Digital, Physical & Hybrid Making in the Middle Years - A Scoping Review

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RESEARCH QUESTIONS

By examining the implementation and descriptions of physical and digital making activities in grades 4-8, we aim to explore how these practices can contribute to creating more playful and equity-oriented teaching and learning in schools. And so we ask:

Based on the scientific literature, how are physical and digital making activities implemented and described in school settings in grades 4-8 (internationally and in Canada)? What types of physical and digital Making activities are reported and recommended? What are the reported effects of these activities and teaching practices?

METHODOLOGY

We conducted a scoping review that included Canadian and International literature.

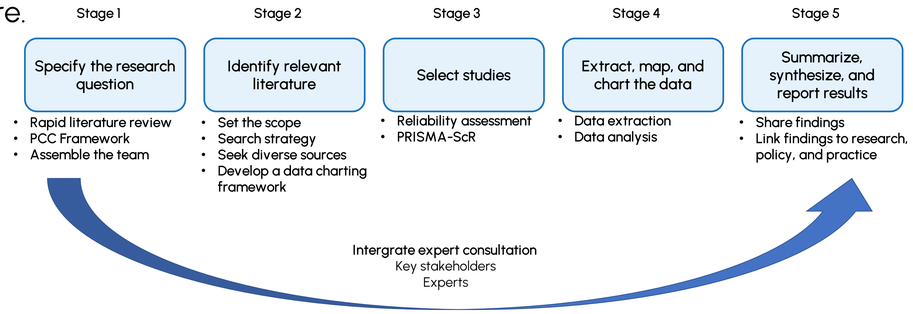

Figure 1. Six steps of Arksey & O'Malley's (2005) framework on scoping review methodology, enhanced by Westphaln et al., (2021).

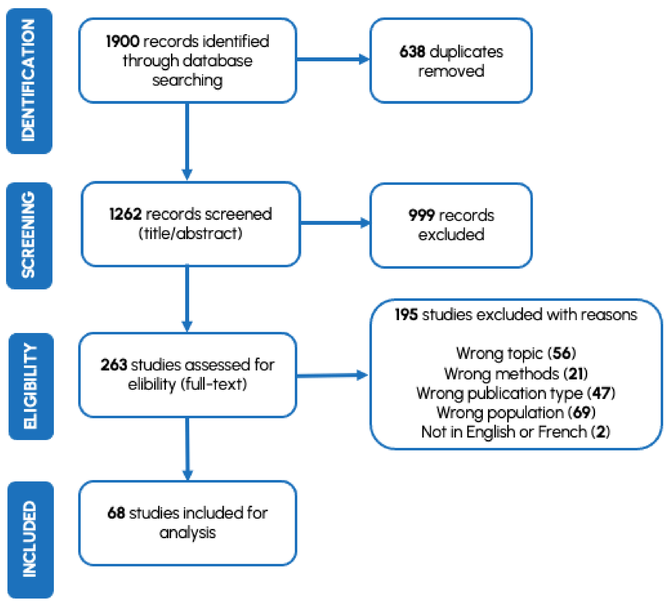

Figure 2. PRISMA Flow Diagram

Stage 2: A librarian developed a search protocol which was tested and then reviewed by a second librarian according to the Peer Review of Electronic Search Strategies (McGowan et al., 2016). 8 databases (French and English) were used.

Stage 3: Use of the *Covidence* software to select studies in accordance with latest PRISMA protocol.

Stage 4: Data extraction and analysis with *Dedoose* software. Integration of experts: Members of the CPSN and librarians contributed during the various stages.

DATA ANALYSIS

The coding of the 68 papers was divided among the 3 team members and carried out from a non-exhaustive list of codes inspired by our research questions and reflecting the PCC model (Peters et al., 2020) — PCC for population, context, and concepts. This list was completed as new codes inductive and theoretical codes emerged, following a general inductive approach (Blais & Martineau, 2006).

SELECTED RESULTS

Countries: 68 papers include studies conducted in 17 countries. Top 5 countries are: USA (19); Finland (9); Canada (7); Spain (4); China (3).
Age Distribution: 9 yrs old (16%); 10 yrs old (24%); 11 yrs old (22%); 12 yrs old (19%); 13 yrs old (19%).

Maker Activities & Learning Objectives

33 papers included rich descriptions of maker activities. 25 activities were connected to curricular expectations, and 16 included learning goals that go beyond the curriculum, most notably focused on individual and community development.

Maker Tools

We also identify a nearly equivalent number of physical (n=18) and digital (n=19) tools, materials and resources, as well as a penchant for a hybrid making (n=11).

Table 1. Tools, materials and physical resources: some examples

Category	Material	Example of an activity	Age	Reference
Recycled materials	**Wood, fabric, cardboard, plastic box**	*Students identify a problem experienced by one of the characters in a book and propose a solution that they will create from the available materials.*	*10-11*	Montgomery & Madden (2019)
Electronics	**E-textile LilyPad Arduino**	*As part of the science and technology curriculum create their own luminous hat.*	*11-13*	Hebert & Jenson (2020)
Technology	**3D printer**	*Students make a prosthetic bone for a professional stuntman and parent with a disability. The prosthesis would be used as an accessory in a future film.*	*13-14*	Hansen et al. (2019)
	Laser cutting machine	*After analyzing the life cycle of a pair of jeans, students map the different stages from production to consumption. Laser-cut icons help them map the entire process. They can then identify the problematic points on which to intervene and propose a solution (e.g. waste robot).*	*8-11*	Geser et al. (2019)
Other	**Body (dance, movement)**	*Students designed and created objects (prototype ships, toys) representing the English colony that they reproduced in their classroom. The teacher encouraged movement in the classroom, sometimes incorporating dance into her lessons and daily teaching.*	*9-10*	Herro (2021)

Table 2. Reported Positive Effects on Students (n=59)

Categories	Codes
Disciplinary learning (n=25)	Digital Literacies (8); STEM (7); Science (6); Mathematics (5); Engineering (4); STEAM (2); Literacy (4); Multimodal literacy (3); Maker literacy (2); Language learning (2); Biology (1).
Social Dimensions (n=32)	Communication, Teamwork, Participation, Sharing and Collaboration (24); Identity (7); Social Behaviour Enhancement (2); Equity (1)
Affective Dimensions (n=49)	Motivation and Engagement (31); Enjoyment (17); Positive Attitudes (13);Sense of Agency (12); Sense of Empowerment (10); Enthusiasm (10); Creativity (9)...
Metacognitive & Strategic Skills (n=25)	Problem Solving (16); Creativity (10); Critical Thinking (8); Planning (4); Design Skills (3); Decision Making (2); Inquiry Skills (2); Metacognitive Skills (1)

Table 3. Reported Positive Effects on Teachers (n=15)

Categories	Codes
Pedagogical (n=14)	Practices (8); Methods (5); Redirecting Authority (5); Disciplinary Knowledge (3); Realizing Students' Capabilities (1).
Social (n=5)	Connecting with Students (2); Equity-Oriented Approach (2); Collaboration (1).
Affective (n=4)	Empowerment (2); Enjoyment (1); Agency (1); Confidence (1).

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