

Design research in early literacy within the zone of proximal implementation

Citation for published version (APA):

McKenney, S., Kirschner, P. A., & Voogt, J. (2012). Design research in early literacy within the zone of proximal implementation. In J. van Aalst, K. Thompson, M. J. Jacobson, & P. Reimann (Eds.), *The Future of Learning: Proceedings of the 10th international conference of the learning sciences* (Vol. 1, pp. 96-102). International Society of the Learning Sciences.

Document status and date:

Published: 01/01/2012

Document Version:

Version created as part of publication process; publisher's layout; not normally made publicly available

Please check the document version of this publication:

- A submitted manuscript is the version of the article upon submission and before peer-review. There can be important differences between the submitted version and the official published version of record. People interested in the research are advised to contact the author for the final version of the publication, or visit the DOI to the publisher's website.
- The final author version and the galley proof are versions of the publication after peer review.
- The final published version features the final layout of the paper including the volume, issue and page numbers.

[Link to publication](#)

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal.

If the publication is distributed under the terms of Article 25fa of the Dutch Copyright Act, indicated by the "Taverne" license above, please follow below link for the End User Agreement:

<https://www.ou.nl/taverne-agreement>

Take down policy

If you believe that this document breaches copyright please contact us at:

pure-support@ou.nl

providing details and we will investigate your claim.

Downloaded from <https://research.ou.nl/> on date: 12 Aug. 2022

Open Universiteit
www.ou.nl



Design Research in Early Literacy within the Zone of Proximal Implementation

Susan McKenney, Open University of the Netherlands & Twente University, PO Box 2960, 6401DL Heerlen, susan.mckenney@ou.nl

Paul Kirschner, Open University of the Netherlands, PO Box 2960, 6401DL Heerlen, paul.kirschner@ou.nl
Joke Voogt, Twente University, PO Box 217, 7500 AE, Enschede, j.m.voogt@utwente.nl

Abstract: Despite intentions to the contrary, insights on pedagogically appropriate innovations with representative teachers in everyday school settings are severely limited. In part, this is because (design) research is often conducted at the bleeding edge of what is possible, exploring innovative uses of new technologies and/or emerging theories, while insufficient research and development work focuses on what is practical, today. This leaves a problematic gap between what could be useful research in theory, and what can be useful research in practice. This paper calls for (design) researchers to attend to factors that determine if and how innovations are understood, adopted and used by teachers and schools, and gives one example of how this was tackled in the domain of early literacy. Across ten studies, researchers collected data that helped shape an intervention that can be implemented by representative teachers, for diverse learners, in varied school settings.

Purpose

Educational (design) research strives to develop theoretical understanding that will ultimately improve the quality of teaching and learning. But even when research contributes to programs that are robustly designed and promising in specific settings, most prove difficult to scale up (cf. Penuel, Fishman, Cheng, & Sabelli, 2011). In part, this is because research is conducted at the bleeding edge of what is possible (i.e., exploring new technologies and/or emerging theories). There is no disputing that such work is greatly needed to seek out new ways to potentially enhance the quality of teaching and learning. However, in the excitement of exploring what is *possible tomorrow*, there is insufficient research and development work focusing on what is *practical today*. This leaves a problematic gap between what *could* be useful research in theory, and what *can* be useful research in practice. With the aim of generating ‘usable knowledge’ (cf. Lagemann, 2002) and creating innovations that truly serve teaching and learning in practice, this contribution calls for researchers to devote attention to not only fine-grained issues of pupil learning and instruction, but also to broader factors that determine if and how innovations are understood, adopted and used by teachers and schools. Allowing these issues to steer design is necessary to yield innovations that can feasibly be implemented outside of (often highly enabling) research and development trajectories. We argue for more research conducted from the perspective of actual implementation and provide an example of how this was accomplished across nearly a decade of design research related to early literacy.

Toward Relevant and Useful (Design) Research

Revisiting a Familiar Challenge

A hundred years ago, psychologists Hugo Musterburg and John Dewey called for a linking science that would connect theoretical and practical work. In the last 20 years, researchers in the field of curriculum have increasingly called for the development of theoretical understanding that can guide the design of educational innovation (van den Akker, 1999; Walker, 1992). At the same time, researchers in the learning sciences have emphasized the need for research to be situated in authentic contexts to understand learning as it naturally occurs and specifically, what that means for how we shape education (Bransford, Brown, & Cocking, 2000; Brown, 1992). In addition, researchers have stressed the need for innovations to fit into the complex and diverse systems in which they are implemented (Hall & Hord, 2010). Doing so requires developing theories and models to underpin such innovations (Penuel, et al., 2011). Such work must be fed by research and development investigations that are tightly connected to practical realities such as dominant curricula; school cultures; high stakes assessments; interest and expertise of teachers (McKenney, Nieveen, & van den Akker, 2006). They must also be sufficiently problematized to focus efforts not on quasi-problems (e.g., “our teachers need ideas for how to use the iPads® we gave them”), but on problems that are urgent enough to warrant scientific investigation to yield solutions and/or theoretical understanding that can help solve them (McKenney & Reeves, 2012).

The Zone of Proximal Implementation (ZPI)

For research to be relevant and useful, it must reflect an understanding of practical realities and concerns of the domain studied. Studying the status quo of teaching, learning and settings, and designing innovations such that

they gradually bridge from the current situation to the desired situation, is essential to developing both the knowledge and the tools required to address real needs in today's classrooms. This perspective has been referred to as the Zone of Proximal Implementation (ZPI; McKenney, 2011). Vygotsky's concept of the zone of proximal development – the distance between what learners can accomplish independently and what they can accomplish through guidance or collaboration – has previously been applied to large scale reform (Rogan, 2007; Rogan & Grayson, 2003); school leadership (McGivney & Moynihan, 1972); and the mediation of educational partnerships (Oakes, Welner, Yonezawa, & Allen, 1998). Similarly, others have referred to the need to pursue certain innovation goals in stepwise fashion, gradually moving from the current situation toward what is desired (Sullivan, 2004). A similar basic concept is applied to the design of educational innovations; but rather than focusing on what can be achieved by learners, it focuses on what can be implemented by teachers and/or schools. The ZPI refers to the distance between what teachers and schools can implement independently and what they can implement through guidance or collaboration (McKenney, 2011). Designing for the ZPI means explicitly tailoring products and processes to fit the capabilities, opportunities and limitations present among teachers and in schools. It also means planning for implementation scaffolding (e.g., honoraria or researcher co-teaching) to fade away in a timely fashion, while simultaneously developing the ownership and expertise among practitioners that will engender the desire and ability to sustain innovation. This is done, in part, through responsive (and sometimes participatory) design, fed by insights concerning learners, practitioners and context.

Implementation-prone Designs

In their book on conducting educational design research, McKenney and Reeves (2012) identify four characteristics of innovations that are *prone* to successful implementation, namely innovations that are value-added, clear, compatible and tolerant. During the inception, creation and testing of educational innovations at the ZPI, these characteristics may be considered criteria to be met. *Value-added innovations* offer something better than what is already in place. Similar to Rogers' (Rogers, 2003) notion of the relative advantage, the potential benefits of value-added innovations visibly outweigh the investments required to yield them. *Clear innovations* enable participants to easily envision their involvement. Innovations may be clear through high levels of explicitness via *a priori* specifications of procedures and/or interactive mechanisms whereby developers and users co-define the innovation or elements thereof. *Compatible innovations* are congruent with existing values, cultures, practices and beliefs. They are innovative, but the innovations and/or their underlying assumptions do not violate or reject fundamental concerns and principles of those involved. *Compatible innovations* are also aligned with non-changeable aspects of the educational system, such as assessment frameworks or policies. Finally, *tolerant innovations* are those that “degrade gracefully” (cf. Walker, 2006) as opposed to yielding “lethal mutations” (cf. Brown & Campione, 1996) during the natural variation in enactment that inevitably comes along with differing contexts, resources, expertise, acceptance levels and so on. Tolerance refers to how precisely core components must be enacted for the innovation to be true to its goals, and how well an innovation withstands local adaptations.

The remainder of this contribution describes how a multi-year (design) research series of studies was conducted within the zone of proximal implementation. Attention is given to how data were collected pertaining to the characteristics described above. The innovation was *PictoPal*: a technology-supported intervention designed to foster the development of emergent reading and writing skills in four and five year old children. Two main strands of inquiry have been attached to the PictoPal endeavor: technology for early literacy; and the influential role of teachers designing the PictoPal materials.

The PictoPal Studies

Technology for Early Literacy

Clay, (1966) emphasized that literacy begins long before school entry, calling this phenomenon emergent literacy. Underpinning this notion, which involves synergistic development of listening, speaking, reading, writing and viewing from birth, are several assertions which have been stressed by other experts as well. First, well-known theorists have long claimed that children play active roles in their own development (Bruner, 1983; Piaget, 1952; Piaget & Inhelder, 1969; Vygotsky, 1962). Clay's position that children are active learners about print long before they can read or write is consistent with this view. Second, Macnamara (1972) argued that language learning is driven by and dependent on the capacity to understand and participate in social situations. This is well-aligned with Clay's view that social interaction is the basis of emergent literacy.

The computer's potential to promulgate discourse and thereby knowledge creation has been examined across various age ranges (McLoughlin & Oliver, 1998; Scardmalia, Bereiter, & Lamon, 1994). In terms of early childhood literacy, studies have shown that properly shaped collaborative use of the computer can contribute to pro-social behaviours, including: lively interactions, shared vocabularies, mutual enjoyment and spontaneous, active off-computer play (Brooker & Siraj-Blatchford, 2002; Van Scoter, 2008). In such ways, technology can serve as a catalyst for social interaction and contribute positively to fostering early literacy (Van Scoter, 2008).

Yet teachers struggle to integrate technology with their classroom cultures (Labbo et al., 2003; Olson, 2000). This situation is exacerbated by a lack of high-quality emergent literacy materials (de Jong & Bus, 2003; Segers & Verhoeven, 2002). Appropriate software for fostering literacy skills in young children should be created in such a way that the learner's previous knowledge is taken into account, involve learners actively and encourage the use of language and the explorative nature and curiosity of young children (Brooker & Siraj-Blatchford; Plowman & Stephen, 2005). In addition, computer activities of young learners should be integrated with related classroom activities (Van Scoter, 2008) and embedded in appropriate pedagogical models for technology applications for young children (Plowman & Stephen, 2005).

The PictoPal studies examine how the computer can contribute to an understanding of the nature and function of written language. Doing so requires that attention be given to the relationship between spoken and written language and the purposes for which reading and writing are used. As in oral language learning, children's concept formation regarding written language is driven by its use, in an environment rich with meaningful messages and functional print (Warash, Strong, & Donoho, 1999; Van Scoter, 2008). The main question shaping this strand of inquiry is *"How can the technology-supported learning environment, PictoPal, contribute to helping kindergarteners understand the nature and function of written language?"*

Teachers as Designers

Teacher involvement in the development of classroom curricula often fosters a sense of ownership, which increases the chances of actual curriculum use (Fullan, 2003). When teachers are supported during the design of innovative curricula, they can learn more about the innovation (Crow & Pounder, 2000), which also increases the chances of the implementation being successful. This is partly because teachers are then better informed, and able to visualize how curriculum enactment could look. Being able to 'see' a curriculum in action is an important factor considered by teachers as they weigh off the amount of effort they invest and the potential benefits of the innovative curriculum (cf. Doyle & Ponder, 1978).

Designing requires teacher time and effort, but also has the potential to improve implementation of an innovative curriculum. There are various ways to involve teachers in design and support that involvement. This strand of inquiry is concerned with answering the research question, *"What forms and levels of involvement are feasible, and still yield the benefits of ownership, and understanding a new curriculum?"*

Research approach

The Designed Intervention

PictoPal is an ICT-rich learning environment with two main components: (a) on-computer activities through which pre-readers use words, sound and images to construct written texts; and (b) off-computer activities that prompt children to 'use' their printed documents for authentic purposes. For example, children create grocery lists using the computer and then 'shop' for the items on the printed list in the 'store' corner of the kindergarten classroom. Alternatively, they prepare a weather forecast with the aid of the computer, and then 'deliver' the forecast to their class from the television corner (from inside a 'television' fashioned by the children from a large cardboard box). Figure 1 shows children, composing a recipe for vegetable soup (left) and then following the cooking instructions on their printed recipe (right). For more information about the PictoPal learning environment, please refer to McKenney and Voogt (2009).



Figure 1. Children Creating the Recipe on the Computer (left) and then Following it in the Classroom (right).

The Methods Used

The PictoPal studies have been underway for nearly a decade. Evolving through five different prototypes, ten different studies have been completed relating to the two strands of inquiry described. Comprehensive portrayal

of the studies is therefore not possible here. Table 1 provides an overview of the studies including the prototype concerned, focus of the data collection in each study, methods used and the report reference for additional details.

Table 1: Research overview of focus and methods in the 10 studies to date

Study		A	B	C	D	E	F	G	H	I	J
Prototype	-	■									
	1		■								
	2			■	■						
	3					■	■				
	4							■			
	5								■	■	■
Focus	Teacher/school habits, beliefs, values, resources	■									
	Children's habits, attitudes	■									
	Pupil learning gains		■		■			■	■	■	■
	Pupil engagement		■			■					
	Integration					■					
	Teacher experiences			■				■	■	■	■
Methods	Teacher and child questionnaires	■							■	■	■
	Site visits, field notes	■							■	■	■
	Document analysis	■							■	■	■
	Pre/post-test		■		■	■	■				
	On-pc observation		■				■				
	Off-pc observation						■				
	Teacher interviews			■					■	■	■
Reporting	(S. McKenney & Voogt, 2005)	■									
	(S. McKenney & Voogt, 2010)	■									
	(S. McKenney & Voogt, 2009)		■		■	■	■				
	(S. McKenney & Voogt, in press)			■				■			
	(Cviko, McKenney, & Voogt, 2012)								■		
	Cviko, McKenney Voogt, 2010)									■	
	Cviko, McKenney, Voogt, 2011)									■	

Selected Results

Practical Innovation: How the Research Informed Intervention Design

Throughout the series of studies, data were collected that informed the design of both PictoPal and its accompanying supportive mechanisms (teacher guides, professional development workshops). In hindsight, it is clear that the data contributed to developing an intervention that was, as characterized earlier, value-added, clear, compatible and tolerant. Table 2 provides an overview of how the research helped to develop PictoPal within the zone of proximal implementation.

Table 2. Research methods used to feed design within the zone of proximal implementation

	Pre-design (needs/context analysis)	During development (prototyping and formative evaluation)	With stable design (used as means to study teacher design practices)
Value-added (better than status quo)	Site visits to see learning practices and ask about problems, <i>in the baseline situation</i>	Pre/post-tests of pupil learning <i>during use</i>	Pre/post-tests of pupil learning <i>with implementation scaffolds removed</i>
Clear (participants can envision their involvement)	Teacher interviews to explore mindsets, habits and conventions within the classroom/school <i>in the baseline situation</i>	Teacher interviews to explore mindsets, habits and conventions within the classroom/school <i>during use</i>	Teacher interviews to explore mindsets, habits and conventions within the classroom/school that are <i>sustained or changed after the innovation</i>
Compatible	Teacher interviews and child	Field notes concerning	Teacher interviews to

(compatible with values, beliefs, surrounding educational context/system)	questionnaire to explore values, cultures, beliefs, priorities, and contextual /system factors <i>in the baseline situation</i>	values, cultures, beliefs, priorities, and contextual /system factors that <i>help or hinder implementation</i>	explore values, cultures, beliefs, priorities, and contextual /system factors that are <i>sustained or changed after the innovation</i>
Tolerant (withstands the natural variation of actual use)	Site visits and field notes of actual behaviors of teachers and learners and reasons for them <i>in the baseline situation</i>	Observation of teachers and learners (and conjectured reasons for their conduct) <i>during use</i>	Observation of teachers and learners, and document analysis of both teacher products and learner products resulting from use with <i>implementation scaffolds removed</i>

Relevant Theoretical Understanding: Insights on Developing Technology for Early Literacy

This decade of design studies has yielded multiple reports and different kinds of insights. The papers cited in Table 1 offer detailed descriptions of findings and the data supporting them. In this section, examples of theoretical understanding emerging from the PictoPal studies are given:

- Related to shaping technology for early literacy, several important understandings include:
 - o Combining on- and off-computer activities can significantly influence children’s understanding of functional literacy.
 - o Children engage in dialogue about their work on and off the computer with peers or adults, though the quality of the conversation differs.
 - o Once the software has been mastered (about two turns), new elements can be introduced into the learning environment (e.g., contrary to initial hypotheses, there is no need to teach the image-based vocabulary).
 - o Children can use PictoPal semi-independently; the limited guidance they need is best given by an adult, but can be handled by an older child (e.g. Grade 6).
- Related to understanding the influence of teachers as designers, several important understandings include:
 - o Curricular ownership is positively related to the level of technology integration.
 - o Kindergarten teachers tend to limit new initiatives in the classroom - even if they support them - until a safe, trusting, routine and predictable classroom climate has been firmly established.
 - o Well-structured, even modest design involvement fosters curricular ownership, facilitating implementation.
 - o Providing tailored support can build teacher understanding and endorsement of core ideas, while freedom and creativity should be encouraged to develop different manifestations of those core ideas.

Reflections

The PictoPal studies were carried out over nearly a decade. After an initial needs and context analysis, the evaluation of early prototypes could be characterized as proof-of-concept work, focusing especially on the soundness and feasibility of the envisioned intervention. Thereafter, additional prototypes were developed and iteratively tested. During this work, implementation concerns received particular attention. Once the design stabilized, a more extensive look was taken at issues that could potentially increase effectiveness. Earlier work thus fed the research on shaping technology for early literacy. After one study (Study D in Table 1) showed substantial learning gains using materials that had been created by teachers themselves, research turned more explicitly toward exploring teachers as designers, how ownership is created through the design process, and its resulting influences in technology integration. Pupil learning was still examined, but mostly in light of these processes.

The PictoPal intervention was designed to be usable in a wide range of schools, by different kinds of kindergarten teachers, with diverse groups of learners. It has also been tested under varying conditions. The fact that teachers in several schools have continued using PictoPal, even outside of the research activities and with no external support suggests that it did fall within their ZPI. This is likely due, in part, to being value-added, clear, compatible and tolerant. The research findings indicate that PictoPal grew to become value-added because, in addition to regularly resulting in significant pupil learning gains, teachers appreciated how it addressed a known and disconcerting gap between the existing language curriculum used in schools and the national interim targets for early literacy. Use of PictoPal became clear to teachers through their involvement in designing content, and through examples, passed along from previous teachers (e.g. through video), of how PictoPal came to life in the classroom. While PictoPal was extremely innovative, being joined by very few other technologies for early literacy that support the development of ‘discursive prowess’ (Lankshear and Knoebel, 2003), it was also

designed to be compatible with existing values, cultures, beliefs and priorities that are shared by most kindergarten teachers, e.g. that children learn through play (dramatic play features frequently in the off-computer activities); or that children shape understanding about the world through first-hand experiences (using printed texts for authentic purposes). The studies also explored different scenarios that would help teachers orchestrate the implementation of PictoPal, especially providing guidance during on-computer activities (e.g. adding an agent to the software, peer tutors, adult guides) in ways that are compatible with the options available in representative settings. Finally, PictoPal grew tolerant over time. As the intervention matured, it became clear which features had to be adhered to more strictly to achieve pupil learning (e.g. duration of intervention; structure and layout of words in the software grid; and a gradual increase in difficulty level); and which ones could be tailored by teachers to their own preferences, themes or inspiration.

The need for researchers to seek understanding about where teachers and schools are, how they perceive the problem(s) to be addressed, and to and frame innovations within a reachable distance, has been described in literature (e.g. Bielaczyc, 2006; Blumenfeld, 2000; McKenney & Voogt, in press). This paper further emphasizes the importance of explicitly collecting data that can attune both interventions and theoretical insights accordingly. It offers some examples of how that was accomplished in one case relating to technology for early literacy. Toward increasing the relevance and usefulness of educational (design) research, less examples are needed of what might be potentially possible, and more examples are needed of how to understand and design for what is realistically feasible: in the Zone of Proximal Implementation.

References

- Bielaczyc, K. (2006). Designing social infrastructure: Critical issues in creating learning environments with technology. *Journal of the Learning Sciences*, 15(3), 301-329.
- Blumenfeld, P., Fishman, B. J., Krajcik, J., Marx, R. W., & Soloway, E. (2000). Creating Usable Innovations in Systemic Reform: Scaling Up Technology-Embedded Project-Based Science in Urban Schools. *Educational Psychologist*, 35(3), 149-164.
- Bransford, J., Brown, A., & Cocking, R. (2000). *How people learn: Brain, mind, experience and school*. Washington, DC: National Academy Press.
- Brooker, L., & Siraj-Blatchford, J. (2002). 'Click on Miaow!': how children of three and four years experience the nursery computer. *Contemporary Issues in Early Childhood*, 3(2), 251-273.
- Brown, A. L. (1992). Design Experiments: Theoretical and Methodological Challenges in Creating Complex Interventions in Classroom Settings. *Journal of the Learning Sciences*, 2(2), 141-178.
- Brown, A. L., & Campione, J. (1996). Psychological theory and the design of innovative learning environments: On procedures, principles, and systems. In L. Schauble & R. Glaser (Eds.), *Innovations in learning* (pp. 289-325). Mahwah, NJ: Earlbaum.
- Clay, M. (1966). *Emergent Reading Behaviour*. Unpublished doctoral dissertation, University of Auckland, New Zealand.
- Crow, G.M., & Pounder, D. G. (2000). Interdisciplinary Teacher Teams: Context, Design, and Process. *Educational Administration Quarterly*, 36, 216-254.
- Cviko, A., McKenney, S. & Voogt, J. (2010). *Docenten als ontwerpers en uitvoerders van een ICT-rijk curriculum voor beginnende geletterdheid*. Round table presentation at the ORD annual meeting, June 23-25: Enschede.
- Cviko, A., McKenney, S. & Voogt, J. (2011). *Teachers as (re-)designers of an ICT-rich learning environment for early literacy*. Paper presentation at the ECER annual meeting, September 13-16: Berlin.
- Cviko, A., McKenney, S., & Voogt, J. (2012). Teachers enacting a technology-rich curriculum for emergent literacy *Educational Technology Research and Development*, 60(1), 31-54. doi: 10.1007/s11423-011-9208-3.
- de Jong, M. T., & Bus, A. G. (2003). How Well Suited are Electronic Books to Supporting Literacy? *Journal of Early Childhood Literacy*, 3(2), 147-164. doi: 10.1177/14687984030032002
- Doyle, W., & Ponder, G. (1978). The practicality ethic in teacher decision-making. *Interchange*, 8(3), 1-12.
- Fullan, M. (2003). *Change forces with a vengeance*. London: RoutledgeFalmer.
- Hall, G., & Hord, S. (2010). *Implementing change: Patterns, principles and potholes*. Upper Saddle River, NJ: Prentice Hall.
- Labbo, L., Leu, D., Kinzer, C., Teale, W., Cammack, D., Kara-Soteriou, J., & Sanny, R. (2003). Teacher wisdom stories: Cautions and recommendations for using computer-related technologies for literacy instruction. *The Reading Teacher*, 57(3), 300-304.
- Lagemann, E. (2002). *An elusive science: The troubling history of education research*. Chicago: University of Chicago Press.
- Lankshear, C., & Knoebel, M. (2003). New technologies in early childhood literacy research: A review of research. *Journal of Early Childhood Literacy*, 3(1), 59-82.
- Macnamara, J. (1972). Cognitive basis of language learning in infants. *Psychological Review*, 79, 1-12.

- McGivney, J., & Moynihan, W. (1972). School and community. *Teachers College Record*, 74, 209-224.
- McKenney, S. (2011). *Designing and researching technology enhanced learning for the zone of proximal implementation*. Invited paper presentation at the Art and Science of Learning Design workshop. September 13-14: London Knowledge Lab, London.
- McKenney, S., & Reeves, T. (2012). *Conducting Educational Design Research*. London: Routledge.
- McKenney, S., & Voogt, J. (2005). *Using ICT to foster (pre) reading and writing skills in young children*. Paper presented at the American Educational Research Association, Montreal.
- McKenney, S., & Voogt, J. (2009). Designing technology for emergent literacy: the PictoPal initiative. *Computers & Education*, 52, 719-729.
- McKenney, S., & Voogt, J. (2010). Technology and young children: How 4-7 year olds perceive their own use of computers. *Computers in Human Behavior*, 26, 656-664.
- McKenney, S., & Voogt, J. (in press). Teacher design of technology for emergent literacy: An explorative feasibility study. *Australasian Journal of Early Childhood*.
- McKenney, S., Nieveen, N., & van den Akker, J. (2006). Design research from the curriculum perspective. In J. van den Akker, K. Gravemeijer, S. McKenney & N. Nieveen (Eds.), *Educational design research* (pp. 67-90). London: Routledge.
- McLoughlin, C., & Oliver, R. (1998). Maximising the language and learning link in computer learning environments. *British Journal of Educational Technology*, 29(2), 125-136. doi: doi:10.1111/1467-8535.00054
- Oakes, J., Welner, K., Yonezawa, S., & Allen, R. (1998). Norms and policies of enquiry-minded change: Reaching the 'zone of mediation'. In A. Hargreaves, A. Liebermann, M. Fullan & D. Hopkins (Eds.), *International handbook of educational change* (pp. 952-975). Dordrecht: Kluwer.
- Olson, J. (2000). Trojan horse or teacher's pet? Computer and the culture of the school. *Journal of Curriculum Studies*, 32, 1-8.
- Penuel, W., Fishman, B., Cheng, B., & Sabelli, N. (2011). Organizing research and development at the intersection of learning, implementation and design. *Educational Researcher*, 40(7), 331-337.
- Piaget, J. (1952). *The Origins of Intelligence in Children*. New York: W. W. Norton.
- Piaget, J., & Inhelder, B. (1969). *The psychology of the child*. New York: Basic Books.
- Plowman, L., & Stephen, C. (2005). Children, play and computers in pre-school education. *British Journal of Educational Technology*, 36(2), 145-157.
- Reeves, T. (2000). *Enhancing the worth of instructional technology research through "design experiments" and other development research strategies*. Paper presented at the Annual AERA Meeting, New Orleans.
- Rogan, J. (2007). How much curriculum change is appropriate? Defining a zone of feasible innovation. *Science Education*, 91, 439-460.
- Rogan, J., & Grayson, D. (2003). Towards a theory of curriculum implementation with particular reference to science education in developing countries. *International Journal of Science Education*, 25, 1171-1204.
- Rogers, E. (2003). *Diffusion of innovations* (5th ed.). New York: Free Press.
- Scardmalia, M., Bereiter, C., & Lamon, M. (1994). The CSILE Project: Trying to bring the classroom into World 3. . . In K. McGilly (Ed.), *Classroom lessons: Integrating cognitive theory and classroom practice* (pp. 201-228). Cambridge, MA: MIT Press/Bradford Books.
- Segers, E., & Verhoeven, L. (2002). Multimedia support of early literacy learning. *Computers in Education*, 39(3), 207-221.
- Sullivan, M. (2004). The reconceptualisation of learner-centred approaches: a Namibian case study. *International Journal of Educational Development*, 24, 585-602.
- Tebbutt, M. (2000). ICT in science: problems, possibilities and principles. *School Science Review*, 81(297), 57-64.
- van den Akker, J. (1999). Principles and methods of development research. In J. van den Akker, R. Branch, K. Gustafson, N. Nieveen & T. Plomp (Eds.), *Design approaches and tools in education and training* (pp. 1-14). Dordrecht: Kluwer Academic Publishers.
- Van Scoter, J. (2008). The Potential of IT to Foster Literacy Development in Kindergarten. In J. V. Knezek (Ed.), *International Handbook of Information Technology in Education* (pp. 149-161). London: Springer.
- Vygotsky, L. (1962). *Thought and language*. Cambridge, MA: MIT Press.
- Walker, D. (1992). Methodological Issues in Curriculum Research. In P. W. Jackson (Ed.), *Handbook of Research on Curriculum* (pp. 98-118). New York: Macmillan.
- Walker, D. (2006). Toward productive design studies. In J. Van den Akker, K. Gravemeijer, S. McKenney & N. Nieveen (Eds.), *Educational design research* (pp. ZZ-XX). London: Routledge.
- Warash, B., Strong, M., & Donoho, R. (1999). Approaches to environmental print with young children. . In O. G. Nelson & W. M. Linek (Eds.), *Practical classroom applications of language experience: Looking back, looking forward* (pp. 53-58). Boston, MA: Allyn & Bacon.