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Parents Support Preschoolers' Use of a Novel Interactive Device

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Past research has found that preschool children's ability to learn educational content from interactive media may be hindered by needing to learn how to use a new interactive device. However, little research has examined the instructional supports parents provide while their children use interactive media. Forty-six preschool children and their parents participated in a 30-min interaction with a novel interactive device. Children were assessed before and after the interaction on knowledge of letters and numbers and device skills. Children improved from pre- to posttest on device skills, but not content knowledge. In general, parents used a wide range of strategies during the interaction. Specific parental support for using the device did not result in increased device skills; however, parents who focused their support on content had children who performed better on content assessments. The findings are discussed in terms of the effectiveness of different parent support strategies for children's use of interactive devices and learning of educational content during the preschool years. Copyright © 2015 John Wiley & Sons, Ltd.

Key words: preschool; computers; interactive media; parent–child interaction; scaffolding

According to a recent report by Common Sense Media (2013), 61% of 0- to 8-year-old children had used a computer at some point; and almost all (91%) 5- to 8-year-olds had used a computer. In addition, 14% of 0- to 8-year-olds use a computer daily (Common Sense Media, 2013). On a typical day, children spend an average of 11 min playing computer games, using educational software, doing homework, or watching videos (Common Sense Media, 2013). Empirical research on computers has examined children's learning of computer mechanics, cognitive skills, and content knowledge, such as health or science topics (Subrahmanyam, Kraut, Greenfield, & Gross, 2000). However, most of this research has focused on school-aged children or adults; and only limited research has examined children under the age of 5 years using computers (Wartella & Jennings, 2000). Preschool children's learning needs on the computer may be different from older children, especially until they develop

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basic operational skills, such as moving the mouse and clicking on objects (Plowman & Stephen, 2007). Given the increased prevalence of interactive media use in young children and parents' perceptions that computers are important educational tools for children, it is important to understand how parents structure young children's learning about and from computers. The goals of the current study were to build on prior research demonstrating differences in how parents focus their instruction when teaching children using a computer (e.g. Lauricella, Barr, & Calvert, 2009) and to examine differences in children's learning associated with different parent instructional strategies.

Questions about how parents structure children's learning from interactive media should be considered within the context of other research demonstrating children age 5 years and younger can use interactive media on their own and can successfully learn from this solitary involvement with interactive media (DeJong & Bus, 2002; Korat, 2009; Shamir, Korat, & Barbi, 2008). When faced with a new video or computer game, many children use a discovery method to negotiate the rules (Greenfield et al., 1996). Through trial and error, children learn successful problem-solving techniques and master the games or activities (Greenfield, 1996; Greenfield et al., 1996). In many ways, interactive media itself scaffolds learning for children by giving feedback and only allowing movement to the next level through successful gaming strategies (Dipietro, Ferdig, Boyer, & Black, 2007; O'Keefe & Zehnder, 2004). Children's ability to succeed on their own when using interactive media may promote the idea that children should learn from these tools on their own, perhaps reinforcing the idea that adult guidance is unnecessary while children are using interactive devices (Plowman, McPake, & Stephen, 2008). Indeed, Plowman et al. (2008) found most parents (75%) of 3- or 4-year-old children believed children taught themselves how to use interactive media. About half of the parents (50%) also believed they were not needed to support their children's learning from interactive media. Despite the potential for solitary use and learning, preschool-aged children face a number of difficulties in their initial use of (and therefore learning educational content from) interactive media.

In order to learn content from interactive media, children must first be able to negotiate the mechanics of the device. Strommen (1993) presented a *Cognitive Model of Device Difficulty* to explain the difficulties preschool children have using some interactive devices. Strommen explained that preschoolers might not have enough working memory to negotiate the different rules required to successfully use a computer, such as moving and clicking objects. In terms of computer mechanics, children under 5 years have demonstrated the motor skills necessary to use computers (Strommen, Revelle, Medoff, & Razavi, 1996). In considering preschool children's use of three different types of computer-pointing devices (i.e. trackballs, joysticks, and a mouse), children improved their speed with all three devices significantly over 5 days of practicing (Strommen et al., 1996). Children showed the biggest gains in using the mouse, which was the most difficult at the beginning of the task, because the children needed to learn to hold it still, control it, and press the button (Strommen et al., 1996). Given the difficulties that young children have with some of the mechanical skills necessary to operate a device like a computer, parental support during interactive device use may increase learning.

Limited research has addressed how parents engage with their young children while using interactive media (Plowman et al., 2008; Rideout, Foehr, & Roberts, 2010; Subrahmanyam et al., 2000). At least one study has examined the ways in which parents initially teach their children (prior to formal schooling) how to use a computer. Lauricella et al. (2009) examined parent–child interactions while using a computer storybook. Lauricella et al. (2009) found 4-year-old children

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needed parental support to operate the device, and there were differences in how the parents engaged with the children. Parents in a parent-oriented mouse group operated the mouse and used a higher amount of content talk, such as story relevant questions. Parents in the child-oriented mouse group let the child operate the mouse and used a higher amount of computer mechanics talk (Lauricella et al., 2009), such as click the mouse or hit the arrow. These findings indicate there are differences at the dyadic level in how parents and children use computers.

As Plowman et al. (2008) noted, one source of confusion for parents may be a lack of clarity about how to support learning for young children while using interactive media. Part of parents' uncertainty about their efficacy in helping children learn how to use a computer may stem from an uncertainty about whether to focus on teaching children how to use the device itself (e.g. clicking a mouse) or to focus on the content knowledge children must have to succeed at a game (e.g. identify letters and numbers). In a study examining differences in how parents and teachers guided preschool children's use of interactive media, preschool teachers encouraged independence and built confidence in skills using the computer by discussing the problems and successes that children had while doing the activity, whereas parents focused primarily on computer mechanics (Plowman, Stephen, & McPake, 2010). For example, parents were observed helping instruct children how to navigate to a website by clicking on the correct icons; however, parents still believed children taught themselves, and 75% of parents did not know how their children learned operational skills.

The finding that parents of preschool children focus on operations is similar to Gauvain's (1992) study of parent–child dyads during a planning task. Gauvain (1992) found parents of preschool children focused on the structure and procedures of the activity, and parents of older children used bigger picture connections and strategies. Stephen, McPake, Plowman, and Berch-Heyman (2008) interviewed preschool children about what children their age would need to do to use the games. The children explained a series of mechanical operations, such as click the button and look for the object, without any mention of how to negotiate game content. Stephen et al. (2008) suggested children were able to recall the operations as routine with little understanding of why the operations were needed or how they were connected to the game content. This implies that providing operational scaffolds may be a successful strategy for parents to use with preschool children; however, parents must adjust their techniques as the children master the operations (Gauvain, 1992; Plowman & Stephen, 2007).

In summary, research with preschool children has demonstrated individual differences in the motor skills needed to use a mouse; and with practice, children can quickly show gains (Lauricella et al., 2009; Strommen et al., 1996). Although preschool children can use interactive media on their own, there is variation in how parents use computers with children. Some parents take charge of the mouse or game, whereas others are more collaborative, and still others allow the child to take control (Lauricella et al., 2009). In addition, parents of preschool children tend to focus more on computer mechanics than big picture strategy (Gauvain, 1992; Plowman & Stephen, 2007). Understanding the ways in which adults can most effectively support children's computer learning is crucial as increasing emphasis is being placed on children's development of computer skills, even in the preschool years (National Association for the Education of Young Children and the Fred Rogers Center for Early Learning and Children's Media's, 2012).

The goal of the current study was to examine parent–child dyads playing novel computer games in order to understand what preschoolers learn in the context of computer game play and how parents structure and support the experience. The

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first hypothesis, related to Strommen's (1993) model, was that children who have better device skills would learn more content in the interaction. The second hypothesis was that there would be individual differences in parents' focus of support of children's experience, such that more parents would focus on device mechanics-related support than content-related support. The third hypothesis was that children of parents who focus on supporting the computer mechanics would demonstrate the greatest improvement in device skills, whereas children of parents who focus on supporting educational content would demonstrate the greatest improvement in content knowledge.

METHOD

Participants

The participants were 46 children ages 3.25 to 4.50 years ($M = 3$ years and 8 months, $SD = 4$ months; 50% female) recruited from Southern California through direct mailings and referrals from participating families. In terms of ethnicity, 56% were Caucasian, 13% were African American, 16% were Hispanic, 2% were Asian, and 13% were multi-ethnic or biracial participants. Of the accompanying parents, most of the participants were mothers ($n = 40$); however, six parents were fathers. The average age of the parents was 34.75 years ($SD = 12.11$ years). In terms of parents' education level, 9% had a high school diploma or GED, 44% had some college, 16% had bachelor's degrees, and 31% had advanced degrees. Forty-three percent of parents worked full-time, 7% worked part-time, and 50% were homemakers, retired, unemployed, students, or disabled. Participation required the child not have prior experience with *Clickstart: My First Computer*. All participants spoke English as the primary language in the home. Participants were compensated $20 for their participation. Three children were unable to complete the mouse posttest, and one child was unable to complete the keyboard posttest; therefore, they were not included in the analyses.

Materials and Measures

Clickstart: My first computer

The parent–child interaction involved using Leapfrog's *Clickstart: My First Computer*. The Clickstart included a game console, a wireless keyboard, and a computer mouse with mouse pad that can be adjusted depending on the child's handedness. The game console plugged into a standard television. The keyboard mirrored the standard visual and functional keyboard layout of letters and numbers with arrow keys, a space bar, a backspace, and an enter key, as well as Clickstart-specific keys, including hint, pause, and music keys. Each row of the keyboard was colour coded, and each function key had its own colour.

The device had a set amount of potential feedback. Before each game, the device explained the instructions for playing (e.g. 'Tap the keys on the keyboard to open clams. As you play keep your eyes open for sea stars. Watch closely to see where the fish hides'). The device also asked questions (e.g. 'What would you like to play?') and made statements that told the child explicitly what to do (e.g. 'Click on a game with your mouse.'). The game responded to all key presses and mouse clicks (e.g. 'G. G is for grouper!'); and when the child gave a correct response, the game responded with a declaration of success (e.g. 'G. G is for grouper! Ooh! That is good!').

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Two games were used for the interaction to ensure the child used both the mouse and the keyboard. The first game was *Finding Nemo: Sea of Keys* played at level 1. This game required using the keyboard for letter recognition. The on-screen display had a keyboard with each key in the shape of a clam. At the beginning of the game, a fish hid behind one of the clams/letters. Children achieved the game's goal of finding the fish by pressing the corresponding key on the keyboard. Each time a participant pressed an incorrect letter, the game named the letter and an object that started with that letter, for instance 'N, N is for Net'. When the correct letter was pushed, the game said, 'You found the fish friend!' The game provided prompts in four situations. First, if a user pressed the 'Hint' key, the game said, 'He's hiding in the clam with the letter "N" on it'. Second, if a user pressed a non-letter key, the game prompted, 'Try pressing a key with a letter on it'. Third, if the fish was not found, the correct clam began to bubble. Fourth, if the participant attempted to use the mouse the game prompted, 'Use the keyboard for this game'.

The second game the participants played was *Dora the Explorer: Number Groups Matching* played at level 2. This game required mouse manipulation in a traditional memory card-matching task. The goal of the game was number recognition, matching cardinal numbers with the amount the numbers represent. Participants matched six pairs by mousing over cards and clicking to flip them over. For instance, one card had the number '8' and another card had eight ladybugs. If participants pushed keys on the keyboard, the game prompted, 'Use the mouse for this game'. If participants clicked over six cards without making a match, the game said, 'Do you need a hint?' If participants pressed the 'Hint' key, the game reminded them to 'Click on the cards to make a match'.

After playing the two interaction games, parent–child dyads could play any of the games on the Clickstart console for the remainder of the time. There were seven additional games available to play. Six of the additional games were games played with the keyboard. Only one additional game was played using the mouse.

Demographic and media exposure questionnaire

Before participating in the parent–child interaction, all parents completed a demographic questionnaire about their income, education level, ethnic background, and employment status. Parents also completed a media exposure questionnaire indicating their attitudes about and exposure to media, their household media environment, and their child's media habits. This questionnaire was based on a media survey that examined media use for children ages 0 to 6 years (Rideout, Vandewater, Wartella, & Kaiser Family Foundation, 2003). Parents answered questions about how often their child used a computer. Participants had five response options: *every day* (4), *few times a week* (3), *once a week* (2), *occasionally* (1), and *never* (0). Parents' responses to this question comprised the computer prior exposure variable ranging from 0 to 4. Parents were asked when their child uses the computer does s/he use the keyboard and use the mouse. Parents had four response options: *almost always* (3), *sometimes* (2), *rarely* (1), and *no* (0). These two variables were used to create the keyboard and mouse prior exposure variables ranging from 0 to 3.

Procedure

Parents and children participated in a laboratory setting, which had a comfortable living room set-up, for a 90-min session. Parents completed a consent form and

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children provided verbal assent before participation began. The visit consisted of a pretest with a trained interviewer, a 30-min parent–child interaction with the Clickstart, and a posttest with the same trained interviewer.

Interaction games

Following these pretest assessments, the interviewer instructed parents they had 30 min to play two target games: *Finding Nemo: Sea of Keys Level 1* and *Dora the Explorer: Number Matching Level 2.* As described above, *Sea of Keys* provided children both letter recognition and keyboard identification practice, and *Number Matching* provided children practice with number identification, mousing, and clicking practice. (Note: Level 2 was selected because it would be challenging for most children to accomplish without the help of a parent.) Parents were asked to play each game twice and were told they could take as long as they wanted with each of the games. Parents were given a *Games to Play* checklist and a basic game instruction sheet. The instruction sheet had a picture of the keyboard and computer screen. The interviewer explained:

> Each game will give you instructions and let you know whether to use the keyboard letters, arrows or mouse to play the game. You can also press the 'HINT' button if you need help.

Parents were told that after they completed the ordered checklist, they could repeat any game or play any of the games that were not on the checklist except *1, 2, 3 Click*, the mouse pretest game. All games involved letters or numbers in some fashion. Finally, the interviewer advised parents they could help their child with any aspect of the game or computer, 'just like you typically would at home'. The free play portion of the interaction was coded for how long the dyad spent playing games that required keyboard or mouse use and that focused on letter or number knowledge. After the 30-min interaction, the interviewer returned to the room to conduct the posttest while the parent finished completing the surveys. The posttest was exactly the same as the pretest.

Pre- and posttest outcomes assessment

Children were tested before and after playing the interaction game on their ability to name letters and numbers, their ability to identify letters on a keyboard, and mouse manipulation to test both content knowledge and procedural knowledge of computer skills. These outcome assessments measured children's knowledge and ability for the educational skills that were the focus of interactive games played during the parent–child interaction. All child outcomes were based on the proportion correct out of a highest score. The test and order in which children were asked about letters and numbers were counterbalanced across participants.

Content knowledge. Children played a number-related mouse game during the interaction (*Dora the Explorer*); therefore, children were asked to name three numbers in pretest. The interviewer showed the child a number on an easel and asked, 'What is this number called?' Test A used numbers 2, 8, and 5, while Test B used numbers 1, 9, and 4. The proportion of numbers that children identified correctly comprised the outcome of *mouse content knowledge.* Children played a letter-related keyboard game during the interaction (*Finding Nemo*). In pretest, children were asked to name five target letters, chosen to represent different locations on the computer keyboard. The interviewer showed the child each of the five targeted letters one at a time and asked, 'What is this letter called?' Test A used the letters G, E,

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N, P, and B. Test B used the letters C, I, M, T, and J. The proportion of letters that children correctly named comprised the outcome of *keyboard content knowledge*. The keyboard and mouse content knowledge scores were averaged for *pretest content knowledge* and *posttest content knowledge* scores.

Device skill. To test children's ability to use a mouse, the interviewer said, 'Now we are going to play a game on the computer that uses the mouse'. The experimenter oriented the child to the mouse by placing her or his hand on the mouse and explained how to click the mouse to select an object. The interviewer said, 'In this game, we want you to use the mouse to click as many colored balls on the screen as you can!' The number of balls the child clicked during the game *1, 2, 3 Click* within 1 min and 30 s was recorded. As the game did not have a discrete number of possible clicks, the proportion correct was based on the highest amount clicked by any child in posttest (48[1]). The *mouse device skill* outcome was the proportion of bubbles that children 'popped' in 90 s during pre- and posttest.

To test children's skill at using a keyboard, the interviewer said, 'This is a keyboard with letters and numbers. Your name starts with the letter (first letter of child's name). I want you to find (letter) and push it as fast as you can!' The child was then shown the series of five letters on the easel, the same letters that they had named previously. Each time, the interviewer asked the child to 'Find and press this letter on the keyboard as fast as you can!' Children were given approximately 30 s to find the letter before the interviewer moved on to the next letter. The outcome was the proportion of letters that children correctly pressed on the keyboard. (Note: Although the stimuli for this task involved letters, this task was specific to children's device skill as they did not need to know the specific letters to answer correctly. Children could produce a correct response by identifying the superficial similarity between the letter on the card and on the keyboard.) The two device skill variables (i.e. keyboard identification and mousing ability) were averaged to create a *pretest device skill* variable and a *posttest device skill* variable.

Interaction Coding

A coding scheme was created to analyse how parents engaged their child during the Clickstart interaction. Coding of the target game interaction was done from videotape. Two trained coders coded each device, parent, and child utterance by marking every time a behaviour occurred over the 30-min interaction. It was possible that the different behaviours could occur simultaneously; in these instances, coders would mark all behaviours or talk that occurred. Each variable below was created as a proportion of the target parent's total talk and behaviour to control for variations in amount of parent engagement. Analyses were also run using total number of utterance for comparison; however, the pattern of findings was the same, so the proportion variables were used in analyses. The coding scheme was adapted from Gauvain (1992) and Perez and Gauvain (2009). Reliability for the coding was established by having two other coders code 20% of the interactions. These resulted in high reliabilities for each of the codes (99% agreements or higher).

Parent behaviours

Five types of parent talk and behaviours were coded focusing on computer device operations and content knowledge: directives; connections; take over; motor skill help; and other content-related talk.

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Directives. Directives were statements that told the child explicitly what to do during game play. *Device directives* directed the child to use the keyboard or mouse (e.g. 'push the key', 'move the mouse'). *Content directives* directed the child about the game content (e.g. 'find the A', 'match the ladybugs').

Connections with device and screen. Parent statements that made bigger connections between the game and the screen or the child's experiences were coded as connections. *Device connections* were parent statements that made a connection between the keyboard or mouse and the device (e.g. explaining the connection between the layout on the screen and the keyboard, physically pointing at the screen or having the child go to screen and point). *Content connections* were parent statements that connected content to something the child would know (e. g., 'J is for Jeremiah, your name!').

Takes over. These codes were verbal and nonverbal behaviours in which the parent took over the game, keyboard, or mouse for the child. *Device take over* was coded when the parent pushed keys on the keyboard or moved and/or clicked the mouse for child. *Content take over* was coded when the parent told the child exactly how to solve the game without physically taking over. For example, 'push this key right here' while pointing to the key, or 'click on the card on the top'.

Other device support. These codes were both verbal and nonverbal directions about how to physically use the device. *Device skill* was coded when the parent explained how to press the keys or how to hold or move the mouse. *Device physically modelling* was coded when the parent helped guide child's hand to click the button or when the parent used her/his hand to help guide the mouse.

Other content support. Content questions were coded when the parent asked the child a question about the game or what they were supposed to do. For example, 'where is he hiding?' or 'what letter is he behind?'

RESULTS

The first set of analyses explored the relationship between children's performance at pre- and posttest and their demographics, prior computer use, and the duration of time playing the different games. The second set of analyses examined the different strategies that parents used during the interaction, and the relationship between the strategies and children's pretest and posttest device skill and content knowledge.

Preliminary Analysis

Child outcomes

The means and standard deviations of children's pre- and posttest device skill and content knowledge can be found in Figure 1. Paired-samples *t*-tests indicated that children significantly improved from pretest to posttest in device skill, $t(42) = 4.90$, $p < 0.001$, Cohen's $d = 0.54$, but not content knowledge. Univariate ANOVA analyses indicated no significant gender differences in pre- or posttest content knowledge or device skills. To test Strommen's (1993) Cognitive Model of Device Difficulty (i.e. when children struggle with the mechanics of the device

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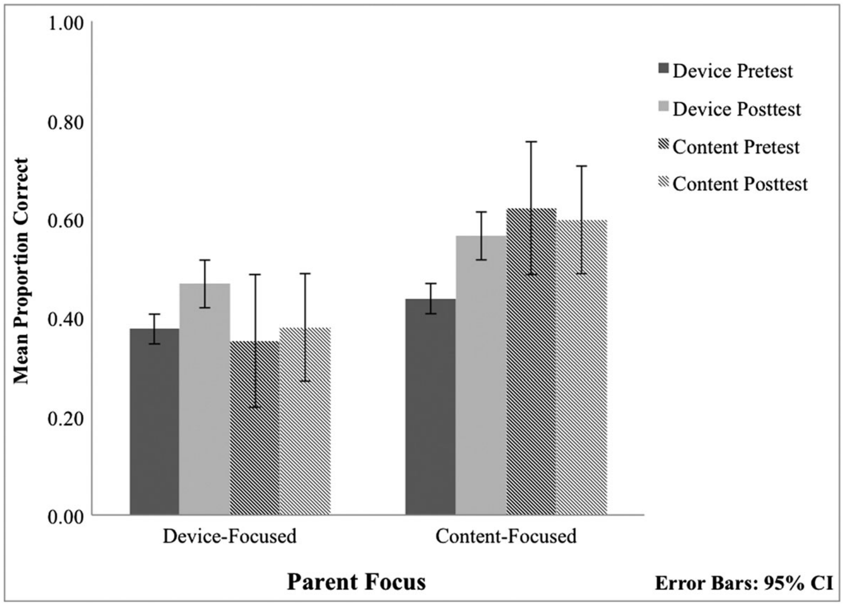

Figure 1. Child pretest and posttest outcomes by parent focus.

they are unable to learn the intended content), bivariate correlations tested the relationship between children's posttest content scores and their pre- and posttest device skills. In support of Strommen's model, posttest content scores were significantly positively correlated with both pretest device skill, $r = 0.55$, $p < 0.001$, and posttest device skill, $r = 0.53$, $p < 0.001$. However, a regression analysis predicting posttest content scores from pre- and posttest device skills, while controlling for children's pretest content knowledge, indicated that only children's pretest content knowledge remained a significant predictor of posttest content scores, $\beta = 0.88$, $R^2 = 0.86$, $p < 0.001$. These findings suggest that although children's content knowledge was related to their use of the device, children who had more proficiency with the device did not learn more content.

Child's age and prior computer use

Bivariate correlations examined the relationship between age and pre- and posttest assessment of device skill and content knowledge (see Tables 2 and 3). Age was significantly positively correlated with pretest and posttest device skill ($r = 0.37$ and 0.33, $p < 0.05$, respectively), but not with pretest or posttest content knowledge. Parents reported children had either rarely or infrequently used a computer before participating in this study ($M = 0.24$, $SD = 0.43$); previous experience using a computer was not related to children's age, pretest device skill, or duration of game play in the current study.

Duration of game time

The total time playing the games was examined as variations could impact the interactions parents had with their children. The total time playing the games varied from 9 min and 51 s to 34 min and 33 s ($M = 18$ min and 39 s, $SD = 4$ min and 55 s). The variability reflects differences in the amount of time during the interaction that dyads spent on- or off-task. The target keyboard game was played for an average of 5 min and 3 s ($SD = 4$ min and 9 s), and

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the target mouse game was played for an average of 6 min and 1 s ($SD = 2$ min and 50 s). Parents and children had a choice of playing any game they wanted after they played each target game twice. On average, dyads spent significantly more time playing keyboard games ($M = 12$ min and 20 s, $SD = 4$ min and 20 s) than mouse games ($M = 6$ min and 18 s, $SD = 2$ min and 50 s), $t(42) = 7.25$, $p < 0.001$, Cohen's $d = 1.65$

Bivariate correlations examined the relationship between duration of play and child outcomes (see Tables 2 and 3). There was a significant negative correlation between posttest device skill and duration of game play, $r = -0.36$, $p < 0.05$. The less time children spent playing the games, the better they did in posttest on device-related skills. Therefore, duration of game play was included in all analyses examining child outcomes.

Parent Support Strategies

On average, parents had 380.93 ($SD = 140.84$) discrete utterances or behaviours coded over the 30-min session. Parents most often used the directives strategy (approximately 19% of the time); they used the connections strategy approximately 4% of the time and the take over approximately 5% of the time. Parents used the device skill strategy approximately 2% of the time and the device modelling strategy approximately 5% of the time; parents asked content-related questions approximately 8% of the time.

Paired-samples *t*-tests of the discrete strategies indicated there was no significant difference in use of connections or directives based on whether the focus of the support was on content or device. However, parents were significantly more likely to take over using the device than to take over the content, $t(41) = 3.29$, $p < 0.01$, Cohen's $d = 0.79$ (see Table 1).

Relationships between parent support strategies and child outcomes

Bivariate correlations examined the relationship between parents' use of different strategies and children's age, duration of game play, prior computer use, and pretest

Table 1. Means (standard deviations) and range for all support strategies

Support strategy	Average	Minimum	Maximum
Connections	0.04 (0.02)	0.00	0.11
Device	0.02 (0.02)	0.00	0.07
Content	0.02 (0.01)	0.00	0.06
Directives	0.19 (0.10)	0.05	0.52
Device	0.10 (0.05)	0.02	0.24
Content	0.09 (0.07)	0.00	0.30
Take over	0.05 (0.05)	0.00	0.21
Device	0.04 (0.05)	0.00	0.21
Content	0.01 (0.02)	0.00	0.11
Device skill	0.02 (0.02)	0.00	0.10
Device modelling	0.05 (0.06)	0.00	0.23
Content questions	0.08 (0.06)	0.00	0.31
Total proportion device	0.23 (0.09)	0.07	0.47
Total proportion content	0.20 (0.07)	0.04	0.39

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and posttest scores (see Tables 2 and 3). With regard to device skill (see Table 2), there was a significant positive correlation between parents' use of device connections and children's age, $r = 0.31$, $p < 0.05$. Parents were more likely to use the making connections strategy if the child was older. Use of discrete device strategies and the proportion of overall device support were unrelated to children's pretest or posttest device skill level. With regard to content knowledge (see Table 3), there were two significant correlations that emerged. There was a significant negative correlation between age and parents overall use of content strategies, $r = -0.32$, $p < 0.05$, and their use of content directives, $r = -0.31$, $p < 0.05$. Parents were more likely to use content strategies with younger rather than older children.

Content- versus device-related support strategies

Finally, the proportions of all content-related talk and behaviour were summed to create an overall content-related support variable, and all device-related talk and behaviour were summed to create an overall device-related support variable. A paired-samples *t*-test indicated no significant difference in the proportion of overall content-related versus overall device-related support during the interaction.

Taken together, the findings related to parents' use of specific strategies present a muddled picture of the relationship between parents' attempts to support their children's use of and learning through an interactive computer game. Parents varied their strategies based on children's age, but the use of discrete strategies was unrelated to children's posttest skill or knowledge. It is possible that rather than discrete strategies being related to children's learning that it is the overall focus of parents' strategies that is most relevant for understanding children's learning. To examine relationships between the focus of parents' strategies and children's learning, a parent focus variable was created.

Parent focus on content or device

Parents' proportion of overall content talk and behaviour was subtracted from their proportion of overall device talk and behaviour, resulting in a variable reflecting whether parents were more focused on the content or the device during the interaction ($M = 0.01$, $SD = 0.13$). This variable ranged from parents who were much more focused on content than device support (-0.31) to parents who were much more focused on device than content support (0.29). All parents who had scores below 0 were coded as being content-focused ($n = 19$; M child age = 42.87 months, $SD = 3.09$; 47.8% female child), and all parents who had scores above 0 were coded as being device-focused ($n = 23$; M child age = 45.11 months, $SD = 4.27$; 47.4% female child). There were no significant gender differences by parent focus; however, there was a trend toward a significant difference in child age by parent focus, $t(40) = 1.97$, $p = 0.06$, Cohen's $d = 0.60$. Given the children of device-focused parents tended to be older than children of content-focused parents, the following analyses included age as a covariate.

A $2 \times 2 \times 2$ repeated measures ANCOVA was conducted to examine the relationship between parent support and child improvement with time of testing (pretest vs. posttest) and type of outcome (content vs. device) as the within-subjects variables, parent focus (content vs. device) as the between-subjects variable, and child age and duration of game play as covariates.

There was a main effect of age, $F(1, 38) = 3.94$, $p < 0.05$, partial $\eta^2 = 0.09$, such that older children had higher scores than younger children. In contrast, there were no main effects of duration of play, time of testing, or type of outcome. There was a trend toward a significant time by outcome type interaction, $F(1, 38) = 3.08$, $p = 0.09$, partial

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Table 2. Correlations between age, game play duration, prior computer use, parent support strategies, and pretest and posttest device skill

	Age	Duration	Prior computer use	Device directives	Device connections	Device modelling	Device skill	Device take over	All parent device support	Pretest device	Posttest device
Age	—										
Duration	−**0.47****	—									
Prior computer use	−0.10	0.01	—								
Device directives	0.16	−0.08	−0.24	—							
Device connections	**0.31***	0.03	0.03	−0.13	—						
Device modelling	−0.10	−0.21	0.10	−0.03	−0.06	—					
Device skill	0.01	0.04	0.05	−0.13	0.03	0.18	—				
Device take over	0.23	−0.20	−0.10	−**0.34***	**0.36***	0.06	**0.35***	—			
All device	0.20	−0.26	−0.10	**0.31***	0.27	**0.69****	**0.44****	**0.49****	—		
Pretest device	**0.37***	−0.22	−0.01	0.06	−0.25	−0.08	−0.12	−0.19	−0.18	—	
Posttest device	**0.33***	−**0.36***	−0.01	−0.06	−0.13	−0.24	−0.12	−0.02	−0.25	**0.74*****	—

Note: All times are minutes and seconds; significant correlations are noted in bold.
$^*p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$.

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Table 3. Correlations between age, game play duration, prior computer use, parent support strategies, and pretest and posttest content knowledge

	Age	Duration	Prior computer use	Content directives	Content connections	Content questions	Content take over	All parent content support	Pretest content	Posttest content
Age	—									
Duration	−**0.47****	—								
Prior computer use	−0.10	0.01	—							
Content directives	−**0.31***	0.15	0.11	—						
Content connections	−0.15	−0.07	0.08	−0.22	—					
Content questions	−0.09	0.14	0.04	−**0.36***	−0.04	—				
Content take over	0.13	−0.19	−0.14	0.06	−0.18	−0.11	—			
All content	−**0.36***	0.17	0.12	**0.67*****	−0.10	**0.37***	0.29	—		
Pretest content	0.06	0.08	0.05	0.09	0.00	0.14	0.05	0.21	—	
Posttest content	0.21	−0.07	−0.05	0.09	−0.07	0.08	0.11	0.18	**0.93*****	—

Note: All times are minutes and seconds; significant correlations are noted in bold.
$^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$.

$\eta^2 = 0.08$, reflecting the *t*-test findings (reported above) indicating pre-to-posttest improvement in device skills but not content knowledge. There was a significant interaction between time of testing and duration of game play, $F(1, 38) = 4.32$, $p < 0.05$, partial $\eta^2 = 0.10$. To examine this finding, a difference score for overall (i.e. combined device and content) pre- and posttest scores was created, $M = 0.11$, $SD = 0.21$ Follow-up correlation analyses revealed that children who played the games longer during the interaction had a significantly smaller degree of change from pre- to posttest, $r = -0.41$, $p < 0.01$.

Finally, there was a main effect of parent teaching focus, $F(1, 38) = 9.44$, $p < 0.01$, partial $\eta^2 = 0.20$, and a trend toward a significant interaction between parent teaching focus and outcome type, $F(1, 38) = 3.48$, $p = 0.07$, partial $\eta^2 = 0.08$. As is illustrated in Figure 1, children of content-focused parents ($M = 0.59$, $SE = 0.05$) had significantly higher scores than children of device-focused parents ($M = 0.38$, $SE = 0.05$). Follow-up independent samples *t*-tests were conducted comparing children's overall device skill and content skill scores by parent focus group. There was no significant difference in children's device skills based on parent focus. In contrast, children of content-focused parents had significantly higher content knowledge scores than children of device-focused parents, $t(40) = 2.48$, $p < 0.05$, Cohen's $d = 0.74$.

DISCUSSION

The goal of the current study was to explore the ways that parents and children engage during an interactive media task in order to elucidate how preschool children use computers and how parents support learning in this interactive media context. To examine parents' structuring of this educational interaction, parents and their preschool children played two target games on a novel interactive device during a 30-min session. The intended educational goals of the games were to teach children letter and number recognition. The mechanics needed to succeed at the games included keyboard letter identification and mousing manipulation.

The preschool-aged participants were more likely to improve in their use of the novel device itself rather than demonstrate improvements in knowledge of the intended educational content of the games. These findings are similar to findings in previous research showing that children can improve computer mechanics with practice, even in a very short session (Strommen et al., 1996). The first hypothesis was that children with better device skills would learn more content in the interaction. Although children with higher content knowledge had better device skills, children who had more proficiency with the device did not learn more content. Additionally, if children had poor device skills they took longer to play the game; but the increased duration of game play did not result in increased device skills, and proficiency with the device did not lead to gains in content knowledge.

Children who played the games longer during the interaction had less overall increase in scores from pretest to posttest. Additionally, children who spent less time playing the games had better device mechanics than children who played the games for longer. This pattern of findings suggests that the interaction for some of the children may have been too brief to target their zone of proximal development, which is the phase in children's learning of a new skill in which they can learn with assistance but cannot accomplish the task on their own (Vygotsky, 1978). For the children in the current study for whom longer play had no demonstrable benefits for content learning, the novel device (and/or the accompanying

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parent) may not have provided the necessary scaffolding to support children's learning of new letters and numbers.

Children's working memory may have been the mechanism of difficulty in this case; in other words, children's working memory may have been taxed as they tried to learn the device (Strommen, 1993). Recall Strommen's (1993) suggestion that the working memory demands required to learn how to use a novel device may interfere with children's ability to focus on the intended educational content. The current findings can be interpreted as reflecting that some children had poor device skill; therefore, they struggled to accomplish the educational goals of the game. Whether or not Strommen's Cognitive Model of Device Difficulty explains the lack of relationship between content knowledge and device skill (once pretest content knowledge is accounted for) is less clear. On one hand, it is possible that children with low device skills may have developed proficiency using the device with longer game play, potentially promoting improvements in content knowledge. On the other hand, these findings indicate the confounded nature of the relationship between device skills and content knowledge, particularly when considering the keyboard. In order for children to appropriately use a keyboard, they need to be able to recognize the letters and numbers on the keyboard. This confounded relationship between educational content and device mechanics may be reduced in newer, touchscreen technologies (e.g. iPads). In using touchscreen technologies, children can directly press a letter or number on the screen, removing the keyboard and mouse 'middle men'. Using touchscreens may require fewer working memory demands for young children, and therefore may be more likely to result in content learning. Thus, future tests of Strommen's hypothesis should consider the changing mechanics of the devices used to provide children with educational experiences and games.

Based on previous research documenting parents' tendency to focus their support for children's computer use on device-level instruction rather than the educational content of the games (Gauvain, 1992; Lauricella et al., 2009; Plowman & Stephen, 2007), the second hypothesis was that parents would focus more on device mechanics-related support than content-related support. In contrast to this hypothesis, there was no overall difference in parents' use of strategies to support device skills or content leaning. Although children improved their device skills, there were no mean differences in the amount of device versus content support parents provided.

Parents' instructional strategies are a second potential mechanism contributing to differences in children's learning through the novel device. Although the relationship between device skill and content learning was not strongly established in the current study, children did demonstrate learning even from this short interaction with a novel device. Additionally, parents used a variety of strategies to support children's learning. The third hypothesis was that parents who focused on supporting the computer mechanics would have children who demonstrated the greatest improvement in device skills, whereas parents who focused on supporting the educational content in the games would have children who demonstrated the greatest improvement in content knowledge. This hypothesis was partially supported.

The overall pattern of findings suggested better performance overall (in both content and device knowledge) for children of content-focused parents. Parents who focused on letters and numbers during the interaction had children who performed better on both content knowledge and device skills at pre- and posttest when compared to the children of device-focused parents. The difference in children of device-focused and content-focused parents was particularly related to

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differences in content knowledge, as opposed to device skills; children of content-focused parents had higher content knowledge than children of device-focused parents. Additionally, parents who focused on educational content during the game play interaction also had children with more knowledge of letters and numbers at pretest. Two possibilities exist here. First, content-focused parents who provided more support for content than device learning during the in-lab interaction may also be more likely than device-focused parents to emphasize the learning of letters and numbers at home as well. From this perspective, these findings support other research suggesting that parents' active involvement in helping their children learn their letters and numbers has demonstrable benefits to children's school readiness. These findings also suggest that parents can use multiple technological platforms to support preschoolers' learning of the types of knowledge that will support school readiness.

Second, these findings highlight the dynamic nature of learning in a triad that includes the child, the parent, and the device. In the current study, both children's prior knowledge and parents' support of children's learning were related to growth in children's knowledge even in a 30-min interaction. If children had prior knowledge of letters and numbers and their parents provided support for content learning, then children learned more letters and numbers during the interaction. This pattern is further illuminated by considering the effects related to age. Children of device-focused parents tended to be older than children of content-focused parents, and older children were better at device skills than younger children. Thus, the fact that children of content-focused parents had more content knowledge is not solely related to age. In addition, the younger the child was, the more parents focused on providing content support. In practice, parents should know that their efforts to teach their children educational content while using an interactive device (even if the parents are not that comfortable with the device itself) may lead to learning of educational content; and future research should further delineate the factors that lead to the learning of educational content from these kinds of interactive devices.

Theoretically, this pattern of findings presents a complicated picture of the types of supports that parents provide to children at different ages. One factor to consider is the fact that parents who focused on the device mechanics did not have children who did better on device skills overall, or improved on device skills over the interaction, than children of content-focused parents. The children of device-focused parents were older than the children of content-focused parents, and older children generally had higher device skills. Based on these findings, it would be expected that children of device-focused parents would have greater device skills. One possible reason that device strategies did not lead to improvements in children's use of the device is that too much parent focus on the device may have been frustrating for the child, particularly if the child was not improving during the interaction on their own through practice. Directions and prompts were given throughout the game by the game itself, and children received immediate feedback when they made an error. Parents who focused on the device may have been perceived by children as 'piling on' criticisms about children's failure to correctly use the device. In this case, the interaction could have taken on a tone of negativity or frustration, pointing to the need in future research to consider whether devices that are too difficult for children to master provide an emotional barrier to motivation and engagement, in addition to the working memory demands involved in learning how to operate the device.

Additionally, parents may have been using inefficient support techniques with the device. Past research has suggested that parents need to be sensitive to their

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children's current ability level and adjust their support to this level in order for children to benefit from the teaching (Gauvain & Perez, 2008). When children were older, parents provided more connections between the device and the screen. This strategy, while appropriate for older children, may not have provided enough support for how to use the device. Although the sample size was too small to warrant extensive statistical examination of the specific strategies that different parents used, a cursory examination of the parents in this study indicates that overall parents were more likely to take over using the device than take over the content. These support strategies may not have allowed the child to get enough practice with the device; and the parent taking over the task may have made the child feel less in control and less engaged.

These findings suggest by implication the importance of considering the role of control in children's learning from interactive media. One study of preschool children found that children engaged with interactive tasks more when they were in charge of operating the computer (Calvert, Strong, & Gallagher, 2005). Preschool children who controlled a computer were the most engaged across multiple sessions with parents, whereas children whose parent controlled the computer and those in a joint-controlled condition were significantly less engaged in the second session. However, despite individual differences in control and engagement, there were no significant differences in story memory based on who controlled the mouse or the pace of the story (Calvert et al., 2005). Thus, future research should consider whether the parent (i.e. by taking over) or child is driving the interaction, and whether who has control is related to learning from interactive devices.

Based on the Calvert et al. (2005) findings, regardless of who is in control of the device, children's content learning may not be tied to learning how to use the device specifically or to who within the interaction is controlling the computer. Additionally, the pattern of findings in the current study does not mean that parent support while using the device was not beneficial. Thus, future research should continue to examine the specific strategies that parents use when they are focused on supporting children's learning of the educational content in a game or learning how to play the game itself.

Although these findings highlight important aspects of how parents and children learn about and use computers, the study should be considered within several limitations. The first limitation was the small sample size, which limited power, generalizability, and the number of predictors that could be included in the models. The second limitation was the correlational nature of the study and the lack of comparison conditions. A comparison child-only condition in which the child played the games alone would allow for understanding if parent support was necessary for children to learn the device, the content, or both. Future studies should compare children playing alone or with a parent in order to further understand the factors leading to improvement in both device use and knowledge of educational content. In addition, other experimental conditions could vary whether parents receive a content- versus device-related script to support the interaction. The dynamic interaction between the dyad should also be explored, including how parents respond to children asking for help and how children respond to a specific direction from parents.

In conclusion, this research presents some of the first data on how parents and preschoolers interact using a novel interactive device. Findings suggest that preschool children can improve their computer mechanics in a short amount of time. However, parents may not know how to appropriately support preschoolers' learning how to use an interactive device. Interactive games are increasingly present in the lives of preschool children. Many interactive games targeted at preschool

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children market themselves as promoting learning or cognitive skills, especially vocabulary; however, if the device is difficult to use, the child may not be able to learn the content (Strommen, 1993). Parent support of these games in an age-appropriate way could benefit preschool children's use of these tools specifically but can also contribute to children's learning of early educational material that can prepare them to enter school and provide the foundation for future academic success.

Note

1. The denominator of the mouse device skill variable was based on the highest possible number of clicks for a child participant in posttest. This decision was made because there was no discrete cut-off for number of times children could click the mouse. Additionally, a pilot study with undergraduates revealed a highest level of 85.4, which when used as a denominator resulted in a floor effect for percentage. Thus, it was determined that taking the highest amount of any child at posttest (after experience with the device) accurately reflected the highest level of expected performance for a child of this age on this task.

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