Technology-mediated personalised learning for younger learners: concepts, design, methods and practice

Introduction

Technology-mediated personalised learning has a rich history (Reich, 2020). In the late 2000s, the concept of 'personalised learning' was introduced to refer to learning that happens less face-to-face and through whole-class instruction with more time for the individual to work with adaptive learning tools that address individual needs by providing tailored support (Fitzgerald et al., 2018). Personalised learning has been defined in many different ways but recurring elements within definitions are the characteristics of the learner that are taken into account (e.g., prior knowledge, interests, preferences), design components that enable personalisation during learning (e.g., pace, sequence, technology, choice) and the learner outcomes that are targeted (e.g., agency, motivation, performance) (Bernacki et al., 2021). It has been argued that if we consider children's differences when we develop learning environments, children will benefit in terms of learning outcomes, learning experience, and attitudes towards particular subjects (Reynvoet et al., 2021). Nowadays teachers have access to digital technologies which have accelerated the movement towards personalised learning environments (Plass & Pawar, 2020). The increased popularity of digital personalised learning environments across multiple domains such as educational public policy decisions (financing projects which promote digital technologies), personalised learning platforms promoted by private EdTech companies and academic research investigating the concept.

The use of digital learning technologies has facilitated many opportunities to personalise the learning environment. A systematic review by Griffith et al. (2020) on the factors that influence learning when young children use interactive apps showed that children benefit from interactive and game-like activities, adaptive learning technologies and immediate, individual feedback which promote repeated and varied practice of academic skills. Teachers on the other hand benefit from actionable data and learner feedback (Fitzgerald et al., 2018). Intelligent tutoring systems and exploratory learning environments are two examples through which technology-mediated personalised learning can be established (Holmes et al., 2018). Lately, the optimisation and personalisation of learning environments was further boosted with the increasing use of learning analytics in which the analysis of large data sets is central (Gašević et al., 2016). Furthermore, in light of the widespread disruption to young children's education due to the global pandemic, the interest in technology-mediated personalised learning has particularly become a pertinent and beneficial topic for research to enable remote teaching (Major et al., 2021).

Moving the debate forward

Although technology-mediated personalised learning has been the goal of many innovative projects, to date research has mainly focused on the technological implementation, often neglecting the pedagogical perspective. This is also reflected in empirical studies investigating the effectiveness of technology-mediated personalised learning which often show small to moderate results with regard to children's performances on standardised tests (Liu et al., 2020; Reich, 2020). Research has also investigated the concern of whether technology-mediated personalised learning will widen gaps between children's

learning results instead of closing it (Fitzgerald et al., 2018; Reich, 2020). Either way, it seems that using technology-mediated personalised learning environments cannot guarantee effective teaching and practice. Rather, before implementing personalised learning, we should progress thinking by investigating some of the primary challenges and how these challenges could result in a better understanding of young children's learning processes. Building on a workshop on the same theme during the 2020 Interaction Design for Children conference (Vanbecelaere et al., 2020), challenges were identified in four key areas: (1) the concept of technology-mediated personalised learning; (2) the design of personalised technologies; (3) the evaluation methodologies exploring the effectiveness of personalised learning; and (4) the impact of technology-mediated personalised learning on pedagogical practice, learning experiences and/or the teacher-learner relationship. This BJET special section sought to map out current research to address challenges in these four key areas to help move the debate forward and map out future directions for research.

Concepts

The first aim of the special issue is *to refine the concept of technology-mediated personalised learning* and *to discuss whether this conceptualisation has to be expanded or developed when focusing on educating younger learners.* Personalised learning has been conceptualised and operationalised in many different ways resulting in a lack of consensus around the definitions and terms used within the field. Achieving a better understanding of technology-mediated personalised learning can aid research through supporting comparisons and transferable knowledge to enable the consolidation of existing empirical evidence as well as allowing educational practitioners to assess the potential benefits of these tools. Van Schoors et al. (2021) present a systematic review of the digital personalised learning literature in both primary and secondary education to address this lack of consensus, focusing on the different conceptualisations used, the types of tools and how they are implemented as well as the existing evidence of impact on learning outcomes. The review reveals the diversity in concepts and tools as well as a positive trend in learning outcomes, concluding with guidelines for further research in this area.

Furthermore, while some researchers emphasize that the learner becomes central during learning in terms of choice, responsibility, personal relevance, student voice (Basham et al., 2016; Fitzgerald et al., 2018), other researchers stress the control that is exercised by the program/system and which is related to restricted learner choice/responsibility (Liu et al., 2020). This highlights the importance of the social context and the unique characteristics of young children in relation to the use of personalised digital technologies. In relation to this Rice and Cun (2021) use the lens of psychosocial developmental theories to examine how existing digital personalisation processes can be better targeted to young children as well as how parents and caregivers could be involved in the process. They make a series of recommendations to improve digital personalisation approaches for young children which address identity, types of learning and support systems.

Design

The second aim addresses *the design of personalised technologies* and *posits the question whether this design might be different when younger learners are targeted*. Designing personalised technology is a process that requires, apart from technical competence, extensive subject domain and cognitive modelling expertise, and therefore typically requires the input from varied experts. Kucirkova et al. (2021) present research which involved interviews with a range of professionals to identify dilemmas designers might face when designing personalised learning environments. The result of the research

consists of a framework including three types of personalisation: customisation, individualisation and adaptation in learning, which can be used by stakeholders to enhance dialogue and shared understanding when designing for personalisation.

When thinking of personalised learning for younger learners and technology in particular, one challenge that emerges is that the expertise required to inform, for example, sequencing or other adaptive strategies, is not readily available in the form of precise and explicitly formulated knowledge. As such, methods are needed to provide access to experts' 'tacit' knowledge and experiences (Porayska-Pomsta et al., 2013). Methods for designing personalised technology tend to yield instructional and domain knowledge, subsequently there are other aspects where additional design methods and guidance may be needed. In response to this, Benton et al. (2021) reflect on the design process followed in a large-scale adaptive literacy game for linguistically and cognitively diverse groups of children, and focus on how to specifically design for optimal challenge in games within a personalised learning context. They identify three key design tensions and present a set of design recommendations to guide researchers and designers to take a multi-dimensional view of challenge through the adaptive game design process.

Methods

The third aim focuses on *the effectiveness of technology-mediated personalised learning and the methodologies that are applied*. So far, only a limited number of studies have focused on the children's learning effects (Holmes et al., 2018; Xie et al., 2019). Informed by the media debate, several researchers argued to use value-added approaches to investigate which specific characteristics of the digital learning environment induce learning (Clark et al., 2016). This evidence can be obtained by conducting controlled designs in which the effects of personalised learning environments are contrasted with non-personalised learning environments. The study of Debeer et al. (2021) empirically validated the beneficial impact of an adaptive learning game by analyzing the log data from an adaptive and nonadaptive version of the Number Sense Game (NSG) that trains early numerical skills. The researchers used innovative approaches to model the students' progress over time, thereby giving an indication of the students' learning efficiency.

Another challenge with regard to the effectiveness of technology-mediated personalised learning is to enhance our understanding of which operationalisations of personalisation are effective. Different taxonomies (Bernacki et al., 2021; Plass & Pawar, 2020) showed the large diversity among technology-mediated personalised learning environments. For example, it is not yet clear whether the sequencing of tasks is more effective when relying on algorithms which automatically decide on the sequencing of tasks than when teachers can change the sequence of the tasks themselves based on their own estimation of a child's ability which Serra et al. (2021) investigated within the context of a digital serious game. Participants used the learning tool for six months, and the effects of the sequencing (by the teacher or system) were examined through pre and posttests in terms of children's performance.

Practice

The fourth aim looks beyond effectiveness to consider how personalised learning can change how we understand practice and research. The *implementation of technology-mediated personalised learning* changes the dynamic of the classroom, as it impacts learners and teachers (Basham et al., 2016). Theories of classroom technology integration assume that teachers' dispositions towards digital technologies influence the extent to which teachers integrate these tools within their classroom practice

(Blömeke et al., 2015). In their study, Berkling et al. (2021) interviewed elementary school teachers at several points during the integration of an adaptive literacy game. Based on a content analysis themes were identified which reflected teachers' dispositions towards digital technology and their actual use of the literacy game, presented as different teacher personas. Insights are provided into how teachers' appropriation stances evolved over the duration of the intervention and implications of personas for professional development are suggested.

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