Chapter 10
Exploring Teacher Roles and Pupil Outcomes in Technology-Rich Early Literacy Learning

Amina Cviko, Susan McKenney, and Joke Voogt

Background: A Study About Teacher Roles

This study is concerned with three roles for teachers in enabling information and communications technology (ICT)-rich early literacy learning: executor-only, re-designer, and co-designer. The executor-only role involved teachers in implementing ready-to-use ICT-rich early literacy activities. The re-designer role and the co-designer role each involved teachers in designing activities before implementing them. In the re-designer role, teachers collaboratively adapted ready-to-use activities and materials for their current curriculum. In the co-designer role, teachers collaboratively designed completely new learning activities and materials for their classes. The executor-only role requires teachers to invest time and effort in implementation, and the re- and co-designer roles require teachers to invest their time and efforts in collaborative design as well as implementation.

The role differentiation is based on the premise that teachers' involvement in curriculum design can influence curriculum implementation and, in so doing,

A. Cviko (✉)
Department of Educational Sciences, Faculty of Behavioral Sciences, University of Twente, Postbox 217, Enschede 7500AE, The Netherlands
e-mail: aminacviko@gmail.com

S. McKenney
Welten Institute, Open University of the Netherlands & Department of Instructional Technology, Faculty of Behavioral Sciences, University of Twente, Postbox 217, Enschede 7500AE, The Netherlands
e-mail: susan.mckenney@utwente.nl

J. Voogt
University of Amsterdam, Nieuwe Prinsengracht 130, Amsterdam 1018VZ, The Netherlands

Windesheim University of Applied Sciences, Zwolle, The Netherlands
e-mail: j.m.voogt@uva.nl

M. Orey, R.M. Branch (eds.), *Educational Media and Technology Yearbook*,
Educational Media and Technology Yearbook 39,
DOI 10.1007/978-3-319-14188-6_10

influence pupil learning outcomes. When the use of ICT is planned, structured, and integrated effectively by teachers, an ICT-rich learning environment can contribute to pupil's literacy attainment (Higgins, 2003). Participation by teachers in curriculum design activities, such as engaging in aligning a new curriculum unit with existing curriculum and classroom activities, can contribute to curriculum implementation (Penuel, Fishman, Yamaguchi, & Gallagher, 2007) and to improved student learning outcomes (Fishman, Marx, Best, & Tal, 2003). Also, teacher involvement in curriculum design can create a sense of co-ownership in teachers towards the curriculum (Fullan, 2003). The investments teachers are willing to make in implementing innovating curricula (e.g. as is the case with activities for ICT-rich learning) are particularly influenced by their perceptions concerning three elements of curriculum practicality: the effort required and the benefits gained, i.e. cost-benefit ratio; how well innovation is specified, i.e. instrumentality; and alignment with classroom needs, i.e. congruence (Doyle & Ponder, 1978). Also, teacher perceptions about teaching/learning, ICT, and subject matter can influence implementation of ICT-rich curricula (Niess, 2005; Tondeur, Valcke, & van Braak, 2008).

Several assumptions underlie the study about teacher roles in the design and implementation of ICT-rich learning activities. First, an active role in design of ICT-rich learning activities positively influences classroom implementation. Second, teacher perceptions about teaching/learning, ICT, and early literacy influence implementation of ICT-rich learning activities. Third, curriculum implementation influences pupil learning outcomes.

Teacher involvement in curriculum development can foster curriculum implementation (Carl, 2005; Fullan, 2003). Specifically, teachers participating in designing together curricular activities (e.g. opportunities for classroom activities) can contribute to improved classroom practice (Garet, Porter, Desimone, Birman, & Yoon, 2001). Yet such work can be conducted in many ways. Teacher involvement in curriculum design can take various forms, necessitating different tasks and effort while creating and using activities and materials. Different forms of teacher involvement in curriculum design can have a differential impact on teachers' sense of co-ownership, perceptions about the practicality of curriculum activities, and curriculum implementation and attainment. The problem underlying this study is the need for understanding various forms of teacher involvement in designing ICT-rich learning activities and how they contribute to implementation of ICT-rich learning and pupil learning outcomes. This study focuses on forms of active involvement in curriculum design (roles) and the question of whether a particular one is optimal for teachers and pupils.

Specific forms of active involvement during design are shaped by the aforementioned teacher roles (executor-only, re-designer, co-designer). These roles, together with teacher perceptions, are likely to influence how teachers integrate ICT-rich learning in their classrooms. In this study, teachers in each role used on- and off-computer activities for early literacy, called PictoPal. For this study, effectiveness of ICT-rich learning environment (ICT-rich learning activities PictoPal) is defined in terms of pupil learning outcomes. With the aim of discovering the comparative benefits and drawbacks of each role, the study examined teacher perceptions, classroom

implementation, and pupil learning outcomes in and across each role. The research question guiding the study was:

> *Which teacher role (executor-only, re-designer, or co-designer) contributes most to the effectiveness of an ICT-rich learning environment for early literacy?*

The research question was addressed in four sub-studies. Three sub-studies focused on a particular teacher role (executor-only, re-designer, or co-designer), and one cross-case sub-study focused on the comparative differences across the three teacher roles. Taken together, this study examines the impact of teacher roles on implementation of ICT-rich activities and pupil learning outcomes in the context of early literacy learning.

Contextualizing the Study

Early Literacy Development of Young Children

The importance of early literacy has been long established by research and endorsed by experts. Literacy skills involve the ability to communicate by means of reading and writing (Verhoeven & Aarnoutse, 1999). Children need literacy skills to successfully participate in their educational careers and society. In the Netherlands, primary school education promotes literacy acquisition in children aged 4–12 years. During the first 2 years of Dutch primary education, 4–6-year-olds develop early literacy skills. Early literacy refers to development of oral language (speaking, listening), written language (reading and writing, often in combination with pictures and scribbling), and conceptual skills (Cooper, 1993). The Dutch reference framework identifies four language domains for primary education: (1) verbal language skills: conversation skills, listening, and speaking; (2) reading skills; (3) writing skills; and (4) concepts (Expertisecentrum Nederlands, 2010). Each of these language domains is represented in the national attainment targets for kindergarten literacy: (1) functional reading and writing, (2) functions of written language, (3) relationship between spoken and written language, (4) language awareness, (5) book orientation, (6) technical reading and writing, (7) reading comprehension and writing, (8) story concepts, and (9) alphabetical principle (phoneme-grapheme link).

The formulation of the attainment targets for literacy and language education aims to support teachers in developing their early literacy curricula (Verhoeven & Aarnoutse, 1999). This implies that early literacy curricula should address a broad array of early literacy skills. According to Justice and Pullen (2003), teachers should view early literacy as an integrated package of areas of skills and focus equally on written and oral behaviours in young children, including, for instance, understanding the function and form of print and the relationship between oral and written language. Over-emphasis on one aspect of early literacy skill can limit teachers' views of the broader picture (Elster, 2010). According to McKenney, Bradley, and Boschman (2012), a narrowed view about early literacy may lead to curricula which

overemphasize pre-reading skills (e.g. letter-sound linkage and technical reading) and underemphasize writing abilities and conceptual development. According to Snow (2006), the essence of operating literately is not simply the operation of the various components but the process of constructing meaning; she argues that instruction should not focus on the components without linking them to the central purpose. From their observations of early literacy classroom practices, Neuman and Roskos (2005) suggest that generally young children are subjected to a narrow, limited curriculum, for instance, targeted to basic sounds and letter skills. Snow (2006) identified a concern that children at risk are likely to be provided pre-reading skill-focused instruction that fails to emphasize meaning, as a result of a limited view about early literacy. Justice and Pullen (2003) recommend early literacy activities that address both written language and phonological awareness, including meaningful opportunities for knowledge attainment as well as explicit exposure to key concepts. Also, Neuman and Roskos (2005) recommend a supportive learning environment with a wide variety of reading and writing resources that actively build language and conceptual knowledge and instruction that integrates meaningful learning with foundational skills.

Technology Integration

The potential of ICT applications to support early literacy development in children aged 4–6 has been demonstrated through prior research, for example, by storybooks on the computer, which combine multimedia and interactive additions that support aspects of literacy (De Jong & Bus, 2003). When integrated with other activities, ICT has the potential to support children in learning key concepts and the functions of language (McKenney & Voogt, 2009). Segers and Verhoeven (2005) found that language games can stimulate early literacy skills in children; however, because children engage in interacting with peers about their computer use, the authors suggested that the link between computer activities and classroom activities should be considered as a factor influencing pupil's early literacy learning outcomes. Experts agree that teachers should address early literacy in developmentally appropriate ways, integrating technology to support the meaningful learning (International Reading Association, 2009).

Technology integration refers to incorporating technology in meaningful and authentic ways into the curriculum and day-to-day practices to support early literacy development of young children (McManis & Gunnewig, 2012). Nowadays, technology is present in everyday lives of young children. For instance, youngsters now regularly observe someone produce an on-screen text to convey a message for a communicative purpose. Technology-integrated activities in early literacy development can prepare children for using technology as a communication tool, for instance, by writing with technology (Merchant, 2007). Niederhauser and Lindstrom (2006) found that technology-using kindergarten teachers perceive interactive activities with technology as a communication tool to yield good or successful implementation.

Primary schools have invested in applications of ICT, such as computers and educational software, for teachers and pupils to promote effectiveness of teaching and pupil learning outcomes (Higgins, 2003). Research shows that ICT integration into existing classroom practice by teachers is challenging (Turbill, 2001) and that teachers struggle to use computers in their classrooms effectively (Gimbert & Cristol, 2004; Merchant, 2007). According to Merchant (2007), little research answers teachers' questions on how to integrate ICT as a tool effectively. Technology-rich activities can be effective in kindergarten classes, only if teachers use technology in developmentally appropriate ways, offering pupils engagement that is fitting in terms of age, culture, and individual needs (Parette, Quesenberry, & Blum, 2010). While technology integration offers multiple opportunities to address a wide range of early literacy learning goals, doing so places high demands on teachers.

PictoPal

Through integrated computer and classroom activities, children can learn the functions of written language in meaningful ways. PictoPal refers to ICT-rich on- and off-computer activities for early literacy. PictoPal consists of eight on- and off-computer activities and focuses on supporting four national interim attainment target goals for early literacy: (1) functional reading and writing, (2) functions of written language, (3) relationship between spoken and written language, and (4) linguistic awareness. An example of a PictoPal on-computer activity is that children compose and print a list of ingredients using software featuring written and spoken words and pictograms. Off-computer children then engage in a play activity to 'buy' the ingredients listed on the printed page (e.g. in the store corner of the classroom) in order to cook a dinner (e.g. in the kitchen area of the classroom). Figure 10.1 shows an example of an on-and off-computer activity in which children engage in writing a recipe and then following it.

Fig. 10.1 On-computer activity: writing a recipe (*left*), off-computer activity: using the recipe to cook (*right*)

In using PictoPal, teachers focus on integrating activities to convey the purposes of language in a meaningful way and engage children in exploring the functions of written language themselves. In this way, teachers actively address interim goals concerning the functions of language. When teachers implement PictoPal on- and off-computer activities in integrated fashion, PictoPal can stimulate early literacy development in children and contribute to reaching the interim goals (McKenney & Voogt, 2009). Greater effects on pupil learning outcomes were found when teachers implemented PictoPal on-computer activities together with other activities than when teachers implemented PictoPal on-computer activities only (Verseput, 2008). The three teacher roles (executor-only, re-designer, co-designer) aim to support pupils' early literacy development by stimulating teachers in the integration of on- and off-computer learning activities.

Theoretical Framework

Teacher Involvement in Curriculum Design

Development of early literacy can be supported through technology-integrated curricula, yet the overall influence of technology on children's literacy development is determined by the teacher (Labbo & Reinking, 2003). It is the teachers who embrace, resist, or try-out technology as a tool to support teaching and learning. Also, to successfully implement ICT-rich activities, teachers need to understand how to use teaching strategies with technology and why technology is important to young children and also show ability to use the technology and apply it in the classroom (Parette et al., 2010).

In the present study, an active role of teachers in designing ICT-rich learning activities is assumed to positively influence classroom implementation. Successful curriculum implementation further implies teachers to be actively involved in collaborative curriculum development (Carl, 2009). This section discusses key issues related to engaging teachers in collaborative curriculum design.

First, active participation in collaborative development of learning activities and materials can foster understanding of the curriculum (Crow & Pounder, 2000) and create a sense of co-ownership amongst participants (Fullan, 2003). Teacher involvement in collaborative design of curriculum materials can foster implementation of technology-integrated curricula as well. Penuel, Fishman, et al. (2007) found that teacher engagement in planning for implementation was significant for promoting implementation. Teachers need to be informed enactors of ICT-integrated curricula in order to implement curricula successfully. Collaborative curriculum development by teachers should feature hands-on opportunities and examples of technology-integrated lessons to support teachers to successfully integrate technology (Keengwe & Onchwari, 2009). Collaboration in teams and subsequent continuous support in early stages of implementation could help teachers understand to effectively implement curriculum materials in the classrooms (Parette et al., 2010).

Second, co-ownership towards a new curriculum is considered an important factor for curriculum implementation because it seems to drive curriculum use and sustained curriculum change/reform (Fullan, 2011). According to Carl (2005, 2009), the teacher role as implementer of a curriculum, developed by curriculum specialists, is detrimental to the teacher experience of taking ownership of a curriculum. Through involvement in curriculum development, teachers may experience ownership of the developed curriculum (Carl, 2009; Fullan, 2003; Kirk & MacDonald, 2001). Teachers' commitment, which can be seen as an indicator of teachers' sense of ownership towards new curriculum, has been shown to significantly account for variance in the degree of curriculum use in the context of innovative curricula (Abrami, Poulsen, & Chambers, 2004).

Third, curriculum practicality is an important factor in determining if teachers will implement an innovation. Involvement in design could influence teacher perceptions of practicality of the design, which in turn could influence curriculum implementation. Curriculum practicality involves three aspects: (1) how well a curriculum is specified, (2) how congruent a curriculum is with classroom, and (3) the ratio of effort required to benefits gained (Doyle & Ponder, 1978). This stance has also been corroborated through recent studies. Teachers' perceptions of costs, successful implementation, and the value of a curriculum determine for a part the actual curriculum use (Abrami et al., 2004). Also, a fit with existing classroom practice can be of influence on effective implementation (Abrami et al., 2004). De Grove, Bourgonjon, and van Looy (2012) found that teacher perceptions of technology fitting the current curriculum are linked with teacher perceived intention to use technology. Teachers weigh off their investment in curriculum innovation in relation to the potential and actual benefits gained from it (Doyle & Ponder, 1978). When involving teachers in implementation of innovative curricula, teachers are often faced with considerations about how feasible a curriculum is to implement in their classrooms. To conclude, teacher involvement in curriculum design is assumed to be positively related to successful implementation of technology-integrated curriculum materials. In case of ICT-rich activities for early literacy, successful implementation refers to integration of on- and off-computer learning activities to support early literacy learning.

Teacher involvement during design could presumably be affected by teacher perceptions about their roles. Teachers who are able to adopt a particular role could be expected to perform well in that role. One's knowledge of the nature of a role in a team and the situation when a particular role should be adopted is related to team member performance (Mumford, van Iddekinge, Morgeson, & Campion, 2008). The following section addresses additional teacher perceptions that could influence design and implementation.

Teacher Perceptions Influence Implementation

Teacher perceptions about teaching/learning, ICT, and early literacy are assumed in this study to influence curriculum implementation. Teacher perceptions are defined in this study as perspectives, experiences, and personal feelings of teachers. Several

studies showed that teachers' views on teaching/learning and ICT influence the way ICT-rich curricula are implemented (Niess, 2005; Tondeur et al., 2008). Positive teacher perceptions of technology's influence on student achievement and classroom activities relate positively to technology integration (Inan & Lowther, 2010). What teachers perceive as appropriate for early literacy development in children may affect early literacy instruction (Neuman & Roskos, 2005). In case of ICT-rich activities for early literacy, the views teachers hold about technology, teaching/learning, and the content of early literacy may affect how they implement technology-integrated activities for early literacy. It is plausible that teacher perceptions about teaching/learning, ICT, and early literacy also affect how ICT-integrated activities are designed. Consequently, designing activities can be positively or negatively shaped by perceptions teachers hold about teaching, learning, technology, and early literacy.

Implementation and Pupil Learning Outcomes

Pupil learning outcomes are commonly used as an indicator of effectiveness of a curriculum (Fishman et al., 2003). How teachers implement a curriculum influences pupil learning (Landry, Swank, Anthony, & Assel, 2011), and both the quantity of activities and the quality of implementation may explain pupil learning differences (Landry et al., 2011). The link between implementation of technology-integrated curricula and student learning outcomes is not always straightforward. Cheung and Slavin (2012) explored studies about implementation of ICT-rich literacy curricula and pupil learning outcomes. They reported that poor implementation ratings were related to no effects in pupil outcomes; studies with medium and high implementation ratings were related to significant positive effects on pupil outcomes. However, Cheung and Slavin (2012) caution against attributing poor effects on pupil outcomes to poor implementation, because authors of these studies would be likely to ascribe no effects to poor implementation.

In studies involving teachers in curriculum development, varying results have been found with regard to the effects of implementation on pupil learning outcomes. A study of Lowther, Inan, Ross, and Strahl (2012) showed no significant differences in achievement between students whose teachers were involved in a programme on how to use technology and implementation of technology integration and controls (teachers not involved). But, a study of Landry et al. (2011) involving teachers in implementation of a research-based curriculum accompanied with professional development activities showed improvement in children's early literacy skills. Also, a study of Block, Campbell, Ninon, Williams, and Helgert (2007) involving teachers in a programme on how to use technology found positive effects on pupil early literacy outcomes.

Based on these findings, the connection between curriculum implementation and pupil learning outcomes is not so straightforward. Apparently, a clear notion of what implementation entails is necessary to better understand the relationship. This study explores how teacher roles in design and implementation contribute to

effectiveness of ICT-rich activities (pupil learning outcomes). For this study, effectiveness of PictoPal (the specific ICT-rich learning activities) is defined in terms of pupil learning outcomes. Effective implementation of ICT-rich activities and materials is thus viewed as a necessary condition for positively affecting pupils' early literacy learning outcomes, though it does not guarantee positive results.

Teacher Roles in Curriculum Design and Implementation

As previously mentioned, this study involves teachers in three different roles, executor-only, re-designer, and co-designer of PictoPal, and sets out to examine the effects of each role on the implementation of PictoPal and resulting pupil learning. In this section, each role is defined and justified.

The executor-only role involves teachers in implementing ready-made ICT-rich early literacy learning activities. The role of executor-only is a role teachers (most) commonly take, when they enact curricula designed by others (e.g. as in textbooks). Remillard (1999) showed that teachers engage in planning and fine-tuning activities according to the views teachers hold about teaching and learning in their classes. While not active in design, the role of executor-only does require that individual teachers engage in planning for implementation as well as actual implementation.

The re-designer role involves teams of teachers in a purposeful act of adjusting ICT-rich activities and materials, to align with (and/or replace) the current curriculum used in their classes. Also, the re-designer role involves teachers in subsequent implementation. Re-designing ICT-rich learning activities in a team allows for sharing understanding of what must be revised, based on what teachers view important and feasible in their classes. The re-designer role for teachers implies that participation in re-design is assumed to positively affect implementation. This is because the collaborative re-design could create teacher understanding and co-ownership while also enhancing teachers' perceptions about curriculum practicality and their role.

The co-designer role involves teams of teachers in designing and implementing ICT-rich activities for early literacy. According to Penuel, Roschelle, and Shechtman (2007), co-design engages teachers in considering how materials fit their actual classrooms. The role as co-designer enables teachers to reflect on classroom relevance and create opportunities for success (Kenny & McDaniel, 2011). In this role, teachers can explore new curriculum materials by creating technology-supported learning experiences for their pupils and planning for implementation together with their colleagues (Keengwe & Onchwari, 2009). Co-design engages teachers in formulating goals and decision-making (Penuel, Roschelle, et al., 2007). As with re-design, co-design can foster understanding, co-ownership in teachers, curriculum practicality perceptions, and explication of their role, all of which could support the actual use of the resulting materials. The main aim of this study is to demonstrate differential effects on curriculum implementation and on pupils' learning outcomes given varied roles during teacher involvement in designing ICT-rich materials and activities for early literacy.

The Research Approach

Teacher Roles and Learning Outcomes: Operational Definition

In this study, implementation of PictoPal refers to integrating a series of eight on- and off-computer activities (further referred to as PictoPal activities) in the classroom. The role in which a teacher engages in implementing a series of ready-made PictoPal activities is referred here to as executor-only role. In the re-designer role, a teacher is part of a team of teachers re-designing existing PictoPal activities to fit their current curriculum and engages in implementation of the re-designed activities. Co-designing engages teachers in collaborative design of new PictoPal activities, fitting their current curriculum as well as implementing the activities.

Pupil learning outcomes in this study refer to specific early literacy learning outcomes. Pupil learning outcomes indicate effectiveness of the PictoPal activities as implemented by teachers in three different roles.

Research Questions

The present study aimed to understand how each role influences implementation of PictoPal activities and subsequent pupil learning outcomes. In the long run, the findings from this study can help understand how teachers might ideally be supported in technology integration in kindergarten classes in general; and specifically, the findings will help to provide teachers with appropriate materials, opportunities, and support for the implementation of PictoPal. The main research question was: *Which teacher role (executor-only, re-designer, or co-designer) contributes most to the effectiveness of an ICT-rich learning environment for early literacy?*

The main research question encompasses the comparative benefits and drawbacks of the teacher roles for the effectiveness of ICT-rich learning activities in the context of PictoPal. Effectiveness of ICT-rich learning activities was defined in terms of pupil learning outcomes. To answer the main research question, four sub-studies were performed. In each of the first three studies, one teacher role was examined through teacher perceptions, integration of on- and off-computer activities, and pupil learning outcomes. The fourth sub-study focused on comparing the three teacher roles with respect to teacher perceptions, integration, and pupil learning to understand the value of each teacher role for the effectiveness of ICT-rich activities for early literacy.

The research questions of the four sub-studies were, respectively:

1. *How do teacher perceptions of teaching/learning, technology, and innovation impact integration of a technology-rich curriculum for emergent literacy, and in turn, how does teacher technology integration of the curriculum impact pupil learning?*
2. *What does teacher involvement in re-designing technology-integrated activities imply for implementation and learning outcomes?*

3. *When teachers are involved in co-designing technology-integrated activities, what does that imply for curriculum implementation and pupil learning outcomes?*
4. *Which teacher role (executor-only, re-designer, and co-designer) contributes most to the effectiveness of technology-rich learning activities for early literacy and why?*

Research Methodology

A case study approach, defined as empirical inquiry for investigating phenomena in real-life contexts (Yin, 2003), was applied in the four sub-studies. A case study approach was regarded as suitable for examining three different teacher roles in their actual classroom practice. Each teacher role was studied in a separate sub-study. In three sub-studies each focusing on a particular teacher role, a classroom with a teacher formed a separate case. In these sub-studies, a within-case analysis was used to represent each case separately, followed by a cross-case analysis to compare cases with regard to a common set of measures. A fourth sub-study was conducted to compare three teacher roles. In this sub-study, teachers with a particular teacher role were regarded as a case. A cross-case analysis was used to compare three different cases with each other on a common set of measures. Within each sub-study, mixed methods were used.

In the first three sub-studies, original data were collected; the fourth sub-study used purposefully sampled data from the first three sub-studies. Teachers were interviewed about their perceptions with regard to teaching/learning, ICT, early literacy, their role in design (second and third studies), ownership, and curriculum practicality. Also, teachers were interviewed about their team (second and third sub-studies). Integration was observed in each classroom of participating teachers. Pupil early literacy learning outcomes were examined before and after implementation of PictoPal activities. For examining teacher perceptions, a teacher formed the unit of analysis. A classroom with a teacher formed the unit of analysis for examining technology integration and pupil learning outcomes. And when examining teacher team perceptions (second and third sub-studies), a team formed the unit of analysis. The first stub-study (executor-only) had four cases. The second sub-study (re-designer) had five cases. The third sub-study (co-designer) had three cases.

In the fourth sub-study, a multiple case study was used (Yin, 2003) with three teacher roles (executor-only, re-designer, and co-designer) as separate cases. A cross-case analysis was employed to compare the three cases, which had previously been investigated in independent research studies (Miles & Huberman, 1994; Yin, 2003). The following criteria were used to assign subjects to one of the three cases: (1) no experience with design and implementation of PictoPal, (2) same timing of implementation, and (3) same types of implemented activities. A case (teacher role) formed the unit of analysis. The teacher roles as cases were compared on the following set of measures: teacher perceptions about their role, curriculum practicality, co-ownership, integration, and pupil learning. Data from the cases were

analysed using data displays and by identifying similarities and differences across cases. Quantitative techniques were used to analyse integration data and pupil learning data across cases.

Findings

Sub-study 1: Teacher Role Executor-Only

The first sub-study aimed to better understand the factors that influence integration of ICT-rich activities and the potential connection between integration and pupil learning outcomes given the executor-only role. The sub-study examined how teachers provided with ready-to-use PictoPal materials and activities perceive teaching/learning, technology, and innovation in addition to how they integrate on- and off-computer activities. Also, pupil learning outcomes were examined in a quasi-experimental design in two junior and two senior kindergarten classrooms.

The findings revealed that a high extent of integration was linked to a developmental approach to teaching/learning (e.g. helping pupils to construct meaning); positive attitudes towards technology and PictoPal; teacher confidence about implementation; perceiving PictoPal being congruent with pupils' skills; and investment of effort in implementation. A medium extent of integration was linked to a facilitative approach to teaching/learning (e.g. providing children with the tasks to elicit autonomous activity) and investment of effort in implementation. A low extent of integration was linked to a facilitative approach to teaching/learning and concerns about technology. The experimental group significantly outperformed the control group, with medium effect size for the proportion of variance explained by PictoPal and a large effect size for the learning gain. Significant differences were revealed between the junior classes and one of the senior classes, with a medium effect size for the proportion of variance explained by class. In all four classes using PictoPal, large effect sizes were found for the learning gains.

The findings imply that a developmental approach to teaching and learning, positive perceptions about technology, and PictoPal are linked to a high extent of integration. However, they do not suggest that a significantly higher extent of on- and off-computer activities is linked to significantly higher pupil learning outcomes. Further details about this sub-study are available in Cviko, McKenney, and Voogt (2012).

Sub-study 2: Teacher Role Re-designer

The second sub-study aimed to gain a better understanding of what involvement of teachers in the re-design of ICT-rich activities implies for implementation and pupil learning. Two case studies were performed involving a total of six teachers in re-designing, whereby five of them implemented PictoPal in three junior and two

senior kindergarten classrooms. The study examined teacher perceptions about collaborative re-design, their role, co-ownership, and curriculum practicality and integration of on- and off-computer activities. Pupil learning outcomes were studied in a quasi-experimental design.

Findings showed no difference in the extent of integration of on- and off-computer activities between the five teachers. Findings on pupil learning outcomes showed that the experimental groups significantly outperformed the control groups, with medium effect sizes for the proportion of variance explained by PictoPal. In the experimental groups, the effect sizes for the learning gains were large. Significant between-class differences in pupil learning outcomes were found with medium and large effect sizes for the amount of variance explained by class. Also, medium and large effect sizes were found for the learning gains in the five classrooms.

This study implies that the team members' similar extent of integration is linked to the teachers' positive perceptions about collaborative re-design; positive perceptions about practicality; perceiving the re-designer role as not a regular teacher practice; and a slight sense of co-ownership towards PictoPal. The extent of integration of on- and off-computer activities could not be linked straightforwardly to the significant between-class differences in pupil learning outcomes. Further details about this sub-study are available in Cviko, McKenney, and Voogt (2013).

Sub-study 3: Teacher Role Co-designer

The third sub-study aimed to gain a better understanding of what involvement of teachers in co-design implies for implementation and pupil learning. A case study was performed to investigate the co-designer role for teachers. Five teachers and two intern teachers were involved in two teams that collaboratively designed a new series of PictoPal activities. This study examined teacher perceptions about teaching/learning, technology, and early literacy; their co-design team, their own role, and their practicality; and co-ownership of PictoPal activities. Also, integration of on- and off-computer activities was examined in three classes, along with pupil learning outcomes. A quasi-experimental design was used to study pupil learning outcomes.

Findings showed no differences in the extent of integration of on- and off-computer activities between the three teachers. Findings on pupil learning outcomes showed a difference in outcomes between the experimental and the control groups. Pupils in the experimental group outperformed the pupils in the control group, with a small size for the proportion of variance explained by learning with PictoPal. The effect size for the learning gains in the experimental group was large. There was no significant difference in pupil learning outcomes between the three classes working with co-designed PictoPal. In each of the three classes working with PictoPal, the effect sizes were large for the learning gains.

Teachers involved in co-designing PictoPal activities seem to reach a similar extent of integration of PictoPal activities and similar pupil learning gains in their

classes. This sub-study implies that a specific view about teaching/learning (i.e. developmental approach), positive perceptions about technology and curriculum practicality, and a sense of co-ownership can be linked to the similar extent of integration between teachers. Further details about this sub-study are available in Cviko, McKenney, and Voogt (2014a).

Sub-study 4: Cross-Case Study

The fourth sub-study aimed to provide insight into the value of the different teacher roles in designing ICT-rich activities. To investigate comparative benefits and drawbacks of the teacher roles, a cross-case study was performed. Ten participants were selected from the previous studies, with four teachers in the executor-only case, three teachers in the re-designer case, and three teachers in the re-designer case. The variables compared across cases were teacher perceptions about their role, curriculum practicality, and co-ownership; integration of on- and off-computer activities; and pupil learning outcomes.

Findings revealed that teachers in the co-designer and executor-only cases embraced their roles. Co-designer case teachers were more positive about the practicality of PictoPal activities than teachers in both the executor-only and the re-designer cases. Co-designer case teachers perceived a greater sense of co-ownership towards PictoPal than re-designer case teachers.

Significant differences in the extent of integration of on- and off-computer activities were found between the three cases, with a large effect size for the proportion of variance explained by case. The extent of integration was higher in the co-designer case than in the re-designer case. Also, integration was higher in the re-designer case than in the executor-only case. Both teacher role and time of 8 weeks of working with PictoPal were significant predictors for degree of integration.

Pupil learning outcomes were significantly higher in the three cases than in their respective control groups. Large effect sizes for the proportion of variance explained by PictoPal were found for both the executor-only case junior and senior pupil groups, a medium effect size was found for the re-designer case junior pupil group, and a small effect size was found for the co-designer case senior pupil group. In all the three cases, large effect sizes were found for the learning gains, measured as the difference between pre- and post-test.

This study implies that positive perceptions about teacher role, practicality, and co-ownership complement the highest extent of integration. Re-designer and co-designer roles appear to contribute more than the executor-only role to the integration of on- and off-computer activities. Since pupil learning outcomes were significantly enhanced in all cases, all teacher roles contributed to the effectiveness of ICT-rich learning. Further details about this sub-study are available in Cviko, McKenney, and Voogt (2014b).

Conclusion

This study set out to examine teacher roles (executor-only, re-designer, or co-designer) to answer the research question about which one contributes most to effectiveness of an ICT-rich learning environment for early literacy. Based on the four sub-studies about teacher roles, the following answer of the research question can be provided. Each teacher role (executor-only, re-designer, and co-designer) contributes significantly to the effectiveness of ICT-rich early literacy learning activities. Although pupil learning outcomes were presumed to be affected by how teachers in their respective roles integrate (ready-to-use, re-designed, and co-designed) ICT-rich learning activities, this study suggests that across teacher roles, pupil learning outcomes were not straightforwardly related to the extent of integration.

Given the findings of this study, several considerations are worth noting with regard to identifying which teacher role is best suited for the implementation and effectiveness of ICT-rich learning. Though the main research question relied upon pupil learning outcomes, it is not easy to give a straightforward answer. This study concluded that involvement of teachers in design enabled them to fully embrace the products and materials to be implemented. This sense of co-ownership is an important factor; in this study, it yielded high degrees of integration and willingness to extend implementation of PictoPal activities beyond the research context. From this viewpoint, it becomes clear that the co-designer role is best suited for the long-term feasibility of implementing ICT-rich learning activities, despite the smaller effect sizes found in pupil learning outcomes.

One may argue that the executor-only role is best suited for teachers who cannot easily adopt a role in design and who want to improve the pupil learning outcomes in the short term at the cost of ownership and thorough understanding of the curriculum activities. Although teachers in this study expressed that PictoPal can be suitable for children who are able to work with activities independently, the executor-only role may not be best suited for implementation in the long run, because teachers may not fully embrace the PictoPal activities. In other words, the executor-only role can be feasible for those children who are able to use PictoPal without guidance from the teacher. A combination of roles is also possible, whereby teachers design materials for those kindergartners, who require teacher guidance, and use ready-made activities for kindergarteners who can work with the materials independently. This combination is already in place in all of the schools who participated in this study that continued with PictoPal.

A surprising finding in this study was that teachers did not perceive the re-designer role to be a regular practice for teachers. Despite the fact that re-designing was new for these teachers, they viewed it as a learning experience, worth investing their time and effort. Teachers re-designed PictoPal activities to reach their goal of creating activities suited for both junior and senior pupil levels. Even though they did meet this goal (i.e. differentiated materials were realized and both junior and senior kindergartners exhibited significant learning gains), the teachers decided that PictoPal was best suited for those children who can use it without teacher guidance

(typically, the more advanced learners). A possible explanation is that the teachers in the role of re-designer as well as teachers in the role of executor-only held a view that children should work and learn as much as possible independently, specifically with on-computer activities. It is possible that the tacit teaching goal and view of these teachers was stimulating independent learning of pupils in kindergarten classes (since these teachers came from the same school, which strongly supported independent learning). It is also possible that teachers felt this way for pragmatic reasons (e.g. that it not feasible to facilitate computer activities while other children in the class are doing different activities). A combination of these explanations seems likely.

Reflections on the Research Methodology

General Approach

Doing research in a kindergarten classroom can be complex, because of complications such as classroom scheduling, technical infrastructure, and teacher time and commitment. The complexity of doing research in practice presents challenges to the research design. For example, pupil populations in the classrooms of the teachers investigated can differ, making it problematic to compare the interventions. Experimental designs in practice contexts may not provide a coherent picture of factors influencing implementation of interventions and pupil learning, because it is impossible to hold certain variables constant (e.g. implementation and pupil classroom experiences), while manipulating others (e.g. teacher roles in design), in order to examine the effects of interventions.

In this study, a case study methodology was considered suitable to investigate what role is the best for a kindergarten teacher regarding technology-rich early literacy learning. Unlike other methods such as some experimental designs or surveys, case studies inherently take the context into consideration (Yin, 2003). A case study approach allowed in-depth investigation of each teacher role.

The findings and conclusions for the implementation and effectiveness of ICT-rich learning activities in the specific context of kindergarten classrooms through a case study can be helpful for extending research in this contexts. Specifically, a well-described case study provides sufficient information for readers to ascertain if and how research findings might be of value in similar contexts. Such information can also help researchers test how widely applicable new findings might be. For example, subsequent studies can investigate if certain predictions hold under a broader range of certain circumstances.

A case study approach allows for the execution of an ecologically valid study. The results of this study were highly relevant for kindergarten early literacy classrooms, because the study was undertaken under natural conditions. The quasi-experimental design used in this study shaped the possibility to examine early literacy outcomes of kindergarteners, making the case study findings more robust.

The Researcher's Role

The role of the researcher in these case studies is important to describe, because the researcher actively participated in the setting in which the study was undertaken and did not only gather data. The researcher in this study was a participant observer, but also facilitated teacher teams and supported them when needed. Researchers can influence study outcomes, because they are present and act in specific ways (e.g. in positive, supportive, and motivating ways) during the research. The researcher's presence may have prompted teachers to answer interview questions in socially desirable ways, or to teach differently when being observed, than they do in daily practice. This is known to be a potential disadvantage of participatory observation which, in this study, could have affected all sub-studies. To mitigate this, triangulation was used (not only observations but also group interviews with teachers) to study the implementation of PictoPal. The results of observations were evaluated together with teachers in each case study. In this way, opportunities were provided for participants to check if observations represented their actual classroom implementation.

Besides introducing bias that might affect the participants, researchers may also be subject to bias. In the process of data gathering, there is a potential danger that a researcher may interpret situations being observed or tested in a particular way, which might not necessarily have been observed as such by others. To minimize the threats related to the role of researcher for research validity and reliability, research assistants were engaged in data gathering and data entry, while for data analysis, critical friends were engaged in reviewing data tabulations and interpretations of data. Disagreements in interpretations between observers and reviewers were discussed until agreement about interpretation was reached. Member checks were undertaken, in which teachers reviewed the data from interviews during evaluations meetings featuring presentation of the research results and interpretations. In this way, teachers also had a role in validating data interpretations.

Reflections on Research Outcomes

The first basic assumption of this study was that involvement of teachers in curriculum design can contribute to curriculum implementation (Fullan, 2003). The second assumption was that teacher perceptions about teaching/learning, early literacy, and technology influence implementation (e.g. Tondeur, Hermans, van Braak, & Valcke, 2008). The third assumption was that curriculum implementation positively influences pupil learning outcomes (Cheung & Slavin, 2012). In this section we reflect on these assumptions, based on the study findings.

Teacher Involvement in Curriculum Design

The first assumption underpinning this study was that involvement of teachers in designing ICT-rich learning activities positively influences implementation of the activities. From this study, it can be concluded that teacher roles in design of ICT-rich learning activities positively influence classroom implementation of on- and off-computer activities. Specifically, the cross-case study revealed that teachers with active roles in design of ICT-rich learning activities (re-designer and co-designer) had a significantly higher extent of integration of on- and off-computer activities, compared to teachers not actively involved in design (executor-only). In line with Penuel, Roschelle, et al. (2007), this study demonstrated that teams of teachers designing activities can be fruitful for actual classroom implementation. The integration during classroom implementation, as demonstrated by teachers in the re-designer and co-designer roles, may have been more aligned with the intentions of the teachers themselves who re- or co-designed PictoPal than in the case of executor-only.

Explanations for these results may be provided by the findings on teacher perceptions about curriculum practicality and co-ownership. Involving teachers in design may induce teachers' commitment because of their input in the design of activities. They may feel valued in contributing their practical insights into the materials their pupils will learn with. This leads to co-ownership, which could motivate teachers to enact the on- and off-computer activities in an integrated manner. Practicality of PictoPal activities and co-ownership towards PictoPal were found to be present in the studies involving re-designers and co-designers. The findings are in line with other studies (De Grove et al., 2012; Wozney, Venkatesh, & Abrami, 2006) suggesting that teachers perceiving a curriculum to fit their current curriculum were likely to implement it successfully.

An active role in design may give teachers an opportunity to see the fit between the activities being designed and their current curriculum, which may contribute to a better understanding of how to implement the designed activities. Also, feeling co-owner of the designed activities may induce motivation and enthusiasm in teachers for implementing the activities, which may contribute to implementation.

Teacher Perceptions Influence Curriculum Implementation

The second assumption in this study was that teacher perceptions about teaching/learning, ICT, and early literacy influence the implementation of ICT-rich learning activities. Specifically, the nature of perceptions about teaching/learning and early literacy can either positively or negatively influence implementation of ICT-rich activities, whereas positive perceptions about technology positively influence implementation.

Based on this study, it can be concluded that a high extent of integration of on- and off-computer activities during implementation is related to a developmentally

oriented view of teaching/learning and viewing early literacy as an important domain. The conclusion corroborates the findings of Kim, Kim, Lee, Spector, and DeMeester (2013), who showed that teacher perceptions about teaching and learning were related to their technology integration practices.

Based on this study, it can be concluded that positive perceptions of technology are related to a high extent of integration of on- and off-computer activities during implementation. The conclusion is in line with the study of Hermans, Tondeur, van Braak, and Valcke (2008) which showed that positive attitudes towards technology positively influence classroom implementation concerning technology integration. Engagement of teachers in meaningful experiences with technology integration could positively influence teacher attitudes towards technology integration in their classes. Ertmer and Ottenbreit-Letwich (2010) recommended an approach which emphasizes technology uses that directly align with teachers' existing beliefs. According to the authors, time, small steps, and teacher collaboration are needed for transforming teachers beliefs to be more open for technology integration.

Implementation and Pupil Outcomes

The third assumption in this study was that pupil learning outcomes are affected by how teachers implement a curriculum. In this study, the extent of integration of on- and off-computer activities was investigated as an indicator of classroom implementation. The study demonstrated that high degrees of integration could not be linked straightforwardly to high pupil learning outcomes. This finding does not corroborate to the finding of Cheung and Slavin (2012) who found that studies with high implementation ratings were associated with large effects on pupil learning. In this study, ICT-rich learning activities positively affected pupil learning outcomes. The study demonstrated that pupils showed significantly improved early literacy outcomes compared to their respective control groups. However, in this study, implementation of PictoPal was measured by *how* teachers integrated the on- and off-computer activities, whereas this study did not evaluate the quality of re- and co-designed PictoPal activities, such as the learning difficulty and the learning opportunities of the activities, indicating that there is more to implementation than the extent of integration.

In the executor-only study, significantly different pupil learning outcomes were found in classes of teachers integrating the ready-to-use on- and off-computer activities to significantly different degrees, with no link between higher extent of integration and higher pupil learning outcomes. This could mean that integration does not affect pupil learning outcomes. From the second and the third sub-study, no conclusions can be drawn with regard to how the extent of integration affects pupil learning outcomes. Specifically, teachers in the re-designer role did not differ in the extent of integration, whereas the pupil learning outcomes did differ between their classes. Teachers in the co-designer role did not differ in the extent of integration, and no differences were found in pupil learning outcomes between their classes.

The PictoPal materials produced in each case were extremely similar in structure, difficulty, and style. However, because the vocabulary and content of each set of materials produced did vary, it is possible that the extent of integration was less important than the variation in the content and quality of the PictoPal activities for influencing early literacy outcomes of pupils. The pupil learning outcome findings from the cross-case study support this. Specifically, when comparing senior pupil learning outcomes with their respective control groups, the proportion of variance attributable to learning with PictoPal activities was larger in the executor-only case than in the co-designer case. Yet, the small differences in the effect sizes between the executor-only and co-designer case may not weigh off the benefits of teachers developing a sense of co-ownership, as was the case when teachers had a co-designer role. In the long run, children may benefit more from co- and re-designed materials, because their teachers fully embrace them, and this positively affects implementation.

Recommendations

Based on this study, several recommendations are provided for further research concerning teacher roles in designing ICT-rich materials and learning activities. This study combined case studies in natural settings for studying how teachers design and implement technology-rich materials and activities for early literacy with a quasi-experimental design for investigating pupil learning. Further research could use this combined approach in other educational contexts, benefitting from the rigour of the quasi-experimental design and the ecological validity of the case study.

Although not deemed feasible within the scope of this study, future investigations could pay more explicit attention to the variation in quality of teacher-made curriculum materials as well as the resulting effects on pupil learning outcomes and integration of ICT-rich learning activities. Teacher-designed materials and activities could be reviewed by experts and compared to the ready-made PictoPal activities. If indeed the variety in quality does account for differences in pupil learning outcomes, then exploration into ways of mitigating this variety seems warranted. For example, perhaps language experts could collaborate with teachers during design.

Also, instead of mitigating variation in material content and quality, future research could remove it. For example, teachers in the role of executor-only could be assigned to implement the activities co-designed or re-designed by other teachers. In this way, the key variable of design participation could be changed while the materials are kept constant. The effects on both the extent of integration and pupil learning could be investigated.

Future studies could also explore teacher roles in longitudinal research to examine how these evolve over time and in different phases of their profession. For example, it is plausible that novice and veteran teachers may develop over time differently in their roles which could affect their technology integration. In this respect it could be helpful to know what kind of role likely suits teachers in different stages of their teaching.

With respect to measurement of pupil learning outcomes, future research incorporate differentiated tests, e.g. with difficulty levels for senior pupils and junior pupils. By including items with different difficulty levels, possible ceiling effects could be resolved. Also, when investigating learning outcomes, it should be kept in mind that the learning curve of junior pupils differs from the learning curve in the senior pupil population. For example, it is difficult for a pupil to improve on the post-test if the first time of measurement the pupil scored high. Yet, for pupils who score low on a pretest, it is easier to improve during intervention and score high on a post-test. To resolve this problem, future research should include weighted items in the test measuring learning outcomes in a pre-post design.

Based on this study, it can be recommended that schools wishing to support early literacy development in kindergarteners can benefit from engaging their teachers in collaborative design of ICT-rich activities. Of the various roles teachers may have, co-design may result in highest levels of ownership and therefore longer use of the activities. Co-design of materials and activities enables teachers to explore possibilities of how to connect technology with curricular themes and activities.

References

Abrami, P. C., Poulsen, C., & Chambers, B. (2004). Teacher motivation to implement an educational innovation: Factors differentiating users and non-users of cooperative learning. *Educational Psychology, 24*, 201–216.

Block, C. C., Campbell, M. J., Ninon, K., Williams, C., & Helgert, M. (2007). *Effects of AWARD reading, a technology-based approach to literacy instruction, on the reading achievement and attitudes toward reading of diverse K-1 students* (Research report 124811). Charlotte, NC: The Institute of Literacy Enhancement.

Carl, A. (2005). The "voice of the teacher" in curriculum development: A voice crying in the wilderness? *South African Journal of Education, 25*, 223–228.

Carl, A. (2009). *Teacher empowerment through curriculum development. Theory into practice*. Cape Town: Juta.

Cheung, A. C. K., & Slavin, R. E. (2012). How features of educational technology applications affect students reading outcomes: A meta-analysis. *Educational Research Review, 7*, 198–215.

Cooper, J. D. (1993). *Literacy: Helping children construct meaning*. Boston: Houghton Mifflin.

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. (2012). Teachers enacting a technology-rich curriculum for emergent literacy. *Educational Technology Research and Development, 60*, 31–54.

Cviko, A., McKenney, S., & Voogt, J. (2013). The teacher as re-designer of technology integrated activities for an early literacy curriculum. *Journal of Educational Computing Research, 48*, 447–468.

Cviko, A., McKenney, S., & Voogt, J. (2014a) Teachers as co-designers of technology-rich learning activities for early literacy. *Technology, Pedagogy and Education*, doi:10.1080/1475939X.2014.953197

Cviko, A., McKenney, S., & Voogt, J. (2014b). Teacher roles in designing technology-rich learning activities for early literacy: A cross-case analysis. *Computers & Education, 72*, 68–79.

De Grove, F., Bourgonjon, J., & van Looy, J. (2012). Digital games in the classroom? A contextual approach to teachers' adoption intention of digital games in formal education. *Computers in Human Behavior, 28*, 2023–2033.

De Jong, M. T., & Bus, A. G. (2003). How well suited are electronic books? *Journal of Early Childhood Literacy, 3*, 147–164.
Doyle, W., & Ponder, G. A. (1978). The practicality ethic in teacher decision-making. *Interchange, 8*, 1–12.
Elster, C. A. (2010). "Snow on my eyelashes": Language awareness through age-appropriate poetry experiences. *Young Children, 65*, 48–55.
Ertmer, P. A., & Ottenbreit-Letwich, A. T. (2010). Teacher technology change: How knowledge, confidence, beliefs and culture intersect. *Journal of Research on Technology in Education, 42*, 255–284.
Expertisecentrum Nederlands. (2010). *Doorlopende leerlijnen taal basisonderwijs [Continous language learning in primary educaiton]*. Retrieved from http://www.leerlijnentaal.nl/
Fishman, B. J., Marx, R. W., Best, S., & Tal, R. (2003). Linking teacher and student learning to improve professional development in systemic reform. *Teaching and Teacher Education, 19*, 643–658.
Fullan, M. (2003). *Change forces with a vengeance*. New York: RoutledgeFalmer.
Fullan, M. (2011). Choosing the wrong drivers for whole system reform. *Centre for strategic education seminar series paper no. 204*. East Melbourne, Australia: Centre for Strategic Education
Garet, M. S., Porter, A. C., Desimone, L., Birman, B. F., & Yoon, K. S. (2001). What makes professional development effective? Results from a national sample of teachers. *American Educational Research Journal, 38*, 915–945.
Gimbert, B., & Cristol, D. (2004). Teaching curriculum with technology: Enhancing children's technological competence during early childhood. *Early Childhood Education Journal, 31*, 207–216.
Hermans, R., Tondeur, J., van Braak, J., & Valcke, M. (2008). The impact of primary school teachers' educational beliefs on the classroom use of computers. *Computers & Education, 51*, 1499–1509.
Higgins, S. (2003). *Does ICT improve teaching and learning in schools? BERA professional user review*. Newcastle, UK: University of Newcastle.
Inan, F. A., & Lowther, D. L. (2010). Factors affecting technology integration in K-12 classrooms: A path model. *Educational Technology Research and Development, 58*, 137–154.
International Reading Association. (2009). *New literacies and 21st-century technologies*. Retrieved from http://www.reading.org/Libraries/position-statements-and-resolutions/ps1067_NewLiteracies21stCentury.pdf
Justice, L. M., & Pullen, P. C. (2003). Promising interventions for promoting emergent literacy skills: Three evidence-based approaches. *Topics in Early Childhood Special Education, 23*, 99–113.
Keengwe, J., & Onchwari, G. (2009). Technology and early childhood education: A technology integration professional development model for practicing teachers. *Early Childhood Education Journal, 37*, 209–218.
Kenny, R. F., & McDaniel, R. (2011). The role teachers' expectations and value assessments of video games play in their adopting and integrating them into their classrooms. *British Journal of Educational Technology, 42*, 197–272.
Kim, C., Kim, M., Lee, C., Spector, J. M., & DeMeester, K. (2013). Teacher beliefs and technology integration. *Teaching and Teacher Education, 29*, 76–85.
Kirk, D., & MacDonald, D. (2001). Teacher voice and ownership of curriculum change. *Journal of Curriculum Studies, 33*, 551–567.
Labbo, L. D., & Reinking, D. (2003). Computers and early literacy education. In N. Hall, J. Larson, & J. Marsch (Eds.), *Handbook of early childhood literacy research* (pp. 338–354). Thousand Oaks, CA: Sage.
Landry, S. H., Swank, P. R., Anthony, J. L., & Assel, M. A. (2011). An experimental study evaluating professional development activities within a state funded pre-kindergarten program. *Reading and Writing, 24*, 971–1010.
Lowther, D. L., Inan, F. A., Ross, S. M., & Strahl, J. D. (2012). Do one-to-one initiatives bridge the way to 21st century knowledge and skills? *Journal of Educational Computing Research, 46*, 1–30.

McKenney, S., Bradley, B., & Boschman, F. (2012). *Assessing teacher beliefs about early literacy curriculum implementation*. Retrieved from http://dspace.ou.nl/handle/1820/4028

McKenney, S., & Voogt, J. (2009). Designing technology for emergent literacy: The PictoPal initiative. *Computers & Education, 52*, 719–729.

McManis, L. D., & Gunnewig, S. B. (2012). Finding the education in educational technology with early learners. *Young Children, 67*, 14–24.

Merchant, G. (2007). Digital writing in the early years. In J. Coiro, M. Knobel, C. Lankshear, & D. Leu (Eds.), *New literacies research handbook* (pp. 755–778). Mawah, NJ: Lawrence Erlbaum.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook*. Thousand Oaks, CA: Sage.

Mumford, T. V., van Iddekinge, C. H., Morgeson, F. P., & Campion, M. A. (2008). The team role test: Development and validation of a team knowledge situational knowledge test. *Journal of Applied Psychology, 3*, 250–267.

Neuman, S. B., & Roskos, K. (2005). Whatever happened to developmentally appropriate practice in early literacy? *Young Children, 60*, 22–26.

Niederhauser, D. S., & Lindstrom, D. L. (2006). Addressing the nets for students through constructivist technology use in K-12 classrooms. *Journal of Educational Computing Research, 34*, 91–128.

Niess, M. L. (2005). Preparing teachers to teach science and mathematics with technology: Developing a technology pedagogical content knowledge. *Teaching and Teacher Education, 21*, 509–523.

Parette, H. P., Quesenberry, A. C., & Blum, C. (2010). Missing the boat with technology usage in early childhood settings: A 21st century view of developmentally appropriate practice. *Early Childhood Education Journal, 37*, 335–343.

Penuel, W. R., Fishman, B. J., Yamaguchi, R., & Gallagher, L. P. (2007). What makes professional development effective? Strategies to foster curriculum implementation. *American Educational Research Journal, 44*, 921–958.

Penuel, W. R., Roschelle, J., & Shechtman, N. (2007). Designing formative assessment software with teachers: An analysis of the co-design process. *Research and Practice in Technology Enhanced Learning, 2*, 51–74.

Remillard, J. T. (1999). Curriculum materials in mathematics education reform: A framework for examining teachers' curriculum development. *Curriculum Inquiry, 29*, 315–342.

Segers, E., & Verhoeven, L. (2005). Long-term effects of computer training of phonological awareness in kindergarten. *Journal of Computer Assisted Learning, 21*, 17–27.

Snow, C. E. (2006). What counts as literacy in early childhood. In K. McCartney & D. Phillips (Eds.), *Handbook of early childhood development* (pp. 274–294). Oxford: Blackwell.

Tondeur, J., Hermans, R., van Braak, J., & Valcke, M. (2008). Exploring the link between teachers' educational belief profiles and different types of computer use in the classroom. *Computers in Human Behavior, 24*, 2541–2553.

Tondeur, J., Valcke, M., & van Braak, J. (2008). A multidimensional approach to determinants of computer use in primary education: Teacher and school characteristics. *Journal of Computer Assisted Learning, 24*, 494–506.

Turbill, J. (2001). A researcher goes to school: Using technology in the kindergarten literacy curriculum. *Journal of Early Childhood Literacy, 1*, 255–279.

Verhoeven, L., & Aarnoutse, C. (1999). *Tussendoelen beginnende geletterdheid: Een leerlijn voor groep 1 tot en met 3 [Interim goals emergent literacy: A line in learning for grade 1 through 3]*. Nijmegen: Expertisecentrum Nederlands.

Verseput, N. (2008). *PictoPal in practice: Integration of ICT-related activities to support early literacy in classroom practice*. Enschede, The Netherlands: University of Twente.

Wozney, L., Venkatesh, V., & Abrami, P. C. (2006). Implementing computer technologies: Teachers' perceptions and practices. *Journal of Technology and Teacher Education, 14*, 173–207.

Yin, R. K. (2003). *Case study research: Design and methods*. Newbury Park, CA: Sage.