EXAMINING MATHEMATICS COACHING

Construct Reliability and Validity of Selected EMC Instrumentation

December 13, 2010

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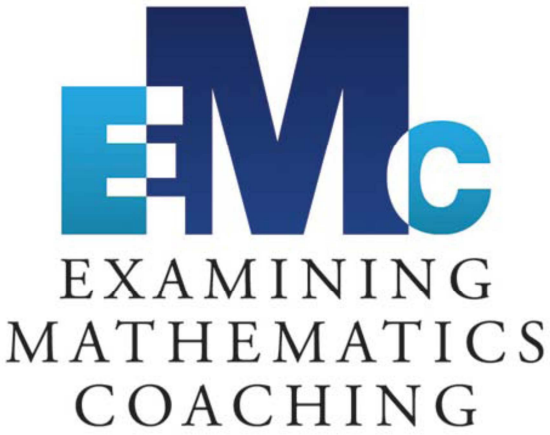

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Contents

Exhibits

Introduction

The Examining Mathematic Coaching (EMC) project is a research and development effort examining the effects of knowledge for coaching embedded in an innovative, previously developed coaching model applied to a population of K-8 teachers in diverse settings. It addresses the DRK-12 Proposal Solicitation challenge: *How can the ability of teachers to provide STEM education be enhanced?* The STEM discipline addressed is mathematics and the audience addressed is school-based mathematics coaches along with the teachers they coach. The context includes rural, urban, and suburban school districts along with districts whose student populations are predominantly Native American.

The EMC project is conducting research on knowledge that contributes to successful coaching in two domains: Coaching Knowledge and Mathematics Content Knowledge. The influence of these knowledge domains on both coaches and teachers will be examined (1) by investigating correlations between assessments of coach and teacher knowledge and practice in each domain and (2) by investigating causal effects of targeted professional development for coaches. The impact of coaches' knowledge will be measured through the lens of teacher change in the domains of content knowledge (focusing on number and operations), reform- and standards-based practice, attitudes and beliefs, self-efficacy, and perceptions of coach effectiveness. Research findings will be used to develop, modify, and apply tools to assist schools and STEM professional developers in areas of coaching such as selection, training, and assessment of impact.

The purpose of this report is to examine the reliability and validity evidence for seven of the eight instruments used to measure the above mentioned domains. Content knowledge is being measured through the use of the Mathematics Knowledge for Teaching (MKT) instrument which is continually being examined for validity and reliability through the Teaching Knowledge Assessment System. Exhibit 1 displays the remaining domains of interest tied to the instrument measuring each domain.

Exhibit 1. Domains of Interest and Instruments of Measurement

Domain	Instrument
Mathematics Teacher Efficacy (MTE) Teacher attitudes and beliefs	Teacher Survey (TS)
Coaching knowledge	Coaching Knowledge Survey (CKS)
Coach perceptions of coaching effectiveness and impact of that coaching	Coaches Coaching Reflection Instrument (CRI)
Teacher perceptions of coaching effectiveness and impact of that coaching	Teachers Coaching Reflection Instrument (TRI)
Coaching skills	Coaching Skills Inventory (CSI)
Teacher reported needs for coaching mathematic	Teacher Needs Inventory (TNI)
Reform- and standards-based teaching practices	Inside the Classroom-Classroom Observation Protocol (ITC-COP)

In the following sections, construct validity and internal reliability evidence on the data produced from each of these instruments is reported. To assess the construct validity of data produced from each instrument, factor analyses with varimax rotations[1] were computed. An orthogonal (varimax) rotation was selected in order to maximize the variance explained. The internal reliability[2] of the overall scales and any revealed subscales was assessed using Cronbach's alpha[3].

The following seven sections provide detailed information regarding (1) the instrument, (2) the results of the factor analysis, (3) the internal reliability computations, (4) any recommendations for modification of the instrument, and (5) mean scores and standard deviations for the factor(s) revealed for each instrument.

[1] An orthogonal rotation that places the final factors at right angles to each other so we can interpret that information provided by one factor is independent of information provided by the other factors.
[2] The internal consistency of survey instruments is a measure of reliability of different survey items intended to measure the same characteristic.
[3] Cronbach's alpha (α) is a measure of the reliability or internal consistency of a composite measure or scale that is based on multiple survey items. Values range from 0 to 1.

Construct Validity and Reliability of the EMC Teacher Survey

The Instrument

The EMC Teacher Survey, a 41 item instrument using 8 point scaled responses, is designed to measure a teacher's personal level of preparedness, anxiety and self-efficacy for teaching mathematics, along with the level of participation in mathematics-related professional development. Areas explored include:

- Level of preparedness, 9 items
- Level of anxiety, 6 items
- Level of engagement in mathematics-related activities, 8 items
- Level of teacher efficacy (confidence, feeling of support, and ability level for teaching mathematics), 18 items
- Background and practices as an educator (demographic data such as highest degree, courses taught, field of study, experience as a teacher, etc.)

Factor Analysis

In March of 2010 and June of 2010, all participating EMC teachers (N = 167; 171) were asked to complete the survey. While the sample size may be considered only fair according to Comrey and Lee (1992), the high communalities[4] revealed for each item reduced the need for a larger sample (MacCallum, Widaman, Zhang, & Hong, 1999).

The Preparedness to Teach Mathematics scale is measured on a numerical continuum of 1 to 8 with Likert descriptors at 1 = Unsatisfactory, 3 = Developing, 6 = Proficient, and 8 = Exceptional. The Anxiety for Teaching Mathematics scale is measured on a numerical continuum of 1 to 8 with Likert descriptors at 1 = Extremely Low, 3 = Below Average, 6 = Above Average, and 8 = Extremely High. The Engagement in Mathematics Activities scale is measured on a numerical continuum of 0 to 8 with Likert descriptors at 0 = N/A, 1 = Extremely Low, 3 = Below Average, 6 = Above Average, and 8 = Extremely High. The Mathematics Teacher Efficacy (MTE) scale is measured on a numerical continuum of 1 to 8 with Likert descriptors at 1 = Extremely Low, 3 = Below Average, 6 = Above Average, and 8 = Extremely High.

All 41 items from each of the four constructs were entered into SPSS for an initial exploratory factor analysis. The results of this analysis revealed a 7 factor structure with problematic loadings for three of the Engagement in Mathematics Activities items. These three items were removed from the analysis and the remaining 38 items formed 6 stable factors that explained 68.49% of the variance in teacher beliefs. Factor 1 consisted of the 9 preparedness items; factor 2 consisted of the 6 anxiety items; factors 3 – 5 form the MTE subscales of support, ability, and confidence, respectively; and, factor 6 consisted of the five engagement items. The factor structure is presented in Exhibit 2. Exhibits 3 – 8 present the item descriptions for each factor.

[4] The communality for a given variable can be interpreted as the proportion of variation in that variable which is explained by the factors.

Exhibit 2. Teacher Survey Factor Structure

	Factor					
Item #	1 Preparedness to Teach Mathematics	2 Anxiety for Teaching Mathematics	3 MTE – Support for Teaching Mathematics	4 MTE – Ability for Teaching Mathematics	5 MTE – Confidence for Teaching Mathematics	6 Engagement in Mathematics Activities
1a	.823					
1d	.813					
1f	.764					
1e	.761					
1b	.749					
1h	.697					
1c	.678					
1g	.656					
1i	.615					
2c		-.833				
2f		-.818				
2e		-.789				
2b		-.786				
2d		-.785				
2a		-.765				
4b			.856			
4h			.812			
4d			.744			
4n			.739			
4l			.712			
4j			.679			
4p				.730		
4i	.421			.669		
4o				.660		
4g				.645		
4r				.536	.431	
4m				.507		
4c					.813	
4a					.738	
4f				.513	.652	
4e					.552	
4q				.401	.519	
4k				.453	.486	
3d						.826
3c						.810
3e						.749
3f						.707
3h						.672

Note: Principal Components Extraction: Factor 1 = 16.36%, Factor 2 = 12.86%, Factor 3 = 11.14%, Factor 4 = 10.11%, Factor 5 = 9.04%, Factor 6 = 8.98%. Total variance explained = 68.49%

Exhibit 3. Factor 1: Preparedness to Teach Mathematics

Item #	Item Description
1a	Providing mathematics instruction that meets appropriate standards.
1b	Teaching problem-solving strategies.
1c	Teaching mathematics with the use of manipulative materials.
1d	Sequencing mathematics instruction to meet instructional goals.
1e	Selecting and/or adapting instructional materials to implement your written curriculum.
1f	Making connections within mathematics and between mathematics and other subject areas.
1g	Providing a challenging curriculum for all students you teach.
1h	Using a variety of assessment strategies.
1i	Using results from student assessment to inform practice.

Exhibit 4. Factor 2: Anxiety for Teaching Mathematics

Item #	Item Description
2a	What is your anxiety level when teaching a difficult math lesson?
2b	What is your anxiety level when you have to explain different ways of solving a difficult math problem to your students?
2c	What is your anxiety level when answering student questions in the mathematics classroom?
2d	What is your anxiety level for assessing your students in the mathematics classroom?
2e	What is your anxiety level for determining if an alternative math solution presented by a student is useful in all situations?
2f	What is your anxiety level for preparing to teach a new lesson in mathematics?

Note. Items on this subscale are reversed.

Exhibit 5. Factor 3: Mathematics Teacher Efficacy: Support for Teaching Mathematics

Item #	Item Description
4b	How supported do you feel for working with fellow teachers during the regular school week on mathematics curriculum and/or instruction?
4d	How supported do you feel for working with knowledgeable peers to increase your mathematics content knowledge?
4h	How supported do you feel to learn new things about mathematics pedagogy in your present job?
4j	How supported do you feel from colleagues to try out new ideas in teaching mathematics?
4l	How supported do you feel to attend mathematics-specific professional development sessions?
4n	How supported do you feel from the school administration for teaching mathematics?

Exhibit 6. Factor 4: Mathematics Teacher Efficacy: Ability for Teaching Mathematics

Item #	Item Description
4g	What is your ability level to gauge student comprehension of a mathematics lesson you just taught?
4i	What is your ability level to craft good mathematics questions for your students?
4m	What is your level of confidence for demonstrating effective math lessons to your peers?
4o	What is your ability level for adjusting your mathematics lesson to the proper level for individual students?
4p	What is your ability level for using a variety of mathematics assessment strategies?
4r	What is your ability level for providing an alternative explanation or example when your mathematics students are confused?

Exhibit 7. Factor 5: Mathematics Teacher Efficacy: Confidence for Teaching Mathematics

Item #	Item Description
4a	What is your level of confidence for learning mathematics at the college algebra level?
4c	What is your level of confidence for teaching mathematics at the middle school level or above?
4e	What is your ability level to respond to difficult mathematics questions from your students?
4f	What is your level of confidence in your mathematics content knowledge?
4k	What is your level of confidence in your mathematics pedagogical content knowledge?
4q	What is your level of confidence that your mathematics content knowledge is above the level of your peers?

Exhibit 8. Factor 6: Engagement in Mathematics Activities

Item #	Item Description
3c	Engaging in informal discussions with teachers about the teaching and learning of mathematics.
3d	Engaging in formal, ongoing discussions with teachers about the teaching and learning of mathematics.
3e	Observing demonstrations of teaching techniques.
3f	Developing curricula or lesson plans, which others review.
3h	Engaging in informal, self-directed learning.

Internal Reliability

Internal reliability for the four scales and the three MTE subscales, as presented in Exhibit 9, reveals a high level of reliability.

Exhibit 9. Reliability Analysis for the Teacher Survey

Scale	Cronbach's Alpha
Preparedness to Teach Mathematics	.933
Anxiety for Teaching Mathematics	.944
Overall Mathematics Teacher Efficacy Scale	.920
Efficacy for Support of Mathematics Teaching	.899
Efficacy for Ability to Teach Mathematics	.894
Efficacy for Confidence in Teaching Mathematics	.882
Engagement in Mathematics Activities	.846

Recommendations

The data produced from the EMC Teacher Survey shows strong reliability and validity. The only recommended change to the instrument is for the removal of the three Engagement in Mathematics Activities items from further analysis.

Descriptive Statistics from EMC Teacher Survey Data Set

Exhibit 10 displays the means and standard deviations each of the scale categories for elementary teachers and middle school teachers. The highest reported mean score was for Preparedness to Teach Mathematics.

Exhibit 10. Means and Standard Deviations for Scale Items on the Teacher Survey

	Elementary Teachers (*N* = 125)		Middle School Teachers (*N* = 46)	
Scale	***Mean***	***SD***	***Mean***	***SD***
Preparedness to Teach Mathematics	5.48	1.01	5.44	0.91
Anxiety for Teaching Mathematics	3.62	1.24	3.49	1.06
Overall Mathematics Teacher Efficacy Scale	4.91	0.94	5.29	0.89
Efficacy for Support of Mathematics Teaching	5.13	1.22	5.26	1.40
Efficacy for Ability to Teach Mathematics	5.00	0.98	5.21	0.88
Efficacy for Confidence in Teaching Mathematics	4.60	1.14	5.41	1.24
Engagement in Mathematics Activities	4.48	1.24	4.64	1.62

Construct Validity and Reliability of the EMC Coaching Reflection and Impact Survey

The Instrument

The EMC Coaching Reflection and Impact Survey (CRIS) was modeled on two pre-existing instruments, the Coaching Impact Instrument (CII) developed by Yopp (2008) and the Coaching and Teacher Reflection Instrument (CTRI) developed by Yopp, Rose, and Meade (2008). The new CRIS provides a tool for monitoring and logging coaching interactions including quantity, quality, and duration of coaching sessions along with measuring coaches' perceptions of coaching's impact on instruction. In June of 2010, all participating EMC coaches (N = 58) were asked to complete the survey for each of the teachers they coach. This resulted in 174 coaching session evaluations.

Factor Analysis

To assess the construct validity of each of the 17 coaching topic reflection items and the 13 coaching impact items, maximum likelihood extractions with varimax rotations were computed on the data for each set of items. The Coaching Topic Reflection scale and the Coaching Impact scale had reasonably high variance explained levels of 65.3% and 54.9% respectively. Exhibit 11 displays the factor structure of the coaching reflection items on the CRIS and Exhibits 12 – 15 display the item descriptions for each factor.

Coaching Topic Reflection Scale

Exhibit 11. Coaching Reflection Survey Factor Structure

	Factor			
Item #	1 Student Centeredness Discussions	2 Mathematics Pedagogy Discussions	3 Coaching Relationship	4 Content Discussions
2l	.734			
2k	.690			
2m	.678			
2o	.674			
2p	.626			
~~2n~~	~~.557~~	~~.499~~		
2q	.536			
~~2j~~	~~.491~~	~~.487~~		
2h		.702		
2g		.667		
2f		.656		
2i		.643		
2c		.598		
2e		.586		
1a			.916	
1b			.889	
1c			.848	
1d			.844	
2b				.825
2a				.805
~~2d~~				

Note: Maximum Likelihood Extraction: Factor 1 = 19.37%, Factor 2 = 18.24%, Factor 3 = 17.37%, Factor 4 = 10.33%. Total variance explained = 65.30%.

Exhibit 12. Factor 1: Student-Centered Discussions

Item #	Item Description
2k	The teacher and I discussed ways to increase student participation in mathematics lessons.
2l	The teacher and I discussed ways to create an environment where students listen to one another's mathematical ideas.
2m	The teacher and I discussed ways to "read" or detect students' understanding of the mathematics being taught.
2o	The teacher and I set goals and objectives aimed at implementing ideas and addressing issues we discussed.
2p	The teacher and I were reflective about her or his students' learning.
2q	The teacher and I were reflective about her or his teaching practices.

Exhibit 13. Factor 2: Mathematics Pedagogy Discussion

Item #	Item Description
2c	The teacher and I discussed mathematical content beyond the grade level(s) she/he teaches.
2f	The teacher and I discussed ways to infuse more mathematical concept development into lessons.
2g	The teacher and I discussed ways to infuse more mathematical problem-solving into lessons.
2h	The teacher and I discussed ways to engage students in thought-provoking activities centered on important mathematical ideas.
2i	The teacher and I discussed ways to emphasize elements of mathematical abstraction or sense-making into lessons.

Exhibit 14. Factor 3: Coaching Relationship

Item #	Item Description
1a	The teacher seemed open to discussion.
1b	The teacher seemed open to feedback.
1c	The teacher seemed willing to reflect on her or his teaching practices.
1d	The teacher seemed to value my input.

Exhibit 15. Factor 4: Content Discussions

Item #	Item Description
2a	The teacher and I discussed significant and worthwhile mathematical content.
2b	The teacher and I discussed mathematical content at the grade level(s) she/he teaches.

Coaching Impact Scale

The Coaching Impact scale consists of 13 items and is measured on a 6 point Likert scale with anchors at 0 = Didn't discuss, or not a topic of emphasis, 1 = Discussed, but no impact, 3 = Moderate impact, and 5 = Very large impact. As shown in Exhibit 16, the 13 items in the coaching impact scale worked together to form one scale.

Exhibit 16. CRI Impact Scale and Item Descriptions

Item	Description	Factor 1 Impact
3c	Discussions with the teacher about ways to infuse more conceptual understanding into lessons.	.822
3g	Discussions with the teacher about ways to engage students in thought-provoking activities centered on important mathematical ideas.	.813
3m	Discussions with the teacher about her or his teaching practices.	.805
3h	Discussions with the teacher about ways to emphasize elements of mathematical abstraction or sense-making in lessons.	.787
3d	Discussions with the teacher about ways to infuse more problem-solving into lessons.	.783
3f	Discussions with the teacher about ways to improve the use of questioning strategies in the context of mathematics instruction (such as, but not limited to, higher-order questions, open questions or wait time).	.760
3l	Discussions with the teacher about her or his students' learning.	.720
3b	Discussions with the teacher about ways of incorporating investigative, inquiry-based or discovery-based mathematics learning into his or her lessons.	.717
3k	The goals and objectives the teacher and I set aimed at implementing ideas and addressing issues we discussed.	..707
3i	Discussions with the teacher about ways to encourage student participation.	.702
3j	Discussions with the teacher about ways to encourage students to pursue intellectual rigor, constructive criticism and/or challenging of ideas.	.674
3e	Discussions with the teacher about ways to "read" or detect students' levels of understanding.	.668
3a	The mathematical content the teacher and I discussed.	.648

Note: Factor 1 = 54.91% of the variance.

Internal Reliability

Internal reliability of the scales on the CRIS, as presented in Exhibit 17, reveals a high level of reliability for all five scales.

Exhibit 17. Reliability Analysis for the CRIS

Scale	Cronbach's Alpha
Student Centered Discussions	.888
Mathematics Pedagogy Discussions	.896
Coaching Relationships	.939
Content Discussions	.889
Impact of Coaching	.939

Recommendations

After removal of the three items with problematic factor structure coefficients, the remaining items form five scales that appear to produce reliable and valid data.

Descriptive Statistics from the EMC CRIS Data Set

Means and standard deviations for the six scales derived from the CRIS are presented in Exhibit 18. The highest mean scores appear for Coaching Relationships and Content Discussions.

Exhibit 18. Means and Standard Deviations for Scale Items on the CRIS (*N* = 174)

Scale	*Mean*	*SD*
Student Centered Discussions	3.37	0.97
Mathematics Pedagogy Discussions	3.14	1.01
Coaching Relationships	4.24	0.85
Content Discussions	3.79	0.93
Impact of Coaching	2.52	1.17

Construct Validity and Reliability of the EMC Teacher Reflection and Impact Survey

The Instrument

The EMC Teacher Reflection and Impact Survey (TRIS) is the teacher version of the CRIS and provides a format for participating teachers to reflect upon the mathematics coaching they have received and then assess the perceived impact of that coaching. In June of 2010, all participating EMC teachers (N = 173) were asked to complete the survey.

Factor Analysis

To assess the construct validity of the 17 coaching topic reflection items and the 13 coaching impact items, maximum likelihood extractions with varimax rotations were computed on the data for each set of items. Exhibit 19 displays the factor loadings for the coaching reflection items and Exhibits 20 and 21 display the item descriptions.

Teacher Topic Reflection Scale

Exhibit 19. Teacher Topic Reflection Factor Structure

	Factor	
Item #	1 Topics Discussed	2 Coaching Relationship
7c	.858	
7e	.849	
7f	.839	
7g	.837	
7h	.807	
7i	.807	
7n	.798	
7l	.785	
7k	.784	
7a	.780	.405
7m	.765	
7p	.759	.408
7b	.757	
7o	.739	
7j	.735	
~~7q~~	~~.715~~	~~.450~~
7d	.674	
6a		.953
6b		.946
6c		.807
6d		.779

Note: Factor 1 = 51.39%, Factor 2= 21.94%. Total variance explained = 73.33%.

Exhibit 20. Factor 1: Topics Discussed

Item #	Item Description
7a	My coach and I discussed significant and worthwhile mathematical content.
7b	My coach and I discussed mathematical content that I teach.
7c	My coach and I discussed ways to increase the level of cognitive demand of the mathematical content I teach.
7d	My coach and I discussed mathematical content beyond the grade(s) I teach.
7e	My coach and I discussed ways of incorporating investigative, inquiry-based or discovery-based mathematics learning into my lessons.
7f	My coach and I discussed ways to infuse more mathematical concept development into my lessons.
7g	My coach and I discussed ways to infuse more mathematical problem-solving into my lessons.
7h	My coach and I discussed ways to engage students in thought-provoking activities centered on important mathematical ideas.
7i	My coach and I discussed ways to emphasize elements of mathematical abstraction or sense-making into my lessons.
7j	My coach and I discussed ways to encourage students to pursue intellectual rigor, constructive criticism and/or challenging of ideas.
7k	My coach and I discussed ways to increase student participation in mathematics lessons.
7l	My coach and I discussed ways to create an environment where students listen to one another's mathematical ideas.
7m	My coach and I discussed ways to "read" or detect students' levels of understanding of the mathematics being taught.
7n	My coach and I discussed ways to improve the use of questioning strategies in the context of mathematics instruction (such as, but not limited to, higher-order questions, open questions or wait time).
7o	My coach and I set goals and objectives aimed at implementing ideas and addressing issues we discussed.
7p	My coach and I were reflective about my students' learning.

Exhibit 21. Factor 2: Coaching Relationship

Item #	Item Description
6a	I felt comfortable communicating with my coach.
6b	I felt my coach respects my opinions and understands my situation and the challenges I face.
6c	I felt comfortable with my coach's reflecting on my teaching practices.
6d	I valued my coach's input.

Coaching Impact Scale

The Coaching Impact scale consists of 13 items and is measured on a 6 point Likert scale with anchors at 0 = Didn't discuss, or not a topic of emphasis, 1 = Discussed, but no impact, 3 = Moderate impact, and 5 = Very large impact. As shown in Exhibit 22, the 13 items in the coaching impact scale worked together to form one scale.

Exhibit 22. Teacher Impact Factor Structure and Item Descriptions

Item	Description	Factor 1 Impact
8g	Discussions with my coach about ways to engage students in thought-provoking activities centered on important mathematical ideas.	.876
8l	Discussions with my coach about my students' learning.	.858
8b	Discussions with my coach about ways of incorporating investigative, inquiry-based or discovery-based mathematics learning into my lessons.	.857
8h	Discussions with my coach about ways to emphasize elements of mathematical abstraction or sense-making in lessons.	.842
8m	Discussions with my coach about my teaching practice.	.840
8i	Discussions with my coach about ways to encourage student participation.	.839
8c	Discussions with my coach about ways to infuse more conceptual understanding into my lessons.	.837
8f	Discussions with my coach about ways to improve the use of questioning strategies in the context of mathematics instruction (such as, but not limited to, higher-order questions, open questions or wait time).	.823
8a	The mathematical content my coach and I discussed.	.816
8k	The goals and objectives my coach and I set aimed at implementing ideas and addressing issues we discussed.	.815
8d	Discussions with my coach about ways to infuse more problem-solving into my lessons.	.813
8j	Discussions with my coach about ways to encourage students to pursue intellectual rigor, constructive criticism and/or challenging of ideas.	.811
8e	Discussions with my coach about ways to infuse more problem-solving into my lessons.	.800

Note: Factor 1 = 69.42% of the variance.

Internal Reliability

Internal reliability of the scales on the TRIS, as presented in Exhibit 23, reveals a high level of reliability for each of the three scales.

Exhibit 23. Reliability Analysis for the TRIS

Scale	Cronbach's Alpha
Topics Discussed	.973
Coaching Relationships	.953
Impact of Coaching	.967

Recommendations

The reliability and validity of the data produced from this instrument was very good after the removal of one item. The recommendation is to remove the one item from further analysis.

Descriptive Statistics from the EMC TRIS Data Set

Means and standard deviations for the six scales derived from the TRIS are presented in Exhibit 24. The highest mean score appears for Coaching Relationships.

Exhibit 24. Means and Standard Deviations for Scale Items on the TRIS (*N* = 174)

Scale	*Mean*	*SD*
Topics Discussed	3.51	1.08
Coaching Relationships	4.60	0.77
Impact of Coaching	2.84	1.37

Construct Validity and Reliability of the EMC Coaching Skills Inventory

The Instrument

The EMC Coaching Skills Inventory (CSI), originally developed by Yopp (2008), is designed to measure a mathematics coach's perspective on his or her own level of effectiveness or confidence with various coaching responsibilities. The inventory has 24 items measured on a 5 point Likert scale with a higher rating indicating a higher level of perceived effectiveness. The 24 items are broken down into five categories: coach/teacher relationships, coaching skills, mathematics content, mathematics-specific pedagogy, and general pedagogy. In March of 2010 and June of 2010, all participating EMC coaches (N = 57) were asked to complete the survey.

Factor Analysis

To assess the construct validity of the data produced from this instrument, maximum likelihood extraction with varimax rotation was computed using all 24 items. The results of this factor analysis should be interpreted with caution due to the small sample size of the data set. Repeat analyses should be conducted with a larger population of coaches in order to ensure the validity of the structure reported below. Exhibit 25 displays the factor structure of the CSI and Exhibits 26 – 28 display the item descriptions for each factor.

Exhibit 25. Coaching Skills Inventory Factor Structure

	Factor			
Item #	1 Mathematics Content and Mathematics Specific Pedagogy	2 Student Centered Pedagogy Coaching	3 Building Coaching Relationships	4 Discarded Factor
16	.840			
15	.829			
8	.808			
6	.784			
13	.772			
10	.738			
12	.737			
14	.730			
9	.626			
11	.600			
~~5~~	~~.546~~			
20		.894		
22		.801		
21		.774		
7		.729		
24		.723		
23		.695		
~~17~~		~~.517~~	~~.415~~	~~.437~~
4			.817	
1			.655	
3			.584	
2			.564	
~~19~~		~~.513~~		~~.582~~
~~18~~		~~.428~~	~~.500~~	~~.529~~

Note: Maximum Likelihood Extraction: Factor 1 = 40.87%, Factor 2 = 16.87%, Factor 3 = 5.06%. Total variance explained = 62.80%.

Exhibit 26. Factor 1: Mathematics Content and Mathematics-Specific Pedagogy

Item #	Item Description
6	How effective do you feel coaching teachers on mathematical content?
8	How effective do you feel coaching teachers on mathematics-specific pedagogy?
9	How confident are you with the mathematics taught at the grade levels that you coach?
10	How confident are you with the mathematical reasoning behind mathematics taught at the grade levels that you coach, meaning the understanding of why we teach it, how it relates to other mathematics topics, and why it is valid?
11	How effective do you feel coaching teachers on number sense and computation topics relevant to their classrooms?
12	How effective do you feel coaching teachers on creating and using mathematical applications and connections for/in their mathematics classes?
13	How effective do you feel coaching teachers on incorporating mathematics conceptual understanding into their lessons?
14	How effective do you feel coaching teachers on incorporating genuine mathematical problem-solving into their lessons?
15	How effective do you feel coaching teachers on incorporating investigative, inquiry-based or discovery-based mathematics learning into their lessons?
16	How effective do you feel coaching teachers on engaging students in mathematical abstraction or sense-making?

Exhibit 27. Factor 2: Student-Centered Pedagogy Coaching

Item #	Item Description
7	How effective do you feel coaching teachers on general (not necessarily mathematics-specific) pedagogy?
20	How effective do you feel coaching teachers on encouraging student participation?
21	How effective do you feel coaching teachers on using strategies to increase student collaboration or dialogue among students?
22	How effective do you feel coaching teachers on creating an environment where students listen to one another?
23	How effective do you feel coaching teachers on the use of cooperative learning?
24	How effective do you feel coaching teachers on classroom management?

Exhibit 28. Factor 3: Building Coaching Relationships

Item #	Item Description
1	How effective do you feel observing lessons and giving teachers feedback?
2	How effective do you feel creating environments where teachers reflect openly on their instructional practices?
3	How effective do you feel helping teachers set goals and objectives aimed at improving their instruction?
4	How effective do you feel creating an environment of open discussion and constructive criticism with teachers?

Internal Reliability

Internal reliability of the scales on the CSI, as presented in Exhibit 29, reveals a high level of reliability for each of the three scales.

Exhibit 29. Reliability Analysis for the CSI

Scale	Cronbach's Alpha
Mathematics Content and Mathematics Specific Pedagogy	.935
Student Centered Pedagogy Coaching	.932
Building Coaching Relationships	.822

Recommendations

The reliability and validity of the data produced from this instrument was very good after the removal of four items. The recommendation is to remove the four items from further analysis.

Descriptive Statistics from the EMC CSI Data Set

Means and standard deviations for the three scales derived from the CSI are presented in Exhibit 30. The highest mean score appears for Student Centered Pedagogy Coaching.

Exhibit 30. Means and Standard Deviations for Scale Items on the CSI (*N* = 61)

Scale	*Mean*	*SD*
Mathematics Content and Mathematics Specific Pedagogy	3.63	0.63
Student Centered Pedagogy Coaching	3.83	0.72
Building Coaching Relationships	3.58	0.65

Construct Validity and Reliability of the EMC Teacher Needs Inventory

The Instrument

The EMC Teacher Needs Inventory (TNI), originally developed by Yopp (2008) and modified for EMC, is designed to help the teacher take ownership of the coaching process. The responses are used by the coach as a tool to help focus the coaching and increase effectiveness. The instrument will be used to ensure all coaching sessions are focused on the correct topics.

Areas explored include:
- Teaching Conceptual and Inquiry-Based Lessons, 4 items
- Classroom Environment, 4 items
- Conceptual Understanding of Mathematics, 6 items
- Mathematics Content Knowledge, 4 items
- Classroom Management, 3 items

The inventory has 21 items measured on a 5 point Likert scale with anchors at 1 = Not at all confident and 5 = Very confident. For each topic item, the participant is also asked to rate their feelings toward working with a coach on the topic. These items are rated on a 3 point scale with 1 = I would not like to partner with my coach, 2 = I'm not sure I would like to partner with my coach, and 3 = I would like to partner with my coach. In March of 2010 and June of 2010, all participating EMC teachers (N = 175) were asked to complete the survey.

Factor Analysis – Part A

To assess the construct validity of the data produced from Part A of this instrument, maximum likelihood extraction with varimax rotation was computed using the data from the 21 topic items. Exhibit 31 displays the factor structure of Part A of the TNI and Exhibits 32 – 34 display the item descriptions.

Exhibit 31. Teacher Needs Inventory Factor Structure (Part A Confidence)

	Factor		
Item #	1 Mathematics Content Confidence	2 Student Centered Classroom Culture Confidence	3 Mathematics-Specific Pedagogy Confidence
18a	.690		
17a	.683		
15a	.678		
16a	.608		
9a	.551		.471
~~5a~~	~~.495~~		
20a		.789	
19a		.712	
21a		.600	.436
7a		.582	
6a		.538	
4a		.512	
~~14a~~		~~.458~~	
~~8a~~		~~.424~~	
12a			.623
1a			.622
~~11a~~	~~.504~~		~~.612~~
3a			.571
10a	.461		.537
2a			.532
~~13a~~			~~.473~~

Note: Factor 1 = 17.17%; Factor 2 = 15.80%; Factor 3 = 15.66%. Total variance explained = 48.63%.

Exhibit 32. Factor 1: Mathematics Content Confidence

Item #	Item Description
9	How confident are you with the math reasoning behind the math you teach – meaning the understanding of why we teach it, how it relates to other math topics, and why it is valid?
15	How confident are you with the math you teach?
16	How confident are you with the math beyond the math that you teach, meaning the next grade level?
17	How confident do you feel planning lessons that include fraction concepts?
18	How confident do you feel planning lessons that include number sense and operations?

Exhibit 33. Factor 2: Student-Centered Classroom Culture Confidence

Item #	Item Description
4	How confident do you feel using cooperative learning?
6	How confident do you feel using strategies to increase student collaboration or dialogue among students?
7	How confident do you feel creating an environment where students listen to one another?
19	How confident do you feel encouraging student participation?
20	How confident do you feel with classroom management?
21	How confident do you feel managing a classroom where students are engaged in inquiry-based or discovery-based tasks?

Exhibit 34. Factor 3: Mathematics-Specific Standards-Based Pedagogy Confidence

Item #	Item Description
1	How confident do you feel incorporating investigative, inquiry-based or discovery-based math learning into your lessons?
2	How confident do you feel using instructional strategies that are likely to increase students' math conceptual understanding or problem-solving abilities?
3	How confident do you feel engaging students in math abstraction and sense-making (including symbol use, theory building, and justification and reasoning)?
10	How confident do you feel creating and teaching math applications and connections to other areas of math?
12	How confident do you feel planning lessons that include genuine math problem-solving?

Factor Analysis – Part B

To assess the construct validity of the data produced from Part B of this instrument, maximum likelihood extraction with varimax rotation was computed using data from the 21 desire to be coached items. Exhibit 35 displays the factor structure of Part B of the TNI and Exhibits 36 – 37 display the item descriptions. Exhibit 38 shows the correlations between Part A and Part B and reveals there is an inverse relationship between the teachers' confidence in an item (Part A) and their desire to be coached on that item (Part B).

Exhibit 35. Teacher Needs Inventory Factor Structure (Part B Desire to be Coached)

	Factor		
Item #	1 Mathematics Content and Mathematics-Specific Pedagogy	2 Student Centered Classroom Culture	3 Inquiry Based Mathematics
11b	0.76		
15b	0.74		
9b	0.73		
10b	0.73		
5b	0.71	0.40	
16b	0.71		
18b	0.70	0.48	
17b	0.69		
13b	0.64		
12b	0.62		
~~14b~~	~~0.56~~	~~0.49~~	
8b	0.55	0.41	
~~3b~~	~~0.49~~		
19b		0.86	
20b		0.83	
7b		0.77	
21b		0.70	
4b		0.67	
6b		0.64	
~~1b~~			~~0.93~~
~~2b~~		~~0.42~~	~~0.46~~

Note: Factor 1 = 31%; Factor 2 = 25%; Factor 3 = 10%. Total variance explained = 66%.

Exhibit 36. Factor 1: Mathematics Content and Mathematics-Specific Pedagogy

Item #	Item Description
5b	How confident do you feel about "reading" or detecting students' level of mathematical understanding?
8b	How confident do you feel encouraging intellectual rigor, constructive criticism or challenging of ideas?
9b	How confident are you with the mathematical reasoning behind the mathematics you teach – meaning the understanding of *why* we teach it, *how* it relates to other mathematics topics, and *why* it is valid?
10b	How confident do you feel creating and teaching mathematical applications and connections to other areas of mathematics?
11b	How confident do you feel planning lessons that include mathematical conceptual understanding?
12b	How confident do you feel planning lessons that include genuine mathematical problem-solving?
13b	How confident do you feel planning lessons that include proportional reasoning?
15b	How confident are you with the mathematics that you teach?
16b	How confident are you with the mathematics beyond the mathematics that you teach, meaning the next grade level?
17b	How confident do you feel planning lessons that include fraction concepts?
18b	How confident do you feel planning lessons that include number sense and operations?

Exhibit 37. Factor 2: Student-Centered Classroom Culture

Item #	Item Description
4b	How confident do you feel using cooperative learning?
6b	How confident do you feel using strategies to increase student collaboration or dialogue among students?
7b	How confident do you feel creating an environment where students listen to one another?
19b	How confident do you feel encouraging student participation?
20b	How confident do you feel with classroom management?
21b	How confident do you feel managing a classroom where students are engaged in inquiry-based or discovery-based tasks?

Exhibit 38. Correlation Between Part A and Part B

Item	Correlation between Part A and B
1. How confident do you feel incorporating investigative, inquiry-based or discovery-based mathematics learning into your lessons?	-0.285
2. How confident do you feel using instructional strategies that are likely to increase students' mathematical conceptual understanding or problem-solving abilities?	-0.581
3. How confident do you feel engaging students in mathematical abstraction and sense-making (including symbol use, theory building, and justification and reasoning)?	-0.161
4. How confident do you feel using cooperative learning?	-0.334
5. How confident do you feel about "reading" or detecting students' level of mathematical understanding?	-0.369
6. How confident do you feel using strategies to increase student collaboration or dialogue among students?	-0.505
7. How confident do you feel creating an environment where students listen to one another?	-0.408

Internal Reliability

Internal reliability of the scales on the TNI, as presented in Exhibit 39, reveals an adequate level of reliability for each of the three scales from Part A and the two scales from Part B.

Exhibit 39. Reliability Analysis for the TNI

Scale	Cronbach's Alpha
Part A	
Mathematics Content Confidence	.823
Classroom Culture – Student Centeredness	.822
Classroom Culture – Math Specific	.824
Part B	
Mathematics Content and Mathematics Pedagogy	.881
Classroom Culture – Student Centeredness	.870

Recommendations

The reliability and validity of the data produced from Part A of this instrument was very good after the removal of five items. The recommendation is to remove the five items from further analysis. For Part B, the recommendation is to remove the four items noted above from the analysis.

Descriptive Statistics from the EMC TNI Data Set

Means and standard deviations for the three scales derived from Part A and the two scales from Part B are presented in Exhibit 40. The highest mean score for Part A appears for Classroom Culture – Student Centeredness and the highest mean score for Part B appears for Mathematics Content and Mathematics Pedagogy.

Exhibit 40. Means and Standard Deviations for Scale Items on the TNI (*N* = 174)

Scale	*Mean*	*SD*
Part A		
Mathematics Content Confidence	3.73	0.73
Classroom Culture – Student Centeredness	3.85	0.63
Classroom Culture – Math Specific	3.35	0.67
Part B		
Mathematics Content and Mathematics Pedagogy	2.47	0.53
Classroom Culture – Student Centeredness	2.37	0.62

References

Comrey, A. L., & Lee, H. B. (1992). *A first course in factor analysis* (2nd ed.). Hillsdale, NJ: Lawrence Erlbaum.

MacCallum, R. C., Widaman, K. F., Zhang, S., & Hong, S. (1999). Sample size in factor analysis. *Psychological Methods, 4*, 84-99.

Yopp, D. (2008). Unpublished manuscript.

Yopp, Rose & Meade (2008). Unpublished manuscript.