Scales for measuring teacher beliefs in the context of teaching mathematics with technology

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Digital mathematical technologies such as function plotters, geometry packages and CAS are an important part of mathematics education. This report provides research-based scales to assess teachers' T) beliefs about teaching with technology, S) self-efficacy beliefs for teaching with technology and M) teachers' self-reported modes of technology use. For the sake of completeness, scales for capturing E) epistemological beliefs, which stem from Laschke & Blömeke (2014), are also included.

For using the scales, it is recommended to replace the word "[technology]" by the particular technology that is referred to (for example "Multiple-representational tools").

T) Scales for measuring beliefs about teaching with technology

	(T1) DISCOVERY LEARNING
1	By using [technology], it is possible to generate many examples, so students can realize relationships and structures (e.g., symmetries of a graph of a function).
2	[Technology] supports tasks where students can explore new content on their own.
3	[Technology] enables students to explore mathematical concepts (e.g., meaning of parameters) on their own.
4	The use of [technology] leads students to actively acquire particular content on their own.
5	The use of [technology] particularly enables students to explore open problems on their own.
	(T2) MULTIPLE REPRESENTATIONS
1	An important advantage of [technology] is the opportunity to quickly change between forms of representations like algebraic expression, graph and table.
2	[Technology] helps to link the different types of representations (e.g., graph, table, algebraic expression).
3	By the use of [technology] students can use different types of representations to solve problems or tasks.
4	The use of [technology] helps students to better understand the link between algebraic expression, table and graph of a function.
	(T3) TIME REQUIREMENT
1	The use of [technology] costs valuable time which is subsequently missing in the mathematics classroom.
2	[Technology] should be avoided in the mathematics classroom since otherwise too much time is lost.
3	The introduction of [technology] costs so much time that its use does not pay off.
	(T4) SKILL LOSS
1	By the use of [technology] students forget procedures and algorithms (or do not learn them at all).
2	The use of [technology] leads to students mastering arithmetic techniques worse or not all.
3	By the use of [technology], students loose essential basic skills (e.g., mental calculation skills, methods of fractional arithmetic or precise drawing skills).
4	Essential skills (e.g., solving systems of equations, calculating matrices or differentiation of functions) are less mastered by students due to the use of [technology].
	(T5) MINDLESS WORKING
1	If [technology] is used, students think less and rely blindly on the output that technology provides.
2	[Technology] misleads students to work on every task without reflection.
3	If students have access to [technology] they think less.
4	When [technology] is used, there is the danger that students just type command sequences without understanding.
5	The output that [technology] provides is accepted uncritically as correct by students.
	(T6) PRIOR MASTERY OF MATHEMATICS BY HAND
1	[Technology] may only be used if the mathematics is mastered by pen & paper.
2	Students should know the mathematical procedures thoroughly before they are provided access to [technology].
3	Within an instructional sequence, students should not work too early with [technology], but rather only if they understood the mathematics sufficiently.
4	[Technology] may only be used to ease students procedural work if the procedures are already mastered without [technology].

S) Scales for measuring self-efficacy beliefs for teaching with technology

	(S2) TASK DESIGN AND SELECTION
1	I can design tasks for the use with [technology].
2	I can adapt tasks (e.g., from schoolbooks) in such a way that the use of [technology] is useful with these tasks.
3	I can distinguish between tasks that are suitable and less suitable for the use with [technology].
4	I can design good [technology]-supported examination tasks.
	(S2) LESSON DESIGN AND IMPLEMENTATION
1	I can design and implement lessons that support discovery learning using [technology].
2	I can design lessons in which the possibilities of [technology] to clarify the relationships between graph, term and table is exploited.
3	I can design lessons in which the graphical potentials of [technology] are exploited.
4	I can use [technology] in many ways in the classroom.

E) Scales for measuring epistemological beliefs (from Laschke & Blömeke 2014)

	(E1) NATURE OF MATH AS RULES AND PROCEDURES
1	Mathematics is a collection of procedures and rules which prescribe how to solve a problem.
2	Mathematics involves the remembering and application of definitions, formulas, mathematical facts and procedures.
3	When solving mathematical tasks, you need to know the correct procedure else you would be lost.
4	Fundamental to mathematics is its logical rigor and preciseness.
5	To do mathematics requires much practice, correct application of routines, and problem-solving strategies.
6	Mathematics means learning, remembering and applying.
	(E2) NATURE OF MATH AS PROCESS OF INQUIRY
1	Mathematics involves creativity and new ideas.
2	In mathematics many things can be discovered and tried out by oneself.
3	If you engage in mathematical tasks, you can discover new things (e.g., connections, rules, concepts).
4	Mathematical problems can be solved correctly in many ways.
5	Many aspects of mathematics have practical relevance.
6	Mathematics helps solve everyday problems and tasks.

	(E3) LEARNING MATH THROUGH TEACHER DIRECTION
1	The best way to do well in mathematics is to memorize all the formulas.
2	Pupils need to be taught exact procedures for solving mathematical problems.
3	It doesn't really matter if you understand a mathematical problem, if you can get the right answer.
4	To be good in mathematics you must be able to solve problems quickly.
5	Pupils learn mathematics best by attending to the teacher's explanations.
6	When pupils are working on mathematical problems, more emphasis should be put on getting the correct answer than on the process followed.
7	Non-standard procedures should be discouraged because they can interfere with learning the correct procedure.
8	Hands-on mathematics experiences aren't worth the time and expense.
	(E4) LEARNING MATH THROUGH ACTIVE LEARNING
1	In addition to getting a right answer in mathematics, it is important to understand why the answer is correct.
2	Teachers should allow pupils to figure out their own ways to solve mathematical problems.
3	Time used to investigate why a solution to a mathematical problem works is time well spent.
4	Pupils can figure out a way to solve mathematical problems without a teacher's help.
5	Teachers should encourage pupils to find their own solutions to mathematical problems even if they are inefficient.
6	It is helpful for pupils to discuss different ways to solve particular problems.

M) Scales for measuring self-reported modes of technology use

	(M1) DISCOVERY LEARNING
1	How often was [technology] used to discover mathematical relationships?
2	How often was [technology] used to generate conjectures?
3	How often was [technology] used to explore situations?
4	How often was [technology] used to search for mathematical structures?
	(M2) MULTIPLE REPRESENTATION
1	How often was [technology] used to dynamically link different forms of representation (e.g., graph, table, algebraic expression)?
2	How often was [technology] used to discuss advantages and disadvantages of different types of representations (e.g., graph, algebraic representation, table)?
3	How often was [technology] used to highlight relations between graph and algebraic expression?
4	How often was [technology] used to highlight relations between graph and table?
5	How often was [technology] used to highlight relations between table and algebraic expression?
	(M3) PRACTICE
1	How often was [technology] used deepen content that had been introduced before?
2	How often was [technology] used to repeat content.
3	How often was [technology] used to practice content.
	(M4) INDIVIDUAL LEARNING
1	How often did learners use [technology] to check their solutions to tasks on their own.
2	How often was [technology] used to support students to find their own solution approaches to solve a task?
3	How often did learners compare and evaluate different solutions, that they had found working with [technology]?
	(M5) REFLECTION
1	How often did you discuss the technical limitations of [technology] with the learners?
2	How often did you discuss with the learners whether the use of the graphic-capable calculator or manual calculation is more efficient?
3	How often did you critically reflect the results of [technology] with the learners?

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