

A Structured Inquiry of Research in Mathematics Educational Technology

Findings and Implications





Our Team

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Overview of the Symposium

- A brief description of the dataset and the Framework of Quality Reporting and measure
- Dissertation studies in mathematics education technology: 1968-2009
- Mathematics education technology research: A look at purposes and quality over 4 decades: 1968-2009
- The relationship of achievement and orientation differences: A meta-analysis of mathematics educational technology studies
- Feedback Form: Paper or <http://csrakes.yolasite.com> (Click on AMTE 2012)



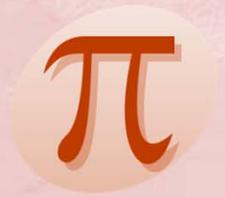


Research in Mathematics Educational Technology: Study Overview

Identification of relevant manuscripts

- Search terms
 - E.g., Technology OR Calculators OR Software
 - E.g., Education OR Teach OR Learn
 - E.g., math OR geometry OR algebra OR fraction
- Databases searched
 - EbscoWeb (e.g., Academic Search Premier, ERIC, PsychInfo)
 - JSTOR, H.W. WilsonWeb (education full text)
 - ProQuest (Research Library, Dissertations & Theses)





Search Results

- 5,488 potentially relevant titles.
- Based on an initial examination of titles and abstracts, the sample was reduced to 1,779 potentially relevant titles.
- During the next phase of coding, 191 articles were excluded from the sample as not relevant.
- By *not relevant*, we mean that the article did not address mathematics, technology, or education (or unable to retrieve full text)
- Final Sample: 1,588 manuscripts





Coding Tool and Process

- Access Database to House Information 
- Inter-Rater Reliability and Content Validity
 - Group coding of random subsample (N=30 articles)
 - Ongoing discussion of difficult coding decisions.
 - Cross Validation of all coding by at least one other group member.





Framework of Quality Reporting

- The Framework of Quality Reporting was developed to capture how well manuscripts identified important information for determining the credibility and usefulness of findings.
- Framework examines non-research manuscripts along with three types of studies: quantitative, qualitative, and mixed methods.





Why Include Non-Research Papers?

- They offer unique insight into the relevance of the research field, a priority in educational policy decisions (Easton, 2010).
- These papers constituted a large portion ($792/1779 = 45\%$) of the papers found in the literature.
- These articles speak directly to the ability of the field of mathematics educational technology literature to enhance the quality of teacher pedagogy.





Mixed Methods (up to 16 pts)		
Non-Research (up to 5 pts)	Quantitative (up to 15 pts)	Qualitative (up to 11 pts)
<p><u>Theoretical Connections (up to 4 pts)</u></p> <ul style="list-style-type: none">• Literature Support (up to 2 pts)<ul style="list-style-type: none">➢ Well Grounded (2 pts)➢ Partially Grounded (1 pt)➢ Not Grounded (0 pts)• Framework/Theory Connections (up to 2 pts)<ul style="list-style-type: none">➢ Well Connected (2 pts)➢ Partially Connected (1 pt)➢ Not Connected (0 pts) <p><u>Design Clarity and Validity (up to 1 pt)</u></p> <ul style="list-style-type: none">• Purpose Statement (1 pt)	<p><u>Theoretical Connections (up to 4 pts)</u></p> <ul style="list-style-type: none">• Literature Support (up to 2 pts)<ul style="list-style-type: none">➢ Well Grounded (2 pts)➢ Partially Grounded (1 pt)➢ Not Grounded (0 pts)• Framework/Theory Connections (up to 2 pts)<ul style="list-style-type: none">➢ Well Connected (2 pts)➢ Partially Connected (1 pt)➢ Not Connected (0 pts) <p><u>Design Clarity and Validity (up to 9 pts)</u></p> <ul style="list-style-type: none">• Purpose Statement (1 pt)• Research Questions/Hypotheses (1 pt)• Design Robustness (up to 3 pts)<ul style="list-style-type: none">➢ Randomized Experiment (2 pts)➢ Regression Discontinuity Design (2 pts)➢ Quasi-Experimental Design with:<ul style="list-style-type: none">▪ Sampling Strategies Unclear (1 pt)▪ Convenience Sample (1 pt)▪ Other Sampling Strategies (2 pts)➢ Use of Control Group (1 pt)• Threats to Validity Addressed (up to 4 pts)<ul style="list-style-type: none">➢ Internal (1 pt)➢ External (1 pt)➢ Construct (1 pt)➢ Statistical Conclusion (1 pt) <p><u>Measurement Trustworthiness (up to 2 pts)</u></p> <ul style="list-style-type: none">• Reliability (1 point)<ul style="list-style-type: none">➢ Internal Consistency➢ Split Half➢ Test-Retest➢ Inter-Rater➢ Alternate Forms• Validity (1 point)<ul style="list-style-type: none">➢ Content➢ Concurrent Criterion➢ Predictive Criterion➢ Construct➢ Discriminant➢ Convergent	<p><u>Theoretical Connections (up to 4 pts)</u></p> <ul style="list-style-type: none">• Literature Support (up to 2 pts)<ul style="list-style-type: none">➢ Well Grounded (2 pts)➢ Partially Grounded (1 pt)➢ Not Grounded (0 pts)• Framework/Theory Connections (up to 2 pts)<ul style="list-style-type: none">➢ Well Connected (2 pts)➢ Partially Connected (1 pt)➢ Not Connected (0 pts) <p><u>Design Clarity and Validity (up to 5 pts)</u></p> <ul style="list-style-type: none">• Purpose Statement (1 pt)• Research Questions/Hypotheses (1 pt)• Threats to Validity Addressed (up to 3 pts)<ul style="list-style-type: none">➢ Internal (1 pt)➢ External (1 pt)➢ Construct (1 pt) <p><u>Measurement Trustworthiness (up to 2 pts)</u></p> <ul style="list-style-type: none">• Reliability (1 point)<ul style="list-style-type: none">➢ Internal Consistency➢ Inter-Rater• Validity (1 point)<ul style="list-style-type: none">➢ Persistent Observation➢ Triangulation➢ Peer Debriefing➢ Negative Case Analysis➢ Referential Adequacy➢ Member Checks➢ Thick Description➢ Dependability Audit➢ Confirmability Audit➢ Reflective Journal

Table 1
Descriptive Statistics for Raw Quality Score by Methodology Group

Group	N	Mean	SD	Min	Q1	Median	Q3	Max	Skewness	Kurtosis	Normality ^a
Mixed Methods	187	8.786	2.71	3.00	7.00	9.00	11.00	15.00	-0.01	-0.68	0.997
Non-Research	355	1.81	1.21	0.00	1.00	1.00	2.00	5.00	1.40	1.13	0.963**
Qualitative	232	5.28	1.72	1.00	4.00	6.00	7.00	9.00	-0.48	-0.40	0.991**
Quantitative	375	8.22	2.80	2.00	6.00	8.00	10.00	15.00	-0.04	-0.64	0.997

*p < .05; **p < .01

^aRyan-Joiner Test of Normality

Table 2
Descriptive Statistics for Percentage of Possible Quality Points by Methodology Group

Group	N	Mean	SD	Min	Q1	Median	Q3	Max	Skewness	Kurtosis	Normality ^a
Mixed Methods	187	0.55	0.17	0.19	0.44	0.56	0.69	0.94	-0.01	-0.68	0.997
Non-Research	355	0.36	0.24	0.00	0.20	0.20	0.40	1.00	1.40	1.13	0.963**
Qualitative	232	0.53	0.17	0.10	0.40	0.60	0.70	0.90	-0.52	-0.41	0.990**
Quantitative	375	0.55	0.19	0.13	0.40	0.53	0.67	1.00	-0.04	-0.64	0.997

*p < .05; **p < .01

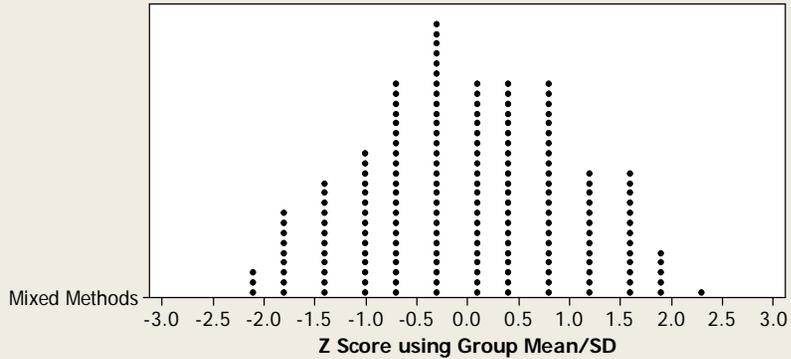
^aRyan-Joiner Test of Normality



Dotplot of Z Score using Group Mean/SD

Type of Study for Design Framework = Mixed Methods

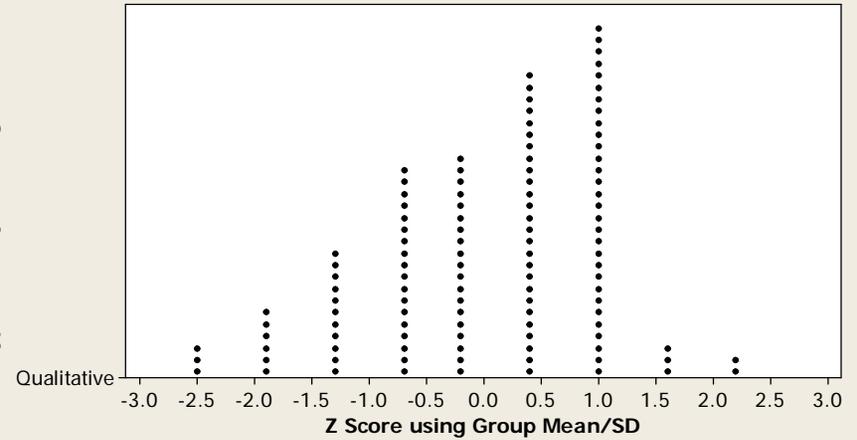
Type of Study for Design Framework



Dotplot of Z Score using Group Mean/SD

Type of Study for Design Framework = Qualitative

Type of Study for Design Framework

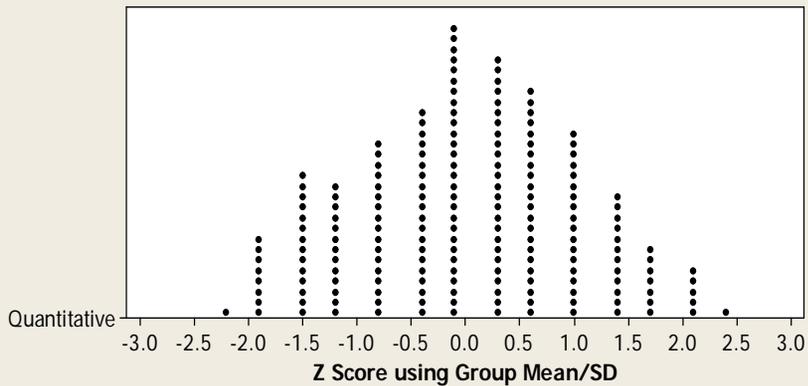


Each symbol represents up to 2 observations.

Dotplot of Z Score using Group Mean/SD

Type of Study for Design Framework = Quantitative

Type of Study for Design Framework

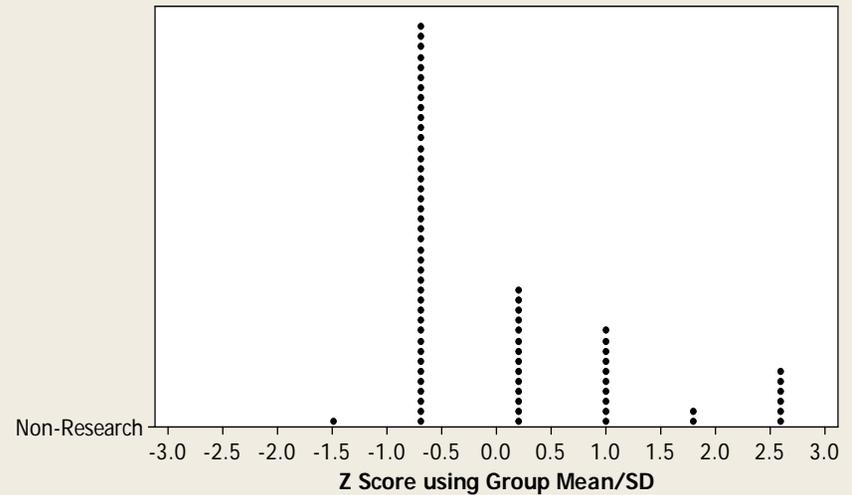


Each symbol represents up to 2 observations.

Dotplot of Z Score using Group Mean/SD

Type of Study for Design Framework = Non-Research

Type of Study for Design Framework



Each symbol represents up to 5 observations.



Are there differences in how well studies address their relevant components?

- ANOVA results: $F(3, 1145) = 64.187, p < .001$
- Tukey PostHoc Comparisons:

(I) StudyType	(J) StudyType	Mean Difference (I-J)	Std. Error	Sig. ^a	95% Confidence Interval	
					Lower Bound	Upper Bound
Mixed Methods	Non-Research	.186	.018	.000	.151	.221
	Qualitative	.069	.019	.000	.031	.107
	Quantitative	.001	.018	.953	-.034	.036
Non-Research	Mixed Methods	-.186	.018	.000	-.221	-.151
	Qualitative	-.117	.017	.000	-.150	-.085
	Quantitative	-.185	.015	.000	-.214	-.157
Qualitative	Mixed Methods	-.069	.019	.000	-.107	-.031
	Non-Research	.117	.017	.000	.085	.150
	Quantitative	-.068	.016	.000	-.100	-.036
Quantitative	Mixed Methods	-.001	.018	.953	-.036	.034
	Non-Research	.185	.015	.000	.157	.214
	Qualitative	.068	.016	.000	.036	.100

Table 3

Descriptive Statistics for Connections to Frameworks by Methodology Group

Group	N	Mean	SD	Min	Q1	Median	Q3	Max
Mixed Methods	187	1.08	0.82	0.00	0.00	1.00	2.00	2.00
Non-Research	355	0.24	0.59	0.00	0.00	0.00	0.00	2.00
Qualitative	232	1.28	0.84	0.00	1.00	2.00	2.00	2.00
Quantitative	375	0.66	0.81	0.00	0.00	0.00	1.00	2.00

Table 4

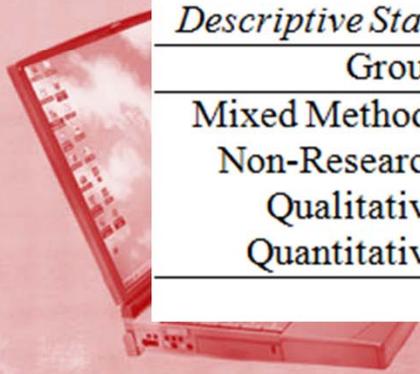
Descriptive Statistics for Grounding in Literature by Methodology Group

Group	N	Mean	SD	Min	Q1	Median	Q3	Max
Mixed Methods	187	1.70	0.54	0.00	1.00	2.00	2.00	2.00
Non-Research	355	0.57	0.76	0.00	0.00	0.00	1.00	2.00
Qualitative	232	1.72	0.52	0.00	2.00	2.00	2.00	2.00
Quantitative	375	1.55	0.62	0.00	1.00	2.00	2.00	2.00

Table 5

Descriptive Statistics for Inclusion of Purpose by Methodology Group

Group	N	Mean	SD	Min	Q1	Median	Q3	Max
Mixed Methods	187	0.99	0.07	0.00	1.00	1.00	1.00	1.00
Non-Research	355	0.99	0.11	0.00	1.00	1.00	1.00	1.00
Qualitative	232	0.99	0.11	0.00	1.00	1.00	1.00	1.00
Quantitative	375	0.99	0.11	0.00	1.00	1.00	1.00	1.00





Discussion

- What do these data suggest about the current landscape of mathematics education technology literature?

