

Effects of Content-Specific E-Learning on Preschool Teachers' Mathematical Noticing: A Two-Study Investigation

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Research Overview

Preschool teachers' professional noticing of mathematical learning situations is critical for early numeracy support, yet rarely targeted in training. We report two studies ($N = 50$ in-service; $N = 529$ pre-service) testing whether short e-learning modules causally improve noticing in everyday classroom scenes, using a novel image-based vignette instrument and a content-specific crossover design.

Purpose of Study

Early mathematical learning is shaped by how preschool teachers perceive and interpret mathematical situations as they emerge in everyday classroom routines – a competence framed as *professional noticing* (Mason, 2002; Sherin, Jacobs, & Philipp, 2011; van Es & Sherin, 2002). High-quality early-childhood mathematics education is a global policy priority (OECD, 2017), and recent international work has emphasised the importance of teachers' noticing ability and pedagogical knowledge for fostering young children's mathematical learning (e.g., Jacobs, Lamb, & Philipp, 2010).

Our recent systematic review (Stiewe & Ehm, 2025) synthesised 35 studies and identified mathematical didactical knowledge (MDK) as the most frequent correlate of noticing – yet existing evidence is almost exclusively cross-sectional. Whether MDK *causally* improves noticing, and whether such gains are *content-specific*, remains untested. To our knowledge, this is the first study to test the causal, content-specific effect of a brief e-learning intervention on preschool teachers' mathematical noticing, using a novel image-based vignette instrument validated across both in-service and pre-service populations. We address three questions: (1) Can a brief, scalable e-learning intervention causally improve preschool teachers' mathematical noticing? (2) Are gains content-specific – does learning about geometry improve noticing of geometric situations specifically, but not numerical ones? (3) Does the effect generalise across in-service and pre-service populations?

Our work directly engages the conference theme by framing digital teacher education as a *local innovation* (a German e-learning system) with *global vision*, offering a transferable methodological template applicable across educational systems.

Research Methods

Study 1 (Pilot, in-service teachers). $N = 50$ practising preschool teachers, recruited Germany-wide, completed a pre-post e-learning intervention covering ten modules across all four mathematical content areas (numbers/sets, space/shape, quantities/measurement, data/combinatorics). The outcome was a newly developed image-based vignette instrument (MSSPS) to investigate the mathematical noticing ability: participants viewed eight illustrated preschool scenes and identified mathematical learning situations within a 2-minute window per scene, providing categorisations and justifications. Math anxiety, mathematics-related self-efficacy, and pedagogical beliefs were assessed as covariates. Insights from Study 1 informed the streamlined, content-specific design of Study 2, exemplifying iterative methodological development.

Study 2 (Main, pre-service teachers). $N = 529$ pre-service preschool teachers from vocational schools and universities were assigned to one of three intervention groups, each receiving a single 90-minute content-specific e-learning module (space/shape vs. numbers/sets vs. quantities/measurement). Each group's untrained content areas served as within-subject controls (content-specific crossover design). The same MSSPS test, math anxiety scale, and self-efficacy/belief measures were administered pre- and post-intervention. A subsample ($n = 90$) additionally completed the validated KomMa MCK/MPCK test (Jenßen et al., 2020) as a manipulation check on MDK gains.

Results and Discussion

Pilot. MSSPS scores increased significantly from pre- ($M = 40.2$, $SD = 12.1$) to post-test ($M = 47.8$, $SD = 13.0$), $t(49) = 3.50$, $p < .001$, $d = 0.55$, indicating that the comprehensive intervention raised noticing in experienced teachers. Math anxiety was negatively associated with baseline noticing, $r = -.24$, $p = .046$, but did not moderate intervention effects.

Main study. Across the full sample, MSSPS scores improved pre- ($M = 32.4$, $SD = 11.2$) to post-test ($M = 36.1$, $SD = 11.8$), $F(1, 526) = 42.30$, $p < .001$, $\eta^2p = .074$. Critically, the predicted Group $\times$ Content $\times$ Time interaction was significant, $F(6, 1572) = 3.45$, $p = .002$, $\eta^2p = .013$: participants showed larger gains in the content area they had been trained on

($M_{diff} = 2.1$, $SD = 4.3$) than in untrained areas ($M_{diff} = 0.6$, $SD = 3.9$). The MDK manipulation check ($n = 90$) confirmed knowledge gains for trained relative to untrained content, $t(89) = 3.21$, $p = .002$, $d = 0.34$. Math anxiety entered as a covariate did not moderate the effect.

Discussion. Findings support a causal MDK $\rightarrow$ noticing pathway and demonstrate that even a brief, content-specific e-learning module shifts a complex professional skill. The within-subject crossover design provides stronger causal inference than typical pre-post designs in this literature, and the cross-population evidence (in-service + pre-service) speaks to the robustness of the approach. The novel image-based vignette instrument worked across both samples, supporting its broader utility for noticing research. Findings suggest that brief, content-targeted digital modules can serve as cost-effective, scalable supplements to preschool teacher training curricula worldwide, and the scalable, modular structure of the intervention is well-suited for adaptation to other educational systems facing similar challenges in early-childhood teacher preparation, including the Asia-Pacific region where high-quality early mathematics education is a shared policy priority.

Keywords

professional noticing; preschool teachers; mathematical didactical knowledge; e-learning intervention; early childhood education

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