Following in Our Footsteps? Parent-Child Conversations about Engineering (Fundamental)

Dr. Brianna L. Dorie, Gonzaga University

Brianna L. Dorie is an Assistant Professor of Engineering at Gonzaga University responsible for the implementation of the first year engineering program. Her research centers around the formation of engineering thinking and broadening participation in engineering.

Following in Our Footsteps? Parent-Child Conversations about Engineering (Fundamental)

One of the major tenets of precollege engineering education is to promote the viability of engineering as a potential occupation, and there are myriad of programs, both formal and informal, that are engaged in this endeavor (e.g. incorporation of engineering into state standards, marketing campaigns such as *Changing the Conversation*, engineering outreach events, etc.). Each program has different foci, but oftentimes the same goal – how do we get more students to consider engineering? Many programs evaluate engagement, formation of engineering identity and even persistence. However, the number of students completing degrees in engineering has seen limited growth, despite this national push.[1] How then do we broaden participation in engineering? While it would be impossible to map all the potential pathways into engineering, we can take insights from the experts – engineers themselves – and apply lessons learned to help others become more aware of the field. By understanding the underlying phenomenon of occupational inheritance, this study aims to provide ways that parents and educators alike can aide in the development and understanding of engineering as a profession to all.

Introduction

Engineers often beget engineers. A survey of freshman engineering courses has shown that a majority of undergraduates have followed in the same occupational area as a parent, a correlation that is stronger with females. [2-3] The concept of occupational inheritance, in which an offspring follows in the same professional footsteps of their parent, isn't a recent phenomenon. It also isn't limited to engineering having been observed several different professions such as law, medical fields and even NASCAR.[4-7] These studies suggest that parents' own deeply held knowledge, attitudes and beliefs are transmitted to their children through parenting action.[8,9] This could include small transmissions such as simple occupational terminology (e.g. stethoscope in nursing) to ways that problems are solved. The transmission process, whether conscious or not, gradually promotes a pathway for a child to mimic a parent's occupational interests – thus allowing children to follow in the occupational footsteps of their parents. So the more that the connection between the occupational space crosses over into family the life the greater the potential for children to develop this transmission. This is not necessarily a formal process, but rather one that occurs in everyday familial interactions, such as conversations.

Conversation is such an essential feature of human existence, allowing us to interact with others, exchange knowledge and information, and even reprogram our brains to work in new ways.[10,11] The way we converse impacts not only what we say, but also what we learn, believe, and eventually become.[12,13] Its formative power is perhaps most apparent in the dialogue

between parent and child, wherein even the youngest brain is highly bound in the analysis of the exchange.[11] There is a profound prerogative to investigate how and under what circumstances conversations about engineering are occurring with our youth -- and what tools may be provided to further enhance their understanding and interest in becoming engineers themselves.

Background

It is essential to expose children to the engineering world of work at a young age, as interest develops from knowledge and familiarity as a child reaches adolescence**.** The family environment is where children are first exposed to the world of work through observations of family members, as well as overhearing family members recount their day in everyday conversation.[14] From this informal exposure, young people can construct ideas regarding work and how it applies to them even before they enter formal education. [8, 15-17]

Lutz & Keil (2002) found that young children have intuitive notions about occupations based upon generalizations that they abstract from real world phenomena.[18] Even preschool age children can distinguish between the kinds of knowledge that certain occupations have. They are able to "cluster" groups of information together to form rudimentary divisions of labor. However, with the youngest children (3 years) they found that even though they could distinguish between what a doctor and a mechanic does, they couldn't extrapolate to broader areas of expertise (i.e., a mechanic might have more knowledge to fix a broken lawnmower than a doctor). A proposed mechanism was that the 3 year olds recognized key words that were more likely to be associated with a certain profession[18] thus highlighting the importance of talk.

However, studies have shown that most children have limited knowledge regarding engineers, and this lack of knowledge can often persist into adulthood.[19-21] Common careers such as firefighter, nurse, and teacher are prevalent because they are readily recognizable and have job description that have been simplified for children. Engineering on the other hand lacks a simplistic explanation due to its complexity and diversity of foci. Children often associate engineers as someone who operates a train (which is actually a matter of semantics depending on the region), a person who fixes cars (auto mechanic) or someone in construction, which are also common associations with adults as well.[21-23] Parents that perpetuate these beliefs can potentially pass down mis-information to their progeny as parents are the predominant source of occupational information for young children.[8, 15, 24]

Parents are a significant influence on the occupational interest of their children.[8, 15, 24] Parents have been identified as the key-socializing agent by introducing a child to roles within different situations.[25-26] The way that parents socialize their children regarding occupations can have profound impacts on the way that the children perceive the occupation and how it can relate to their own self-interests and abilities.[8] Having interviewed engineers, Zhang and Cardella (2010)

found that parents encourage their children to play with particular toys and books, participate in around-the-house projects, and engage in everyday conversations to help their children learn about engineering.[27] These typical parent-child interactions are therefore a way by which parents can potentially socialize their children to recognize and develop traits that ensure success in the same occupation to which the parent belongs.[28] However, these parents did not talk about engineering explicitly, but rather encouraged general skill development.[29] A study on parental attitudes found that parents agreed that young children should learn about careers, but that the process should unfold slowly and that children should be sheltered from the complexities of "real work".[30] However, sometimes this could result in the child not recognizing that the parent is an engineer.[29]

While parents have been identified as an important source of occupational knowledge, the process of *how* they transmit their knowledge, attitudes and behaviors about occupations has received little attention.[31] It is therefore of major interest to understand how engineering parents, whom are expected to have intimate knowledge of the field, interact with their children regarding their chosen occupation. Specifically, what strategies do engineering parents use to facilitate occupational knowledge about engineering to their young child? This study aims to look at how engineering parents engage with their young children about engineering, with focus on how they share engineering occupational knowledge, attitudes and beliefs. Results include information on how parents (and educators), both familiar and not as familiar with engineering, can converse about engineering with young children.

Description of the Study

This exploratory qualitative study investigated engineering parents' strategies using a developed storybook as an impetus for conversation. The storybook follows two protagonists on their way to deliver a package to an engineer. Through conversing with each other the children ponder what an engineer is, who they can be and where they work – allowing for the text and illustrations to build upon the engineering world of work to expose occupational knowledge, attitudes and beliefs (Figure 1).

Through the development of the engineering storybook there were four constructs that were purposefully integrated as to elicit conversation between the parent and child.[32] The intention of these constructs was to encourage talk between the engineering parent and their child around 1) use of the word "engineer", 2) engineering imagery (i.e. turbine, blueprints), 3) who can be an engineer, and 4) if they know any engineers. Means to facilitate these conversations included illustrations, question embedded within the text and two separate prompts that specifically posed the question to the listener (in this case the child).

Figure 1. Example page of the developed storybook (illustrated by Mel Chua).[32]

Twenty-four parents (Table 1) that self-identified as engineers (through a degree conferred or a job association or other) video-recorded themselves reading the developed storybook to their young children (aged 3-5 years) within their own home. This allowed for a naturalistic observation of the parent-child interaction not encumbered by the presence of the researcher.

Table 1 Parent-child dyad distribution of study participants.

	Sons	Daughters	Total
Fathers	6	5	11
Mothers	7	6	13
Total	13	11	**24**

All of the participants (aged 25 to 44) were married with children living at home, with six individuals having a spouse whom was also an engineer. The participants predominantly identified as as Caucasian (Asian = 2, Native American, Other = 2), with two acknowledging Latino/a ethnicities. They hailed from 17 different states, demonstrating a diverse geographical spread.

All participants stated that they had at least one engineering degree, with ten individuals holding advanced degrees (4 M.S. and 6 Ph.D.). In terms of occupations, the majority were working as engineers (n =16), but a few of the participants were represented from academia (n=3) and engineering management (n =2). There was a representative sample from several different

engineering disciplines: mechanical (n=9), electrical/computer (n=5), environmental (n=2), civil (n=2), chemical (n=1), industrial (n=1) and biomedical (n=1) engineering.

Video data was transcribed and segmented using a conversation analysis coding system that distinguishes turns-at-talk between two individuals.[33] Conversation Analysis (CA) is a qualitative method derived from ethnomethodology and discourse analysis and established in the 1960's by social scientists Harvey Sacks, Emanuel Schegloff and Gail Jefferson to distinguish social interaction during discourse. It allows researchers to describe, analyze and understand talk through a series of organizational structure and linguistic notation.[33] Specific notation for CA transcripts were developed by Gail Jefferson to show linguistic emphasis. Additional focus includes the use of adjacency pairs that delineate conditional relevance (e.g., first turn-at-talk of adjacency pair makes the later turn relevant) to ascribe structural relevance to a certain speaker. Common organization of talk include: taking and constructing turns, building sequence of actions, repairing troubles, speaking in ways fitted to occasion, and selection of particular words.

Names were replaced with pseudonyms to protect privacy. Data was derived from the close examination of the specialized transcript and formed the basis for theorizing about the parental strategies by investigating adjacency pairing, which is the main construct of conversation analysis. Transcripts were intricately analyzed through for initial observations using different "keys" to sequester data into manageable phenomenon.[34] Focus was placed on the sections of talk that deviated from the storybook text, as when the parent or child interjected talk.

Findings

Construct 1: The word "engineer"

Within the storybook, the word engineer was integrated into the text a total of eleven times, including front cover and title page. Parents mentions ranged from 8 to 30 times, with mothers on average ($M = 18.5$, $SD = 6.1$) mentioning engineering more than fathers ($M = 14.6$, $SD = 7.7$). While there was a difference in the means by gender, it was not significant ($t(19) = -1.21$, $p < .01$).

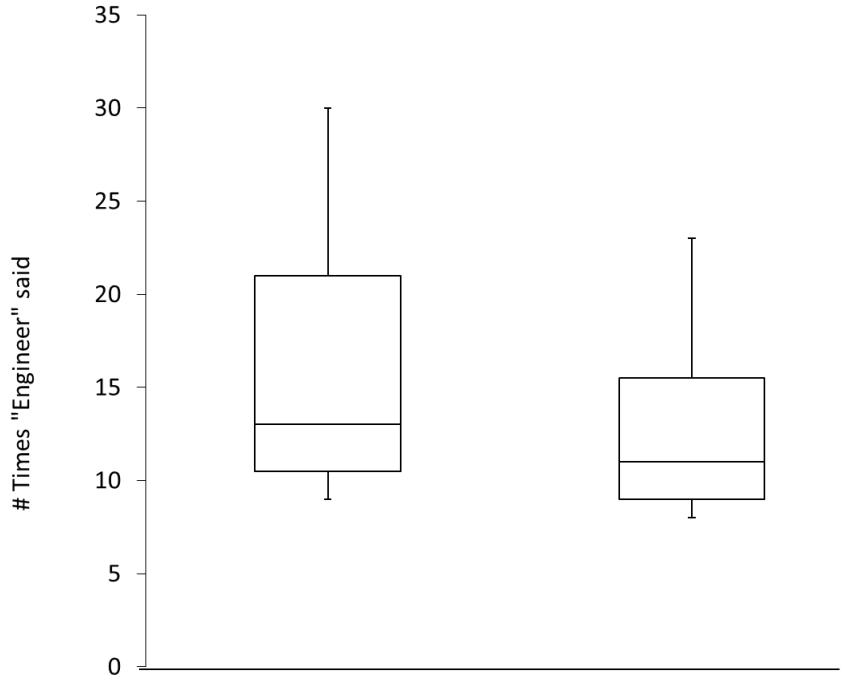

Figure 2. Engineer/ing mentions by parent gender.

Construct 2: Engineering imagery

Context specific engineering imagery was represented through two different illustrations: one representing a turbine (plane) engine and the other was a blueprint image. The images were chosen due to relative connection to professional engineering. The way that parents talked about the engineering imagery included engineer-related vocabulary such as turbine and blueprint, but also simplified language such as plane for turbine and drawing for the blueprint (Table 2). The use of simplified vocabulary might be indicative of the level to which the parent believes the child to be at.

Table 2. Vocabulary use for engineering imagery.

	Turbine Image	**Blueprint Image**
Engineering-related	Turbine (4), Jet Engine (2)	Blueprint (2)
Simplified	Plane (2), Motor of Plane	Drawing, Picture (2), Map
Mis-identified	Fan, Wheel	N/A
From in-line text	N/A	Plans (8)
No identification	13	10

Construct 3: Who could be an engineer

The idea of "who" can be an engineer probed and challenged stereotypes that are common (i.e., that engineers are old white men). The illustrations and text for this construct presented several different options for who can be an engineer. The first deals with the common misconception that engineers work on car being a man fixing a car[23] and is only "male" other than the main character on the page. Other "potential" engineers include a young girl jumping rope (who could one day theoretically grow up to be an engineer) and a lady carrying some materials that is winking at the main characters. The prompt on the page "what do you think?" was intended to see if any of the three characters could potentially be deemed to be an engineer, as well as to determine what traits (e.g., old, young, female / male) they should have. Three children thought that the man fixing the car could be an engineer, and parents responded with affirmation (that it was an acceptable answer) or clarification – though no parent opposed their child's viewpoint. No one thought the little girl jumping rope could be an engineer, whereas eight children correctly responded that the winking women could be an engineer. There were nine children that did not answer the prompt, with the parents either rephrasing or restating the question before moving on. Interestingly, two children identified that a train driver was an engineer (though it was not presented on the page). Both parents gave a token acknowledgement and then moved on reading.

Construct 4: Recognizing engineers

This construct was intended to evaluate how the children recalled their parent's occupation and conversely how the parent's reacted to the response of their child using a call-out with the prompt: "Do you know any engineers?" Out of 24 participants, only four children readily stated (directly after the prompt) that the parent reading the book was an engineer. After encouragement and further prompts an additional seven children also correctly identified their parent's occupation.

Children's answers varied from recognition that the parent was an engineer to identification with common misconceptions, such as misrepresentation as a car mechanic. Additionally, some children expressed that they did not know any engineers or were uncertain – providing deflection through verbal and physical means. There was no discernable pattern with regard to child's response or age. Nor was there any pattern between a child's recognition of parent as an engineer and the types of engineers with whom they interact.

Parent's response included affirmation, repetition, restatement and rephrasing of prompts, statements and no action. While only a small sub-set (n = 3) of the participants' children associated engineers with incorrect attributes such as "fixing cars" and "engines", the parents did not address these inconsistences during the storybook reading.

Discussion

One broad theme that emerged from this study was the idea that the engineering parents missed opportunities to discuss engineering with their children such as connections to their own career. This was evidenced through children not connecting that their parent was an engineer and the parent not putting forth their own occupation. Additionally, there were opportunities for parents to negate or expand upon certain misidentifications with engineering such as the strong association with trains. It was more prevalent for parents to explain and/or reinforce that an engineer drives a train, rather than expound on their own occupation. Having said this, there is the caveat that the engineering parents are not as immersed in the literature regarding engineering education and may not be aware of how important it is to appropriately showcase engineering to young children to garner potential interest in the field.

The following are recommendations for both engineering (and non-engineering) individuals to talk about engineering with young children:

Recommendation 1: Don't be afraid to talk about engineering! Use the word "engineer" in everyday talk, as repeated exposure will allow a child to use it in their everyday conversations. Keep an ear out for times that engineering is mentioned on television commercials or books (you might find that it is used more often than you think).

Recommendation 2: Make a personal connection to your own occupation if you are an engineer. Connecting to personal information is essential in developing and building key interest and knowledge in certain subject.[35] If you feel that the topic is too complex, talk about where you work, what you work on, who you work with and what kinds of things you do (e.g., work outside, use a computer, draw, talk with others, etc.).

Recommendation 3: Address inconsistencies early, and stray away from train / mechanic / construction associations. These beliefs are often hard to mitigate later down the line and those that are not interested in these association may not consider engineering as an ample field of study.

Conclusion

It was found that engineering parents provide both general and specific knowledge about engineering that is informed by their own background. However, while engineering parents display positive attitudes regarding engineering, they may not correct inconsistencies that the child may have - even though they consider themselves knowledgeable about their own field. While this study gives insights regarding engineering-parent child conversations about

engineering, it is just a small observation of the many ways that engineering parents may transmit their own occupational knowledge, attitudes and beliefs. There is a significant need for further studies to investigate the phenomenon of occupational inheritance in engineering.

References

1. National Science Board. 2014. Science and Engineering Indicators 2014. Arlington VA: National Science Foundation (NSB 14-01).
2. Seymour, E., & Hewitt, N. M. (1997). *Talking about leaving: Why undergraduates leave the sciences.* Boulder, CO: Westview.
3. Mannon, S.E., & Schreuders, P.D. (2007). All in the (engineering) family? – The family occupational background of men and women engineering students. *Journal of Women and Minorities in Science and Engineering* 13: 333-351.
4. Lentz, B.F., & Laband, D.N., (1989). Why so many children of doctors become doctors: Nepotism vs. human capital transfers. *The Journal of Human Resources* 24(3): 396-413.
5. Lentz, B.F., & Laband, D.N., (1992). Self-recruitment in the legal profession. *Journal of Labor Economics,* 10(2): 182-201.
6. Kurtz, D.M., (1989). The political family: a contemporary view. *Sociological Perspectives,* 32(3): 331-352.
7. Pinchot, S., Lewis, B.J., Weber, S.M., Rikkers, L.F., & Chen, H., (2008). Are surgical progeny more likely to pursue a surgical career? *Journal of Surgical Research,* 147(2): 253-259.
8. Bryant, B.K., Zxonkovic, A.M., and Reynolds, P., (2006). Parenting in relation to child and adolescent vocational development. *Journal of Vocational Behavior,* 69: 149-175.
9. Caspi, A., Wright, B.R.E., Moffitt, T.E. & Silva, P.A., (1998). Early failure in the labor market: childhood and adolescent predictors of unemployment in the transition to adulthood. *American Sociological Review,* 63: 424-451.
10. Deacon, T. W. (1998). *The symbolic species: The co-evolution of language and the brain*. WW Norton & Company.
11. Kuhl, P. K. (2010). Brain mechanisms in early language acquisition. *Neuron*, *67*(5), 713-727.Kurtz, D.M., (1989). The political family: a contemporary view. *Sociological Perspectives,* 32(3): 331-352.
12. Piaget, J. (1953) *The Origins of Intelligence in Children*. London: Routledge and Kegan Paul.
13. Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes.* Cambridge: Harvard University Press.
14. Galambos, N. L., & Sears, H. A. (1998). Adolescents' perceptions of parents' work and adolescents' work values in two-earner families. *The Journal of Early Adolescence*, *18*(4), 397-420.
15. Auger, R., Blackhurst, A., & Wahl, K. (2005). The development of elementary-aged children's career aspirations and expectations. Professional School Counseling, 8(4), 322-329.
16. Savickas, M. L., Nota, L., Rossier, J., Dauwalder, J. P., Duarte, M. E., Guichard, J., ... & Van Vianen, A. E. (2009). Life designing: A paradigm for career construction in the 21st century. *Journal of vocational behavior*, *75*(3), 239-250.
17. Jablin, F. M., & Putnam, L. L. (Eds.). (2001). *The new handbook of organizational communication: advances in theory, research, and methodos*. Sage Publications.
18. Lutz, D.J., & Keil, F.C., (2002). Early Understanding of the Division of Cognitive Labor. *Child Development,* 73(4): 1073-1084.

19. NAE (National Academy of Engineering), (2002). *Raising public awareness of engineering*. Washington, D.C.: The National Academies Press.
20. NAE (National Academy of Engineering), (2008). *Changing the conversation: Messages for improving public understanding of engineering*. Washington, D.C.: The National Academies Press.
21. Pearson, G., & Young, A. (2002). Technically speaking: Why all Americans need to know more about technology: National Academies Press.
22. Cunningham, C.M., Lachapelle, C., and A. Lindgren-Streicher (2005). Assessing Elementary School Students' Conceptions of Engineering and Technology. In Proceedings: *American Society of Engineering Education*. Portland, OR.
23. Knight, M. and C.M. Cunningham. (2004) Draw an Engineer Test (DAET): Development of a tool to investigate students' ideas about engineers and engineering. In Proceedings: *American Society of Engineering Education*. Salt Lake City, UT.
24. Bandura, A., Barbaranelli, C., Caprara, G., & Pastorelli, C. (2001). Self Efficacy Beliefs as Shapers of Children's Aspirations and Career Trajectories. *Child Development, 72*(1), 187-206.
25. Brim, O. G., & Wheeler, S. (1966). *Socialization after childhood: Two essays*. J. Wiley.
26. Clausen, J. A. (1968). A historical and comparative view of socialization theory and research. Socialization and society, 12-24.
27. Zhang, A., & Cardella, M. (2010, June). Knowledge transmission and engineering teaching. In Proceedings of the 9th International Conference of the Learning Sciences-Volume 1 (pp. 1087-1094). International Society of the Learning Sciences.
28. Kohn, M. L., & Schooler, C. (1969). Class, occupation, and orientation. *American Sociological Review*, 659-678.
29. Dorie, B.L., and M. Cardella. "Engineering Childhood: Knowledge Transmission Through Parenting" Conference Proceedings: *American Society of Engineering Education Annual Conference & Exposition,* Atlanta, GA June 2013.
30. Cinamon, R.G., & O. Dan (2010). Parental attitudes toward preschoolers' career education: A mixed-method study. *Journal of Career Development,* 37(2): 519-540.
31. Wahl, K. H., & Blackhurst, A. (2000). Factors affecting the occupational and educational aspirations of children and adolescents. Professional School Counseling, 35: 367-374.
32. Dorie, B.L., and M.E. Cardella. "An engineering tale: Using storybooks to analyze parent-child conversations about engineering." Conference Proceedings: *American Society of Engineering Education Annual Conference & Exposition,* Seattle, WA June 2015
33. Sacks, H., Schegloff, E. A., & Jefferson, G. (1974). A Simplest Systematics for the Organization of Turn-Taking for Conversation. *Language*, *50*(4), 696. doi:10.2307/412243
34. Sidnell, J. (2011). *Conversation Analysis: An Introduction* (5th ed.). Wiley-Blackwell
35. Crowley, K., & Jacobs, M. (2002). Building islands of expertise in everyday family activity. Learning conversations in museums, 333-356. Lawrence Erlbaum Associates, Publishers.