Improving Pre-Service Teachers' Use of Research to Support Technology-Enhanced Practices

Steven Beyer
Learning Lab
University of Duisburg-Essen
Germany
steven.beyer@uni-due.de

Chirine Ahmad
Learning Lab
University of Duisburg-Essen
Germany
chirine.ahmad@stud.uni-due.de

Tanja Mayer
Learning Lab
University of Duisburg-Essen
Germany
tanja.mayer@uni-due.de

Pia Sander
Learning Lab
University of Duisburg-Essen
Germany
pia.sander@uni-due.de

Michael Kerres
Learning Lab
University of Duisburg-Essen
Germany
michael.kerres@uni-due.de

Abstract: This study investigates the role of research-informed reasoning and practice in teaching, highlighting how review articles can improve (pre-service) teachers' effective integration of research findings regarding the use of digital technologies in education. Despite its importance, research indicates that research use by teachers often fails to translate into everyday teaching practices. Findings reveal a significant gap in how (pre-service) teachers receive and apply research derived from reviews. Focusing on review articles as a means to enhance (pre-service) teachers' engagement with research, this work explores formats for improving access to research knowledge. During a design-oriented workshop, n = 14 pre-service teachers engaged with a review article, a Clearing House-style format, and a chat-based document analysis tool, documenting their perceived advantages, challenges, and improvement suggestions for each format. Results indicate that all three resources collectively supported the participants' research-informed reasoning and practice. This research underscores the need for enhanced engagement with research knowledge among pre-service teachers and suggests directions for future studies to explore the effectiveness of chat-based document analysis tools in educational contexts.

Keywords: digitization, research-informed education, knowledge brokering, review articles, teacher education

Introduction

Teachers, like other professionals, should reflect on their professional actions and improve their daily routines - based on evidence from current research. In many cases, however, we cannot provide research findings that can be labelled as clear *evidence* based on the strict experimental methodology seen in the field of science. But educational change and the improvement of teacher behavior still can be *informed* by current research findings (Renkl, 2022).

At the same time, studies indicate that research findings often are simply not acknowledged and do not translate into everyday practice of teachers sufficiently (Gorard et al., 2020; Rycroft-Smith & Stylianides, 2022). They express a desire to incorporate research findings, yet they report many obstacles, such as difficulties in locating and accessing coherent research reports, understanding the findings, and transforming them into their specific contexts (Cain, 2016; Rycroft-Smith & Stylianides, 2022). Given the reluctant use of research findings by teachers, it becomes pertinent to look at pre-service teachers and how they can be supported in actively using and acquiring current research findings.

In light of the need to enhance (pre-service) teachers' engagement with research, various pathways have been proposed. Rycroft-Smith and Stylianides (2022) identified three primary approaches: fostering teachers'

competencies to access and acknowledge research findings, improving researchers' communication of research knowledge, and enabling intermediaries or knowledge brokers to create user-friendly, easily accessible resources.

Research syntheses – such as the various types of reviews, meta-analyses, and mega-analyses – can inform and support efforts to foster engagement with research more effectively than individual studies, as they provide a broader perspective and consolidate existing findings (Voss, et al. 2020). This contribution focuses on reviews and explores two formats for facilitating easy access to this research knowledge. Reviews are chosen because most published research on using research synthesis to promote (teachers') engagement has concentrated on meta-analyses and related products. The emphasis on meta-analyses stems from the belief that, similar to the evidence-based model in medicine, they represent the highest level of evidence, despite the criticisms surrounding the evidence-based education model (Renkl, 2022). Overall findings indicate a research gap concerning how (pre-service) teachers receive and apply research knowledge derived from reviews. Generally, limited research exists on how educational practitioners access, use, and apply research knowledge from various types of reviews. The primary source is the review by Gorard et al. (2020), which discusses the use of systematic reviews in promoting research uptake. They conclude that there is little robust causal evidence regarding interventions that effectively encourage users to incorporate systematic reviews or research knowledge derived from reviews into their decision-making processes.

This contribution enhances previous research on the use of research knowledge from reviews by examining the potential of chat-based document analysis tools to facilitate access and translate research knowledge into applicable formats. Additionally, while there is a general need to enhance (pre-service) teachers' engagement with research, this contribution specifically investigates how reviews can improve (pre-service) teachers' effective integration of research findings regarding the use of digital technologies in teaching practices. This is particularly important given the slow progress of digitization within educational systems, such as in Germany (Fraillon et al., 2019). Consequently, the anticipated potential of digital technologies often conflicts with the complex challenges associated with their implementation in teaching and teacher education, necessitating supportive measures.

Research Questions

(1) What characteristics of a) a review article, b) a Clearing House-style format and c) a chat-based document analysis tool promotes pre-service teachers' reception and use of research knowledge related to digitalization?

(2) What characteristics of a) a review article, b) a Clearing House-style format and c) a chat-based document analysis tool hinders pre-service teachers' reception and use of research knowledge related to digitalization?

(3) What (re)design ideas can be gathered from pre-service teachers regarding the design features of the a) a review article, b) a Clearing House-style format and c) chat-based document analysis tool?

Methods & Materials

Material

Leber et al. (2023) conducted a critical review that served as a model for this article. The review analyzed 22 studies published between 2018 and 2023, focusing on how digital technologies support the development of information literacy (IL) among students in school settings. It examined various instructional methods and the integration of digital technologies as resources, settings, or content to enhance IL, while also addressing challenges related to standardizing IL terminology in digital education.

This review with its practice-oriented research question was intentionally selected for the course to tackle key obstacles in understanding research. Written in German, it meets the language needs of native-speaking pre-service teachers, ensuring greater accessibility. Additionally, the review's narrative style, as opposed to a heavily

statistical approach, effectively addresses the difficulties many pre-service teachers encounter when interpreting statistical data. The selection of this review aims to enhance accessibility and promote a clearer understanding of research, thereby helping to overcome common challenges.

Furthermore, the content of the review has been adapted into a Clearing House-style format. This format presents engineered research findings for practical use, recognizing that research findings are more likely to be utilized in practice when they are simplified or transformed into user-friendly formats (Gorard et al., 2020). The primary categories of this format include the *theoretical background of the review*, the *review process*, and the *results and implications for teaching practice.*

To accommodate recent technological developments, the potential use of a chat-based document analysis tool, such as ChatGPT, has been considered for disseminating research knowledge and facilitating its application in practice.

Participants

A total of 14 pre-service primary school teachers who attended a research-related, one-semester course were included in the analysis. These participants were enrolled in a Master's degree program in Primary Education. The majority of participants were female (79% female, 21% male), on average 30.6 years old (*Min* = 22; *Max* = 46; *SD* = 7.75) and had on average little opportunities to learn (OTL) how to integrate digital technologies into classroom activities (*M* = 1.07; *Min* = 0; *Max* = 2; *SD* = .73). The participants held mostly positive research-related beliefs (*M* = 3.31; *Min* = 2.83; *Max* = 3.83; *SD* = .26). Both OTL and research-related beliefs were measured on a four-point scale.

Data Collection

As part of a preparatory activity, pre-service teachers were asked to read a review article. After the reading, participants had the opportunity to ask questions to ensure they fully understood the content. This was followed by activities in the course that encouraged reflection on the relevance and application of the research knowledge in context. At the end of the course, a workshop was organized using a design-oriented approach (e.g., Doorley et al., 2018). During the workshop, the pre-service teachers were presented with the familiar review article and two different representations of its content: one in a Clearing House-style format and another in a ChatGPT-style format. Participants had the opportunity to engage with all three. For each, the pre-service teachers were asked to write down on cards the advantages, hurdles, and suggestions for improving in the context of research knowledge use. The content of these cards was documented at the group level.

Data Analysis

The empirical analysis involved conducting a qualitative content analysis (Schreier, 2012). The analysis aimed to gain insights into the characteristics of the three formats perceived beneficial to the pre-service teachers' research use. To address RQ1, RQ2 and RQ3, we used the categories from Rycroft-Smith and Stylianides (2022) as a starting point. Based on the data, we adapted these categories to better fit the present research context with regard to the three areas of advantages, hurdles and suggestions for improvement of the formats: *Comparison and Evaluation*; *Graphic Design*; *Links/Further Information*; *Takeaways/Implications for Practice*; *Easy to Read/Accessible*; *Structure*; *Summarized/Focused*; *Promotion of Understanding*; *Scientific Credibility/Reliability*; *Relevance*; *Effort*.

The resulting coding frame was independently tested on a sample of the data by two coders and collaboratively refined. Subsequently, coding instructions were formulated, and coders independently conducted full coding using MaxQDA24. To assess the agreement between coders in coding the same data, we calculated the inter-coder agreement (O'Connor & Joffe, 2020). By utilizing Kappa (Brennan & Prediger, 1981) to evaluate agreement on 90% of the code segments, the coding frame analysis yielded K_n = .76 for all formats. At the aggregated first-level sub-categories: K_n = .75 for the judgement of the review article, K_n = .78 for the Clearing House-style format and K_n = .70 for the chat-based document analysis tool. In a subsequent step of data analysis, divergent results were reconciled through consensus in coding discussions (O'Connor & Joffe, 2020; Schreier, 2012).

Results

In the analysis of code coverage for the review article, 96% of the material was coded (91 segments) with 38.5% categorized as hurdles, 31.9% as improvement ideas, and 29.7% as advantages. For the Clearing House-style format, 93% of the material was coded (43 segments) with 37% reflecting hurdles, 32.6% advantages, and 30% improvement ideas. Similarly, for the chat-based document analysis tool, 93% of the material was coded (44 segments) with 54.6% categorized as advantages, 43% as hurdles, and 2.3% as improvement ideas.

Review Article

The qualitative content analysis highlighted several key challenges and benefits associated with the review article. The most prominent hurdle identified was the practical implications of the synthesis, particularly its limited relevance to everyday teaching practice, especially in primary education. A significant number of participants noted that the review lacked clear didactic guidance and practical applicability, with concerns raised about the accessibility and usability of digital technologies in the classroom. Additionally, the content was often seen as insufficiently relevant to (primary school) teachers, with multiple references to the difficulty of translating the information into practical classroom strategies. The structure and clarity of the text were also major points of critique. Many participants found the text disorganised, with a lack of clear headings and an overwhelming complexity that required specialised knowledge to comprehend. The synthesis was also criticised for its length, with several respondents noting that it was too extensive and time-consuming to engage with fully, particularly within the constraints of a busy teaching schedule.

Despite these challenges, the review was also recognised for several strengths, though these were mentioned less frequently compared to the critiques. The text's clarity in categorising digital technologies and their effectiveness was appreciated. Participants valued the summarised sections, particularly those presented in table format, which provided a clear and concise overview of the current state of research and the tools available.

Areas for improvement were identified, though these received less emphasis than the primary critiques. Suggestions included enhancing the visual design of the document for better engagement, providing more concise overviews, and offering practical guidance that could be more readily integrated into the school environment. Participants also expressed a need for improved understanding of the content, recommending the inclusion of guiding questions for text comprehension, more explicit summaries, and opportunities to explore digital technologies in a practical context.

Clearing House-style Format

The qualitative content analysis, using the Clearing House-style format, identified several hurdles. The most frequently noted issues were related to the practical implications of the format. Participants expressed frustration with the lack of practical examples and detailed applications, the absence of links to relevant digital technologies and learning resources, and the predominance of digital technologies presented in English, which they felt limited its usefulness in some contexts. Another significant area of concern was the lack of summaries (in table formats; see Review Article above), making it challenging for readers to navigate the content effectively. Visual design was also criticised, although to a lesser extent, with specific references to missing screenshots that could have enhanced understanding. The lack of external links to further information also posed a challenge, particularly when readers sought to explore topics in more depth – like the original review article.

Despite these challenges, the format had notable advantages, although they were mentioned less frequently than the hurdles. The most appreciated aspect was the concise and accessible summary, which provided a quick and clear overview of the content. Participants also valued the practical implications discussed in the synthesis, particularly in relation to teaching practice, though this aspect was less emphasised. The text was praised for its straightforward language, avoiding heavy use of technical terms, which made it easier for readers to comprehend the key points. The structure of the text was also positively noted, especially the clear division into three main sections (Introduction, Review, and Practical Implications), which contributed to a more organised presentation.

Areas for improvement were highlighted, though these were less frequently mentioned. Suggestions included enhancing the visual design by incorporating screenshots, graphics, and videos to make the content more

engaging. There was also a call for better support for understanding, such as introducing the digital technologies with clear explanations of their capabilities, limitations, and costs, and providing precise answers to specific questions. Practical implications could be further improved by including examples applicable to primary education students and offering a more detailed overview of the competencies that can be developed according to curriculum standards. Additionally, participants suggested including links to further resources and explanations for difficult terms to aid in deeper exploration of the content.

Chat-based Document Analysis Tool

The qualitative content analysis regarding the chat-based document analysis tool revealed several key insights, reflecting both the strengths and challenges identified by participants. Advantages were prominently noted in several areas. Participants particularly appreciated the clarity and accessibility of the text, which was often highlighted as a strong point. The inclusion of short definitions and the overall ease of understanding were frequently mentioned, with several participants noting that the format provided a good introduction and an effective overview of methods, practices, and solutions. The ability to ask follow-up questions and receive tailored answers was also highly valued, with users praising the platform's capability to reformulate and deepen the discussion based on individual needs. The structure of the provided answers received positive feedback as well, with participants commending its clear organisation, use of sections and numbering, and overall layout, which made navigation straightforward and user-friendly. The practical implications of the synthesis were another area of strength, particularly in relation to subject-specific applications. Participants frequently mentioned the concrete examples provided for use in the classroom and appreciated the digital technologies and methods that were directly applicable to their teaching. The ability to translate information into specific educational contexts, for example, fostering IL within mathematics education, was seen as a significant benefit.

However, the analysis also highlighted several hurdles. A significant concern was the scientific credibility and reliability of the information provided by ChatGPT. There was considerable scepticism among participants regarding the accuracy and trustworthiness of the content, with frequent mentions of the potential for misinformation or incomplete data. The lack of citations and references to the sources of the review article was a recurring issue, leading to doubts about the overall validity of the results. This scepticism was compounded by concerns about the platform's ability to consistently present the most important findings in a coherent manner, which left some users feeling uncertain about the dependability of the information. The practical application of the digital technologies suggested by ChatGPT also faced criticism. While some participants acknowledged the usefulness of the tools, others pointed out that they were not always well-suited to the specific needs of IL education. The inconsistency in the relevance and applicability of these tools was highlighted as a key drawback. Participants also expressed concerns about the user experience, particularly regarding the platform's functionality. The need for specific and well-formulated prompts to obtain relevant answers was seen as a limitation, with some users finding it challenging to navigate the platform effectively without prior knowledge of how it operates. Finally, the visual design was mentioned less frequently but was still considered an area for improvement, particularly the absence of screenshots, which could have enhanced comprehension and engagement with the content.

Discussion & Outlook

This contribution marks the initiation of a design research process aimed at understanding how best to support (pre-service) teachers in receiving and applying research knowledge derived from reviews to foster technology-enhanced practices. The results presented indicate that the review article, the Clearing House-style format, and the chat-based document analysis tool collectively offered valuable support for the pre-service teachers' research-informed reasoning and practice, but each in a specific use case: locating and accessing relevant research, understanding the findings, and applying the research in practice.

Participants acknowledged that the review article provided significant insights and resources. However, the analysis indicates a need for more accessible, relevant, and practically oriented content, particularly for primary school teachers, to fully facilitate the application of these findings in everyday teaching practice. This aligns with previous research highlighting challenges associated with published research (Cain, 2016). In anticipation of these findings, two additional formats were analyzed. Participants found the Clearing House-style format to be more accessible and focused on practical insights, yet the analysis suggests a need for even more practical examples that

could be utilized immediately, along with more visual support in the description of the digital technologies used. Lastly, participants noted that the chat-based document analysis tool (ChatGPT) offered significant advantages in terms of accessibility, structure, and practical applicability. Furthermore, the analysis underscores the necessity for greater attention to questions of scientific credibility, the reliability of practical tools, and the overall user experience to ensure that the platform effectively supports (pre-service) teachers in utilizing the provided information.

This contribution should be contextualized within its limitations to inform the subsequent cycle of the design research process. Data were collected in a single university context and participants voluntarily registered for these courses, which may introduce some degree of selection bias. Another limitation pertains to the potential for order effects due to the sequence in which the research products were presented to the participants.

Future research can build on the positive results regarding chat-based document analysis tools and include a broader sample that encompasses in-service teachers, who may have different needs in everyday practice compared to pre-service teachers. This future work should consider insights derived from the evaluations of both the review article and the Clearing House-style format to inform the design of the platform based on the chat-based document analysis tool.

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