The Design of User-Interfaces for an AI-Powered Next-Generation Dishwasher

(Technical Paper)

The Parental Role in the Child-Artifact Relationship in Relation to STEM Toys

(STS Paper)

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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

Introduction

COVID-19 transformed our lives by forcing the entire world to social distance from each other. One of the most difficult adjustments was for students to transition from in-person learning to virtual learning. This transition means that the location in which students are "in school" and their parents are "at work" refer to the same place. With a focus on the educational aspect, the impact on children spending more time with their parents, which increases the importance of the parental role, needs to be considered. For example, the term learning coach is a common label that often comes with expected roles and responsibilities on the part of the parent or adult family in the home where the K–12 fully online is taking place (Smith, Burdette, Cheatham & Harvey, 102). Quarantining away from society makes teaching Science, Technology, and Math (STEM) concepts at home difficult, but there have been innovative STEM toys to achieve this goal in an effective manner. The proposed research paper will provide a review of the important elements, that increase learning and excitement, of STEM toys while magnifying the impact of the parental role in the relationship between the parent, child, and the STEM toy.

From STEM toys to next generation dishwashers, understanding how humans interact with technology leads to greater insights which can further improve these existing technologies. The worldwide annual sales of home appliances increased from 580 million units in 2013 to 700 million units in 2017 (Statista, 2017). This upward trend motivates companies to create innovative solutions to appeal to the consumers. The capstone team will create possible user interfaces for a Next-Gen Artificial Intelligence (AI) dishwasher by conducting user interviews and surveys to understand the perspective of the user. By gaining insight from the user's perspective, the research team envisions the Next-Gen AI dishwashers to incorporate the

research we conducted to create a pleasurable experience for users. Improving user experience through STEM toys and Next-Gen AI dishwashers can make a sustainable impact on society.

Technical Topic

As technology rapidly expands in the 21st century, the societal expectations for the abilities and usability of technology increases. Specifically, smart and automatic household appliances have become extremely popular and more affordable for everyone. Users expect their technology to operate at lightning speed without decreasing the capability of the system. The objective of this project is to optimize the user interaction experience through the use of the latest technology with their dishwasher appliance without sacrificing the functionality of the product.

To create the optimal user interface, it is important to consider factors that influence user behavior ranging from the size of the household to typically overlooked personal characteristics like religion (Assadi, 2003, p. 3). A balance between technology and usability of a user interface (UI) is extremely important for a consumer because a UI that is too technologically advanced can become unusable and a UI without limited functionality would result in dissatisfaction from the

Component of Dishwasher	Physical Design Factor	Degree of Influence (%)
Exterior	Label icon	21.50
	Size	21.64
	Button shape	15.82
	Color	10.44
	Panel size	9.95
	Button color	8.23
Interior	Rack size	41.47
	Bar	32.11
	Strength of bar	17.95
	Distance between racks	8.47
Doorknob	Shape of knob	67.40
	Thickness	32.60
Display	LCD size	26.56
	Display font type	22.16
	Color	20.47
	Control sound	14.91
	LCD font size	9.02

Figure 1: Generated Dishwasher's Physical Design Factors and the Degree of Influence. Results of research by Jin, Ji, Choi, and Cho (2009) in the appearance and technology factors in dishwashers effect on customer preference (p. 191).

consumer, an overview of the influence of usability factors is shown below in Figure 1. Figure 2 provides a visualization of the primary components referenced in Figure 1. In the first column of Figure 1, labeled component of dishwasher, the dishwasher is categorized into four sections: exterior, interior, doorknob, and display. Then, the second and third columns of Figure 1 corresponded to a specific physical design factor and its influence on user behavior within its respective component. For example, a study of 200 in-house consumer surveys showed that 20% of dishwasher cycles were not fully loaded and some households preferred higher cleaning temperatures, so the value of energy consumption would be higher than the value listed on the appliance label (Richter, 2011, p. 186). This study shows that most users do not fully comprehend the capabilities and user interface of their dishwashers. Therefore, this project aims to ensure that the user interface is up to date with the latest technology and is intuitive for the consumer while achieving their desired operational capabilities.

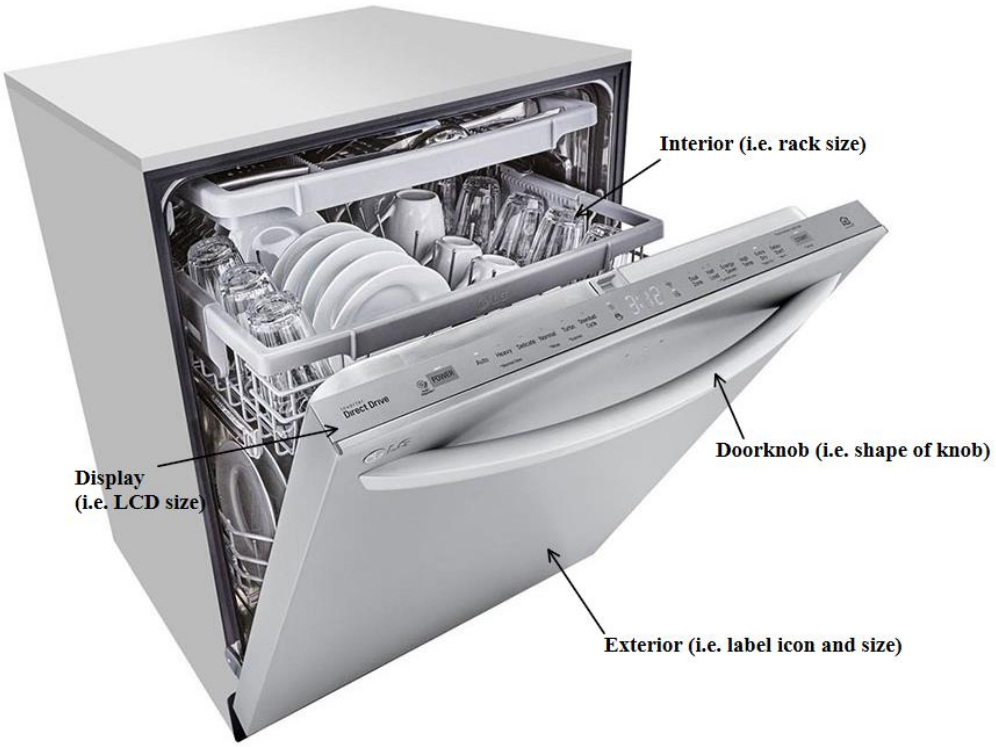

Figure 2: Visualization of Dishwasher Component Terms. The labeled depiction of a dishwasher identifies the physical counterpart to the terms used to describe influencing features (Created by Soumya Chappidi, 2020).

A study from the U.S. The Energy Information Administration found that, out of 80 million households with dishwashers in the United States, 54% of households use this technology at least once a week (McNary, n.d.). Given dishwashers are used daily by a large number of people around the world, having a more streamlined and efficient experience for users would be a great benefit. The next generation of consumers are comfortable with technology and therefore, expect certain features to be present in their devices. This new acceptance of technology and these rapid advancements can create an influx of integration of smart home technology in multiple homes.

Smart technologies have been rapidly emerging and pervading throughout a multitude of industries such as the automotive industry, home connect device industry, and now, even the household appliance industry. The rapidly growing demographic of technologically-savvy consumers require a new approach to daily tasks that are often taken for granted. Through this proposed research, the research team intends to find what users believe would best improve their dishwashing experience. By looking into how smart technologies such as sensors, connectivity, and autonomous features change the way users interact with dishwashers, we aspire to develop a UI that would provide the features and experience that address current pain points in the dishwashing process, improve usability, and provide the features that are expected by consumers for a 20th-century technology.

The approach for the technical project is divided by semester into two main phases, which is shown in Figures 3 and 4. The first semester approach is centered around gathering information about user experience and pain points with their current dishwasher. Phone interviews will be used to collect user accounts of frustrations in the process of loading and unloading and to gain an understanding of how users interact with the dishwasher interface.

More specifically, conversations will be engineered to understand how users comprehend the different cycle options, which capabilities and cycles are most used and why, and the anticipated level of use for an app to operate the dishwasher remotely. In Figure 5, which is shown below, a histogram of interviewees' ages is demonstrated. Diary studies, which are daily written entries regarding the users' dishwashing experience, were also conducted to gain insight into the more immediate frustrations with the loading and unloading routine that may not be revealed during a phone interview.

From: 09/22/20 - 12/11/20	09/22- 10/05	10/06 - 10/19	10/20 - 11/2	11/3 - 11/16	11/17 - 11/30
Research current dishwasher landscape and research similar markets					
User interviews completed					
Map insights, hypotheses and unmet needs					
User diaries completed					
Surveys of potential users sent out					
Interim Report					

Figure 3: Timeline of Project Phase I. Goal dates for milestones in interviews, research, designs, and testing divided by semester into Phase I (Created by Khin Kyaw, 2020).

From: 02/01/21 - 05/04/21	02/01 - 02/15	02/16 - 03/01	03/02 - 03/15	03/16 - 03/29	03/30-04/12	04/13 - 04/26	04/27 - 05/04
Brainstorm concepts based on research							
Narrow down concepts based on technical feasibility and cost							
Create initial designs							
First round user testing							
Use first round user testing and iterate design process							
Second round user testing							
Use second round user testing and iterate design process							
Third round user testing							
Present final designs							

Figure 4: Timeline of Project Phase II. Goal dates for milestones in interviews, research, designs, and testing divided by semester into Phase II (Created by Laura Gustad, 2020).

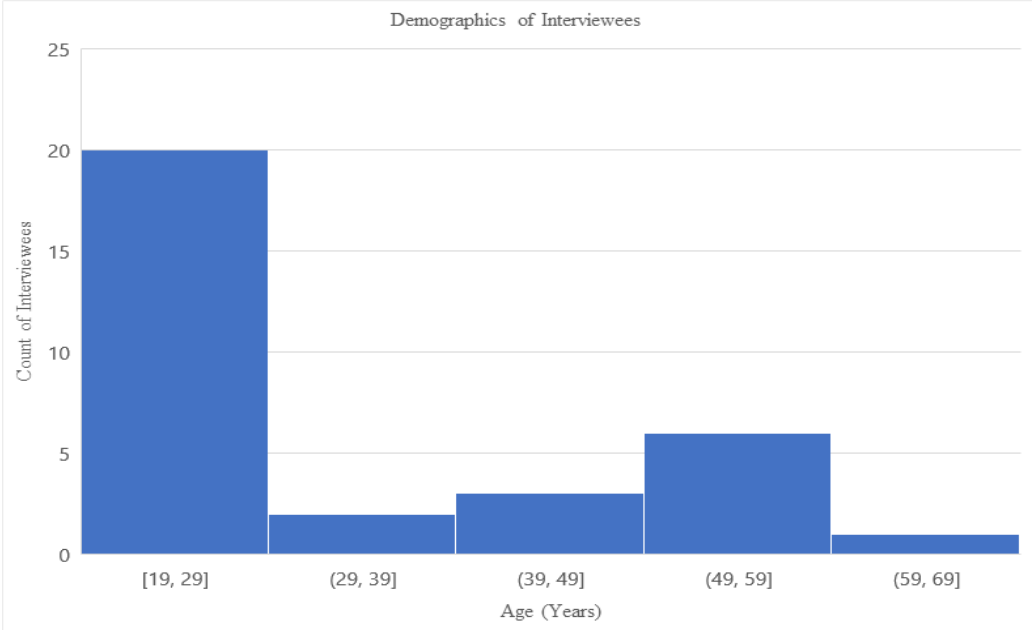

Figure 5: Histogram of Ages of Interviewees. Representation of the age distribution of the sample population interviewed (Created by Soumya Chappidi, 2020).

The second semester will be focused on developing new designs for the dishwasher's user interface. The preliminary designs will be developed based on the data collected in the first semester research and tested iteratively on potential users. The feedback from user testing will be used in improving the usability of the initial prototype for the final designs. To improve user experience, our findings will aid BSH in their decision making and design process by determining which key features to include in their next-generation dishwasher. Our findings will be summarized in a SIEDS conference paper at the conclusion of this project.

STS Topic

From 2011 to 2012, sales of scientific toys and educational toys rose by 17% and 25%, respectively (Raupp, n.d.). Since STEM toys are a gateway to understand the world of engineering, many parents are purchasing these products to encourage their children to learn valuable concepts. The National Science Teachers Association (NSTA) states that parents' involvement in their children's learning is important, and this will be done by providing their

children easy access to science learning resources such as educational toys (NSTA, n.d.). However, there will be a fine line when there is too much involvement with the child. Research has found that parents often provide different types of toys to male and female children (Rheingold & Cook, 1975) and encourage or discourage distinct types of play according to children's gender (Clearfield & Nelson, 2006). This research will be connected to how parents' own gender attitudes are predictive of children's gender beliefs (Coyle, 2015). Since parents are the consumers who are overwhelmingly purchasing STEM toys for male children, there is an impactful opportunity to promote gender balance in engineering (Inman, 2015). The STS research paper addresses the impact of the parental role when children are interacting with STEM toys, specifically on how parental biases are transferred to children through STEM toys. This insightful information will be used to improve STEM toys as well as create a potential meaningful impact on society.

In order to understand the relationship between the STEM toy and society, there are many other nested relationships to consider as well. The STEM toy directly impacts the child playing with it, but it is imperative to focus on the parent-child and parent-artifact relationships as well. A behavioral science study emphasizes the importance of parents communicating with their children because it improves the child's communication abilities and will allow them to develop better social skills (Runcan, Constantineanu, Ielics, & Popa, 2012). Scoping out of these relationships, community and industry stakeholders are engaging in activities such as offering a monthly subscription program for STEM toys to address leakages in the STEM talent pipeline (Zaza, 2019). Another relationship to consider are the toy-makers and how their biases can be reflected in their work. For example, a study focused on Lego® set narratives displayed that across activities, male-oriented products, characters, and anticipated consumers were positioned

as capable and knowledgeable, whereas females were consistently positioned as learners in need of practice and help (Reich, 2018). STEM toys have a plethora of unintentional consequences like enforcing gender biases, however, they also have the ability to minimize them as well. This study will identify which components of the STEM toy parents display or enhance their biases, as well as how that impacts their child. Summarizing these key findings, this paper will create a short guide on where STEM toys can improve.

This project will use the framework of technological determinism to discuss the relationships between the STEM-toy and society. Technological determinism, which was a term coined by an American sociologist and economist named Thorstein Veblen in the 20th century, is the theory that technology controls societal change. There are two categories of technological determinism: hard determinism and soft determinism. Hard determinism states that technology is independent from social constraints. This paper will use soft determinism which is the theory that technological change drives social change but at the same time responds discriminatingly to social pressures (Smith, 1994). An important idea is that the technology is not working singularly to produce societal change, but rather acting as one factor from within society to bring about change (Chandler, 1994). Utilizing soft determinism as the framework to understand the parent-child and parent-artifact relationship will provide insight into how STEM toys can determine young children's skill development.

Critics of technological determinism argue that the relationship between technology and society cannot be reduced to a simplistic cause-and-effect formula (Murphie & Potts, 2003). This oversimplification issue as well as the idea that technology does not determine but operates in a complex social field are the critiques that are most heavily-used. In relation to the relationships

between the STEM toy and society, it is imperative to consider that there are other factors, other than the interactions with the STEM toy itself, that can contribute to gender biases.

Due to COVID-19, there is a growing trend of virtual at-home learning, and it is imperative to understand the dynamic between the child and the parent in relation to the artifact to comprehend how the parental role can impact the child's future endeavors. This change in learning environments results in a change in student-teacher, student-student and parent-child interactions. Having school and home equate to the same space, this leads parents to have other means of educating their children, which results in an increase in the purchase of STEM toys. Using soft determinism, insight can be gained to see how STEM toys affect learning environments in "schools," and where humans can shape technology.

Research Question and Methods

This paper will answer the research question: "How does the parental role affect the child's actions and biases when interacting with a STEM toy?" The primary method for obtaining information will be through a comprehensive literature review, description and analysis of the specific technology, and opinions of the technology from perspectives of parents and children. This background literature review will highlight the importance of STEM toys and display perspectives of parents and children regarding STEM toys.

The secondary research method is conducting semi-structured interviews to gather information on human interactions with STEM toys. These semi-structured interviews will consist of guided questions but allow room for follow-up questions since it allows for the reciprocity between the interviewer and participant (Kallio, 2016). This research method will help drive conclusions because it will provide insight into the perspectives of parents and

children in relation to the STEM toy. The scope of the interviews will be limited to two siblings under eight, and their parents. By utilizing the technique of semi-structured interviews, it will allow for the parents and children to speak from their perspectives on how STEM toys affect their behavior and gain insight if they do drive any biases.

Conclusion

The STS paper analyzes the impact of the parental role on children's biases and actions in the context of the child playing with a STEM toy. The STS analysis of STEM toys in relation to the parental role is expected to demonstrate that parents have the ability to increase biases instilled in children. The STS deliverable will include a concise guide on where STEM toys can improve relative to where parents' biases are placed.

The technical deliverable for the capstone project are user interface designs for a Next-Gen AI dishwasher, which the capstone team will document in a SIEDS Conference Paper. The expected outcome is to improve user experience for BSH consumers who will use the Next-Gen dishwasher. Both the technical and STS portions of the project are intended to understand how humans interact with technology which can lead to greater insights that can further improve these existing technologies.

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