Developing a Measure for Quality Instruction in Community College Algebra Courses with a Mathematical Procedure Focus

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Abstract
How can the quality of mathematics instruction at community colleges be measured? In the Algebra Instruction in Community Colleges (AI@CC) project, we collected classroom video recordings from six community college algebra instructors in order to establish the quality of different aspects of instruction by adapting existing instruments (Mathematical Quality of Instruction (MQI)) and Quality of Instructional Practices in Algebra (QIPA) developed for P-12 settings. This paper presents the challenges that we encounter in the adaptation and calibration of the video analysis tools.

Project Description
Algebra Instruction in Community Colleges (AI@CC) is a NSF-funded project (Watkins, Duranczyk, Mesa, Ström, & Kohli, 2016) that investigates the relationship between teacher instruction and student learning and performance in intermediate and college level algebra courses at community colleges. This project attempts to shed light on characteristics of instruction and interaction in community college classrooms that are associated with student learning and performance in algebra courses. As the study by Heather Hill, Brian Rowan, and Deborah Ball was done in elementary setting and the study by Erica Litke was done in high school setting, there is a need to adjust the protocols from Mathematical Quality of Instruction (MQI) (2014) and Quality of Instructional Practices in Algebra (QIPA) (2015) to better capture the elements of our conceptual model (Figure 1) for community colleges.

Instructional Qualities (Mathematical Variables)
- Instructional level: Quality of instruction
  - Knowledge of subject matter
  - Use of technology
  - Attention to student needs
- Instructional setting: Quality of instructional settings
  - Student learning and course topic
  - Student learning and course topic
- Instructional practices: Quality of instructional practices
  - Student learning and course topic
  - Student learning and course topic

Moderating Variables
- Moderators: Quality of moderating variables
  - Knowledge of subject matter
  - Use of technology
  - Attention to student needs
  - Quality of instructional settings
  - Quality of instructional practices

Empirical Evidence
- Student Learning and Course Topic: Outcome Variables
  - Knowledge of subject matter
  - Use of technology
  - Attention to student needs
  - Quality of instructional settings
  - Quality of instructional practices

Figure 1. Conceptual model for AI@CC Project.

Research Question
How well are the instruments performing in capturing the quality of instruction and interaction in community college algebra courses?

Method
Pilot Data
- 3 Community colleges in Arizona, Michigan and Minnesota
- 3 Full-time instructors and 3 part-time instructors
- 160 students from Intermediate Algebra and College Algebra courses
- About 5 hours of video and audio recordings for each instructor
- Topics included linear equations, rational and exponential equations.

Instruments
- Mathematical Quality of Instruction (MQI)
- Quality Instruction Practice in Algebra (QIPA)

Mathematical Quality of Instruction (MQI)
- K-6 classrooms
- Gathers evidence of quality instruction in 4 areas: Richness of the Mathematics, Working with Students and Mathematics, Errors and Imprecision, and Common Core Aligned Student Practices.
- Videos were segmented and were scored on a 4-point scale.

Quality of Instructional Practices in Algebra (QIPA)
- 9th grade Algebra lessons
- Gathers data in the areas of Teaching Procedures, Building Understanding through Connections, and Mode of Instruction.
- Videos were segmented and were scored on a 5-point scale.

Challenges
As we started coding and calibrating using MQI, we found that:
- The scores and evidences were inconsistent among raters.
- Many of the codes were scored as Not Present.
- Quality of instruction on procedure was not captured as procedure is often the main feature in algebra courses.

Subsequently, we looked into another protocol from Quality of Instructional Practices in Algebra (QIPA), and started adapting MQI and QIPA to fit our needs.

Adaptation
In our adaptation, we incorporated 2 codes (red font) from QIPA into QIPA (Table 1). Example for one of the codes is shown in Figure 2. We also defined the following terms:
- Pre-remediation: Calling students attention to a common problem.
- Conceptual remediation: Identifying the source of student error and pointing to an underlying meaning.
- Procedural remediation: Demonstrating the correct procedure (not just saying the answer is incorrect).
- Brief: Not the focus and does not characterize the segment.
- Extensive: Focus of the segment.

Table 1. Codes for our adaptation of QIPA and MQI

<table>
<thead>
<tr>
<th>Teaching Procedures</th>
<th>Remediation of Student Errors and Difficulties</th>
</tr>
</thead>
<tbody>
<tr>
<td>Making Sense of Procedures</td>
<td>Organization in the Presentation of Procedures</td>
</tr>
<tr>
<td>Supporting Procedural Flexibility</td>
<td>Remediation of Student Errors and Difficulties</td>
</tr>
<tr>
<td>Overall Teaching Procedures</td>
<td>Explorations</td>
</tr>
<tr>
<td>Building Understanding through Connections</td>
<td>Connecting across Representations</td>
</tr>
<tr>
<td>Situating the Mathematics</td>
<td>Making Connections between Concrete and Algebraic Abstractions</td>
</tr>
<tr>
<td>Overall Building Understanding through Connections</td>
<td>Teacher-Led Instruction</td>
</tr>
</tbody>
</table>

Remediation of Student Errors and Difficulties
With this code, we record instances of remediation in which student misconceptions and difficulties with the content are addressed. In a conversation, if students are saying the correct answers then there is no remediation – if sustained, make sure to count student contributions as high. Scores:
- 1: There are no student misunderstandings or difficulties. Teacher JUST corrects answers with out explaining. The teacher does not remediate, or the remediation is confusing.
- 2: Brief Conceptual Remediation occurs. OR Brief or Moderate Procedural remediation occurs.
- 3: Moderate Conceptual Remediation that is not brief or too long. OR Extensive procedural remediation. OR Brief pre-remediation.
- 4: Possess qualities more than a 3 but less than a 5.
- 5: There is conceptual remediation systematically and it goes on at length such as identifying source of student errors, how student errors illustrate misunderstanding OR/AND Ext. Pre-Remediation.

Figure 2. Example of a code with definition and scores, which is adapted from MQI.

With the adaptations, we found that:
- Raters collected more similar evidences among each other.
- Raters scored more consistently among each other.
- The codes are more aligned in capturing quality procedural work and instruction, which is the main purpose of the project.

Acknowledgements
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Reference