The Ecology of Internet Use during Middle Childhood: Physical, Social, Emotional and Cognitive Development

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Abstract: The ecological techno-microsystem provides a comprehensive theoretical framework for organizing the effects of internet use on child development. Ninety children in grades 3 through 6 rated their uses of the internet. Parents and teachers rated each child's level development. Using stepwise regression analysis, the eight measures of child development (i.e., social, emotional, physical and cognitive development rated by parents and teachers) were treated as dependent variables and child rating of internet use (i.e., five items for each of home, school and community use) were treated as independent variables. Various patterns of internet use related to various patterns of child development across all domains, although the most enduring relationships were between internet use and cognitive and social development. Results provide preliminary support for the ecological techno-microsystem.

The internet provides children with opportunities to communicate, access information, and engage in interactive play. Theoretically, such uses of the internet stimulate cognitive and social development (Johnson, 2006; Young, 2007). DeBell and Chapman (2006) concluded that internet use promotes cognitive development in children, "specifically in the area of visual intelligence, where certain computer activities -- particularly games -- may enhance the ability to monitor several visual stimuli at once, to read diagrams, recognize icons, and visualize spatial relationships" (p. 3). Fiorini (2010) reported positive and enduring cognitive benefits of computer use during childhood with some evidence of associations with proactive social behaviour. Meta-analysis confirmed a positive relationship between internet use during childhood and school achievement (Cavanaugh, Gillan, Kromrey, Hess, & Blomeyer, 2004). Johnson (2009) found that internet use for learning and communicating (but not for playing and browsing) were associated with advanced child development in expressive language and metacognitive planning.

Internet use during childhood occurs at home, school, and, to a lesser extent, in the community (Palfrey & Gasser, 2008) and the developmental effects of use vary as a function of context (Hofferth, 2010). In comparing home-based and school-based computer activity, Murphy and Beggs (2003) observed that, at home, children choose their own activities, have ample time for exploration, and learn incidentally. In contrast, at school, teachers control activities, computer time is limited, and learning is teacher-directed. Based on detailed interviews and repeated observation, Burnett and Wilkinson (2005) concluded that creative problem solving was evident in home-based, but not necessarily school-based, use of the internet during childhood.

Presented in Figure 1, Johnson (2010) recently proposed the ecological techno-microsystem which conceptualizes child social, emotional, cognitive and physical development as the consequence of ongoing reciprocal interactions between child characteristics and use of communication, information and recreation digital technology across home, school and community environments. Such a conceptual framework is useful in considering the complexity of internet use during childhood and the extent to which different uses of digital technology may have differing effects on learning and development (Hofferth, 2010).

Research Issues and Questions: Exploration of the Ecological Techno-Microsystem

Ecological theoretical assumptions are difficult to validate because of the comprehensive nature of the proposed variables of interest. The utility of the ecological techno-microsystem in explaining child development has not been systematically investigated. What patterns of internet use (i.e., for purposes of communication, information and playing games) in various contexts of use predict child physical, social, emotional and cognitive development? How much variation in children's development is accounted for by variation in their use of the internet?
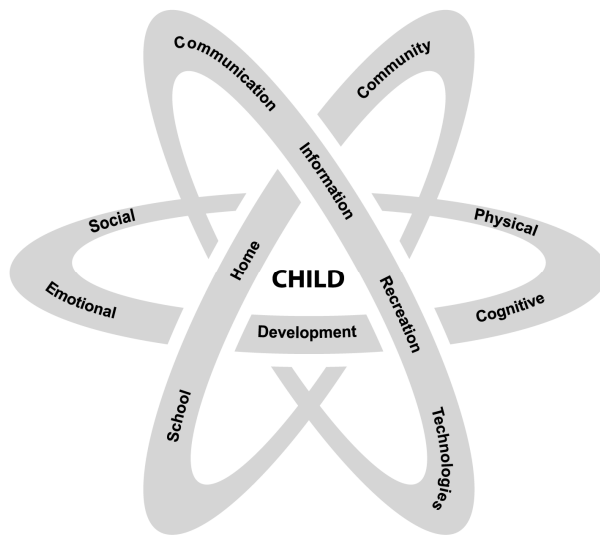
Figure 1: A Theoretical Framework for Organizing the Effect of Internet Use on Child Development

Methods

Children in third through sixth grade (n = 111) attending an elementary school in western Canada were invited, via parental consent, to participate in the study. Ninety-six signed consent forms were returned to the school and included parent-reported family demographic information. Due to child absenteeism from school during data collection, 90 children were included in the sample. Of these children, 20 were in third grade, 22 were in fourth grade, 17 were in fifth grade and 31were in sixth grade. Thirty-one children indicated that they were female, 44 indicated that they were male and gender date was missing for 15 children. As reported by parents, children ranged in age from 100 to 155 months (mean = 127.6, SD = 15.6). Almost 90% of parents reported traditional family structure, 2.5% reported single-parent families and 10% reported that there family was blended.

Toward the end of the school year and having received parental permission, children reported their level of internet use in general (i.e., I use the internet __) and in terms of specific activities (i.e., email, instant message, play games and visit websites) across home, school and community (i.e., at someone else's house) on a 4-point rating scale (i.e., never or hardly ever, once or twice a month, once or twice a week, every day or almost every day). Teachers and parents rated children's level of social, emotional, physical and cognitive ability as summarized in Table 1.

Using stepwise regression analysis, the eight measures of child development (i.e., social, emotional, physical and cognitive development rated by both parents and teachers) were treated as dependent variables and child rating of the internet use items (i.e., five for each of home, school and community) were treated as independent variables.

Domain	Rating Scale item	Rating Options	Mean	SD
Parent Rating of Child Developmental Outcomes				
Social	My child has _____ friends.	1 = no; 4 = many	3.62	.59
Emotional	My child is able to control his/her emotions.	1 = never; 4 = always	3.00	.64
Physical	My child enjoys physical activity (sports or dance).	1 = never; 4 = always	3.27	.76
Cognitive	My child is learning ____ children in his/her grade.	1 = slower than; 4 = faster than	3.30	.84
Teacher Rating of Child Developmental Outcomes				
Social	Classroom popularity	1 = very low; 4 = very high	3.28	1.0
Emotional	Ability to control emotions	1= very low; 4 = very high	3.36	.83
Physical	Physical ability (e.g., gym)	1 = very low; 4 = very high	3.33	.94
Cognitive	General Ability (e.g., memory, problem solving)	1 = very low; 4 = very high	3.32	.73

Table 1. Parent and Teacher Ratings of Child Development

Results

Table 2 provides a summary of children's ratings of the 15 internet use items, five uses across school, home and community environments. Using the internet at school at least a few times each week was reported by over 83% of the children; only 9% reported never or hardly ever using the internet at school. Using the internet at home was less common than using the internet at school with approximately 20% of children reporting never or hardly ever using the internet at home. With respect to using the internet at school and at home, visiting websites and playing games were most commonly reported by children. Online communication (i.e., email and instant messaging) were more likely to occur at home than at school. Among the sample of participating children, community use of the internet was uncommon; 13.4% of children reported using the internet at someone else's house at least a few times each week.

Child Internet Use Rating Scale Item	Response-Option			
	Never	Monthly	Weekly	Daily
School Internet Use				
I use the internet at school.	9.0%	7.9%	68.5%	14.6%
I use email at school.	67.8%	6.7%	21.3%	3.4%
I instant message at school.	86.4%	6.8%	5.7%	1.1%
I use the internet to play games at school.	20.2%	27.0%	48.3%	4.5%
I visit websites at school.	18.2%	21.6%	51.1%	9.1%
Home Internet Use				
I use the internet at home.	20.2%	22.5%	24.7%	32.6%
I use email at home.	57.3%	12.4%	15.7%	14.6%
I instant message at home.	71.6%	9.1%	11.4%	8.0%
I use the internet to play games at home.	25.8%	21.3%	31.5%	21.3%
I visit websites at home.	29.5%	22.7%	28.4%	19.3%
Community Internet Use				
I use the internet at someone else's house.	57.3%	29.2%	11.2%	2.2%
I use email when I am at someone else's house.	80.7	14.8%	4.5%	0.0%
I instant message when I am at someone else's house.	86.2%	10.3%	3.4%	0.0%
I use the internet to play games at someone else's house.	60.2%	28.4%	8.0%	3.4%
I visit websites when I am at someone else's house.	62.5%	28.4%	9.1%	0.0%

Table 2. Percentage of Children Selecting each Response-Option for Internet Use Rating Scale Items

Table 3 presents significant results of the eight regression analyses conducted with child development as the outcome or independent variable and internet use as the predictor or dependent variables. Some of the variation in six of the eight measures of child development was explained by differences in child ratings of different uses of the internet at home, school and in the community (i.e., at someone else's house). Specifically, differences in child rating of the internet use item *I visit websites when I am at someone else's house* accounted for approximately 10% of the variation in parental rating of child social development. Children who were emotionally mature, according to parents, were slightly more likely to report using the internet at school then children who were less emotionally mature. Cognitive development, as rated by both parents and teachers, was positively associated with internet use at school but not to play games and instant message which were inversely related to child cognitive development.

Discussion

For the sample of participating 8 to 12 year old children, using the internet at home and school was normative (Table 2). Visiting websites and playing online games at school occurred at least a few times each week, according to children. Home internet use was less common that school use with 20% of children reporting never or hardly ever using the internet at home, although the pattern of visiting websites and playing online games was similar at home and school. Community use of the internet was not normative for the sample of children; 57.3% reported never or hardly ever using the internet at someone else's house. Among children who did use the internet at someone else's

house, visiting websites and playing online games was most commonly reported. During middle childhood, visiting websites and playing online games are the most commonly reported internet activities across all microsystemic environments. In most cases, playing games and accessing information might be considered extremely safe and cognitive stimulating online activities (Valcke, Schellens, Van Keer, & Gerarts, 2007). Such uses of the internet, particularly as part of a wide range of safe and stimulating childhood experiences, explain the frequently reported positive relationships between internet use during childhood and enhanced developmental and learning outcomes (Cavanaugh et al., 2004; DeBell & Chapman, 2006; Fiorini, 2010; Hofferth, 2010; Johnson, 2009).

Domain	Predictor Variable/s	Beta	t value	r2(adj)	F value
Parent Rating of Child Developmental Outcomes					
Social	I visit websites at someone else's house.	.333	2.91**	.10	(1, 68) 8.47
Emotional	I use the internet at school.	.257	2.19*	.05	(1, 68) 4.80
Physical	I use the internet to play games at school.	-.270	-2.72**	.06	(1, 69) 5.57
	I use email at school.	.217	2.36*	.12	(2, 68) 5.75
Cognitive	I instant message at school.	-.498	-3.56**	.10	(1, 68) 9.01
	I use the internet at school.	.458	3.31**	.16	(2, 67) 7.51
	I use the internet to play games at school.	-.292	-2.50*	.22	(3, 66) 7.48
Teacher Rating of Child Developmental Outcomes					
Social	I use the internet at home.	.217	2.04*	.04	(1, 84) 4.15
Cognitive	I instant message at school.	-.382	-4.01**	.12	(1, 84) 12.88
	I use the internet at school.	.229	2.33*	.20	(2, 83) 11.27
	I visit websites at home.	.225	2.29*	.23	(3, 82) 9.65

*$p < .05$, **$p < .01$

Table 3. Stepwise Regression Analysis: Internet Use Predicting Child Development

Although common, regularly using the internet for purposes of communication was not normative for the sample of participating 8 to 12 year old children. Approximately 30% of children reported using email at home at least a few times each week, approximately 25% reported using email at school at least a few times each week and less than 5% reported using email at someone else's house at least a few times each week. Real-time communication such as instant messaging, perhaps due to the requirement to enter text quickly, was uncommon among the sample of children. With respect to instant messaging, approximately 20% of children reported home-use at least a few times each week, approximately 7% reported school-use at least a few times each week and 3.4% reported instant messaging at someone else's house at least a few times each week. Ecological patterns of internet use during childhood are distinct from those during adolescence and adulthood; children play and read while more mature individuals communicate (Livingstone & Helpsper, 2007; Nie, Simpser, Stepanikova, & Zheng, 2005). From an ecological perspective, child characteristics (e.g., cognitive processing and psychomotor speed) and environmental opportunities and constraints (e.g., school is curriculum and skills focused) interactively influence child developmental outcomes. Johnson (2011) recently reported that "although girls used email more than boys, of the current sample of digital natives, boys who used email were brighter and more popular than boys who did not use email" (p. 64).

Ecological patterns of internet use across home, school and community explained a significant amount of variation in parent and teacher reported level of child development. It is particularly important to note that not all child-reported uses of the internet were positively associated with developmental outcomes. For example, children who reported playing online games at school tended to be rated lower by their parents on physical development than children who were less likely to report playing online games at school. Correspondingly, instant messaging at school was associated with lower levels of cognitive development as rated by both teachers and parents. Although only one child reported instant messaging at school every day or almost every day, five children reported instant messaging at school once or twice a week and six reported instant messaging at school once or twice a month, such children tended to score lower on both measures of cognitive development than did the majority of children who reported never or hardly every instant messaging at school. It may be that instant messaging, particularly at school, attracts

children who are less cognitively competent. Indeed, it seems unlikely that instant messaging at school by elementary school children would be endorsed by their teachers. Elementary school children who use the internet to chat may be less competent than their peers whose use of the internet may be described as more conventional. In comparing visual and verbal reasoning ability and various uses of the internet, Johnson (2008) noted that "students who reported avoiding dangerous uses of the internet (i.e. visiting chat rooms) were cognitively superior to those who frequently engaged in such online behaviour" (p. 391).

In contrast to playing online games and instant messaging at school, general use of the internet was associated with positive developmental outcome for children. For example, differences in the extent to which children reported visiting websites at someone else's house explained 10% of the variation in parental rating of social development. Children who tended to visit websites outside of home and school contexts had more friends than children who did not report such a pattern of internet use. In general, children who used the internet at school had better emotional control, as rated by their parents, than children less likely to use the internet at school. A significant amount of variance, particularly in child cognitive development, was explained by various patterns of internet use. Approximately one-quarter of the differences in parent rating of the item *My child is learning __ children in his/her grade* and teacher rating of the item *Classroom Popularity* were explained by child rating of use of the internet at school and home but not for instant messaging and playing online games. Results of the current investigation suggest that social, emotion and physical development are related to internet use during middle childhood but cognitive development appears to be the most effected. Such a conclusion is consistent with the notion that the internet is an extension of cognitive processes including data storage, retrieval and processing (Johnson, 2008).

Conclusion: Preliminary Validation of the Ecological Techno-Microsystem

Results of the current investigation validate, in a preliminary sense, the potential utility of the ecological techno-microsystem. Children varied in their use of the internet across home, school and community environments. Although patterns of use were apparent and generalizations reasonable, use of the internet appeared idiosyncratic and children differed from each other in their patterns of online behaviour (Johnson, 2011; Rideout, Foehr, & Roberts, 2010). Various patterns of internet use related to various patterns of development across all domains, although the most enduring relationships were between ecological patterns of internet use and cognitive and social development as rated by both parents and teachers. Children who used the internet at home and in the community (all children used the internet at school) were rated by their parents and teachers as having more friends than children who did not report using the internet at home and in the community. Physical development may be compromised by playing online games at school. Cognitive development was associated with some, but not all, patterns of internet use during middle childhood. The techno-microsystem provides a theoretical framework by which to structure the developmental consequences of various ecological patterns of internet use during middle childhood.

Limitations and Future Research

Current findings increase understanding of the relationship between child development and use of the internet. As is the case with all research, measuring variables and sampling a population must be considered in interpreting findings. In the current investigation, children reported their use of the internet and parents and teachers responded to items intended to determine child level of social, emotional, physical and cognitive development. Although querying children directly about their use of the internet is common (DeBell & Chapman, 2006; Roberts & Foehr, 2008), the validity of such approaches has been questioned and alternatives suggested including standardized measures such as the *Internet Vocabulary Test for Children* (Johnson, 2007). Further, due to ease of administration, child developmental outcomes were determined by teacher and parent ratings. Standardized measures of child development are difficult to administer although, perhaps, more valid. Alternate measures of children's use of the internet and developmental capability may not replicate current findings.

The current sample was small (n = 90) and limited to one school and four teachers. It is unlikely that such a sample produced findings that can be generalized to all children in all industrialized nations. From a research design perspective, a major concern of small sample size is failure to find statistical significance (Kim & Livingston, 2010). In this regard, the number of significant results to emerge from analysis of the current data suggests the relationships

reported, for the current sample, are robust and real. Nonetheless, digital media devices change rapidly and access issues such as internet connectivity vary across regions and over time (Hofferth, 2010). Study replication is required with large and diverse samples of children. With respect to children and the internet, research must be ongoing due to our increasingly digitalized society and the increasing ubiquity of digital devices with internet access (Kim, Miranda, & Olaciregui, 2008).

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