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Towards a transdisciplinary approach to evidence-based decision making regarding digital technology use with, by and for children

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NON-TECHNICAL SUMMARY

Individuals and organisations seek evidence to support their decision making regarding children and technology. Parents want to know what they can do to best support their child. Health, education and social welfare practitioners, policy makers, and service providers want to understand the issues and know how best to support children and their families. Similarly, product designers, content developers, engineers and producers want to understand these same issues and how their products may influence children's lives. Additionally, there is increasing recognition of the value of empowering children to be part of the decision making that concerns their lives, and that facilitating this is important to help them understand the implications of their choices.

Scientific evidence is important for decision making because society holds decision makers accountable. Some people may consider this accountability to be evident in legislation related to the responsibility of parents for their child's welfare, of health professionals for their decisions regarding health care of children, and of companies for the injury risks of their product design and manufacture.

These decisions are based on societal assumption that decisions should be informed by relevant and unbiased evidence that has been developed using scientific methods that are reproducible, reliable, and rigorous. The contemporary social assumption is that responsible decision making proceeds from the best available evidence to maximise the probability that decisions will have the intended outcome.

This paper provides a common ground to facilitate transdisciplinary reviews of evidence to support decision making regarding children and technology. It provides a common, respectful terminology for the various types of reviews potentially useful for examining important aspects of children's interaction with technology. It also provides an overview of historical developments and future challenges to support a common understanding of the evolving concepts and methods in reviews. Finally it provides suggestions of practical and conceptual developments that could support transdisciplinary collaboration. In conclusion, this paper presents a transdisciplinary approach to evidence synthesis which builds on recent advances in review approaches to provide value to society by more effectively supporting evidence-based decision making regarding digital technology use with, by and for young children.

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Towards a transdisciplinary approach to evidence-based decision making regarding digital technology use with, by and for children

ABSTRACT

This paper aims to provide common ground to facilitate transdisciplinary reviews of evidence intended to support decision making regarding children and technology. It presents a common purpose by arguing that society holds decision makers accountable and expects them to make use of evidence. Further, it provides a common and respectful shared terminology for the various types of reviews used to examine important aspects of children's interaction with technology. It also provides an overview of historical developments and future challenges to support a common understanding of the evolving concepts and methods in reviews. Finally it provides suggestions for practical and conceptual developments that could enable meaningful transdisciplinary collaboration. This transdisciplinary approach to evidence synthesis builds on recent advances in review approaches to more effectively support evidence-based decision making regarding digital technology use with, by, and for young children.

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INTRODUCTION

This paper argues that reviews of evidence have the potential to support important decisions affecting children growing up in a digital world, but that a number of practical and conceptual problems currently inhibit their effective use in the area of technology use with, by, and for children.

Conceptually, much of the available evidence on children and digital technologies has been developed within a limited disciplinary range that examines only some aspects of a childhood. For example, much of the research on screen use by children has developed in parallel in segregated silos such as health, education, and design. Thus the health research has focussed primarily on negative health impacts such as sedentariness (Wachira et al., 2018), musculoskeletal symptoms (Toh et al., 2020) and mental ill-health (Liu et al., 2016); whereas the education research has focussed on positive educational aspects such as supporting learning with specific technologies (Ibáñez and Delgado-Kloos, 2018), informing pedagogical practice (Nurdiantami and Agil, 2020) and supporting educators (Lantz-Andersson et al., 2018); and human-computer interaction (HCI) research has focussed on principles of interface design for children (Börjesson et al., 2015; Markopoulos et al., 2008), questions of user experience (both positive and negative) and understanding and use of emerging and innovative technologies (Jung and Won, 2018). This multiplicity of research perspectives means that respected organisations who claim to speak with authority about children and childhood can often only offer partial viewpoints, which in turn means that policy and public opinion in this area can appear disjointed and fragmented, contributing to confusion for decision makers (Straker et al., 2018). A transdisciplinary approach may provide a way to create reviews of the evidence that better reflect the complexity of issues arising from children's interaction with technology.

Practically, the different languages, perspectives, and methodological traditions of the broad range of disciplines concerned about children and technology act to inhibit collaborative syntheses of evidence which consider the whole child. For example there are diverse perspectives on the value of evidence provided by different types of reviews, and even the extent to which decisions should be informed by evidence (Evans and Benefield, 2001). This has contributed to misunderstandings and myths such as beliefs that systematic reviews can only be used for quantitative results from randomised controlled trials of intervention effectiveness (Gough and Thomas, 2016). Further, evidence-based practice has been politicized at times with resultant fragmentation in effort rather than collaboration.

This paper seeks to provide a foundation for transdisciplinary work by presenting an overview of reviews that is sensitive to multiple disciplinary perspectives. It therefore presents definitions of key constructs to enable clearer communication across expert fields. In our view transdisciplinarity would be genuinely synthetic rather than just a form of aggregative multidisciplinarity (Callard and Fitzgerald, 2015), so it remains an aspirational goal. We thus present a range of review options and their potential advantages and disadvantages to demonstrate that there is not one type of review that should be more valued and indeed that many types can be potentially useful and also potentially transdisciplinary. The historical background and future challenges of reviews are presented to help develop a shared understanding that this is an area of evolving understanding and methods, and that now is a very opportune time to bring together prior diverse thinking and methods to support transdisciplinary work. The paper concludes with suggestions to encourage transdisciplinary reviews, but starts with an

examination of evidence-based decision making to highlight the potential value of syntheses of evidence.

1.1 Why evidence-based decision making is important

Individuals and organisations seek evidence to support their decision making regarding children and technology. Parents want to know what they can do to best support their child. Health, education and social welfare practitioners, policy makers, and service providers want to understand the issues and know how best to support children and their families. Similarly, product designers, content developers, engineers and producers want to understand these same issues and how their products may influence children's lives. Additionally, there is increasing recognition of the value of empowering children to be part of the decision making that concerns their lives, and that facilitating this is important to help them understand the implications of their choices.

Scientific evidence is important for decision making because society holds decision makers accountable. Some people may consider this accountability to be evident in legislation related to the responsibility of parents for their child's welfare, of health professionals for their decisions regarding health care of children, and of companies for the injury risks of their product design and manufacture.

These decisions are based on societal assumption that reasoning should conform to the standards of the field, and should be informed by relevant and unbiased evidence that has been developed using scientific methods that are reproducible, reliable, and rigorous (Askie and Offringa, 2015; Evans and Benefield, 2001; Gough et al., 2013; Straus and Haynes, 2009; Zimmerman et al., 2007). The contemporary social assumption is that responsible decision making proceeds from the best available evidence to maximise the probability that decisions will have the intended outcome. In the domain of children and technology these decisions address a wide variety of questions, with examples provided in Table 1.

TABLE 1 EXAMPLES OF QUESTIONS ADDRESSED BY DECISION MAKERS REGARDING CHILDREN AND TECHNOLOGY

- What helps children develop into happy, healthy, and productive citizens?
- What are the risks and opportunities of interactions with digital technology?
- What is not known that should be?
- Whose perspectives have not been heard that should be?
- How can society help protect children from harm and promote benefits?
- What are the implications for stakeholders?
- How can limited resources be best deployed to help children?
- Have past decisions resulted in the intended outcomes?

Whilst many decision makers seek evidence, and society expects decision makers to be accountable and use evidence to inform decisions on a wide variety of topics, there are a number of issues which can impede the use of evidence.

1.2 Issues with evidence-based decision making

There is an enormous amount of information available via social media, mass media, government and non-government organisation websites, and scientific literature regarding digital technology use with, by and for young children. Ideally, this information would inform how society can support children growing up in a digital world. However the sheer volume of this information, its variable veracity, its potential relevance, and the complexity of the topic all create barriers to its use.

In the middle of the 20th century the volume of information readily available to parents, and health, education, design and engineering professionals was considerable, but potentially manageable. However in the 21st century the volume of information available is overwhelming. For example, an internet search on 'children' and 'technology' currently returns 3.9 billion hits. Further, just within scientific publications on child* and technol* the Scopus database lists >5,000 in 2020. Evidence-based decision making thus requires synthesis of knowledge into a digestible amount.

Historically, society has often relied on experienced experts in the area to provide a summary of the 'state of knowledge' to help inform future research, practice, policy and products. There was the presumption that experienced experts could sort out rubbish and summarise good quality truthful information. The literature about the review process argues that in the late 20th century it became clear that expert advice could be problematic, resulting in poor decisions regarding practice, policy and products (Petticrew and Roberts, 2008; Sheldon, 2005). For example, a classic study demonstrated that reviews by experts in the treatment of myocardial infarction were often slow in integrating recent advances, and recommended treatments that were not effective, and even potentially harmful (Antman et al., 1992). Additionally, reviews by experts may not reflect the diversity of evidence on a topic (Gough and Thomas, 2016). Evidence-based decision making thus requires trustworthy synthesis of knowledge.

Decision making requires relevant and accessible evidence synthesis (Mays et al., 2005). Some attempts to support decision makers have fallen short of this aim. This could be due to synthesis not addressing the actual information needs of the decision makers, or presentation in overly academic language. Evidence-based decision making thus requires relevant knowledge synthesis.

We suggest that information is often provided from a limited perspective deriving from "siloed" research, practice, policy and product development. As previously mentioned, this has led to authoritative education and health government sources providing conflicting views on children and technology (Straker et al., 2018). Our interest in supporting children to develop into healthy, educated, and connected citizens necessarily draws from a multitude of opinions, themselves relying on different perspectives on what is a complex topic. Consideration of research about the 'whole child' could enable understanding of the balance across multiple outcomes, for example the potential trade-offs between physical activity and sedentary learning. Evidence-based decision making therefore requires a transdisciplinary approach to complex topic knowledge synthesis.

1.3 The rise of evidence synthesis

To address the increasing importance of evidence-based decision making and awareness of the volume, veracity, relevance and complexity of information, there has been a growing interest in effective methods to synthesise evidence.

The history of evidence synthesis is commonly reported to have roots in health research in the 18th century, when James Lind described trying to develop a "full and impartial view" on what had been published previously. Lind appraised prior literature to "root out prejudices" and remove "a great deal of rubbish" (Askie and Offringa, 2015). His work lead to the successful prevention and management of scurvy in sailors (Askie and Offringa, 2015). Other reviews emerged across various fields first half of the 20th century, including Pearson's (1904) review of data from 11 studies of vaccines for typhoid (Clarke, 2016), and Peters' (1933) summary of more than 180 studies on the effects of character education on children (Chalmers et al., 2002). Through the second half of the 20th century reviews of evidence were beginning to be used across the fields of health (Bastian et al., 2010), business (Snyder, 2019), and education (Bearman et al., 2012; Evans and Benefield, 2001).

Around the end of the 20th century there was growing concern that ineffective and costly interventions were being maintained (Sheldon, 2005). This lead to the establishment of the Cochrane Collaboration in 1992 and the Campbell Collaboration in 2000. These international organisations shared similar goals of delivering evidence to support better decision making regarding health care (Cochrane) and education, justice and social welfare (Campbell) through supporting systematic reviews. Reviews were also becoming more frequently used in computer science (de Souza et al., 2015; Garousi and Felderer, 2017) in the first decade of this century.

Since 2000 there has been exponential growth in the number of reviews conducted (Bastian et al., 2010). A recent analysis reported that there were almost 100,000 reviews published annually, composed of over 80,000 narrative reviews and over 10,000 systematic reviews (Ioannidis, 2016). This rapid expansion in the number of published reviews is at least partly related to recognition that they can provide higher quality evidence than that provided by a single study. Single studies are more likely to provide inaccurate or biased evidence as they present one view point based on one situation involving data from one group of people, and thus just one small 'window' view of reality (Sheldon, 2005). Reviews in contrast can combine evidence from multiple studies using different methods (including both qualitative and quantitative information), a broader range of participants, with larger cumulative numbers and therefore increased precision, statistical power and generalisability. Reviews can also have additional benefits including reducing unnecessary duplication of research and thus wastage of research resources (Bastian et al., 2010). Reviews using broad search methods can also help to reduce cultural and discipline biases by identifying evidence outside of the review authors' geographical and disciplinary niche.

2 Developing a shared language of reviews

2.1 The definition and purpose of reviews

To 'review' has been defined as to "view, inspect, or examine a second time or again" (Stevenson, 2010). 'User reviews' are common online, typically reporting a user's view on a product – such as their views on a particular App, movie, toy or baby skin care product. 'Expert reviews' are also common, and can cover goods and services – such as commissioned reviews on the functioning of an early childhood education and care service, or a professional education course, or a research centre. However, the focus in this paper is 'academic reviews', in particular a review article defined as "a paper in a journal that

summarizes recent literature on or developments in a particular subject (Stevenson, 2010).” The audience for these reviews can be other researchers, but other users are being recognised including practitioners, policy makers, and product developers across diverse discipline fields including health, education, communication, design, and engineering. Increasingly the general community, parents and children themselves are being seen as end users.

The common purpose of review articles is to identify and synthesize relevant literature in order to address a certain research question and present an up-to-date understanding of the topic (Palmatier et al., 2018). They thus generally synthesize or analyse research already conducted and reported in primary sources rather than present new results from experimental or other studies. Reviews often share a number of common aims, as illustrated in Table 2.

TABLE 2 EXAMPLES OF COMMON AIMS FOR REVIEWS

- highlight the significance of the problem
- provide and develop theoretical or conceptual frameworks
- define relevant or key terms and important variables
- resolve definitional ambiguities and outline the scope of the topic
- assess the weight and quality of evidence
- provide an integrated, synthesized overview of the current state of knowledge to gain new perspectives
- identify inconsistencies in prior results and potential explanations
- identify and evaluate methods used
- demonstrate gaps in knowledge and
- give suggestions for future research directions.

Reviews often focus on peer-reviewed scientific literature, given the assumed, though contestable, filter of quality that is provided by peer-review. However reviews can also involve other data sources including ‘grey literature’ (Garousi et al., 2019). Grey literature has been defined as “…information produced on all levels of government, academia, business and industry in electronic and print formats not controlled by commercial publishing i.e. where publishing is not the primary activity of the producing body (CGL Luxembourg, 2004)”. Examples of grey literature include: conference proceedings, newsletters, practice guidelines, government documents, census data, policy reports, and interviews. The quality of evidence in grey literature can be the as high as peer-reviewed literature. The lack of commercial publication peer-review filtering may at times be an advantage, by enabling more rapid dissemination of knowledge without hindrance from prior perceptions in the field. The type of data source may also reflect discipline traditions. For example conference proceedings are often subject to rigorous peer review and are highly valued in HCI whereas monographs are highly valued in Humanities. Regardless of the data sources used, reviews may have a specific focus. Table 3 provides examples of common specific focuses for reviews.

TABLE 3 EXAMPLES OF COMMON SPECIFIC FOCUSES FOR REVIEWS

- examine what knowledge currently exists and gaps in knowledge to guide future research
- examine intervention or policy effectiveness to identify optimal management
- examine prevalence and incidence to understand the scope of issues
- examine aetiology to understand mechanisms and risk
- examine methods including outcome assessment accuracy to guide measurement
- examine costs of interventions, processes, policies to guide resource allocation
- examine experiences or meaningfulness to understand lived experiences
- examine theoretical or conceptual approaches to extend understanding

2.2 The variety of types of reviews

A multitude of different types (Garousi et al., 2019; Grant and Booth, 2009; Hamel et al., 2021; Palmatier et al., 2018; Tricco et al., 2016) of reviews have been described including: critical review, conceptual synthesis, literature review, narrative review, mapping review, meta-analysis, meta-interpretation, meta-ethnography, meta-synthesis, meta-summary, meta-narrative, mixed studies reviews, overview, qualitative evidence synthesis, rapid review, realist review, scoping review, systematic mapping, evidence map gap, multivocal literature review, state-of-the-art review, systematic literature review, systematic review, systematized review, and umbrella review.

Reasons for the large number of different types of reviews include not only the different specific purposes noted earlier, but also different disciplinary traditions, such as in health, education and human-computer interaction.

Reviews in health began with narrative reviews, as high value was placed on experience, with the opinions of senior clinicians accepted as the best available evidence. However this was found to result in biased and often incorrect recommendations being made for health care (Sheldon, 2005). The reaction to this was the establishment of highly structured methods to minimise the risk of key biases. This approach worked quite well with simple health interventions amenable to quantitative outcome measures, such as drug randomised clinical trials (RCTs). However such reviews often lacked clinical applicability as the controlled trial lacked ecological validity and important contextual knowledge on the area was ignored. Formulaic reviews of RCTs were also not able to inform why some interventions worked and others didn't, and often lacked evaluation of the impact on each individual as a whole person. Recent developments are attempting to restore a balance between quantitative data methods with minimal risk of bias, and qualitative data methods informing individual and contextual factors.

Space does not allow full consideration of debates about the role of evidence, reviews and synthesis in education. There is considerable diversity of opinion amongst education professionals about the validity of different kinds of data from student performance, studies of school and school systems, studies of classrooms, curriculum and assessment and this debate has changed over time. As teacher autonomy and local authority over schooling has become more centralised leading in the last 20 years or so to comparative studies of national school performance managed by OECD and other national and

international testing services, so what constitutes ways of defining and measuring learning, teaching, outputs and progression have all come into conflict with inherited traditions and values societies demand of their education systems. Current government funded centres such as the Evidence for Policy and Practice Information and Coordinating Centre EPPI-Centre in the UK and the Australian Council for Educational Research produce reviews that have been criticised for being over-dependent on a version of quantitative data and experimental design (Andrews, 2005). New kinds of data analytics now jostle for validity and acceptance alongside a diversity of research in the education field. Debate about the purposes of education (personal development, economic growth et cetera) are common across a constituency of decision-makers - parents, teachers and governments - just as the churn of theories about how children learn (sociocultural, cognitive, behavioural) is constantly being updated with insights from neuroscience, genetics and so forth. This has all led to a state of affairs where what constitutes scientific rigour, evidence, change and reform in education remain significantly contested across the very wide range of decision-makers who have a stake in schools and education systems.

As in other domains, systematic reviews in HCI have become increasingly common over time. Broadly, systematic reviews in the computer-human interaction discipline have explored issues around the use of specific technologies as well as user experience including the ways that humans engage with technology and the impacts of different technology on people. Early reviews were often focussed on the use of specific technologies (e.g., video abstraction (Truong and Venkatesh, 2007) or software process simulation (Zhang et al., 2008)) as well as interface design (Markopoulos et al., 2008) but in more recent years have become more focussed on questions of user experience, the impacts of technology and other related issues such as questions of ethics (Van Mechelen et al., 2020) in child-computer interaction or the empowerment (Van Mechelen et al., 2021) of children.

Whilst the different specific purposes and the different discipline traditions are important contributors to the evolution of the wide variety of reviews there are also other contributing factors including: the resources required, the amount of prior knowledge, the intended end user, the data sources used, the review aim, the transparency of methods, and the degree of formality and structure.

The resources required for a review can vary enormously. Some review types only require a single author using previously held data sources, and can be completed in a matter of days, whereas other types of reviews require multiple authors to enable independent assessments along with access to sophisticated search capacities, data handling and statistical analysis and can take several person years to complete. Rapid reviews were developed as a formalized compromise to overcome the lack of timely evidence developed using full systematic review methods while retaining a lower risk of bias (Haby et al., 2016; Hamel et al., 2021; Plüddemann et al., 2018).

The type of review may also vary with the amount of prior knowledge available. For example scoping reviews (Arksey and O'Malley, 2005; Peters et al., 2015; Pham et al., 2014) are often used if there is little published in the area or for examining emerging evidence, whereas umbrella reviews (Aromataris et al., 2015) can be used where there are multiple prior reviews in the area.

The intended end user may also determine the type of review used. For example a realist (Pawson et al., 2004) review may be used to inform practice, policy or product end users whereas a scoping review may be used to inform researcher end users.

Some review types exclusively deal with either qualitative or quantitative data. For example meta-ethnographic reviews (Mays et al., 2005) use qualitative data to explore perceptions, whereas systematic reviews with meta-analysis use statistical methods to synthesise results from multiple primary studies either using group data or individual participant data. Mixed-methods reviews combine both qualitative and quantitative data (Pluye and Hong, 2014). Some review types draw data from peer-reviewed publications of primary studies whilst others examine grey literature such as government policy.

Along similar lines (Gough et al., 2013; Gough and Thomas, 2016), some reviews are aimed at 'enlightenment' and informing how people understand and think about an issue and have been called 'configurative'. These are interested in the development of theories and understandings of the why and how things work or feel, and often rely mainly on qualitative data (Evans and Benefield, 2001). For example a conceptual review may focus on identifying the attributes of a concept used to build a new theoretical model (Tricco et al., 2016). Other reviews are focussed on 'instrumentation' and reducing bias and increasing precision and generalisability and have been called 'aggregative' (Gough and Thomas, 2016). These are interested in identifying and quantifying what works, and often rely mainly on quantitative data (Evans and Benefield, 2001), for example systematic reviews with meta-analysis.

Some review types require total transparency of each phase of the review process, thus enabling auditability and replication such as systematic reviews. However other review types, such as narrative reviews, often do not require method transparency.

Perhaps one of the most useful distinguishing factors is the degree of structure or formality in the process of conducting a review. For example, a narrative review can be conducted and reported in many different ways, enabling creative approaches. In contrast, systematic reviews now have established and detailed methods which are highly structured to the extent that many journals require authors to confirm, document and justify their method steps against internationally recognised checklists.

There is no broadly accepted taxonomy of types of reviews, however Table 4 presents a summary of the main types of reviews that are widely reported in an order loosely arranged along dual spectrums - from unstructured through to highly structured, and from configurative through to aggregative. The terms used are sensitive to discipline differences to help provide a common language to support transdisciplinary reviews.

TABLE 4 MAIN TYPES OF REVIEWS WITH EXAMPLES, DESCRIPTIONS AND PROS/CONS

Type and examples	Description	Pros	Cons
Narrative E.g. (Lieberman et al., 2009) (Straker et al., 2010)	Evidence synthesis methods characterised by using unstructured methods (Boote and Beile, 2005; Green et al., 2006).	• Flexible in purpose, data sources (can use quant and qual data and grey sources),and methods • Increases potential for expert insights	• Higher risk of bias • May not provide clear practice, policy or product guidance
Conceptual E.g. (Nesset and Large, 2004) (Bond and Bedenlier, 2019)	Knowledge synthesis methods with a particular focus on concepts. Reviews can either be focussed on presenting a particular point of view or argument – 'argumentative review' or focussed on conceptual integration and theory development e.g. 'concept synthesis' or 'critical interpretive synthesis' (Yazdani and Bayazidim, 2020).	• Can provide strong advocacy for a particular concept or approach • Can strengthen critical thinking and understanding	• Higher risk of bias • May not provide clear practice, policy or product guidance
Mixed methods E.g. (Abel et al., 2021) (Nye et al., 2019)	Reviews aimed at integrating both quantitative and qualitative methods. Review may consider only studies using both qualitative and quantitative methods, or may examine both qualitative and quantitative studies. Integration of knowledge from both quantitative and qualitative studies can be done either simultaneously or sequentially (Mays et al., 2005; Pluye and Hong, 2014).	• Enables a richer understanding, for example of not only what intervention works, but also why it worked and what it meant to the people involved	• Can require broader range of skills than commonly possessed by many researchers

Realist E.g. (Tyler et al., 2019) (Coles et al., 2015)	Evidence synthesis method developed in response to criticisms that systematic reviews were not providing practice and policy relevant conclusions applicable to real world complex problems. Often based on a theoretical framework and early involvement of stakeholders (Berg and Nanavati, 2016; Pawson et al., 2004).	• Focuses not only on what works but how and why it works and within what context • Attempts to integrate theory • Conclusions more likely to be relevant to policy and practice	• Not so well developed methods, with little uniformity and limited transparency (although international standards have been proposed) • Theoretical framework may introduce bias
Scoping E.g. (Sequeira et al., 2020) (Facca et al., 2020)	Reviews aimed at identifying what information exists on a topic and where there are gaps in knowledge. Specific terms include: scoping review, evidence and gap map (Peters et al., 2015; Howard White et al., 2020).	• Provides a useful basis to guide future research	• Typically doesn't evaluate the quality of evidence available • Typically doesn't provide guidance for practice, policy or product
Rapid E.g. (Cowden et al., 2020) (Stoilova et al., 2021)	Evidence synthesis method developed in response to large resource requirement and time lag in full systematic reviews. Attempts to use much of the same systematic approach but with some short-cuts taken (Haby et al., 2016; Hamel et al., 2021; Plüddemann et al., 2018).	• Lower risk of bias than non-systematic reviews • Lower resource requirement than full systematic review • Shorter time lag than full systematic reviews	• Lower perceived value • Corners cut may impact on trustworthiness of conclusions

Umbrella E.g. (Nguyen et al., 2020) (Stiglic and Viner, 2019)	Reviews conducted using prior reviews as the source material (Aromataris et al., 2015; Fusar-Poli and Radua, 2018).	• Resource efficient as only a few reviews need to be examined rather than many original sources	• Distance from original sources can mean misconceptions and incorrect understandings of initial reviews are perpetuated
Systematic E.g. (Manning et al., 2017) (Van Mechelen et al., 2021)	Reviews conducted in a manner to minimise risk of bias by following highly structured methods aimed at capturing all available evidence, appraising quality of available evidence and drawing conclusions where there is high transparency in process and reproducibility and therefore trustworthiness (Gough and Thomas, 2016; Munn et al., 2018).	• Lower risk of bias in what evidence examined and conclusions drawn • Can be used with quant and qual data - meta synthesis (non statistical for qualitative or quantitative data) or meta analysis (statistical methods used for quantitative data using group data or individual participant data)	• Mechanical processes can miss critical aspects of understanding why an outcome was observed • For complex issues often lack useful conclusions for practice, policy or product • Can provide illusion of lack of bias but actually reflect strong author bias • Very resource and time intensive

3 Challenges and future directions for reviews

For those responsible for making decisions regarding children and digital technologies, the growing development of evidence synthesis methods based on reviews offers promise that future practice, policy and products will help create a better world for children. However there are a number of challenges to arriving at a utopian position where all of society's decisions are based on the best available evidence.

3.1 Recognising decisions are made for a variety of reasons

Practice, policy and product decisions are not only made on the basis of evidence regarding how to best support children. Decisions are often made in a context which is sensitive to community traditions and expectations, and political and other influences, including financial constraints. Although reviews may be able to include these dimensions to some extent, perhaps the aim for reviews should be to provide for a more informed discussion about practice, policy and products and assist in more decisions being evidence-based.

3.2 Making it relevant to enable implementation by end users

Enabling reviews to have a meaningful impact in society requires attention to the needs of end users who would change policy, practice and products. Early in the history of more structured reviews it became evident that unbiased syntheses of the evidence can challenge beliefs and vested interests. Reviews can therefore be met with hostile responses at times. This is understandable, but may not be the best way to assist evidence-based decision making in society. Another common criticism of reviews is that their conclusions are all the same, and of little practical benefit (Manson, 2016). Many systematic reviews conclude with a statement around the lack of high quality evidence and the need for more research. Further, reviews are commonly criticised for not answering the questions that families, practitioners, policy makers or product designers actually needed asking (Sheldon, 2005). In response to these issues, there is growing support for the early involvement of end users (Andrews, 2005), to help frame the appropriate question and to help the acceptance of the end conclusion having been on the journey for its discovery. However there are caveats with end user involvement, as exemplified with the biased conclusions in some reviews where pharmaceutical organisations with vested interests are perhaps too involved in both primary research and research syntheses (Ioannidis, 2016). Where end user organisations have formal or informal processes for embedding evidence in decision making then integrating reviews into existing system pathways may well assist translation and implementation.

3.3 Dealing with a large volume of existing research

Most types of reviews typically require considerable resources. Review authors should have well developed skills in the review methods used as well as in the specific knowledge domain. This requires society to invest in the training of researchers. Reviews are also time consuming, which requires financial resources. This is becoming an increasingly important issue as the volume of primary research reports grows exponentially (Bastian et al., 2010). This could eventually overwhelm society's capacity to train and fund researchers capable of thoughtful reviews. However developments in technology are

already enabling more efficient conduct of some aspects of reviews. The shift to electronic databases for much of the scientific literature has substantially reduced the researcher time required to search for appropriate research reports, along with the better use of keywords and study descriptions following international standards. Similarly, the digitisation of research reports greatly reduces the time to acquire copies of primary source reports. The promotion of 'open data', whilst enhancing auditability and the ease of individual participant data meta-analysis, also increases potential review workload. There is also a risk that the increasing perceived value of reviews diminishes researcher engagement in primary studies, which are still obviously required. Further, the shift towards more standardised reporting of primary studies and use of common outcome metrics facilitates quicker and more accurate data extraction and analysis. More recently machine learning (Chai et al., 2021) has been successfully used to dramatically reduce researcher time required to screen for research reports appropriate to include in a review. By reducing the time researchers need to commit to rudimentary tasks such as finding relevant primary reports, there is comparatively more time available for higher level conceptual synthesis and interpretation, and thus potentially more insightful, relevant and useful conclusions.

3.4 Bringing together different types of evidence

The history of evidence synthesis highlights the pendulum swings between in-depth understanding of an area with high risk of bias through to superficial and mechanical reviewing with low risk of bias. Recent academic discussions and method developments are attempting to find ways to support approaches which balance strong context knowledge with low risk of bias (Gough and Thomas, 2016). Methods for combining evidence from different types of studies are also emerging, in recognition of the limitations of the information that RCTs alone can provide (Aromataris and Munn, 2020). Methods are also being refined for including the synthesis of both quantitative and qualitative information, to enable a more thorough understanding (Centre for Reviews and Dissemination, 2008). There is an ongoing process in method development to better support review authors to select (Kastner et al., 2016) and use the right type of review for any given specific purpose and thus create a synthesis of the evidence which has both high trustworthiness and high context understanding.

3.5 Bringing together expertise and understandings from multiple disciplines to address complex topics concerning the whole child as a way forward

There is growing recognition that many of the practice, policy and product topics currently relevant to children and digital technology are quite complex and would benefit from not only the knowledge and perspectives of multiple disciplines, but also from a transdisciplinary approach transcending the compartmentalised knowledge and perspectives of multiple disciplines. This will require substantial commitment from individuals, including a culture of acceptance of other perspectives. Whilst transdisciplinary research has been promoted for a number of years (de Souza et al., 2015; Dickens, 2003; Magill-Evans et al., 2002), it is often problematic, as discipline experts come with their own language, philosophy and traditions. As argued at the start of this paper, there are both conceptual and practical challenges in bringing together diverse disciplines across sciences and humanities.

Practically, reviews with a higher degree of structure can provide a method built around the framework of a formal set of procedures which can make it easier for researchers from varied backgrounds to begin to collaborate. Early structured reviews were heavily focussed on quantitative analysis of RCTs

for health interventions, and so did not provide an attractive method for other purposes or disciplines. However the recent developments in using systematic reviews to address a broader range of questions, and for structured reviews to examine a broader base of evidence (including qualitative), is making the use of structured approaches more accessible and attractive for non-effectiveness questions and non-health disciplines. By providing a scaffolded structure to support collaboration, they may be a practical starting point to enable researchers from diverse disciplines to work on developing a shared conceptual understanding of both the evidence and the specific topic. Current materials to support structured reviews are commonly discipline based, using language and perspectives that are not conducive to transdisciplinary collaboration. Therefore support materials should be developed which build on the common ground of language and understanding presented in the paper. The emergence of transdisciplinary support materials could provide an ideal starting point for researchers from different disciplines to work together – and develop richer shared transdisciplinary understanding as they traverse the established review process pathway together.

Conceptually, the complexity inherent in topics concerning children and digital technology reinforces the necessity of considering the whole child. A conceptual framework derived from systems theory, compatible with the bioecological model (Bronfenbrenner and Morris, 2006) and family systems theory (White and Klein, 2008), and widely used in human-computer interaction (Straker et al., 2009) may provide a useful start for a child-centric transdisciplinary approach. As illustrated in Figure 1 it would enable consideration of the biological, psychological, and social aspects of a child interacting with the physical and information aspects of digital technologies whilst undertaking some task. It would also recognise that this interaction occurs within a local context, which for children will often involve interactions with other people, such as family, peers and educators, as well as other aspects such as the physical surrounds. And it would also recognise that there may be multiple local contexts, such as home and school, and that these contexts in turn are situated within a broader physical and cultural environment. All of these interactions evolve over time, as the child develops and as the technology and other aspects of their surroundings change. However the conceptualisations in this model may not capture important aspects required for transdisciplinary understanding. For example philosophical perspectives on the value of combining evidence and intuition may be critical to an overarching model. Therefore important work needs to be progressed in developing shared understandings of the creation of meaning and models to capture these.

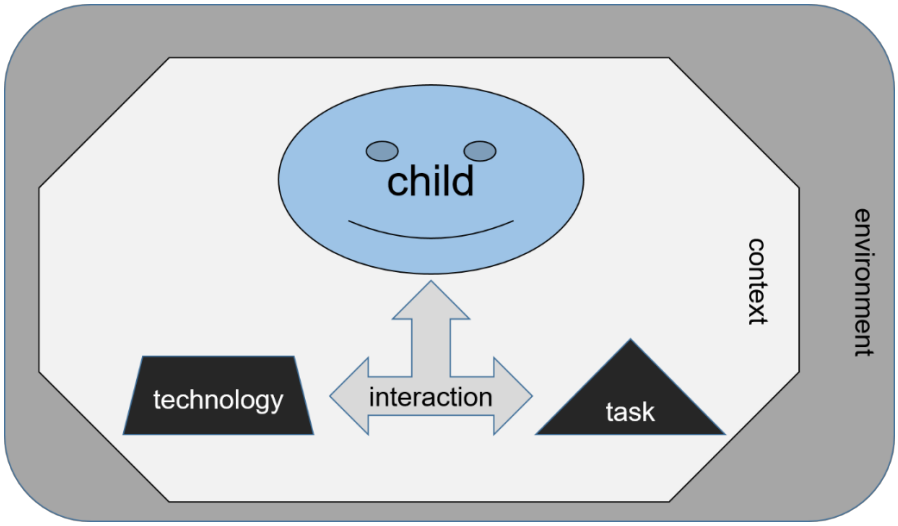

FIGURE 1 A TENTATIVE CHILD-CENTRIC TRANSDISCIPLINARY MODEL FOR CONSIDERING CHILDREN AND DIGITAL TECHNOLOGIES

4 Conclusion

This paper provides a common ground to facilitate transdisciplinary reviews of evidence to support decision making regarding children and technology. It argued that society holds decision makers accountable and expects them to make use of evidence. It provided a common, respectful terminology for the various types of reviews potentially useful for examining important aspects of children's interaction with technology. It also provided an overview of historical developments and future challenges to support a common understanding of the evolving concepts and methods in reviews. Finally it provided suggestions of practical and conceptual developments that could support transdisciplinary collaboration. In conclusion, this paper presented a transdisciplinary approach to evidence synthesis which builds on recent advances in review approaches to provide value to society by more effectively supporting evidence-based decision making regarding digital technology use with, by and for young children.

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