How Elementary Age Children Learn To Use Digital Technology

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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Abstract

As new technologies are developed and released constantly, it can be difficult to keep up with all the new features and methods of using them. Without prior experience or understanding, individuals would struggle with translating their physical motions to affect a virtual and flat computer screen. Not only do young children lack the experience of using previous technologies, but they also have not fully developed their brains to be fully capable of physically and mentally understanding the actions that accompany using a digital technology. Understanding what young children are capable of and at what ages can help creators of technology to create more effective designs for their target demographic. One crucial step to this process will be to determine the processes that children go through to learn how to use new technologies. This investigation will occur through combining the findings of multiple sources of published research and synthesizing a conclusion from the analyzed results. The processes in which children obtain the skills to use modern technologies have not been fully researched until now. After researching the topic, the evidence mainly points towards the methods of self exploration and peer learning. With these findings, it is time for this underrepresented group to finally have its voice heard and for engineers to start to take them into account.

How Elementary Age Children Learn To Use Digital Technology

Introduction

With the continuous development and release of new technology to the public, consumers are constantly faced with new technologies and features to learn how to use (Wallace, 2020). Consumers who are used to this trend may find little difficulty in adapting to new designs, but children lack the experience, and sometimes mental ability, to participate in this race (Lauricella et al., 2008). Children may not have developed the reading comprehension skills or mental heuristics necessary to learn a new digital technology by themself, yet they somehow still manage to do so. The term digital technology will be used to describe common household devices with a touchscreen user interface, such as an iPad. Given that 85% of children have access to some form of digital technology, this phenomenon affects almost all households nationwide (Erikson Institute, 2016). With the current pandemic forcing schools to rely solely on online education, it is crucial that young children are able to understand the digital systems they are using (Dong et al., 2020). Given the pervasive use of digital technologies by American children, any barriers to using these technologies will affect a massive market. In a time of mandatory online education, failure to properly use a computer to attend classes or the inability to look for supplemental materials can set back already struggling children. A better understanding of the learning process will aid developers of technology to create designs more suited for children with potential benefits in fields where children are the target demographic, such as education and entertainment.

The research will be analyzed through the Social Construction of Technology framework which will provide context to the technology to help engineers determine how these tools can be refined to better suit the capabilities and needs of children, a group which often does not have a voice to influence how technology is developed (Klein & Kleinman, 2002). Ultimately, the goal of this research is to answer the question: how do elementary-age children learn to use digital technology? This research paper will investigate how the processes of exploration and teaching enable elementary-age children to operate digital technology. By analyzing the results of previous research on how this demographic interacts with technology, both processes can be further understood and this knowledge can be used to better design technology for children.

Social Construction of Technology

The Social Construction of Technology (SCOT) framework is a way of analyzing a problem by assuming that technological development is determined by the influence of relevant social groups and the compromises that they make with each other in order to satisfy every group's interests (Klein & Kleinman, 2002). This framework demonstrates the influence that society has over technological development and how society's desires can manifest into prominent technologies. A common critique to this framework is society's inability to successfully compromise between every social group's needs. In fact, some social groups are ignored completely and their desires are never taken into account when designing technology. In this case, relevant social groups would include the children, parents/guardians of the children, and the designers of the technology. By designing technology that better matches the capabilities of children, every group benefits. The children benefit by having easier to learn technology with accessible functionality. The parents and guardians benefit because they care about the success of their child(ren) and having their children better equipped to participate in online education and future online interactions would contribute to their future success. By creating more successful products,designers make more profits and have their technologies used by more consumers. Young children are actually a commonly underrepresented social group due to their lack of self-agency and consumer power in the economic market. Also, their inability to reliably and effectively communicate their interests and the lack of a listening audience results in them being often ignored. This can be troublesome when designing technology for this demographic because the instructions may be unclear or the design may not be interpreted as intended. One goal of this research paper is to give a voice to this group to allow for engineers and designers to create more fitting designs that more closely match the demographic's mental and physical capabilities. For example, the minds of young children are still developing, so recognizing symbols or understanding the relationship between a physical gesture and an onscreen effect may be beyond the scope of their comprehension. Part of this research paper will investigate what aspects of digital technology that are typically taken for granted should be reconsidered when designing for younger children in order to successfully capture their attention and to relay the intended message. The status quo is that some digital technologies overestimate the physical and mental capabilities of young children. By designing technologies with their specific needs and capabilities in mind, engineers can help young children more effectively gain the knowledge and skills needed to operate the technologies.

Counterargument

Opponents to this research would argue that lowering the barrier to entry to using these types of technologies for young children could lead to increased exposure to screens at a young age and could be harmful to the health of the children. Introducing children to these types of technologies, or even further encouraging this type of behavior, can distract them from other activities, such as physical, social, or academic extracurriculars. A survey of elementary schoolers in Japan showed that increased screen time in children can lead to increased obesity rates, less physical activity, decreased academic performance, and dryer eyes (Mineshita et al., 2021). Academic performance was measured through a self perception of a student's grades and how well they understood the material in class. Part of the reason this research is important is because the global pandemic has removed the choice of how much screen time children should have. Online learning has become a necessity in most education systems to reduce the spread of the virus (Dong et al., 2020).

Even when the pandemic is over, these symptoms will still persist, as some schools may continue to offer online learning opportunities, so preventing or dealing with these symptoms must occur through other means, such as limitations set by parents on the amount of time a child can spend with a screen. Another important aspect of the survey to note was that the timing of the screen time also had an effect on the symptoms experienced. Screen time in the nighttime and near bedtime had a greater effect in causing the above symptoms than normal screen time. With this knowledge, the severity of the described issues can be minimized or even eliminated if the proper precautions are taken.

Digital Dependence

As schools become increasingly dependent on digital technologies to support their students' learning, it becomes even more important to ensure that these students are able to fully utilize these tools to get the most out of their education. In the United States, schools are transitioning to using personal laptops as the centerpiece of the education system (Fowler & Fowler, 2020). Early exposure to these technologies will allow students more time to familiarize themselves with the functions of these technologies. In order to prepare children to use technology they are likely to use in the future, it would make the most sense to pick a popular system to give students a supportive time and space to learn the technology.

However, one of the main types of laptops that school systems are using is the Google Chromebook (Fowler & Fowler, 2020). The Google Chromebook runs using the Chrome operating system, which differs from the popular iOS and Windows systems that make up a majority of the market. About 32.2% of systems user systems run on iOS; 30.9% of systems run on the Windows OS; and a mere 1.1% of systems use the Chrome OS (Vaughan-Nichols, 2020). Even using a Linux system, which makes up 2.87% of the market, would prepare students for a greater range of technologies. Using a standardized piece of technology on a national level is a powerful tool that can be utilized to passively build a strong foundation of knowledge for a whole generation. Unfortunately, the decision by the American school system to concentrate their resources on Google Chromebooks is a waste of this opportunity and a disservice to the students who could be learning how to use a technology that they will likely end up using later in their careers. Analyzing how the status quo was reached can aid in determining how it can be changed. The SCOT framework suggests that there was a social group that desired this product and advocated for its widespread use. The main appeals of the Google Chromebook are its durability and simple design, perfect matches for the American public school system (Fowler & Fowler, 2020). Thus, an analysis using the SCOT framework would conclude that Google's ability to create a product which catered to the specific needs of this social group is how it gained this dominant position. One goal of this research would be that the results are able to lead to the development of a new piece of technology that better fulfills these requirements and also uses a more popular operating system to better prepare students for the future.

In today's situation, online learning has become more prevalent than ever before due to the global pandemic. A majority of online learning in China uses WeChat, a popular social networking app in Asia (Dong et al., 2020). Unlike in the United States, this application is popularly used by the general public, so the transition from using a school-related technology to a post-education career is smooth and does not require a student to learn another new technology. Taking advantage of the unique influence that the education system has on a nation's children in order to accustom children to the nation's society and culture is an effective method of slowly integrating children into the broader society and preparing them for their futures. The STS framework of SCOT can be seen here through the cultural difference in China compared to America. The two countries can be seen as two distinct social groups. The social group of China has a culture that focuses on togetherness and the community, while a social group containing a western country like the United States has a culture that values individuality and innovation. The China social group will have desires of a shared culture, hence the support and introduction of WhatsApp into the school culture, tying young children into the culture from a younger age (Dong et al., 2020). The United States does not have the same focus on community, so the society does not push as strongly for an equivalent system in America, which is why no technology was developed to fulfill that role. The newly pervasive use of online learning is another incentive to ensuring that the technologies that children are using are designed with their needs in mind. In order to facilitate the education of the younger generation, engineers should try to design systems that are easy for children to learn in order to not distract students from their learning objectives.

More Knowledgeable Other (MKO)

Analyzing how groups besides our target demographic learn to use technology can provide a broad insight into what a general individual needs to learn a new technology. This information can then be used to frame one's understanding of children in particular. In a survey of college students, it was found that most of them attributed their technological skills to either individually reading instructions or through informal learning from interacting with peers, friends, or family (Hossain et al., 2019). Informal learning is described as learning that is self organized and not from a higher authority's instruction. This type of learning differs from formal learning because the individuals involved have an intrinsic motivation to pursue their goals, which is a stronger motivator than simply being told to complete a task. This survey introduces the idea of a More Knowledgeable Other (MKO), which is an individual who has better understanding or knowledge than the learner at the task at hand (Hossain et al., 2019). By working together with an MKO, learners can obtain new knowledge and skills faster and easier than they could without one (Hossain et al., 2019). When the learner demonstrates or expresses that they do not possess the ability to perform an action that the MKO can perform, the MKO steps in to complete the task for the learner. In the process of observing the MKO complete the task, the learner can gain the knowledge demonstrated in front of them and use that knowledge later when it is once again required. In a survey conducted with 253 students, 92.1% of students reported that their classmates taught them computer and internet skills, 56.1% reported same-age friends from other schools, and 38.3% reported older friends from the same school (Hossain et al., 2019). Methods in which these peers helped included introducing them to new programs or computer applications, giving hands-on training, and sharing knowledge through providing manuals and explaining information. As reported by a study done by Lauricella, similar methods can also be observed in young children, which will make the evidence above useful in determining the effectiveness of certain techniques on young children's learning of novel digital technologies (Lauricella et al., 2008).

The Digital Play Framework

In order to successfully use digital technology, children need to first build a foundation of knowledge and understanding through creative experimentation. The Digital Play Framework dictates the various stages a child goes through when experiencing a new technology and how the child eventually gains a sufficient understanding of how to use it. There are two main stages of the Digital Play Framework, epistemic play and ludic play (Bird & Edwards, 2015). Epistemic play is when the child learns facts and builds their foundation of knowledge for a technology. The goal of this stage is for the individual to figure out what the object can do. The second stage, ludic play, is when the child can begin to use their imagination and creativity to deliberately perform some function for their own enjoyment. Although passing the epistemic stage is necessary to reach the ludic stage, the individual can return to the first stage at any time to learn more about the object and expand the possible interactions they could have. In an experiment observing how children learned how to use a video camera, the epistemic stage consisted of finding and exploring the different functions of each button and manipulating the camera at different angles (Bird & Edwards, 2015). The ludic play stage involved the children showing off their filmed footage to others and intentionally aiming the video camera at scenes that the children wanted to film, demonstrating an understanding of how the footage was created and how it could be used for personal enjoyment. Ludic play is the point in which the child is capable of truly "playing" with the toy for entertainment rather than discovering new features that can be used later. This evidence supports the subclaim because it describes a recorded process in how children begin to build their foundation of knowledge.

Since children develop relatively quickly, targeted age groups must be specific so as to not bore the child or challenge them beyond their capabilities because they use their knowledge of the real world to affect how they interpret symbols on a screen (Martens, 2012). This information should be handled with care because it is not guaranteed that a child has necessarily reached a certain developmental level simply based on their age, so designs should be flexible and not strictly correspond to a user's age. Children between the ages of two to seven are grouped as being in the early childhood stage while children from the ages of six to eight are in middle childhood (Martens, 2012). Taking into account the differing needs of differently aged children is a part of the SCOT framework by defining a relevant social group and determining what it desires from a technology. Since different aged children have different capabilities, each group will also have a different set of needs from a technology. The International Children's Digital Library (ICDL) took a similar approach when they incorporated children into their design teams because younger children "can have needs that are far different from those of adults" (Martens, 2012). Due to the difference in experience and mental ability, young children may need different visual or audio cues to understand how a technology works. When using technology, children can also have different expectations of certain features, such as the fact that children using the ICDL tended to search for books using filters different from what most adults would expect them to. In scenarios where children could think differently from adults, it is important to remember to include the opinions of children in order to capture their opinions to successfully predict how other children will behave. Since children sometimes have difficulty understanding symbology, another strategy that has proven effective for the ICDL is bringing the physical environment into the digital space. It was found that children were able to more quickly recognize user interface symbols if they resembled real-life objects or concepts that the children were already familiar with, presenting a bridge between reality and the screen in front of them (Yan & Fischer, 2004). Generally common images such as an icon of a trash can are understood by children because they understand the purpose of the real-life equivalent. In comparison, a backwards arrow is not as common in the physical world and has a different function on a computer screen than if seen on a street sign. This disparity is exacerbated by societal and cultural differences that can affect a child's understanding of technology. For example, children in America can more quickly recognize alphanumeric icons compared to Chinese children who were able to more quickly recognize pictorial icons (Yan & Fischer, 2004). This difference can be attributed to the different dominant writing systems of each culture, with English having an alphanumeric writing system and Chinese having a character-based writing system. Another… These cultural differences demonstrate the importance of identifying the proper relevant social groups who will be using a particular piece of technology. In order to accommodate for a certain demographic's strengths and weaknesses, it is important to include the opinions and experiences of members of the relevant social group in order to understand what that group wants most. Another crucial aspect of SCOT is the compromises that occur between the various social groups. In this case, if a website needed to be designed for both an American and a Chinese audience, the designers would need to compromise between the two groups on what types of icons to use in the user interface. A reasonable compromise would simply be to include both types of icons or a toggle that could switch between two sets, one of alphanumeric icons and one of pictorial icons. This solution is not particularly strenuous or difficult, but requires keeping in mind the different needs of multiple groups of users, hence the analysis through the SCOT framework.

Scaffolding

Young children have not fully developed their brains yet and thus require assistance with some tasks. Vygotsky's zone of proximal development describes the scenario in which an individual can barely accomplish a task, but once they are helped in performing the task, they become capable of then performing the task alone and their potential expands (Lauricella et al., 2008). For example, using a computer mouse requires the ability to recall long-term memory while simultaneously being able to use working memory to operate the mouse (Lauricella et al., 2008). Most young children lack the mental ability to operate a computer mouse, thus they require the assistance of another individual to operate the mouse for/with them. Continually challenging a child and expanding their zone of proximal development is a simple way to help encourage growth and learning. This process is known as scaffolding. Examples in which this occurs in parent-child relationships are in watching television and reading books where the parent will guide the child's understanding and fill in any gaps in knowledge. An example relating to digital technology is when parents provide scaffolding to their child to use a computer mouse. In an experiment where parent-child pairs were asked to read through a digital storybook, the parents of the children who handled the mouse were observed to give directions on how to operate the mouse to their child (Lauricella et al., 2008). This scaffolding is an example demonstrating how children learn the skills of how to use a mouse, as Vygotsky theorized that providing this base of support would enable the child to apply this skill later (Lauricella et al., 2008). The way this process works is that the child is almost physically and mentally capable of performing a certain task, in this example the task is operating a computer mouse successfully, but the child is missing a piece of information that would allow him/her to carry out the task. When the parent demonstrates this process or otherwise aids the child on this task, the child gains the schema of how this task is performed and can then reproduce these instructions in the future.

Ways in which this support was given was through taking turns in using the mouse or simultaneously holding the mouse and performing the action together. These and other similar interactions between a child and a peer or parent provide a controlled environment for the sharing of information, which leads to a build up of knowledge for the child (Lundtofte, 2020). Countries in which the effects of this process are particularly visible are England, Luxembourg, Greece, and Malta. A study performed in these four countries revealed that children under the age of five typically only use digital technology with adult supervision (Palaiologou, 2016). This paired use is an optimal environment for the parent to provide scaffolding and support to the child as they begin to learn how to use the technology. Over 60% of children under 3 years old in these countries are using digital technology, which provides a plethora of opportunities for knowledge acquisition. The reason this scaffolding is so important is because this method of learning has proven to be one of the most effective methods. At a young age, children still rely on their parents to resolve any problems they may encounter, so understanding how to assist a child and to teach them how to overcome a problem in the future can be beneficial for both parties. Studies have revealed that young children learn how to use new user interfaces the fastest when there is guidance to prevent them from causing errors and they receive feedback quickly (Lim et al., 2012). Also, consistent designs throughout the site allow children to use less mental energy on relearning old knowledge, so they can focus on new concepts as they appear. Overall, there is a focus on decreasing the amount of effort that a child must exert in order to learn new information. This decrease allows for a faster increase in knowledge since fewer mental resources are expected of the child and these can be provided by a teaching presence.

Six- and seven-year-olds can interpret directions if they are given in the form of a physical command, such as swipe left or slide down. In an experiment testing the effectiveness of various types of instruction on young children, it was observed that watching a human perform the action was most effective (Hiniker et al., 2015). Audio cues and a visual representation of an onscreen hand performing the action were slightly less effective. Although a metric to note is that these results are most evident in children younger than four years old because by then the differences in these three methods begin to diminish and disappear by age five. A possible explanation for this change is the fact that the children under four are usually spoken to using child-directed speech, a speech pattern specifically tailored for facilitating communication, and the audio cues were not made with this speech in mind. Also children under three years old are still developing the ability to understand symbolism, so the onscreen hand gestures would be ineffective if they were not understood to be a hand. A fourth method, a simple visual demonstration of the result with no hand symbol, was universally ineffective and was not understood by most participants. The importance of this research is that by having instructions that are tailored specifically to a child and to what the child is currently capable of understanding, designers can ensure that their instructions will be understood and properly carried out.

Conclusion

Nation-wide online learning and the increased integration of home technologies have young children interacting with and relying on digital technology more than ever before. Online education has spread throughout the globe and understanding how to use a computer mouse or how to navigate a web page has become a crucial skill. Whether it be through individual exploration and experimentation with a technology or through guided instruction, young children are gaining the skills they need to navigate the digital landscape. Taking advantage of these two methods is critical to designing technologies specifically meant for children in order to reduce the strain on their minds in already difficult times. Through an analysis of the SCOT framework, taking into account the opinions of children can lead to more effective technologies that better work with children and their mental capabilities.

With these methods in mind, designers of technology can now adjust their plans to account for the capabilities of young children or to include features that promote learning from MKOs. By trying to listen to the needs of young children, the market of technology aimed at this social group can be expanded and products can be improved. A major impact of this improvement would be a greater accessibility to online learning, further improving the quality of education in America. Alongside creating newer technologies, there is also a social responsibility that comes with this knowledge. A key factor of Vygotsky's sphere of proximal development is that there is a MKO willing to share their knowledge with the younger generation when opportunities arise. These teachings are a way of paying forward the teachings that likely occurred in the childhoods of many.

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