Validating a Culturally Responsive Measure of Student Math Engagement Using Factor Analysis

Data

- Data for this analysis consisted of 2,727 student survey responses

Black	Latino	White	Other
541	671	1,168	323

Middle	High
1,660	1,065

The Final AM-ME Survey

- Students were administered a **subset of questions** from the 70 items developed by the AM-ME Research Group
- To reduce administration burden a **planned missingness** design was used
  - A six form design meant that each student answered ½ of the total questions
  - This methodology was used only to allow us to test more questions, the final survey design will be a single form survey

Survey 1	Survey 2	Survey 3	Survey 4	Survey 5	Survey 6
A	A	A	B	B	C
B	C	D	C	D	D

Approach

To identify the factor structure of our data, we took a **three-stage approach**

1. Exploratory Factor Analysis (to identify grouping of items)
2. Confirmatory Factor Analysis
3. Tests for measurement invariance

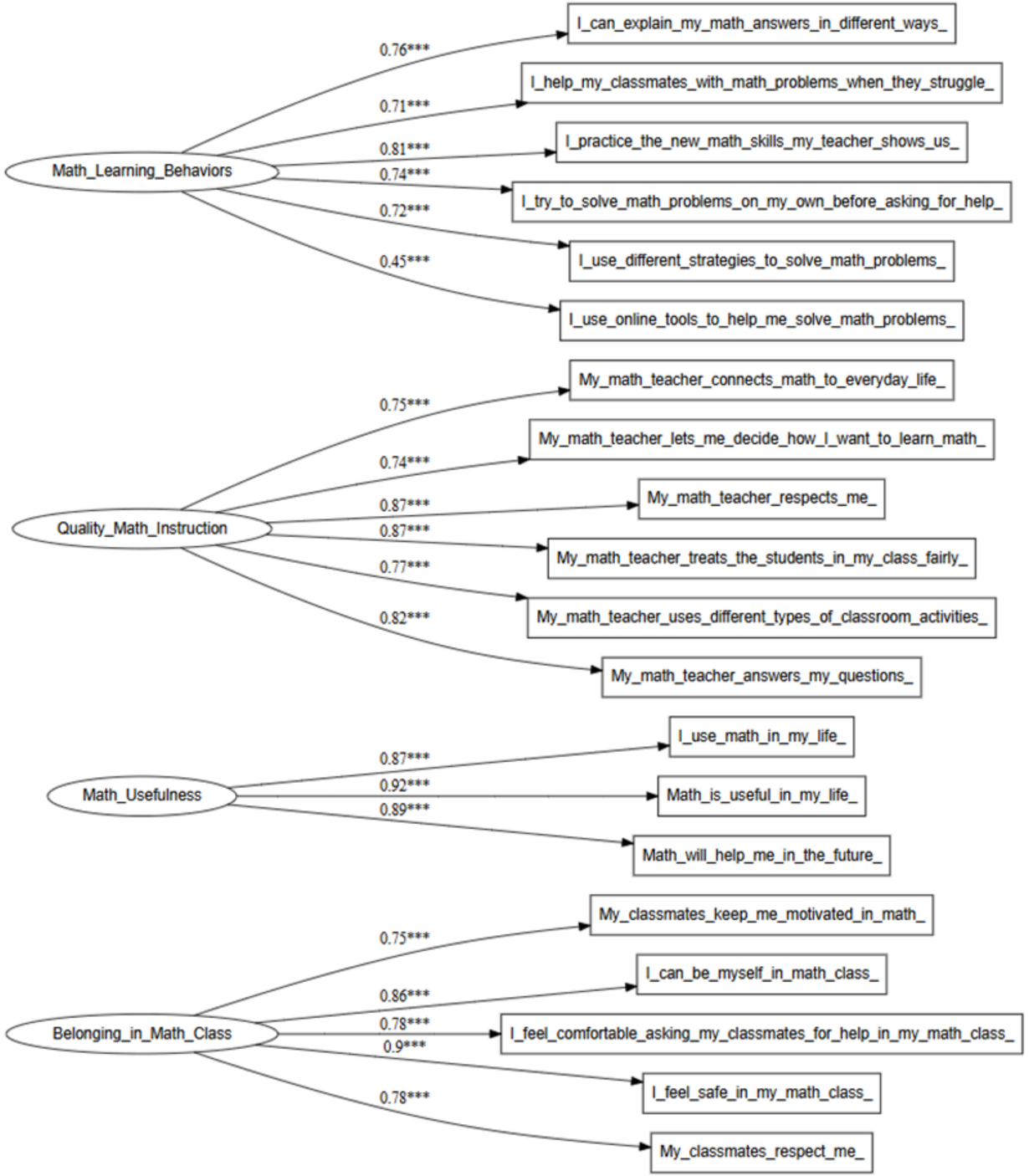
Exploratory Factor Analysis (EFA)

- Data was **investigated with EFA** using a varying number of factors (4-8 factors were tested)
- Comparison of **eigenvalues and face validity of scale**s was used to determine that an 10-factor model represented the data most accurately
- Items were considered as loading onto a factor if their loading was **> 0.35**
- Some **cross-loading items were retained** based on content-fit
- Two factors were **single-item factors** or only had items that heavily cross-loaded and **were removed** from subsequent analyses
- Factors with many items were narrowed down though t**heory, grounding in qualitative data**, and through **IRT analysis** (to be presented in the next presentation)
- All items are **Likert scale items** which were treated as ordinal, and a diagonally weighted least squares estimator was used

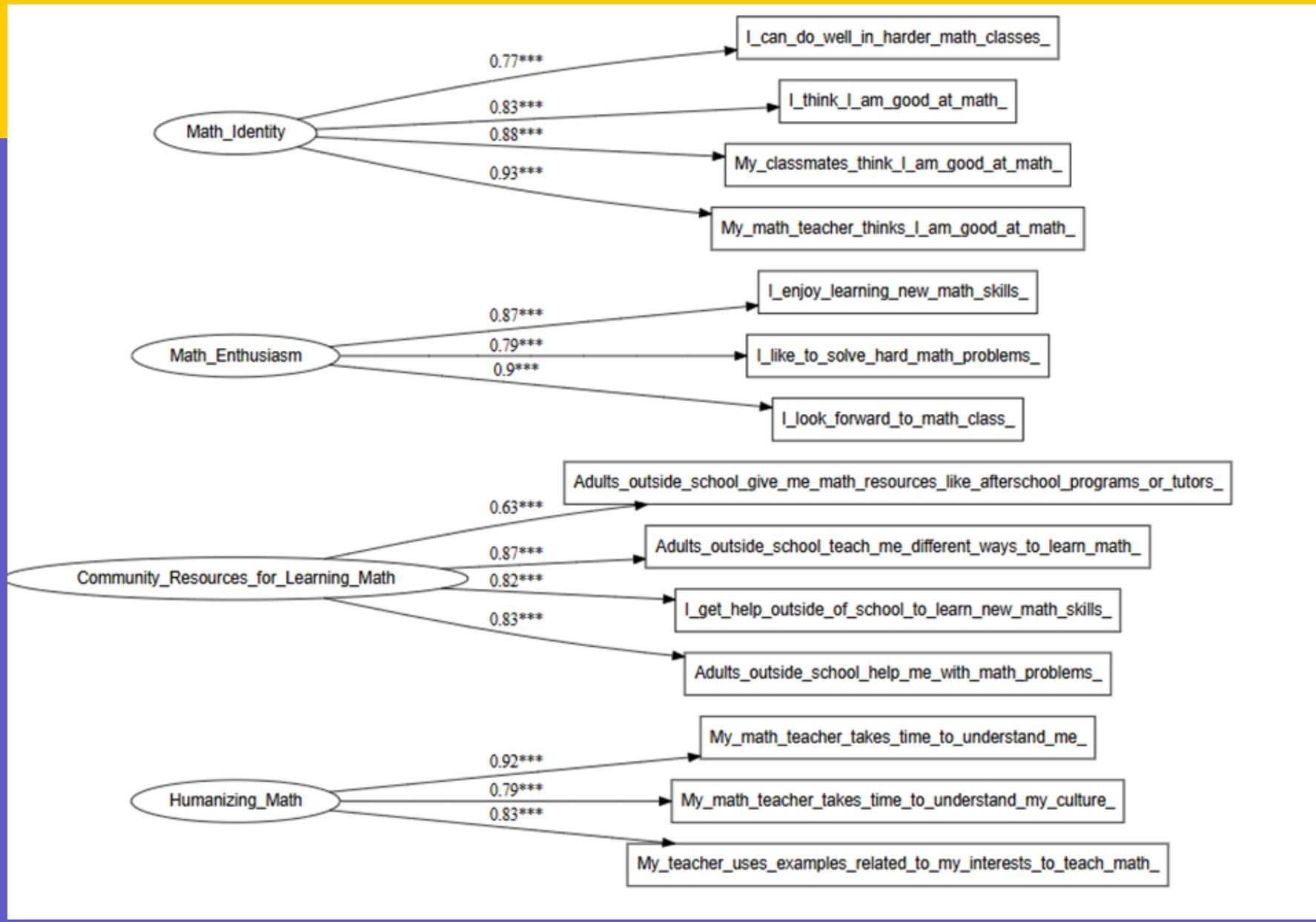
8 Factor Model

- **Humanizing Math: 3 items** (e.g., “My math teacher takes time to understand my culture.”)
- **Math Growth Mindset: 3 items** (e.g., “I like to solve hard math problems.”)
- **Positive Math Identity: 4 items** (e.g., “I think I am good at math.”)
- **Belonging in Math Class: 5 items** (e.g., “I can be myself in math class.”)
- **Perceived Math Utility: 3 items** (e.g., “I use math in my life.”)
- **Quality Math Instruction: 6 items** (e.g., “My math teacher connects math to everyday life.”)
- **Math Learning Behaviors: 7 items** (e.g., “I practice the new math skills my teacher shows us.”)
- **Community Resources: 4 items** (e.g., ”Adults outside school help me with math problems.”)

Factors


Math_Learning_Behaviors
0.76***
0.71***
0.81***
0.74***
0.72***
0.45***
I_can_explain_my_math_answers_in_different_ways_
I_help_my_classmates_with_math_problems_when_they_struggle_
I_practice_the_new_math_skills_my_teacher_shows_us_
I_try_to_solve_math_problems_on_my_own_before_asking_for_help_
I_use_different_strategies_to_solve_math_problems_
I_use_online_tools_to_help_me_solve_math_problems_
Quality_Math_Instruction
0.75***
0.74***
0.87***
0.87***
0.77***
0.82***
My_math_teacher_connects_math_to_everyday_life_
My_math_teacher_lets_me_decide_how_I_want_to_learn_math_
My_math_teacher_respects_me_
My_math_teacher_treats_the_students_in_my_class_fairly_
My_math_teacher_uses_different_types_of_classroom_activities_
My_math_teacher_answers_my_questions_
Math_Usefulness
0.87***
0.92***
0.89***
I_use_math_in_my_life_
Math_is_useful_in_my_life_
Math_will_help_me_in_the_future_
Belonging_in_Math_Class
0.75***
0.86***
0.78***
0.9***
0.78***
My_classmates_keep_me_motivated_in_math_
I_can_be_myself_in_math_class_
I_feel_comfortable_asking_my_classmates_for_help_in_my_math_class_
I_feel_safe_in_my_math_class_
My_classmates_respect_me_

Factors


Math_Identity
0.77***
0.83***
0.88***
0.93***
I_can_do_well_in_harder_math_classes_
I_think_I_am_good_at_math_
My_classmates_think_I_am_good_at_math_
My_math_teacher_thinks_I_am_good_at_math_
Math_Enthusiasm
0.87***
0.79***
0.9***
I_enjoy_learning_new_math_skills_
I_like_to_solve_hard_math_problems_
I_look_forward_to_math_class_
Community_Resources_for_Learning_Math
0.63***
0.87***
0.82***
0.83***
Adults_outside_school_give_me_math_resources_like_afterschool_programs_or_tutors_
Adults_outside_school_teach_me_different_ways_to_learn_math_
I_get_help_outside_of_school_to_learn_new_math_skills_
Adults_outside_school_help_me_with_math_problems_
Humanizing_Math
0.92***
0.79***
0.83***
My_math_teacher_takes_time_to_understand_me_
My_math_teacher_takes_time_to_understand_my_culture_
My_teacher_uses_examples_related_to_my_interests_to_teach_math_

CFA Fit Statistics

Model	χ^2	*df*	χ^2/df	*p*	CFI	TLI	RMSEA [90% CI]	SRMR
CFA (whole sample)	2,105.32	532	3.96	< .001	.99	.99	.03 [.03, .03]	.05
CFA (partial sample)	1,535.35	532	2.89	< .001	.99	.99	.04 [.04, .04]	.06
Common guidelines[a]	—	—	**< 2 or 3**	**> .05**	**≥ .95**	**≥ .95**	**< .05 [.00, .08]**	**≤ .08**

[a]Based on Schreiber (2017), Table 3.

Chi-Squared may be senstitive to sample size (e.g. Cheung and Rensvold 2002)

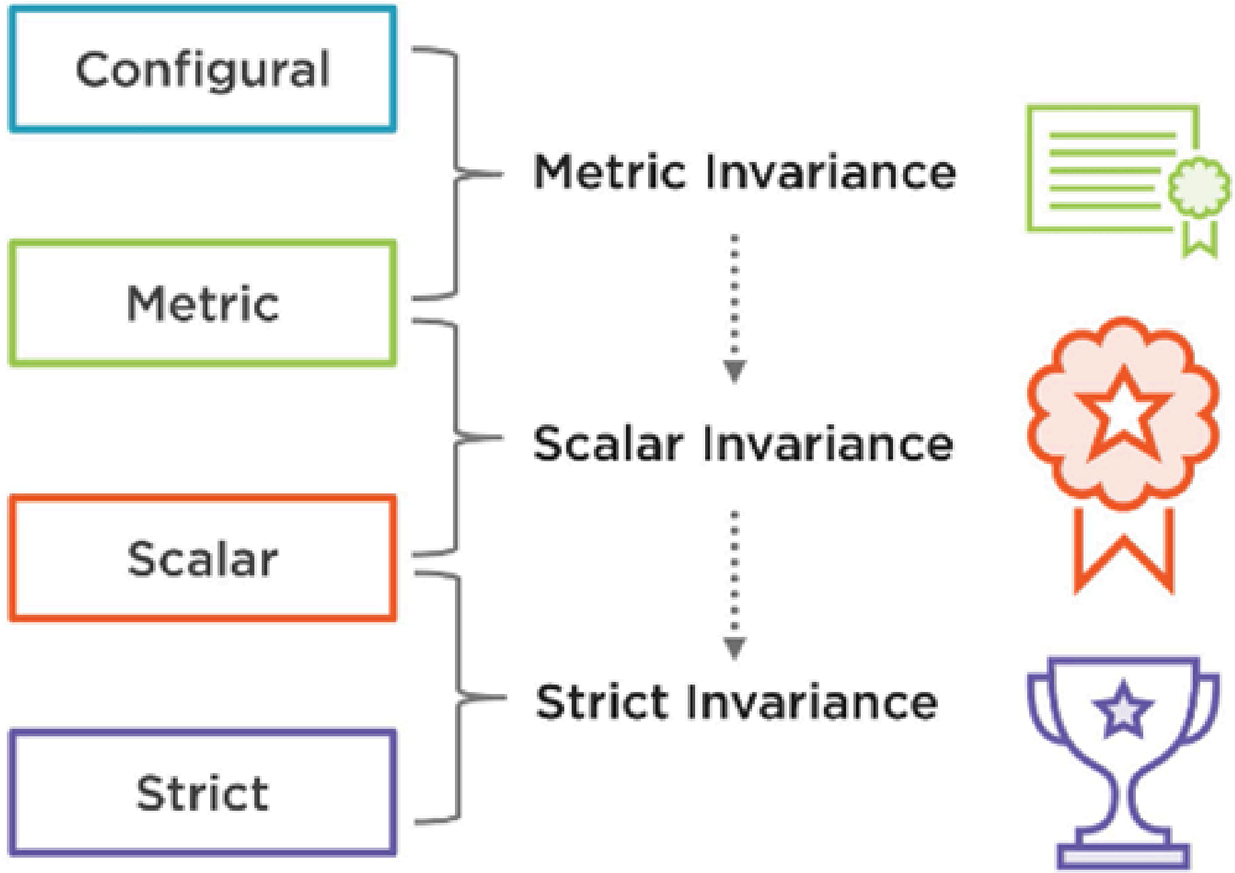
Measurement Invariance

Configural equivalence: factor structure is the same across groups

Metric equivalence: Factor loadings are similar across groups.

Scalar equivalence: Values/Means are also equivalent across groups.

Strict: Residual variances are the same.



Measurement Invariance Models (Black, Latino, Other)

Model	χ^2	*df*	χ^2/df	*p*	CFI	TLI	RMSEA [90% CI]	SRMR
CFA model	2,105.32	532	3.96	< .001	.99	.99	.03 [.03, .03]	.05
Configrual	3,693.40	1,596	2.31	< .001	.99	.98	.04 [.04, .04]	.08
Metric	4,147.64	1,650	2.51	< .001	.98	.98	.04 [.04, .04]	.09
Scalar	4,055.22	1,774	2.29	< .001	.99	.99	.04 [.04, .04]	.09
Common guidelines[a]	—	—	**< 2 or 3**	**> .05**	**≥ .95**	**≥ .95**	**< .05 [.00, .08]**	**≤ .08**

[a]Based on Schreiber (2017), Table 3.

Measurement Invariance Models
Next Steps

Formal model fit comparison testing:

1. Satorra-Bentler (SB) scaled chi-square
2. Comparison of scaled fit measures

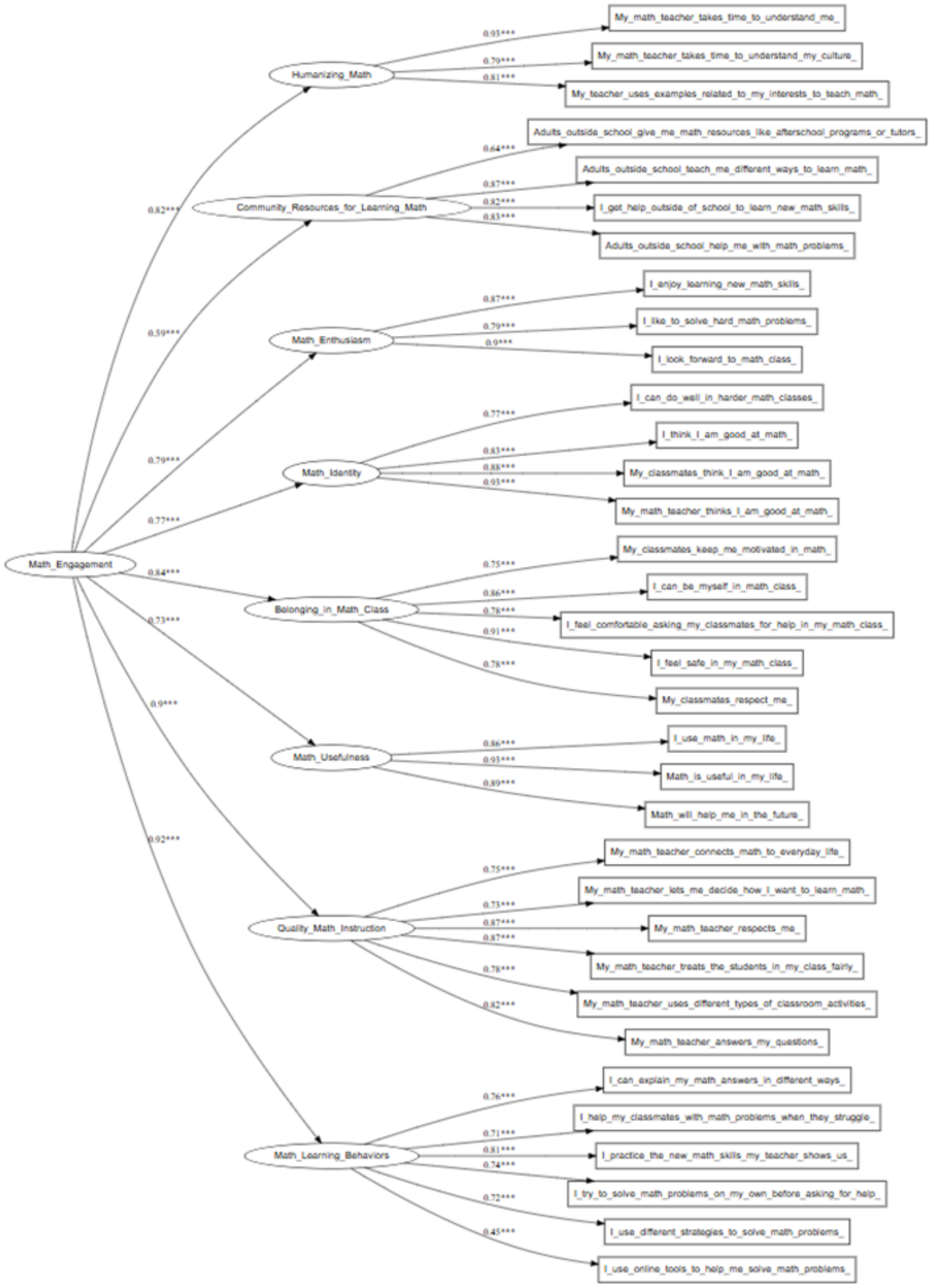
Alternative Models

- Hierarchical/Higher Order
- Bi-Factor

Model	χ^2	*df*	χ^2/df	*p*	CFI	TLI	RMSEA [90% CI]	SRMR
Baseline CFA	2,105.32	532	3.96	< .001	.99	.99	.03 [.03, .03]	.05
Higher Order/Hierarchical	3,024.72	552	5.48	< .001	.98	.98	.04 [.04, .04]	.07
Common guidelines[a]	—	—	**< 2 or 3**	**> .05**	**≥ .95**	**≥ .95**	**< .05 [.00, .08]**	**≤ .08**

[a]Based on Schreiber (2017), Table 3.

Higher Order



The Adapted Measure of Math Engagement Research Group includes six students (Antonio Chavira, Brianna Espy, Ryan Ombongi, Serrah Ssemukutu, Salma Ahmed, and Diamond Tony-Uduhirinwa), five teachers (Nathan W. Earley, Karina Mazurek, Kathleen Morgan, Karla Rokke, and Ashly Tritch), and five researchers (Marisa Crowder, Samantha E. Holquist, Diane (Ta-Yang) Hsieh, Claire Kelley, and Mark Vincent B. Yu). Researchers Alyssa Scott, Olivia Reyes, and Avalloy McCarthy also extensively contributed to this work. Bloomington Public School District leaders Betsy Hawes, Marcie Coval, Julio Caesar, and Rik Lamm provided support to this work. Jennifer Widstrand served as the project manager.

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