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

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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

Abstract

Due to the COVID-19 pandemic, it is apparent that quarantining away from society makes teaching Science, Technology, Engineering, and Math (STEM) concepts at home difficult, but there have been innovative STEM toys to achieve this goal in an effective manner. With the K-12 curriculum being fully online, the increased importance of the parental role is shown especially with the term learning coach, which is a common label that often comes with expected roles and responsibilities on the part of the parent or adult family members in the home (Smith, Burdette, Cheatham & Harvey, 102). In the context of the relationship between the child and the STEM toy, this increased importance of the parental role comes with several possible issues that need to be considered. For example, 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). However, since parents are the consumers who are purchasing STEM toys for overwhelmingly male children, there is an impactful opportunity to promote gender balance in engineering (Inman, 2015). To address the lack of research regarding parents' involvement with children interacting with STEM toys, this paper uses soft technological determinism. This framework provides insight into how STEM toys can determine young children's skill development by understanding the parent-child and parent-artifact relationship. This paper analyzes the research question: "How does the parental role affect the child's actions and biases when interacting with a STEM toy?"

Theoretical Framework

This project uses the theoretical 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 uses 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 provides information 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 vital 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 changes in student-teacher, student-student and parent-child interactions. Having school and home equate to the same space 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.

Literature Review

Many parents are purchasing STEM toys to encourage their children to learn valuable concepts because of their accessible nature and ability to be a path to understand the world of engineering. For example, from 2011 to 2012, sales of scientific toys and educational toys rose by 17% and 25%, respectively (Raupp, n.d.). 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.). An idea to be cognizant of is that there will be a fine line when there is too much involvement between the child and the parents. Parents often provide different types of toys to male and female children (Rheingold & Cook, 1975). They are also able to encourage or discourage distinct types of play according to children's gender (Clearfield & Nelson, 2006). This research is 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). This information on the parental role provides a theoretical framework for understanding the impact of this 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). Through the lens of soft determinism, this fact shows that the fundamental structure of the toy itself affects who plays with the toy. This also goes hand in hand with the fact that the players of society, in this case the parents, are more inclined to choose the toy that best "fits" with their child's gender. This relationship with the set narratives of the toy and the consumer who is buying the toy can lead to detrimental consequences, especially for the children who would like to dive deeper into a STEM career. Being cognizant that STEM toys have a plethora of unintentional consequences like enforcing gender biases, will allow consumers and others in society to realize that STEM toys also have the ability to minimize these biases as well. This will in turn allow the parent consumers to shape the STEM toys to be more gender-neutral and allow for a greater impact on their children in gaining an interest in STEM careers.

Methodology

This paper answers 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 is through a literature review, which aids in understanding the importance of STEM toys and displays perspectives of parents and children regarding STEM toys.

This paper conducts an analysis of various ways that parents can implement their biases on their children through STEM toys. A finding is 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). An important aspect that must be considered is that of the toy-makers and how their biases can be reflected in their work. The Lego® study, which had set narratives, provides background information and reinforces gender biases, with the main point being 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). These biases in the descriptions can cause parents to solely purchase toys that are intended for their child's gender, and thus could allow them to move away from the more STEM-focused toys for their female children. However, since parents are the consumers who are using their abilities to purchase STEM toys for male children, there is an impactful opportunity to promote gender balance in engineering (Inman, 2015).

To gather information on human interactions with STEM toys, the secondary research method is conducting semi-structured interviews. The first parts of these interviews are a brief ten-minute observation period with a child interacting with a littleBits® STEM toy without the parent, and is followed by another ten-minute observation period with the parent included. These

semi-structured interviews consist of guided questions towards the parent, which are listed in the Appendix, but allow room for follow-up questions since it allows for the reciprocity between the interviewer and participant (Kallio, 2016). The first interviewee is Ramya Vaddempudi, who is the mother of an eight-year-old boy named Vihaan Gude. The second interview is with Satish Palakurthi who is the father of an eight-year-old girl named Lalitha Palakurthi**.** Through these interviews of children of different genders, the insights provide a more qualitative analysis and give a unique perspective in comparison to the conclusions of the literature review.

Results and Discussion

Due to the greater importance in remote learning, this project's purpose was meaningful in order to facilitate relationships which were forced to change due to the demands of the pandemic. Through the literature review, results show that parents' own gender attitudes are predictive of children's gender beliefs (Coyle, 2015). The parent's beliefs are those that the child cannot control, and thus it is important to understand the existence of them in order to provide better responses in the child-artifact relationship. The relationship between the toymaker and the parent is another key component which needs to be examined on a deeper level. By creating narratives that are gender-neutral and thus allowing for a wider audience to utilize these tools provides a greater impact on society. The literature review shows the importance of the relationships outside of the child-artifact relationship and how they impact the child's outlook on careers in the STEM field.

From the interview process, one key result is that in the period with the interaction of the parent, both children are checking for verification if they were conducting the process correctly. However, in the period without the interaction of the parent, the children are more prone to try various ways of solving the problem. By having a trusted figure of authority in close vicinity, it

is more comfortable for the children to ask them rather than figuring out the process themselves. Also, one component of the relationship is that the children seem to be more afraid to be wrong in front of their parents and therefore would only want to try fixing the STEM toy the "right" way. However, in STEM career fields, the previous action of trying to solve the problem through various methods tends to be one that is more favorable. These observations show that it is necessary for children to have space in order to gain the true experience that the STEM toy is meant to provide.

Another key finding is that the instructions of the littleBits® toy is difficult for the children to follow and thus needed them to try various ways in order to fix the toy accurately. One component to this problem is that the diagrams are color-coded but not numbered and this made it difficult for the children to figure out which component is supposed to go in the right place. In this case, both parents are helping them try to figure out which component is supposed to go where and are acting as a guiding force. This action allows both children to get to a basic standard where they are able to experiment more of the higher-impacting components of the STEM toy. For example, with the parent helping them create a structure with the dimmer component, the children are able to understand that using a water faucet is very similar to using the dimmer component. These connections to the real-world implementations of the technology are more difficult to understand without the guiding force of the parent explaining the fundamentals. Through these findings it is imperative to have a balance of parental interaction in the child-artifact relationship. The parent's role is to allow space for the child to experiment as well as provide a guiding force when the child needs to understand the fundamentals.

In terms of the child-artifact relationship, both children interact with the toy slightly differently. Vihaan is enthusiastic from the get-go and uses phrases such as "It looks cool!" and

"Oh wow, I actually did it!" (Vihaan Gude, personal communication, February 21, 2021). A moment that is impactful in this observation period with Vihaan is one where he says, "I think I get this only a teensy-weensy bit", but he continues to play with the toy and figures out how it works by himself. On the other hand, when interacting with the toy, Lalitha maintains focus and does not comment as much as she is playing with the toy (Lalitha Palakurthi, personal communication, February 21, 2021). This is simply a different way to process information. However, as soon as Lalitha learns about the real-world connections to the toy she is building, she gets excited and it becomes apparent in the way she plays with the toy. This shows that both children are enthusiastic in their own ways and the attractiveness of the real-world connections to children.

In the semi-structured interview with the parents, on the topic of what the parents look for in a toy, one similarity between both parents was the fact that it was important to see how much their children can learn from the toy and to have a toy that enables their children to think in an innovative manner (Ramya Vaddempudi, personal communication, February 21, 2021). Both parents also agreed that by having their children play with a STEM toy, it can increase their interests in engineering and have the ability to provide them practical experiences (Satish Palakurthi, personal communication, February 21, 2021). This importance placed on the STEM toys by the parents is one that is important in providing more exciting STEM toys to their children. Through the literature review, observational and semi-structured interviews, it is apparent that there needs to be a balance in the parental role when it comes to the child-artifact relationship.

Conclusion

STEM toys have the ability to create a new generation of excited engineers in our society. Ensuring that the child-artifact relationship is getting the attention it deserves is imperative in order to motivate children in pursuing an interest in STEM. In order to do this, it is necessary to understand the importance of the parental role in this relationship. From the findings in this study, it is apparent that there is a necessity in the proper balance of the parent's interaction: being a guiding force when necessary as well as giving their children space to explore when needed. This freedom allows children to explore and develop problem solving tools that can allow them to have a greater impact in the STEM field.

A limitation to this study is the sample size of the interviewees in the observational and semi-structured interview components. With respect to the child-artifact interaction, further work should be done to see if there are any generalizations that can be made on how boys and girls interact with the toy differently. Further work on the relationship between the parent and the toymaker should be done in order to provide a greater emphasis on the importance of the structure of the STEM toy and the narrative that the toy brings with it. Noticing that both the consumer, who is the parent, and the toymaker can impact a child's career is one of the reasons why it is imperative to examine this relationship further. By providing ways of establishing gender-neutral narratives in the STEM toy itself, it will improve the impact on children who want to move further in a STEM career.

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APPENDIX

Interview questions for parents of children who interacted with STEM toy:

1. When purchasing a toy for your child, what qualities do you look for in the toy?
2. What skills do you want your child to gain when they are interacting with a STEM toy?
3. Do you think having your child play with STEM toys would increase his/her interest in engineering and thus pursue a career in it?
4. What types of STEM toys do your kids play with?