SOCIAL DEVELOPMENT LAB
UNIVERSITY *of* VIRGINIA

CODING MANUAL

THE MATHEMATICS SCAN (M-SCAN)

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Contents#

Introduction

The Mathematics Scan (M-Scan) is an observationally based rating scale designed to assess the quality of standards-based mathematics teaching practices. The domains of quality were primarily conceptualized based on implementation category from the National Council of Teachers of Mathematics' (NCTM) Standards for Teaching and Learning Mathematics (2007). Two existing measures, the SCOOP Notebook and the Classroom Assessment Scoring System (CLASS) served as a foundation for M-Scan measurement development. The SCOOP measure used classroom artifacts, observations, and instructional materials to measure mathematics instructional practices (Borko et al., 2005; Borko, Stecher, & Kuffner, 2007). The M-Scan selected, defined, and adapted eight dimensions from the SCOOP measure. The structure of the coding protocol and the 1 to 7 scale was based on the Classroom Assessment Scoring System (CLASS; Pianta, Hamre, & LaParo, 2007). Coding guidelines were established with descriptions to correspond to numerical ratings from 1 to 7 (segmented as low [1-2], medium [3-5], and high [6-7]).

Three noteworthy characteristics require mention. First, M-Scan offers efficiency; the dimensions can be coded in a time-efficient manner, a necessary practicality for researchers in large-scale studies. Second, M-Scan gives a holistic assessment of mathematics lessons; it considers the entire lesson, beginning, middle, and end. Third, M-Scan provides a framework for understanding standards-based mathematics teaching practices.

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General Overview of Coding

The M-Scan consists of nine dimensions and uses a seven-point rating scale, ranging from 1 to 7. The scale is as follows:

1-2= low
3-5= medium
6-7= high

Materials needed for M-Scan coding

These items should be stored with your data collection materials:

- Your own paper copy of this coding protocol
- M-Scan Observation Form
- Pen or pencil

Using the Mathematics Scan (M-Scan) Measure

M-Scan codes are based on a full mathematics lesson. Coders watch the first 30 minutes of the video-recorded lesson and take notes throughout the 30-minute segment to record what occurs during the lesson. Coders write their notes on the back of the coding sheet or on separate pieces of paper that can be stapled to the coding sheets. The notes are used as examples and references when completing the M-Scan coding for that segment. After the first 30 minutes, the video is paused to allow a period for coders to reflect and mark "soft codes" (i.e. initial ratings) on the coding sheet by underlining the number corresponding to the initial code. These marks will serve as indicators of what happened during the first part of the lesson.

After assigning "soft codes" for the first 30 minutes, coders continue watching the lesson, following the procedures done in the first 30 minute segment. Once coders have watched the entire lesson, final codes are assigned. Coders should refer to the coding guides while coding.

M-Scan Items and Rating Scale

In this section, we introduce the 9 dimensions items in detail, with descriptions of what each rating scale point looks like for each item. Below is a template of the rating scale.

1,2	3,4,5	6,7
Low	*Medium*	*High*

1. Structure of the Lesson: The extent to which the design of the lesson is organized to be conceptually coherent such that activities are related mathematically and build on one another in a logical manner.

NOTE 1: Ratings of observations should take into account interruptions for procedural activities that are not part of the instructional unit, when these interruptions consume a non-trivial amount of time.

NOTE 2: If a warm-up (i.e., brief, possibly unrelated segment at beginning of class) does not interfere with overall flow of lesson, it should not count against the overall score for this measure.

	Low (1, 2)	**Medium (3, 4, 5)**	**High (6, 7)**
Logical Sequence	Overall, the components of the math lesson do not appear to be logically organized.	Some components of the math lesson are logically organized, but others do not seem to fit.	All components of the math lesson are logically organized.
Mathematical Coherence	The components of the lesson are not mathematically connected.	Some components of the lesson are mathematically connected.	All components of the lesson are mathematically connected and coherent.
Promotion of Deeper Understanding	The lesson does not lead students to a deeper understanding of the mathematical concepts.	The lesson leads students toward partial depth of understanding mathematical concepts or the lesson leads students toward depth some of the time.	The lesson leads students to a deeper understanding of the concept.
Notes			

2. Use of Representations: The extent to which the lesson promotes the use of and translation among multiple representations (pictures, graphs, symbols, words) to illustrate ideas and concepts. The use of and translation among representations should allow students to make sense of mathematical ideas or extend what they already understand.

NOTE: Dimension includes both exposure (by teacher or curriculum) and use by students. As outlined in NCTM's *Principles and Standards for School Mathematics (2000),* "students in grades 3-5 should continue to develop the habit of representing problems and ideas to support and extend their reasoning. Such representations help to portray, clarify, or extend a mathematical idea" (p. 206).

	Low (1, 2)	**Medium (3, 4, 5)**	**High (6, 7)**
Presence of Representations	Teacher and/or students rarely use more than one representation of a mathematical concept.	Teacher and/or students sometimes use more than one representation of a mathematical concept.	Teacher and/or students often use more than one representation for a mathematical concept.
Teacher Translation among Representations	For the representation(s) used, the teacher does not make connections to concepts or between representations. (i.e., procedural approach to use of representations).	For the representation(s) used, the teacher makes some connections to concepts and between representations.	For the representation(s) used, the teacher often makes connections to concepts and between representations.
Student Translation among Representations	Students do not translate between representations.	Students sometimes translate back and forth between representations. They *do not* explain their representations.	Students translate back and forth between representations. They also explain their representations at times.
Notes			

3. Use of Mathematical Tools: The extent to which the lesson affords students the opportunity to use appropriate mathematical tools (e.g., calculators, pattern blocks, fraction strips, counters, virtual tools) and that these tools enable them to represent abstract mathematical ideas.

NOTE: When students use equipment and/or objects to collect data that are later used in exploring mathematical ideas, the equipment/objects are not considered to be mathematical tools unless they are also explicitly used to develop the mathematical ideas.

	Low (1, 2)	**Medium (3, 4, 5)**	**High (6, 7)**
Opportunity to Use Tools	Students do not use tools and/or are only permitted to use tools for help with procedural skills.	Students sometimes use tools to investigate concepts and solve problems.	Students often use tools to investigate concepts and solve problems.
Depth of Use	Connections are never made between tools and mathematical concepts.	Connections are sometimes made between tools and mathematical concepts.	Connections are often made between tools and mathematical concepts.
Notes			

4. Cognitive Demand: Cognitive demand refers to command of the central concepts or "big ideas" of the discipline, generalization from specific instances to larger concepts, and connections and relationships among mathematics concepts. This dimension considers two aspects of cognitive demand: task selection and teacher enactment. That is, it considers the extent to which the selected task is cognitively demanding and the extent to which the teacher consistently and effectively promotes cognitive depth (Stein & Lane, 1996).

	Low (1, 2)	**Medium (3, 4, 5)**	**High (6, 7)**
Task Selection	The tasks of the lesson are focused on memorization or procedures without connections to underlying concepts. None of the tasks are open-ended.	Some of the tasks are focused on memorization or procedures without connections to underlying concepts, *and* some of the tasks are focused on procedures with connections to underlying concepts or non-algorithmic, complex thinking. Some of the tasks are open-ended.	The majority of the tasks of the lesson are focused on procedures with connections to underlying concepts or non-algorithmic, complex thinking. Most of the tasks are open-ended.
Teacher Enactment	The teacher rarely provides feedback, modeling, or examples that promote complex thinking by students. The teacher rarely encourages students to make conceptual connections.	The teacher sometimes provides feedback, modeling, or examples that promote complex thinking by students. The teacher sometimes encourages students to make conceptual connections.	The teacher often provides feedback, modeling, or examples that promote complex thinking by students. The teacher often encourages students to make conceptual connections.
Notes			

5. Mathematical Discourse Community: The extent to which the classroom social norms foster a sense of community in which students can express their mathematical ideas openly. The extent to which the teacher and students "talk mathematics," and students are expected to communicate their mathematical thinking clearly to their peers and teacher, both orally and in writing, using the language of mathematics.

NOTE: There is a "high bar" on this dimension because there is an expectation for students to have an active role in promoting discourse; this should not be only the teacher's role. This is in contrast to Explanation/Justification. The rating does take into account whether discourse focuses on mathematics content but not the cognitive depth of that content.

***Mathematical Thinking** = processes, strategies, and/or solutions.

	Low (1, 2)	**Medium (3, 4, 5)**	**High (6, 7)**
Teacher's Role in Discourse	The majority of math discussion in the classroom is directed from the teacher to the students. Students' ideas, questions, and input are rarely or never solicited.	Some of the math discussion in the classroom includes student participation, but some is teacher-initiated. Students' ideas, questions, and input are sometimes solicited.	Throughout the math discussion in the classroom, students consistently participate. Students' ideas, questions, and input are frequently solicited.
Sense of Mathematics Community through Student Talk	Student to student talk rarely or never occurs. When students talk, they rarely share mathematical thinking* and language.	Student to student talk sometimes occurs. When students talk, they sometimes share mathematical thinking* and language.	Student to student talk frequently occurs. When students talk, they often share mathematical thinking* and language.
Questions	All of the teacher's questions have known/correct answers.	Most of the teacher's questions have known/correct answers, but some encourage mathematical thinking*.	Some of the teacher's questions have known/correct answers, but many are encourage mathematical thinking*.
Notes			

6. Explanation and Justification: The extent to which the teacher expects and students provide explanations/justifications, both orally and on written assignments.

NOTE: Simply "showing your work" on written assignments – i.e., writing the steps involved in calculating an answer – does not constitute an explanation.

	Low (1, 2)	**Medium (3, 4, 5)**	**High (6, 7)**
Presence of Explanation and Justification	Students rarely provide explanations or justify their reasoning. Teachers rarely ask "what, how, why" questions or otherwise solicit student explanations/justifications.	Students sometimes provide explanations and/or justify their reasoning. Teachers sometimes ask "what, how, why" questions or otherwise solicit student explanations/justifications.	Students often provide explanations and/or justify their reasoning. Teachers often ask "what, how, why" questions or otherwise solicit student explanations/justification.
Depth of Explanation and Justification (procedural and conceptual)	Student explanations often focus on procedural steps *and rarely* include conceptual understanding of the topic(s).	Student explanations sometimes focus on procedural steps *and sometimes* include conceptual understanding of the topic(s).	Student explanations rarely focus on procedural steps *and often* focus on conceptual understanding of the topic(s).
Notes			

7. Problem Solving: The extent to which instructional activities enable students to identify, apply and adapt a variety of strategies to solve problems. The extent to which the problems that students solve are complex and allow for multiple solutions.

NOTE: This dimension focuses more on the nature of the activity/task, rather than the enactment. To receive a "High" rating, problems should not be routine or algorithmic; they should consistently require novel, challenging, and/or creative thinking.

[1] Student formulation of problems can improve the score for this domain, but scores should not decrease if this is not present.
[2] Student formulation of problems may involve students extending/following up on problems not originally formulated by students

	Low (1, 2)	**Medium (3, 4, 5)**	**High (6, 7)**
Students' Engagement with Problems	Students rarely engage in problems that allow them to grapple with mathematical concepts. Students often work on exercises for which they are practicing an already learned procedure.	Students sometimes engage in problems that allow them to grapple with mathematical concepts. Students sometimes work on exercises for which they are practicing an already learned procedure.	Students often engage in problems that allow them to grapple with mathematical concepts. Students rarely work on exercises for which they are practicing an already learned procedure.
Presence of Problem Solving with Multiple Strategies	Classroom activities encourage only one strategy to solve each problem.	Classroom activities sometimes encourage multiple strategies to solve each problem.	Classroom activities often encourage multiple strategies to solve each problem.
Student Formulation of Problems *(when applicable)*[1, 2]	If students formulate problems, they are generally procedural.	If students formulate problems, they are sometimes solved with multiple strategies.	If students formulate problems, they are generally solved with multiple strategies.
Notes			

8. Connections/Applications: The extent to which the lesson helps students connect mathematics to other mathematical concepts, their own experience, to the world around them, and to other disciplines. The extent to which the lesson helps students apply mathematics to real world contexts and to problems in other disciplines.

NOTE: The experiences may be teacher-generated or student-generated, but they should relate to the students' actual life situations.

	Low (1, 2)	**Medium (3, 4, 5)**	**High (6, 7)**
Connections	Meaningful connections between mathematics learned in the classroom and other math concepts, experiences, disciplines, and the world are rarely made.	Meaningful connections between mathematics learned in the classroom and other math concepts, experiences, disciplines, and the world are sometimes made.	Meaningful connections between mathematics learned in the classroom and other math concepts, experiences, disciplines, and the world are often made.
Applications	Students are never asked to apply the math they learn to the world around them. The class work is not relevant to students' lives.	Students are sometimes asked to apply the math they learn to the world around them. The class work is potentially relevant to the students' lives.	Students are often asked to apply the math they learn to the world around them. The class work is relevant to the students' lives.
Notes			

9. Mathematical Accuracy: The extent to which the mathematical concepts are presented clearly and accurately throughout the lesson. The extent to which student misconceptions are present, and whether teachers handle student misconceptions in a way that clarifies conceptual understanding.

	Low (1, 2)	Medium (3, 4, 5)	High (6, 7)
Accuracy in Teacher Presentation	A few of the concepts and procedures presented to the students by the teacher are mathematically accurate. Most of the concepts and procedures are mathematically inaccurate.	Most of the concepts and procedures presented to students by the teacher are mathematically accurate, but on a few occasions, the concepts and procedures are mathematically inaccurate.	The concepts and procedures presented to the students by the teacher are mathematically accurate.
Clarity of Mathematical Concepts	The mathematical concepts are not articulated clearly by the teacher. There is ambiguity in presentation of key mathematical concepts.	The mathematical concepts may be articulated with some clarity by the teacher. There is some ambiguity in presentation of key mathematical concepts.	The tasks in the lesson allow students to transfer the mathematics to future mathematical experiences.
Responsiveness to Student Mathematical Thinking *(code this portion NA if no misconceptions are observed)*	Student misconceptions are obvious in the lesson. The misconceptions are not noticed or addressed appropriately by the teacher. By the end of the lesson, students appear to retain misconceptions. Teacher response leads to ambiguity or confusion about mathematical concepts.	One or more student misconceptions are observed during the lesson. The misconceptions may have been addressed by the teacher, and student understanding was improved due to teacher responses. Teacher responses may lead to further clarity, but some ambiguity or confusion by students may also be present.	Student misconceptions may or may not have been observed during the lesson. The teacher clarified all misconceptions that students had during the lesson. Teacher responses lead to improved clarity about mathematical concepts.
Notes			

Approach to Reliability Training

M-Scan Reliability

The M-Scan training is a five day process involving reading, listening to conversations about each coding dimension, watching videotapes, and coding practice tapes. Training in the M-Scan involves a four phase process and each phase has a corresponding letter of the acronym PTRD: 1) preparation, 2) training/mastery phase, 3) reliability phase, and 4) drift test phase. Master coders keep track and record trainee's progress of attaining and maintaining reliability through these phases.

<u>(1) Preparation Phase:</u> Trainees read *Mathematics Teaching Today: Improving Practice, Improving Student Learning* (NCTM, 2007) and the *Principles and Standards for School Mathematics* (NCTM, 2000), as well as readings on cognitive demand, use of representations, mathematical tools, problem-solving, and discourse in mathematics teaching and learning. Trainees record notes and questions.

<u>(2) Training/Mastery Phase:</u>

- Trainees meet with a master coder to discuss questions from the preparation phase and attend the training session on mathematics coding. During the training, they review and discuss the coding manual, observation forms, and highlights from the readings.
- Trainees practice with the expert on at least two full class mathematics videos. After the training session, trainees watch two videotaped classes independently and take notes. Afterward, ratingsare compared to those of the master coders.
- After trainees have watched and coded the assigned set of "training" videos, the master coders identify gaps and look for convergence. More training tapes are assigned if gaps are present. Trainees' progress to the reliability phase when ratings from the training videos converge with master codes.

<u>(3) Reliability Phase:</u>

- Trainees watch and code six mathematics "reliability" video observations, without conferring with the master coder.
- Trainees meet with a master coder after watching the six mathematics "reliability" video observations. The master coder will identify gaps and look for convergence. Trainees' ratings are scrutinized carefully to figure out whether: 1) errors are systematic, for example, some constructs/items need further work, or 2) errors are not systematic, in which case the trainee and the master coder need to carefully review and discuss the codes together.
- Once the master coder has verified that the trainee is reliable. The trainee is able to code video mathematics observations using the M-Scan.

(4) Drift Test Phase:

- Twice a month, all coders meet to co-code one video mathematics lesson to check for drifts in coding. All coders confer to verify convergence with the master coders.

M-Scan Coding Sheet

The coding sheet for M-Scan is attached on the following page.

M-Scan Observational Measure of Standards-Based Mathematics Teaching Practices	
Structure of the Lesson *Logical sequence* *Mathematical coherence* *Promotion of deeper understanding*	**1 2 3 4 5 6 7**
Multiple Representations *Presence of representations* *Teacher translation of reps* *Student translation of reps*	**1 2 3 4 5 6 7**
Use of Mathematical Tools *Opportunity to use tools* *Depth of use*	**1 2 3 4 5 6 7**
Cognitive Demand *Task selection* *Teacher enactment*	**1 2 3 4 5 6 7**
Mathematical Discourse Community *Teachers' use of discourse* *Sense of mathematics community through student talk* *Questions*	**1 2 3 4 5 6 7**
Explanation and Justification *Presence of expl/just* *Depth of expl/just*	**1 2 3 4 5 6 7**
Problem Solving *Students' engagement w/problems* *Presence of multiple strategies* *Student formulation of problems*	**1 2 3 4 5 6 7**
Connections/Applications *Connections* *Applications*	**1 2 3 4 5 6 7**
Mathematical Accuracy *Accuracy in teacher presentation* *Clarity of mathematical concepts* *Responsiveness to student mathematical thinking*	**1 2 3 4 5 6 7**
Did the teacher present any content that was incorrect or communicate any misconceptions? _____Yes _____No ***If yes, please describe:***	