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Design of a multi-dimensional instrument for reviewing the quality of apps for elementary geometry

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Current state of research and theoretical framework

In contrary to the high speed of technological expansion, the research on didactical quality of technology-supported materials for school mathematics seems to have been less rapid in the last two decades. The current approaches for its evaluation are various but not extensive enough which grounds an intensive ongoing debate in the TWG 16 of the upcoming ERME congress. On the one hand, a conventional approach is the usage of criteria catalogues or checklist. On the other hand, researchers argue against their usage due to different reasons, e.g., their inconsideration of socio-constructivist view of learning (Squires & Preece, 1999) or their tangible usage which is exposed to many factors that cannot be controlled (Krawehl, 2010), e.g., the dynamic feature of the online market changing on a daily basis. Moreover, the usefulness and effectiveness of technological tools may depend on the settings, context and instructional goals, what make it difficult to follow a straight-on checking list for their quality estimation. An undertaken analysis of geometry apps regarding pedagogical, mathematical and cognitive fidelity has shown that the majority of them had limited potential to support students in developing geometrical conceptual understanding (Larkin, 2016). It has emphasized the importance of further reviews and this is relevant not only in Australian context but in other contexts such as the German one. Another study has shown that the majority of existing apps are created for pre- and elementary schoolchildren but are not aligned to the content standards of the targeted audience (Powell, 2014). Therefore, this study focuses on a comprehensive approach for identifying essential potentials and limitations of apps along with analogue media that considers multimedia learning (Mayer, Borges, & Simske, 2018) in addition to educational standards and curricula for mathematics (e.g. in Berlin-Brandenburg schools) referring to content-related- and process-oriented competences as coherent, rather than distant proficiencies.

Research question and methodology

How can the quality of technology-enhanced resources for supporting the development of students' competences regarding "Space and shape" be analysed through a comprehensive approach, is the question to be tackled in the study.

The poster shows a multi-dimensional evaluation instrument (EI) that is a specific part of a comprehensive multidisciplinary and dynamic evaluation model, developed through a research-based design involving qualitative approaches. The EI includes mathematics, didactics and media facets in an appropriate incorporation. A systematical peers- and experts review about its objectiveness, validation, and importance of its criteria items has taken place. Collected feedback

was used for adaptation and re-design of the EI, and pilot trials as different phases of the design cycle.

Results and their implications in practice and research

The review criteria in the created EI are grounded on a national framework about excellence of learning environments. Hence, the development of the EI resulted with review criteria structured in six dimensions: (1) mathematical and didactical significance, (2) articulation, communication and social organization, (3) differentiation, (4) logistic and technical support, (5) assessment and (6) networking of resources similarly as the key characteristics of learning environments (Wollring, 2009) and recommendations about implementation of digital media by Krauthausen (2012).

The outcomes of the design-research process would be implemented in a teachers' professional development program about elementary geometry. The aim of the designed instrument is to offer teachers a possibility to systemize the overwhelming amount of apps and actively engage themselves in reviewing processes and sharing best-practice instances, which would enable them to think about the benefits and limitations of a meaningful usage of technology in their classrooms.

Other beneficiaries may also be designers who could consider potentials of technology in future re-designs and novel designs. Finally, the study may contribute in further research in mathematics- and media education towards development of a sustainable evaluation model that may have a potential for both national and international scaling up.

Formal presentation of the research work on the poster

Besides information about the theoretical framing, the poster (A0 size) illustrates the research design in a form of a diagram. Exemplary excerpts of the created on-line EI are presented as tables. Previews of selected apps for elementary geometry available in the German language also appear on the poster.

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