Media and Attention, Cognition, and School Achievement

Marie Evans Schmidt and Elizabeth A. Vandewater

Summary

Marie Evans Schmidt and Elizabeth Vandewater review research on links between various types of electronic media and the cognitive skills of school-aged children and adolescents. One central finding of studies to date, they say, is that the content delivered by electronic media is far more influential than the media themselves.

Most studies, they point out, find a small negative link between the total hours a child spends viewing TV and that child's academic achievement. But when researchers take into account characteristics of the child, such as IQ or socioeconomic status, this link typically disappears. Content appears to be crucial. Viewing educational TV is linked positively with academic achievement; viewing entertainment TV is linked negatively with achievement.

When it comes to particular cognitive skills, say the authors, researchers have found that electronic media, particularly video games, can enhance visual spatial skills, such as visual tracking, mental rotation, and target localization. Gaming may also improve problem-solving skills.

Researchers have yet to understand fully the issue of transfer of learning from electronic media. Studies suggest that, under some circumstances, young people are able to transfer what they learn from electronic media to other applications, but analysts are uncertain how such transfer occurs.

In response to growing public concern about possible links between electronic media use and attention problems in children and adolescents, say the authors, researchers have found evidence for small positive links between heavy electronic media use and mild attention problems among young people but have found only inconsistent evidence so far for a link between attention deficit hyperactivity disorder and media use.

The authors point out that although video games, interactive websites, and multimedia software programs appear to offer a variety of possible benefits for learning, there is as yet little empirical evidence to suggest that such media are more effective than other forms of instruction.

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Like their elders, America's youth have an almost dizzying assortment of entertainment technology from which to choose.[1] Children and adolescents, however, are a special media audience, in part because they are developmentally vulnerable and in part because they are among the earliest adopters and heaviest users of entertainment technology.[2] Adolescents in particular have widely adopted the use of digital media for daily life activities. Indeed, the stereotypical view of many Americans is that teenagers spend their lives immersed in electronic media. While adolescents are doing homework on the computer, with a word-processing program open for text, they are surfing the Internet. Simultaneously they are instant messaging with friends about events at school, about who likes whom, who "dissed" whom, or what a pain the homework assignment is. Meanwhile, television is on in the background, and they are listening to music on their iPods. At least some evidence confirms this picture, as Donald Roberts and Ulla Foehr describe in their article in this volume.

Though concerns about the influence of media and technology on American youth are many and varied, especially prominent are fears that they impair cognitive development and academic achievement. Critics of television have long blamed the medium for various ills, including declines in standardized test scores, mental inactivity, and reduced attention and concentration.[3] Video games, computers, and the Internet have drawn similar charges.[4]

In this article, we examine empirical evidence regarding the links between television and other electronic media, on the one hand, and learning and cognitive development in children and adolescents, on the other. We review research findings, in turn, on achievement, language and symbol systems, visual and spatial skills, problem-solving skills, attention, and, finally, hypertext. Some areas have generated a fair amount of theory and research; others, very little. Interestingly, evidence that contradicts or supports existing assumptions has often had little effect on proclamations, policy, and punditry on this topic. Everyone, it seems, has an opinion about how electronic media influence children's learning. Our goal is to summarize what is known—and what is not—about how these media shape adolescents' cognitive development, as well as to identify those areas in urgent need of additional empirical research.

Electronic Media and Achievement

Researchers investigating the influence of media have found modest negative links, or none at all, between the total time children spend viewing television and their school achievement. A review of twenty-three studies, varying across several measures, found an overall weak negative association (median = -.06) between television viewing and achievement.[5] Moderate TV viewing—one to ten hours a week—was positively associated with achievement (compared with no television at all), whereas heavier viewing—more than eleven hours a week—was negatively linked with achievement (-.09).[6] Numerous correlational studies, with large samples, have found similar small negative effects of total time spent watching TV on achievement.[7]

Many studies have found what social scientists call curvilinear relations between hours of TV viewed and achievement. In other words, up to a certain threshold number of hours viewed, TV viewing is linked positively with achievement; above that threshold the link becomes negative. A meta-analysis of more than 1 million students by Micha Razel suggests that the optimal number of hours of TV viewed daily decreases as children get older; for a nine-year-old two hours a day is optimal, whereas for a seventeen-year-old it is half an hour.[8]

Research that takes into account relevant characteristics of the children under study, such as their IQ and socioeconomic status, typically finds no significant link between hours of TV viewing and achievement.[9] IQ, in particular, plays a large role in the association between TV watching and achievement; students with lower IQ scores, for example, watch more television, on average.[10]

The amount of time spent viewing television also appears to influence achievement for children from different socioeconomic backgrounds in different ways. Watching a lot of television is negatively linked with achievement for advantaged children.[11] But TV viewing is positively associated (or not associated at all) with achievement for disadvantaged children or those with limited proficiency in English.[12] George Comstock and Haejung Paik interpret these findings as meaning that television viewing and academic achievement are negatively associated when TV displaces cognitively enriching experiences, but positively associated when it *provides* such experiences.[13]

When researchers examine the relative importance of media content and total time spent with media, they find that content matters more. For example, empirical evidence strongly supports the notion that high-quality educational programming has positive benefits for children's academic skills, academic engagement, and attitudes toward learning.[14] The evidence is particularly strong for preschoolers, as described in the article in this volume by Heather Kirkorian, Ellen Wartella, and Daniel Anderson.

It does not seem that time spent with media greatly displaces time spent reading or doing homework, largely because American youth spend so little time doing either.[15] When TV first became available, TV viewing replaced "functionally similar" activities, such as listening to the radio, reading comic books, and going to a movie.[16]

Studies have not consistently found that time spent watching television, in general, reduces adolescents' time spent in school-related activities. Most cross-sectional correlational studies, for instance, have not found a significant link between television viewing and less reading.[17] A few studies of the influence of TV on young children, however, suggest that TV viewing may hinder the acquisition of reading skills over time.[18] In a recent longitudinal study in Germany, Marco Ennemoser and Wolfgang Schneider found negative associations between total TV viewed by children at age six and reading achievement at age nine, even when controlling for IQ, socioeconomic status, and prior reading ability.[19] Importantly, the negative association was between achievement and entertainment viewing; educational TV viewing was generally linked positively with reading achievement. This finding is consistent with other research that suggests that TV's effects on reading are largely dependent on the content viewed.[20] For instance, Anderson and his colleagues found that educational TV viewing at age five positively predicted book reading in adolescence in a prospective longitudinal cohort.[21]

Electronic Media and Language and Symbol Systems

Some researchers have evaluated whether learning from television, which engages both the auditory and the visual systems, is more or less efficient than learning through either symbol system alone. Several studies have compared viewer comprehension of a combined audiovisual presentation with comprehension of either an audio or visual version alone. Most reveal an advantage for the audiovisual presentation; subjects recall more of what they hear and see together than what they see or hear only.[22]

One study found benefits of video gaming for visual attention, including greater attentional capacity, quicker attention deployment, and faster processing.

Electronic Media, Attention, and Visual Spatial Skills

According to Gavriel Salomon, different media forms recruit, and develop, different cognitive processes. His seminal book, *Interaction of Media, Cognition, and Learning,* provides evidence for this premise. He demonstrates that repeated exposure to cinematic codes presented on film, such as the zoom technique, leads children to internalize these codes. In one experiment, eighth graders who watched a film that used repeated zooms achieved higher scores on a search task that required them to find details in a complex display. In fact, for eighth graders who earned low scores on a pre-test of the search task, viewing the film improved scores more than practicing the search task itself. Similarly, students who watched a film depicting the unfolding of a three-dimensional object significantly improved their scores on a test requiring identification of unfolded objects.[23]

Salomon's research also provides evidence that educational programs can enhance particular cognitive abilities. When *Sesame Street* was first introduced to Israel, school-aged children who watched the program improved on tests of attention and inference making. In a later experiment, second graders who watched the program for eight days in school performed better on measures of select cognitive skills than a control group who watched adventure or nature films.[24]

Daniel Anderson and Patricia Collins note, however, in a review of the effects of TV on cognitive development, that the benefits revealed by Salomon's studies are short-term, small, and specific to educational programs or instructional films.[25] Further, because Salomon's work suggests that internalization requires repeat, heavy exposure to particular media content, it is unclear to what extent cognitive skills would be enhanced in typical TV viewing environments.

Few studies have examined the links between television and spatial skills, and those that have are inconclusive.[26] Analysts have conducted far more research on video games. These studies suggest that video games may positively affect a variety of visual spatial skills. Adult video game players, for example, have better hand-eye coordination than non-players.[27] In one experimental study, spending fifteen minutes playing an Atari video game improved adults' performance (fifty milliseconds relative to controls) on a simple reaction time test.[28] Children's previous video game experience has also been associated with shorter reaction times on color and shape discrimination and stimulus anticipation tasks.[29]

Several studies suggest that video game play may enhance spatial reasoning skills in youth.[30] In one experiment, Patricia McClurg and Christine Chaille found that playing select computer games for five minutes, twice a week, for six weeks improved fifth, seventh, and ninth graders' performance on a paper and pencil mental-rotation task in which students view a three-dimensional target shape in one orientation and must indicate whether another shape is different or the same in a different orientation. In fact, fifth graders who had received the video game training scored higher than ninth graders who had not played the video games.[31]

Richard De Lisi and Jennifer Wolford found positive effects on spatial skills of playing the video game *Tetris*, which requires mental rotation. After eleven thirty-minute sessions of playing *Tetris*, third graders showed improved scores on a paper-and-pencil test of mental-rotation skills. Before the video game training, children in the control group, who played a game that required no mental rotation, and children in the experimental group earned similar scores; after training, the students who had played *Tetris* scored significantly higher than the control group. Only the experimental group received significantly higher scores on the test after training.[32]

A series of experiments by Shawn Green and Daphne Bevelier reveal that video game play yields improvements in several aspects of visual attention. Experienced adult gamers are able to track more items in an array of dynamic distractor items, to locate more quickly a briefly appearing target, and to process more efficiently an ongoing stream of information.[33]

In a recent analysis, Matthew Dye and Bevelier examined the relative visual attention skills of child gamers and non-gamers. Similar to the adult studies, the study found benefits of gaming for visual attention, including greater attentional capacity, quicker attention deployment, and faster processing.[34]

Not all video game training studies, however, have found improved spatial skills among players.[35] In one study, adults trained on *Tetris* did not increase their mental-rotation scores more than controls, although advanced *Tetris* players did have superior mental-rotation skills, relative to *Tetris* novices. This finding, however, could be attributable to what social scientists call selection: individuals with superior mental rotation skills are more likely to play games like *Tetris.* A video game training experiment with seventh graders did not reveal improvements in spatial visualization, even though the same experiment improved spatial visualization skills in adults.[36]

Kaveri Subrahmanyan and Patricia Greenfield point out that the content of the game influences whether, and what, visual spatial skills are learned. In an experiment, fifth graders who played *Marble Madness*, a game that requires a player to guide a marble through a grid, increased their dynamic spatial skills significantly, as tested on a computer test battery; students who played a fill-in-the-blank word game showed no improvement on spatial skills. Children whose spatial skills were the lowest on a pre-test improved the most with video game practice.[37]

Electronic Media and Problem-Solving Skills

Video game play may also enhance problem-solving skills.[38] Postulating that video games provide informal training in inductive discovery, Greenfield and several colleagues administered questionnaires to college undergraduates during various stages of *Evolution* play. They documented a process of inductive discovery: as play went on, players induced the rules and strategies inherent to the game. A demonstration and teaching session, as provided for some study participants in a comparison group, had no effect on the final skill levels for either novices or skilled players.[39]

One growing popular concern is whether electronic media use is associated with attention deficit hyperactivity disorder (ADHD).

The long-term positive benefits of electronic media depend, in large part, on whether children can learn abstract knowledge or problem-solving skills and transfer them to new situations. Although children, at various ages, can learn specific facts from television, little research has specifically investigated whether they can transfer that learning, and, if so, how. Evaluations of educational television shows have provided mixed evidence for transfer.[40] For instance, an evaluation of *CRO*, a program for six- to eleven-year-olds that focuses on science and technology, found that children understood the educational content of an episode about airplanes and flight. They could not, however, transfer underlying principles learned from the program (for example, about the dynamics of flight) to problems with a different set of stimuli (for example, a new set of model airplanes).[41] Another study, of *Sesame Street*, found that five- and six-year-old children could not transfer a problem-solving strategy to a new problem, even though they could replicate the strategy with a problem similar to the one they saw on the show.[42] Slightly more promising findings have come from studies of the math series *Square One TV*. In one study, some of the children transferred problem-solving skills learned from the program to new problems, though transfer performance was worse than performance on recall and comprehension measures.[43] In another study, viewing *Square One TV* in schools for six weeks led to improved performance for fifth graders on math problems not shown on TV.[44]

Although evaluations of specific programs have failed to provide consistent evidence of transfer of learning, it is yet plausible that transfer occurs.[45] For example, studies have demonstrated transfer effects, such as those found for *Square One TV*, with preschoolers and school-age children.[46] Further, Anderson and several colleagues have demonstrated long-term positive effects of viewing *Sesame Street;* children who watched the program at age five received higher grades in the math, English, and science courses they later took in college.[47] Such findings strongly suggest that some form of transfer of learning occurs; the specific mechanisms that underlie such effects, however, have yet to be described.

Shalom Fisch, in his capacity model, contends that transfer from television is possible, as long as four conditions are met: the child must understand the content of the program, must create an abstract mental representation of that content (separate from its specific context on TV), must remember the content and see its relation to the new problem, and must apply the remembered content to the new problem. A breakdown in any of these areas can impede transfer of learning. The likelihood of transfer also depends on the age of the viewer (older viewers transfer more effectively) and the content of the specific program. Transfer is more effective if the educational content is embedded in the narrative. But if it is embedded too deeply, the child may have difficulty generating an abstract representation of the content.[48] Fisch therefore recommends program repetition, as well as repetition of the same content in multiple contexts, to increase the likelihood of transfer of learning. Although Fisch's theory is based on established research and theory about transfer of learning, it is relatively new and still largely untested with respect to television.

As with television, very little research has empirically tested whether video games facilitate transfer of learning. In one experiment, Hitendra Pillay found that playing computer games improved fourteen- to sixteen-year-old students' performance on computer-based educational tasks.[49] Students in the experimental groups played a puzzle or adventure computer game and were subsequently tested on an interactive multimedia problem-solving program. Students who played the adventure game performed better on the problem-solving task. Pillay views these findings as consistent with the research on transfer; the adventure game was more similar to the problem-solving task and therefore facilitated transfer of learning. Playing entertainment games, Pillay also suggests, may develop users' structural knowledge, allowing them to learn effectively from other computer applications.

Electronic Media and Attention

One growing popular concern is whether electronic media use is associated with attention deficit hyperactivity disorder (ADHD). Children warrant diagnosis of ADHD if they exhibit inattention, hyperactivity, or impulsivity that significantly impairs social or academic functioning for at least six months.[50] According to parents, television viewing captures the attention of children with ADHD for extended periods of time and is one of the few activities capable of doing so.[51] Given the widespread speculation about links between electronic media use and ADHD, it is surprising how little researchers know about the subject.[52] Correlational work suggests a possible link, albeit a small one; the work does not answer the question of whether children with ADHD simply use electronic media differently than children without ADHD. The evidence for a link between ADHD and electronic media use is thus, at this stage, inconsistent.

To date, only a few studies have compared media use in children with a confirmed clinical diagnosis of ADHD and media use in children without ADHD. Richard Milich and Elizabeth Lorch found no significant differences in time spent watching television or in types of TV content viewed among boys, aged seven to twelve, with and without ADHD.[53]

More recently, Ignacio David Acevado-Polakovich and several colleagues, in a cross-sectional study, found greater TV viewing among school-aged children with a diagnosis of ADHD. But the link disappeared when the authors specifically controlled for the mother's education level (lower in children with ADHD) and whether the child had a TV in his or her bedroom. School-aged children with ADHD were two times more likely to have a TV in their bedroom; thus, they potentially had greater access to TV, which could account for their heavier TV use. However, children with ADHD who did not have television sets in their bedrooms did watch more TV than children without ADHD who had no television in their bedrooms. Children with ADHD also were significantly more involved with TV, as measured by parental report.[54]

Acevado-Polakovich and colleagues conclude that any link that may exist between television viewing and ADHD is complex. School-aged children with ADHD may be more involved with TV because it may serve as a substitute for social interaction, and children with ADHD are more likely to experience peer rejection. Further, the authors found that children with ADHD are more likely to watch TV with an adult, perhaps in part because, by parental report, TV viewing is a comparatively low-conflict, low-stress activity for them to do with their children. All these factors could account for increased TV viewing among children with ADHD.[55]

Some studies rely on computer game tasks for laboratory tests of children with ADHD, because they are thought to promote the best possible test performance in this population.

Analysts have also conducted research on attention problems, as distinct from clinical disorders. Jeffrey Johnson and several colleagues, in a prospective longitudinal study, found a weak to moderate association (odds ratio = 1.44) between television viewing at age fourteen and attention problems (as assessed by the Diagnostic Interview Schedule for Children) at age sixteen. This link remained when the authors controlled for relevant child and family variables, including parent income and education, presence of childhood neglect, and learning or attention difficulties at baseline. Youth who watched three or more hours of television a day were at greatest risk for subsequent attention problems. Notably, the authors did not find evidence that attention problems at age fourteen predicted subsequent television viewing at sixteen years of age.[56]

A few cross-sectional studies have also examined the link between attention problems and television viewing. One study found that TV viewing and attention problems, as assessed by the Child Behavior Checklist (CBCL), were related (r = .20) among second- and third-grade children in Turkey. Children who watched TV less than two hours a day scored lower on the attention problems subscale of the CBCL than children who watched TV two or more hours a day.[57]

Another study found a positive link between fourth- and fifth-grade students' television viewing and teacher ratings of attention problems and impulsivity, as assessed by the Attention and Hyperactivity subscales of the ADD-H Comprehensive Teachers Rating Scale (r = -.4). The study, however, found no link between TV viewing and parent ratings of attention problems or impulsivity, a laboratory measure of attention (the Stroop Color and Word Test), or classroom observation. Further, the type of program viewed was not differentially linked with attention outcomes. Television viewing predicted less classroom attention during independent work periods.[58]

Very few studies have examined links between electronic media other than TV and attention. One cross-sectional study surveyed seventy-two adolescents (time use) and their parents to assess ADHD, as indicated by the Conner's Parent Rating Scale (CPRS), and found a significant association between playing video games for more than one hour each day and an increase in scores on the inattention and ADHD portions of the CPRS. There was no association between time spent watching television or using the Internet and ADHD symptoms. Because the authors did not test for the direction of the link, it is plausible that adolescents with ADHD simply spend more time playing video games.[59]

Interestingly, video games may provide optimal learning conditions for children with ADHD. Some studies rely on computer game tasks for laboratory tests of children with ADHD, because they are thought to promote the best possible test performance in this population.[60] Why is this so? In particular, video games offer immediate feedback, which is highly motivating for children with ADHD. External rewards are almost continuous during game play, but especially just before and contingent to any of the child's responses to the game.[61] Also, video games increase activation and arousal, which may improve task performance. Matthias Koepp and several colleagues have demonstrated that video games effectively stimulate the neural reward system by causing the brain to release dopamine, which is associated with learning and positive reinforcement.[62]

Electronic Media and Engagement of Attention

Researchers have, in fact, explored what design features allow electronic media to hold attention for long periods of time. They use the term engagement to reflect the degree of intensity associated with an episode of attention.[63] Engagement is also used to denote a *phase* of attention. Each episode of attention is made up of three phases—initiation, engagement, and termination.[64] Holly Ruff and Mary Rothbart explain that engagement, the intermediate phase, follows either an orienting reaction or a voluntary intention to attend to a stimulus or event.[65]

During the initiation phase, attention is "captured" by salient or novel events in the environment through the three- to five-second orienting response.[66] Engagement results if "pre-attentive" processes determine some value in the information detected by the orienting response, and it allows the child to stay focused on an event.[67]

Engagement during television viewing is typically variable. Dan Anderson and several colleagues first proposed the phenomenon of attentional inertia based on observations of children watching television. They found that a child who looks at television is more likely to continue looking if he has been looking for some time. Conditional survival probability plots revealed that the probability of a child looking away peaks at about one second then progressively declines with each successive three-second period that he continues looking, until it levels off at about fifteen seconds.[68] When viewers look at television, most look away after a short time (less than three to five seconds), a finding that applies equally to infants as young as six months, preschoolers, and adults.[69] Thus, at all ages, when the viewer first looks at a television program, the probability that she will look away is high; as she continues to look, however, the probability of looking away dramatically declines.

Inertial engagement, which is only one form of engagement, is thought to be the "cognitive glue" that holds sustained attention together across breaks in TV content, such as cuts, edits, or commercials, external distractions, or when TV content becomes temporarily incomprehensible.

Dan Anderson and Elizabeth Lorch found that inertial engagement kept preschoolers looking at *Sesame Street* when content changed. A child who had been looking at *Sesame Street* for a sustained period before that change was more likely to continue looking afterward.[70] The same phenomenon was found for adults viewing prime-time television and commercials.[71] Anderson and Lorch hypothesized that initially a person watching television continues viewing based on whether the content is understandable; however, once the viewer has been looking for about fifteen seconds, the attention becomes generalized to the medium of television, which makes the viewer resistant to distraction.[72] Anderson and several colleagues found that three- and five-year-old children were less likely to turn toward a distractor (a slide preceded by a beep off to the side of the TV screen) if they had been looking at the television for fifteen seconds or longer.[73]

Engagement with television varies according to whether the content is comprehensible. It also appears to vary as a function of the relevance of particular content to the overall narrative of the television program. Five- to eight-year-old children were slower to respond to a secondary task (button pressing in response to a tone) during viewing of content deemed central rather than incidental to the narrative.[74]

Elizabeth Lorch and Victoria Castle also found that five-year-olds responded more slowly to a secondary task during normal segments than during language-distorted segments of *Sesame Street,* suggesting that engagement is deeper when content is understandable. When content is difficult to understand, "breakdowns" in attention may free up capacity for the secondary task.[75]

Researchers have used measures that assess engagement to examine how the formal features of television—cuts, sudden camera changes, movement, sound effects—affect attention to television viewing.[76] In a study of adults' television viewing, Byron Reeves and several colleagues found electroencephalogram (EEG) decreases in alpha waves (usually associated with increased cognitive activity) that were time-locked to the presence of formal features, such as scene changes.[77] A team of researchers using the secondary task reaction time (STRT) procedure found slower reaction times during commercials that were simple overall (globally simple messages). *Local* complexity (presence of formal features), however, also produced slower reaction times.[78] Thus, it appears that formal features temporarily "engage" attention, although whether the engagement is sustained is likely a function of comprehensibility.

Video games typically provide interesting sensory stimuli, which recruit attention. However, attention is likely sustained by other features of games, one of which is fantasy.[79] When playing computer games, the user enters an imaginary world, where he or she is free to participate in a variety of situations, without real-world consequences.[80] Fantasy may enhance learning by stimulating children's interest.[81] It also may focus attention and increase engagement.[82] Games in which the fantasy is directly tied to the content may be more motivating.[83]

Games also may increase motivation by providing clearly defined goals.[84] Clear, specific goals are related to improved performance.[85] When a learner sets clear goals, he can evaluate whether he has met them. When his performance does not attain his goal, the learner is motivated to close the gap between goal and performance, thus leading to greater effort.[86] Fran Blumberg asked second and fifth graders about the game features that captured their attention and about the strategies they used after playing a video game for ten minutes. As expected, older children and more frequent players performed better on the game. Second graders were more likely to talk about their feelings about the game, whereas fifth graders emphasized their specific goals and standards for play. Concern for standards was associated positively with performance, whereas concern for feelings was associated negatively with game performance.[87]

In sum, despite the increasing use of video games in education, analysts know little about what exactly children learn from gaming, primarily because of a lack of rigorous research on learning outcomes.

Challenge is another feature of engaging video games. The optimal game provides a set goal structure but leaves players uncertain about whether they can achieve it. Video games also offer players the opportunity to control elements of the experience. Education research that is not specific to video games suggests that giving learners control increases motivation and learning.[88]

Some research has also examined whether video games can promote "flow," which Mihaly Csikszentmihalyi characterizes as a state in which a person loses herself in a deeply pleasurable activity.[89] Richard Bowman, in an analysis of *Pac-Man* play, depicts video games as powerful because they can induce a flow experience in players.[90] Games that foster flow experiences share several characteristics. Players' skills typically fit the difficulty level of the game.[91] The game should have levels of increasing difficulty, so it can keep pace with players' growing skill levels. In addition to well-defined goals, games should provide immediate, relevant feedback.[92] In a study of children's flow experiences while playing video games, Yavuz Inal and Kursat Calgitay administered a "flow scale" to children aged seven to nine. According to children's self report, games with varying levels of difficulty promoted the flow experience; challenge, in fact, was the greatest contributor to flow state.[93]

Games can, ideally, provide an inquiry-based learning experience, whereby learners approach new material through trial and error, in a safe space. Games offer learners the opportunity to try again and again, receiving feedback, all while experimenting with different strategies. Newer multi-user games allow learners to work collaboratively or as a team and thus to also practice social skills.

At present, there is scant evidence, however, to establish definitively the effectiveness of games in educating, largely because few empirical studies have been conducted. In 2005, Harold O'Neil, Richard Wainess, and Eva Baker conducted a thorough review of studies of the educational potential of games. Of the thousands of articles published between 1990 and 2005, only nineteen contained qualitative or quantitative data. Overall, the authors do not find evidence that games have particular benefits for learning, and they speculate that games alone (without instructional support) are not sufficient as learning tools. They further contend that games that fail to teach fail because they lack effective instructional design.[94]

In sum, despite the increasing use of video games in education, analysts know little about what exactly children learn from gaming, primarily because of a lack of rigorous research on learning outcomes.[95]

Gavriel Salomon and Tamar Almog further contend that technology should ultimately serve pedagogy, insofar as it is a tool for facilitating learning. The technology is simply the means to enact the pedagogy. The pedagogical philosophy embedded in the technology will determine what is learned. Psychology and educational technology research should thus inform software design to maximize learning outcomes.[96]

Learning from Hypertext

Hypertexts—dynamic texts, such as a website or multimedia software program, presented on a computer in a nonlinear fashion—offer a number of advantageous possibilities for learning. Hypertexts are interactive, allowing users to take in information at their own pace in the way they are most likely to derive meaning from it.[97] Hypertexts are open-ended; they allow readers to choose the information they want to retrieve and the order in which they want to retrieve it.[98] In fact, readers build their own text as they navigate through the information presented.[99] Typically, hypertexts recruit and sustain high levels of attention.[100]

With hypertexts, readers must create the structure of the text based on their own knowledge, whereas in traditional texts, readers use the existing structure of the text to make inferences that enhance comprehension.[101] Hypertexts thus require additional cognitive skills, as readers are responsible for determining what information they need to further increase their understanding of the topic and how to access it.[102] Research has focused on comprehension and control of hypertext.

Several studies have assessed learning from hypertexts.[103] In a review of all quantitative studies of hypermedia and learning outcomes published between 1990 and 1996, Andrew Dillon and Ralph Gabbard found no overall comprehension advantages for hypermedia (even across a variety of comprehension measures) over paper presentations.[104] However, hypermedia did offer significant advantages for particular tasks, such as visual categorization and discrimination and searches through large amounts of information.[105]

Readers' prior knowledge of a topic likely affects their comprehension of hypertexts. In one study with adults, prior knowledge improved recall from the text and also influenced how users navigated through the reading environment.[106] Readers lacking prior knowledge may have difficulty navigating the hypertext, as they may find it hard to find the information they need.

Interest in content has been associated with easier, more efficient navigation through the text, whereas interest in dynamic text features, such as sound effects and video, has been associated with less comprehension.[107]

Increased control may offer advantages for some hypertext users. However, the benefits of increased control may vary with the ability of the user. Complexity may, in fact, hinder performance in students by confusing them.[108] Some studies report a user preference for hypertexts offering control, even though learning may not be improved.[109]

Almost all studies of hypertext navigation have focused on adults. Kimberly Lawless and several colleagues, however, studied children's navigational strategies through hypertext. Fourth-, fifth-, and sixth-grade children completed a domain knowledge pre-assessment, individual and situational interest pre-surveys, and post-tests of recall. In addition, the computer recorded the path navigated by each user. Based on the data, the study identified distinct navigational profiles, similar to those for adults. Most students, the "knowledge seekers," focused on the information portions of the hypertext. A smaller group of students, the "feature seekers," spent most of their time exploring features, such as animation and movies. A third group of students, "apathetic hypertext users," spent little overall time with the hypertext. The most knowledgeable students were more likely to be the apathetic users; the least knowledgeable, the feature seekers. The knowledge seekers fell in between. The authors concluded that prior knowledge affects navigational strategy, in that it may enhance interest in content.[110]

Research on learning from hypertext is limited, especially with regard to children. Dillon and Gabbard point out that the research suffers from a host of methodological flaws, limiting the conclusions that can be drawn. They argue for greater focus on the design variables responsible for different learning outcomes, as well as how those design variables interact with individual differences in users.[111]

Media and the Family

More than half (53 percent) of eight- to eighteen-year-olds have reported that their parents set no rules about watching TV. Among those who reported having rules, only 20 percent indicated that those rules are enforced "most of the time."[112] More specifically, among seventh to twelfth graders, only 13–14 percent have parental rules limiting how much television they watch each day; only 17 percent have rules limiting the time they spend playing video games each day. Although parents are slightly more likely to set rules regarding computer use, only 23 percent of seventh to twelfth graders have parental rules limiting the time they spend or the types of activities they pursue on the computer. The most common rule (one that applies to 36 percent of these adolescents) is that they cannot watch TV until they finish their homework or chores.[113]

Research on parental monitoring of media use has had mixed findings. The share of parents who actively supervise their children's media use varies from study to study.[114] However, research over the past forty years suggests that less than half of parents enforced TV viewing limits or regularly discussed TV content with their children, whatever their ages.[115]

Children whose parents set television viewing rules watch forty fewer minutes of television each day than children whose parents set no rules.[116] Another effective form of parental involvement is active mediation. When parents watch TV with their children and talk about the content viewed, children demonstrate improved comprehension of content and TV production techniques.[117]

Various technologies have been developed to help parents monitor their children's electronic media use. Parents can, for instance, control children's exposure to media content by selecting videotapes for their children. However, research suggests that children typically watch videos that are similar to what they watch on broadcast television.[118] Video recorders, for the most part, do not appear to have substantially changed how families monitor television. Research has not yet been conducted on the Digital Video Recorder (DVR), which also has the potential to influence children's TV viewing. The V-chip, which was designed to enhance parental control, has not been used by most parents.[119] Parents have, however, been more proactive about limiting access to Internet content than limiting access to TV. Amanda

Lenhart reports that more than half of households with teenagers use Internet filtering software.[120]

Few studies have examined parental regulation of video game play. Peter Nikken and Jeroen Jansz report that parents use the same forms of mediation, including restrictive, active, and coviewing, for computer gaming as for television viewing. With video game play, however, parents are most likely to use restrictive mediation, or rules; they are least likely to use coviewing, the strategy that they use most often for television viewing.[121]

Media in Schools

Increasingly, electronic media, particularly the interactive technologies afforded by computers, have been adopted in school settings in America. *Channel One*, an in-school news program first introduced in 1990, rapidly became part of the school curriculum. Its use for delivery of non-educational messages such as televised food advertising has been noted and roundly criticized.[122] According to the National Center for Education Statistics, 35 percent of public schools in the United States had access to the Internet in 1994; nine years later, that figure had risen to 100 percent. The share of instructional rooms in public schools connected to the Internet has also increased dramatically. In 1994, only 3 percent of instructional rooms had computers with Internet access; by 2005, that figure had soared to 94 percent.[123]

Interestingly, though both educators and parents tend to view television with suspicion and have doubts about its use as an educational tool, they view computers almost uniformly (and unquestioningly) as conferring educational benefits on children and youth. The reasons are twofold. First, the interactive nature of computers, whereby children can control both the content and the speed of information presented, is widely assumed to enhance learning. Second, part of the appeal of computers is the widespread recognition that they are essential to future educational or business endeavors. Thus, familiarity and facility with computer technologies is viewed as a crucial skill for successful entry into the adult world. Though both of these views make intuitive sense, little empirical research supports either.

Educators, in particular, have been quick to jump on the "interactive technology" bandwagon. Scores of programs use computer technologies to enhance or aid learning in basic reading skills, math, and science. Few of these programs, however, have been tested for efficacy against more traditional, teacher-based strategies. It has simply been assumed that interactivity enhances learning; little solid empirical research based on randomized controlled designs has addressed the subject.

In a recent review of research, the Institute of Education Sciences What Works Clearing House found that using interactive technologies advances learning no more than traditional teaching techniques.[124] What matters are the ways in which teachers choose to use, present, and teach with the technology—choices that are in large part dictated by their own comfort and familiarity with the technologies. This finding, of course, makes perfect sense. It suggests that children's use of technology (and its possible educational advantages) is only as good as the instruction they receive in how to use it. Though in some ways the insight may seem obvious, it is important to emphasize it because of the widespread assumption that the technology alone, regardless of how it is used, will enhance learning.

Conclusions

Over the past half-century, the advent of each new electronic medium or technology has been both celebrated and viewed with alarm, often simultaneously. Television, cable television, video games, computers, the Internet, cell phones, and iPods have each been regarded with dismay and sometimes downright panic by adults concerned with learning and education. It might be worth noting that the growing popularity of the novel as a new writing form in the mid-nineteenth century was viewed with similar alarm. The general notion then was that novels would ruin young minds. Today, however, novels are widely respected, are the subject of serious study by young people, and are believed to foster imagination, creativity, and independent thought. More often than not, both dismay about the problems and excitement about the opportunities presented by electronic media and technology focus on characteristics of the medium itself, such as visual displays, interactivity, and the like. The assumption is that time spent with media or technology, regardless of content or quality, is central to the way they shape youthful learning and academic skills. As Marshall McLuhan famously said, "The medium is the message."

But the influence of electronic media and technology on youthful learning and cognitive development cannot be so neatly summarized. It turns out that content matters. High-quality educational television programs seem to have positive effects for children's learning, academic skills, and academic engagement. The significance of content probably explains why examinations of the links between total amount of viewing and achievement are not particularly useful (and indeed have resulted in very few links being demonstrated). The centrality of content has even begun to emerge in examinations of television and attention problems. In a 2007 study, Frederick Zimmerman and Dimitri Christakis report finding links between high doses of entertainment television before the age of three and attention problems five years later. Educational TV viewing, in contrast, was not associated with subsequent attention problems.[125] Fundamentally, the implication is quite straightforward: not surprisingly, children learn the things we teach them.

This simple point, however, keeps getting lost amidst the furor over electronic media and children's learning. The empirical evidence suggests that electronic media are no different from any other teaching tool—good for some things, bad for others. The work ahead is to discover the nuances of this truth—in essence, what is beneficial, for whom it is beneficial, and when it is beneficial.

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