible grouping, targeted instruction, adjusted levels of cognitive demand, utilization of learning frameworks, and progress monitoring offers us the vehicle for ensuring that all students have the opportunity to gain a deep understanding of mathematics.

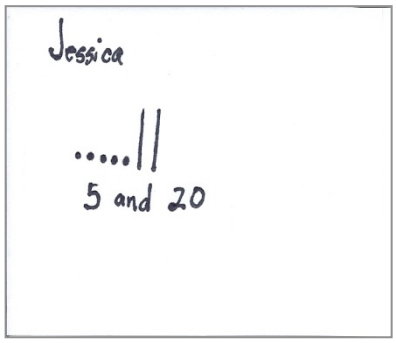
Formative Assessments

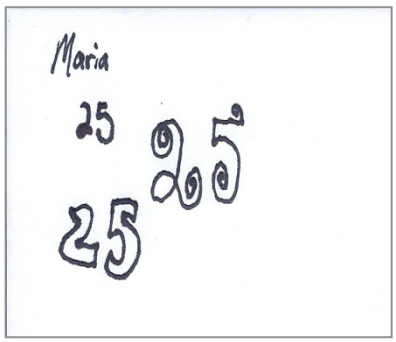
Formative assessment pinpoints instructional needs and direction. It involves teachers using evidence of students' understanding to adjust instructional practice (Popham, 2008). The responses students offer on formative assessments reveal current knowledge, level of understanding, possible misconceptions, and potential gaps in knowledge. "Formative assessment drives mathematics instruction and is the key component in Response to Intervention" (Oberdorf & Taylor-Cox, 2011, p. 3). The information provided by formative assessments gives the teacher evidence that directs a meaningful instructional response. "Using formative assessments to gather information about students' explicit academic needs serves to empower students (and the teacher!)" (Taylor-Cox, 2011, p. 16). Recognizing and responding to the knowledge a student currently owns and the knowledge a student needs next are the foundations of meaningful instruction.

Formative assessments do not have to be long and intensive. Often one or two good questions/problems/tasks reveal what students already know and/or need to learn about a concept. Formative assessments can occur prior to instruction, during instruction, and after instruction. Teachers need to use the information gleaned from ongoing formative assessments to differentiate the mathematics instruction.

For example, in a primary classroom, the teacher asks the students to show 25 in several different ways. The responses from the class include the following;





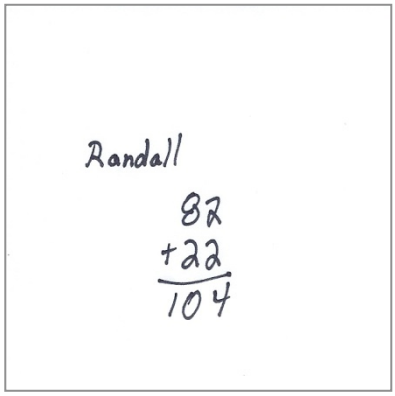


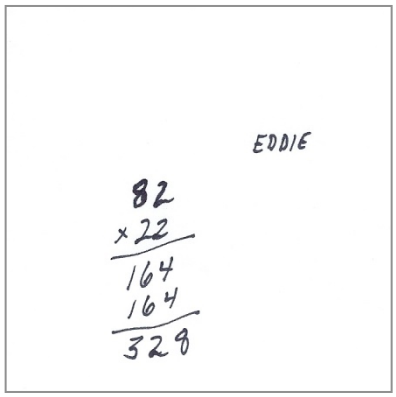
The responses to the formative assessment indicate different levels of understanding. Clearly, Matt understands how to represent 25 in many ways. His knowledge of composing and decomposing 25 is strong, as is several other students who offered similar responses. Jessica appears to have some understanding of how to represent 25. She illustrates and writes one way to compose the value. Her response is similar to several other students' responses. Maria's response to the formative assessment (adorable, as it is) shows that she is ready to learn more about

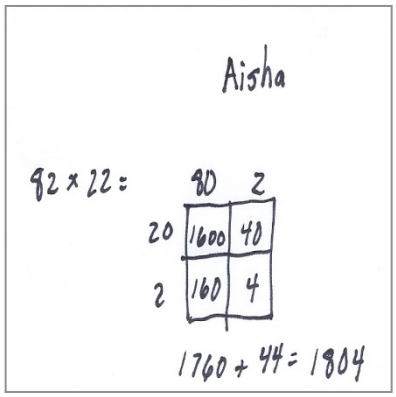
how to compose and decompose values. There were several other students who offered responses to the formative assessment that indicated similar readiness levels.

In an intermediate classroom, the teacher poses this formative assessment;

Hannah can jump 82 times in one minute. If she continues at the same rate, how many times can she jump in 22 minutes? Use words, numbers, and/or pictures to explain your answer. The responses from the class include the following;







The responses to the formative assessment indicate different levels of understanding. Randall and the other students who gave similar responses erroneously added the quantities given in the problem. Eddie attempted the traditional algorithm for multiplication. He and the other students who responded similarly understand the needed operation but have some gaps in procedural skills most likely associated with place value. Aisha used a partial products strategy to find and prove her answer. She and several other students gave responses that indicate that they have strong procedural skill and conceptual knowledge in multiplication.

Flexible grouping

Once we have the formative assessment data, we can use these data to form instructional groups that are purposeful and flexible. The groups are purposeful because they are formed based on the academic needs and/or the learning frameworks of the students. The small groups work on learning situations that are appropriately matched to their needs. The groups are flexible because they change based on the specific needs of the students. Tomlinson and Imbeau (2010, p. 90) consider flexible grouping a "nonnegotiable aspect of effective differentiation"

because students are "multidimensional learners" who need varied group structures. The groups change depending upon the evidence found through daily formative assessments and ongoing learning needs/strengths. Sometimes students are in homogeneous groups based on content readiness. Other times the students are in heterogeneous groups because students with diverse understandings have things to learn from each other. The instructional groups may also be heterogeneous by ability and homogeneous by learning preference. Sometimes the whole class needs to work together on a task or concept. The amount of time students spend in small instructional flexible groups varies based on the needs of the students.

Targeted Instruction and Levels of Cognitive Demand

Once we have our instructional groups we can begin targeting instruction and adjusting the levels of cognitive demand for the students. Targeted instruction involves teaching students exactly what they need to learn next. As the National Mathematics Advisory Panel (2008, p. *xx*) reported "what is developmentally appropriate is largely contingent on prior opportunities to learn" more than it is on a specific age or grade level. Using the information from the formative assessment, the teacher can offer each student instruction that is not based solely on grade level, but based on the student's current knowledge and actual needs.

In the primary classroom example, the teacher offered Matt's group meaningful challenge by teaching the students how to compose and decompose 3-digit numbers. The teacher worked with Jessica's group on representing 2-digit numbers in more than one way. The teacher back-mapped to composing and decomposing single-digit numbers to build foundations for Maria's group. Each group received targeted instruction based on the information gleaned from the formative assessment.

In the intermediate classroom example, the teacher offered strategic intervention for Randall's group helping them create and solve less complex multiplication story problems. The teacher worked with Eddie's group on the building meaning for the traditional algorithm using accurate place value language and other ways to record the partial products. The teacher provided meaningful challenge for Aisha's group by adding a new level of complexity to the problem (e.g. *Every odd minute Hannah jumped 82 times, but every even minute she jumped 81 times*). The implementation of differentiated, targeted instruction resulted in significant progress for each group of students.

Targeted instruction is even more beneficial when it is coupled with adjusting the level of cognitive demand (LCD). The LCD is the degree of thinking and ownership required in the learning situation. The more complex the thinking and the more ownership (invested interest) the students have for the learning, the higher the LCD. Likewise, lower LCD requires straightforward, more simplistic thinking and less ownership by the students. Having high expectations for all students is critically important; however, posing consistently high LCD can actually set some students up for failure. Similarly, posing consistently low LCD for students is disrespectful to the students. What we need to do is to adjust the LCD to meet the exact needs of the students at the specific time of instruction (Taylor-Cox, 2008).

While there are various ways to adjust the LCD, one way is to use the tried-and-true framework brought forth by Bloom (1956). Lower levels of cognitive demand involve recall and comprehension. At these levels, the teacher asks students to remember something (recall, recite) and asks the students about their basic comprehension (explain, summarize). The medium levels of cognitive demand involve application and analysis. The teacher asks questions that involve knowledge in another situation (apply, show) and understanding how the parts relate (compare, classify). The higher levels of cognitive demand include evaluation and synthesis. The teacher asks questions about judging the value of something (evaluate, recommend) and restructuring the parts to make a new whole (design, create).

Other ways to adjust the LCD include modifying the level of ownership required in the learning situation, using different levels of mathematics processes, and incorporating depth of knowledge levels (Webb, 1999). For example, if a group of students is ready for a challenge, the teacher may opt to provide a task that is open-ended and requires students to make decisions about how to communicate and represent the solutions. The task is differentiated for the students through adjustment of the LCD because more student ownership, decision making, and strategic thinking are required. However, the same group of students may need a lower level of cognitive demand if, for example, the content is unfamiliar and more difficult.

Learning Frameworks

As we differentiate mathematics instruction, we need to incorporate learning frameworks (including, but not limited to learning styles, multiple intelligences, environmental needs, affective needs, interests, and accommodations) in ways that help students use their strengths to learn mathematics. Some students learn best by

watching; others by doing; still others by listening. Some students have strengths and/or interests in music, sports, poetry, and art. Other students have language acquisition needs, specific disabilities, and cultural backgrounds that respond well to differentiation by learning preferences. We need to find out our students' learning frameworks *and* incorporate these into our instruction. Just as we use formative assessment data to form instructional groups, we can use inventory and observation data to form instructional groups based on students' learning frameworks.

Progress Monitoring

Monitoring and evaluating students' learning progress allow educators to make needed adjustments in instruction. Educators should ask;

- Is the student making progress?
- What does the student need to learn next?
- How solid is the student's understanding?
- Does the student need more work with a specific concept?
- Is the student having difficulty maintaining and utilizing specific concepts?
- What misconceptions does the student have?
- Where are the learning gaps?
- Is the student's knowledge incomplete? If so, what is missing?
- (Taylor-Cox, 2009, p. 9).

By consistently answering these questions and assessing the effectiveness of instruction, we can change what is not working and strengthen what is working in ways that help all students gain progress in learning mathematics.

Conclusion

Differentiated math instruction serves as an essential course of action as we strive to meet the needs of all students. Using formative assessments, flexible grouping, targeted instruction, adjusted levels of cognitive demand, utilization of learning

frameworks, and progress monitoring the teacher can implement more effective instruction for students. Across-the-board and improved use of differentiated math instruction will help students make greater and greater progress in learning the rich and comprehensive mathematics needed for college and career readiness. Differentiated math instruction is the key to the future success of mathematics education for ALL students!

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