Parental Strategies for Introducing Engineering: Connections from the home

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Background

Parents are one locus of control in the education and development of their children, not only at formal ventures, but also in the home (Yun et al, 2010; Catsambis, 1995; Fan & Chen, 2001; Seyfried & Chung, 2003). Parents are the ones whom typically purchase toys, read books, take children to museums, and interact with their child on a daily basis.

Research in both science and engineering education literature has shown a child's interest is significantly impacted by the parent's viewpoint (George & Kaplan, 1998; Szechter & Carey, 2009). Background knowledge of a particular subject, such as science or engineering, has the ability to affect how they interact with their children, impacting what main concepts the children will learn (Yun et al., 2010). However, many adults and children alike have a minimal understanding of engineering (NAE, 2008).

Additionally, parents have a major influence on a child's career choice (Taylor et al., 2003; Dryler, 1998). A survey of undergraduate engineering students found that women were significantly more likely to have a parent who is an engineer and to have previously studied engineering before college (Mannon & Schreuders, 2007). Numerous studies (Knowles, 1998; Marjoribanks, 1997; Mau and Bikos, 2000; Smith, 1991; Wilson and Wilson, 1992) have found that college students and young adults cite parents as an important influence on their choice of career. Yet parents may be unaware of the influence they have on the career development and vocational choice of their children. Children typically have more understanding of their parents' occupations, when compared to other possible occupations (Seligman, Weinstock, & Neil, 1991). Thus engineering parents may pass on engineering-related knowledge, interests and aspirations to their progeny in a process called occupational inheritance. The purpose of this study is to determine what engineering parents are doing to educate their children about engineering so that we can use this knowledge to inform the development of engineering activities for all students.

Methods

Interviews of 24 self-identified parents with engineering backgrounds were analyzed to capture a variety of approaches that parents have taken in order to shape their children's exposure to engineering. Participants included practitioners from industry (n = 8), engineering faculty (n = 14), and students (n =2), from twenty different engineering disciplines. The open-ended interviews included information about parents' background, interactions with children that led to engineering learning (content, strategies and reactions), parenting ideology, and parent's own understanding of engineering. The data was open and axially coded for general themes. This paper focuses on what the parents stated that they did with their children to learn about engineering.

Results

Though parents were invited to participate in the study if they taught engineering to their children, a majority (88%) stated that they don't do such explicitly.

> *"We've made comments in passing or in conversation, but we haven't really had an explicit conversation yet about what it means to be an engineer."*

> *"We didn't really make a conscious effort to do that [teach engineering]."*

Instead the parents mentioned that they wanted their children exposed to broader concepts such as science and technology. They didn't necessarily want to limit their child's learning to engineering concepts.

> *"I wouldn't say [I've exposed him] engineering directly, but more via science and technology."*

> *"I wasn't trying to teach them just engineering concepts; I want them to be exposed to everything. So I wasn't specifically teaching them engineering, but I think it is important for them to know about it because I am an engineer."*

Also several of the parents mentioned that they are encouraging "fundamentals" for future engineering learning. Examples include problem solving, rational thinking, creativity, curiosity dealing with consequences/failure and basic physics/math skills.

> *"We don't do as much engineering, but rather basic physics and we try to do things that are very, very fundamental."*

> *"I believe that [rational thinking] is the way people should think, very fundamentally. That's the way we [engineers] look at things, right?"*

> *"We don't talk about engineering concepts but more fundamental things like ideas of convection and temperature."*

Parents primarily reported helping their children learn about engineering through informal based discussions (spontaneous conversations, queries from children) and interactions with media (books, computers, television, and toys). In addition, hands-on activities, outreach opportunities and educational materials were mentioned (see Table 1).

Table 1. Parental practices to introduce "engineering".

Informal Discussions	
▪ *Work Visits*	Take kid to work/lab which generates questions to parents about what they do, also includes work done at home
▪ *Real World*	Discussions about 9/11, explanation of how things "work", what happens on a construction site, tours.
▪ *Queries*	Dinner, car or bedtime conversations, spontaneous questioning from child, parent posing situations or quizzing on knowledge.
Media	
▪ *Print*	Encyclopedia, science books, newspapers, storybooks, non-fiction books.
▪ *Television*	Home improvement shows, PBS (Word Girl, Super Why!, Design Squad), Bob the Builder, Star Trek.
▪ *Toys*	Building (Legos, Tinker Toys, K'nex), mechanical toys, gear kits, train set.
▪ *Games/Puzzles*	Board games (Blockus, Chess, Crack the Case, Guess Who?), Sudoku, puzzles
▪ *Computers*	West Point Bridge Designer, educational computer games (math or physics), helping to install programs.
Hands-on Activities	
▪ *Building*	Paper airplanes, helping around house, crafts, model car, sand castles, and simple construction projects.
▪ *Experiment*	Chemistry experiments (cleaning pennies, Mentos & Coke), science fair projects, combining materials and noting results.
▪ *Tinkering*	Taking things (music box, toaster, boxes) apart or put them back together.
Outreach	
▪ *Programs*	Girl Scouts, afterschool programs, space day/camps.
▪ *Designed Environments*	Children's Museum(s), Aquariums, Science Centers.
Education	
▪ *Kits*	Circuit kits, Lego robotics, and telescopes.
▪ *Curricular*	Helping with homework, giving extra tasks (i.e. math quizzes, workbooks in summer)

Informal Discussions

A vast majority of the parents (n=96%) mentioned that informal discussions were part of their repertoire for interacting with their child. These conversations allowed the parent to share knowledge and were often initiated by the child asking a question. Some common locations included bedtime discussions, dinner table conversations and talking while in the car. Parents would also point out specific concepts to their child and even quiz them on previous knowledge.

Media

Several different types of media were also used to facilitate the learning of concepts such as the books, Internet, toys/games and computers. Television also has its claims for introducing engineering information. One parent stated that the television series "Star Trek" was his impetus for going into engineering, and another found out that the series was responsible for his daughter studying physics.

Hands-on Activities

Parents cited a range of different hand-on activities that they did with their children, ranging from making paper airplanes to mixing different household products in a mini-chemistry experiment. One parent talked about after visiting a ornamental garden that her child wanted to make a house for the "fairies". When they went home they gathered some organic materials around the backyard. However, the child had difficulty getting the materials to stay up, so the parent explained that the fairy house needed to have support. This simple interaction allowed the parent to talk about forces and even bring in her personal expertise about engineering.

Outreach

Some parents involved outside sources for introducing concepts to their child such as by visiting museums or going to programs that offered additional expertise.

Education

Some parents expressed the fact that the current school system wasn't meeting their child's need for engineering preparation, so they felt the need to take things into their own hands.

> *"I think the way schools teach math is not demanding enough. So if I don't teach them at home, I feel their talents will get wasted."*

General Observations

Though most parents mentioned the fundamental foundations for learning engineering, they did not often state what exactly children should learn about engineering. In most cases they were a little hesitant to make a strong connection between engineering and what they did with their child.

One parent stated that his daughter didn't find out what he did as an engineer until she got to college herself, even though he thought that he had discussed his job with her on many occasions (she got a degree in Physics anyway).

Not a single engineering parent mentioned the engineering design process with their children, though one parent did recall how their child had "an innate way of figuring

things out, you can see she's kinda got the engineer thought process" and several mentioned that they promoted general problem solving skills.

Discussion

As these are activities that engineering parents used to introduce concepts to their children, they provide an insight on how to introduce engineering concepts in the classroom. Many of the parental practices outlined in Table 1 can be translated to classroom practices. One limitation in the classroom is the fact that the teachers are not as familiar with engineering and may need some additional training to feel comfortable using everyday activities to introduce engineering concepts.

This work will be used to inform a future study in which we plan to investigate how parent-child conversations, situated around several activities at a museum, help to develop engineering interest and expertise. Additionally, we home to use this to develop engineering activities for the classroom.

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