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An Engineering Tale: Using storybooks to analyze parent-child conversations about engineering (Fundamental)

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An Engineering Tale: Using storybooks to analyze parent-child conversations about engineering (K-12 Fundamental)

Introduction

Envisioning a larger workforce of engineers, with broad participation from a diverse set of workers, is one of the central concerns of engineering education research. While many current K-12 programs focus on engineering thinking and design (e.g. Project Lead the Way, Engineering is Elementary, Design Squad), there is still a need to promote aspiration and understanding of engineering as an occupation, especially in out-of-school environments where children spend a majority of their time.¹

Career aspirations and expectations of children have already started to develop prior to entering formal schooling.^{2,3} During this critical development period, parents serve as the major source of career information coupled with media (television, print, etc.) and other social experiences. While the significance of parents' role in the development of the occupational awareness of their offspring is reported in numerous studies, the process by which it occurs is not well understood.³

In engineering and other fields it is common for children to follow in the career footsteps of their parents in a phenomenon called occupational inheritance.^{4,5} Because of this strong correlation between the similarity in parents' and their offspring's career paths, it is hypothesized that parents share some type of apprenticing behavior – either overtly or subconsciously – that helps to indoctrinate their children into their own chosen profession. This anticipatory socialization process has been attributed to social norms, personal knowledge, attitudes and beliefs that they share through everyday activity.⁶

The focus of this study is specifically on engineering parents as the phenomena of occupational inheritance occurs with roughly half of undergraduate that choose to study engineering.⁴ Using frameworks derived from Bryant's socio-cognitive career theory⁶, the study will investigate strategies that engineering parents use to facilitate occupational knowledge to their child when reading an engineering-themed storybook. Specifically, what knowledge, attitudes and beliefs are shared during storybook reading?

Background

A storybook is used in this study to facilitate conversation around engineering, as parents have reported books to be the most important tool for their child's development. Additionally, shared reading has positive effects on children's understanding of concept as well as benefits for emergent literacy.⁷ However, few studies have looked at the influence of media on the career development of children, though it has been implied as the primary source of occupational learning.³ This premise is supported by a study that showed that even a short exposure to a book supporting women in non-traditional

occupations was instrumental in changing kindergarten children's perceptions of women's career roles.⁸

The storybook was developed specifically for this study and focused on the engineer's world of "work" to be able to present occupational knowledge. The storybook centered on two kids on a mission to deliver an odd shaped package to an engineer. Along the way they ponder who an engineer is, what they do, and where they work before eventually meeting up with a team of engineers. In particular, the focus of the storyline was upon the take-away message that engineers make the world a better place through the process of asking, imagining, planning, and creation to solve problems that are small or great which is derived from the National Academy of Engineer's report *Changing the Conversation*.⁹

The text of the storyline allows the reader(s) to become an active player in a journey to find the "engineer" through several artifacts and locations that illuminate aspects of the engineering occupation through what, where, who and why questions. In addition, the storybook repeats the word "engineer" multiple times (n=8 in text, plus twice in title pages), as research has shown that repetition is important for children to absorb new words.^{10,11} The illustrations contains both misconceptions of engineering (i.e. engineers fix cars like mechanics do) as well as engineering imagery (e.g. turbine, blueprints). Several sections of the book were left intentionally vague to facilitate conversation. For example, a blueprint of the ramp was provided within the illustrations, but was not referenced in the text.



Figure 1. Sample page from developed engineering storybook.

Methodology

As this study is looking personal interactions between a parent and a child, an exploratory qualitative methodology was chosen to allow for “rich” data to review the issue in the depth and detail required.¹² Conversation analysis was used to distinguish the knowledge, attitudes and beliefs that engineering parents shared with their children while reading an engineering storybook. Notations derived from Jefferson¹³ were used to transcribe the dyad’s interactions – both verbal and non-verbal. In addition, reading behavior was evaluated using the Adult Child Interactive Reading Inventory (ACIRI).¹⁴ Parents were also asked to fill out the Parental Engineering Assessment survey (PEAs)¹⁵ to gauge predisposed engineering knowledge, attitudes, and behaviors along with additional questions regarding reading frequency (# of book/week), type (storybook, picture, early reader) and accessibility (at home, daycare, other).⁷

Participants were contacted through email and asked to share the study information with other in order to reach a larger area. Purposeful sampling based on the composition of the parent-child dyad was elicited to present a balanced design (see Table 1). Twenty-four participants that self-identified as engineers (through a degree conferred or job association or other) video-recorded themselves in their own home, reading a provided storybook to their young children, aged 3 to 5 years. Participants hailed from 17 different states, specified eight different engineering disciplines, and also had a variety of academic backgrounds (6 PhDs, 4 M.S., 13 B.A. in engineering). Additionally, there were seven dual-engineering couples as well as a stay-at-home mom, an entrepreneur and a sales clerk.

Table 1. Participant demographic breakdown by dyad (n = 24)

Mother - Daughter (n = 6)	Father – Daughter (n = 5)
Mother - Son (n = 7)	Father – Son (n = 6)

Results

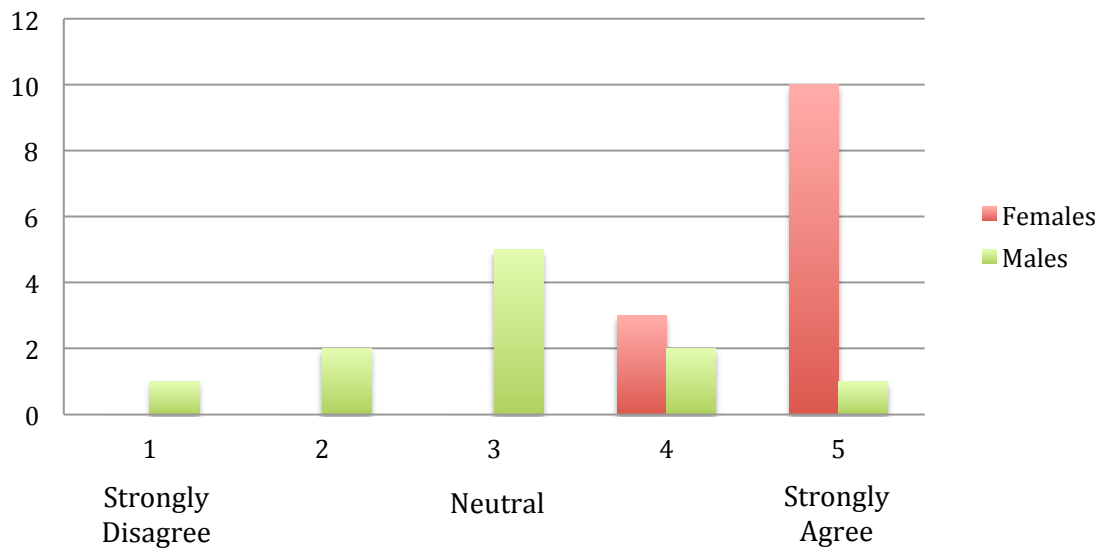
The quality of conversations between the parent-child dyads varied dramatically from no external talk between a father and his silent daughter, to tangential storytelling between a mother and her son. While readings styles also differed, the ACIRI evaluated the reading behaviors based upon 1) enhancing attention to text, 2) promoting interactive reading and 3) using literacy strategies. Each subcategory had four different measures that was rated 0-3, for a total range of 0 to 36. The average ACIRI was 23, indicating that the majority of the participants had an active engagement reading styles.

As expected the engineering parent had high confidence in knowing what engineers do but lower confidence in teaching engineering skills to children. However they still wanted young children to have an understanding of what engineering is about, though fathers were less likely to think it necessary for their children to learn about engineering at a young age than mothers.

Table 2. Selected measures for the Parental Engineering Assessment Survey. with ratings from 1 (strongly disagree) to 5 (strongly agree).

Theme	Item(s)	Mean	St Dev
Parental Ability to Teach	I know how to teach engineering skills to my child(ren).	3.95	.89
	I know how to explain engineering-related concepts to my child(ren).	4.40	.60
	I know how to help my child(ren) with his/her engineering ideas and skills.	4.25	.72
Importance of Learning	I want my child(ren) to understand what engineers do.	4.70	.57
	I think it is necessary to learn engineering as early as possible.	3.70	1.22

Figure 2. Parental gender differences in regard to the necessity of early learning of engineering.



Parents tended to focus more on relations of the illustration to the text, than the content itself - which is a common reading technique for children of this age. However, parents often didn't provide explanations when their children were unable to respond to the prompts deliberately planted into the storybook. One engineering parent didn't even correct the misconception (that engineers fix cars like a mechanic) put forth by the child when asked what an engineer does, and that same child was unable to recognize that her own father was an engineer.

One interesting thing that was not captured within the a priori coding scheme, was the use of vocabulary above and beyond what was presented in the storybook text. Some vocabulary was derived from the illustrations – such as reference to blueprints as well as the turbine motor. However, some engineering parents provided additional details for the “engineers” in the story such as describing actions (e.g. measuring, testing, building) and even including specific terms (e.g. water quality, control testing).

Table 2. Examples of knowledge, attitudes and beliefs observed.

Knowledge	Explanation of illustrations beyond text
	Additional vocabulary used
	Connect to real life
Attitudes	Intonations when talking
	Engineering takes perseverance
Beliefs	Stereotypes persist (train, mechanics)
	The idea that engineering is “hard”

Discussion

Several of the results told an interesting tale: while engineering parents are expected to have a high degree of understanding about their field, they had difficulty in expressing occupational knowledge, and in some cases even had difficulty correcting misconceptions that the child held, such as engineers aren’t mechanics. Also, several parents expressed astonishment when their child did not recognize that they too were engineers. Engineering parents also provided additional engineering knowledge during the storybook reading.

In discussing engineering with young children, we recommend that the word “engineer” gets used multiple times. Parents who used the word more often have children who know what their parent’s occupation was, but they were also able to provide more queries.

The results of this study can be used to develop materials to inform parents (as well as the general public) of strategies with which to engage conversations about engineering, and can be extended to other non-familiar occupations as well.

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