AC 2012-4385: PARENTS' CONCERNS ABOUT THE INCLUSION OF ENGINEERING EDUCATION IN P-12 CLASSROOMS

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Parents' Concerns about the Inclusion of Engineering Education into P-12 Classrooms

Abstract

There is an increasing interest in providing more opportunities for pre-college/university students to learn engineering concepts and content. Particularly, adopting engineering activities into P-12 classrooms has been one of the emphases for attracting more students to engineering. The primary purpose of this paper is to initiate discussion about parents' concerns and suggestions about the inclusion of engineering education in P-12 classrooms. In addition, this paper provides an overview of important concepts related to content analysis including benefits, procedure, and practical implications to increase general understanding of the method. In an effort to increase the validity and reliability of the technique, transparent steps are presented throughout the paper.

Keywords: Parents' concerns; pre-college engineering education; quantitative and qualitative content analysis

Introduction

Researchers from a variety of social science disciplines have long been interested in studying the ways in which parents influence their children. Thus far, their findings demonstrate that parents play a pivotal role in children's education.[1, 2] Many societies have also acknowledged the importance and benefits of science, technology, engineering, and mathematics (STEM) education for international leadership roles in the 21st century global economy. Among STEM disciplines, increasing the focus upon engineering education is a recent and growing trend. In particular, a great number of efforts to include engineering learning in pre-kindergarten through 12th grade (P-12) continue to develop, because there is a general understanding that pre-college engineering education will provide a diverse STEM talent pool[3, 4]. In order to provide more opportunities and ultimately motivate young learners to choose careers in engineering, educators and policymakers have focused on expanding a variety of programs, such as K-12 outreach programs and teacher training, to help young learners' as well as the general public's understanding of what engineering is. Many engineering education experts have also assessed and discussed the status of current P-12 engineering education in addition to developing engineering standards.

Given the growth in the number of interests and efforts directed towards developing pre-college engineering education, many concerns and challenges have been discovered. One issue concerns increasing the diversity of engineers by attracting women and minorities to the field.[5] There has also been concern with increasing teachers' confidence and knowledge in teaching engineering disciplines in their classrooms[3, 6]. Considering the important role of parents and their growing interests in children's education, we found an unrealized opportunity to understand the connection between parents and the movement towards pre-college engineering education. From the research literature, we know parents are an important bridge between school and students. Therefore, this paper explores that gap, particularly focusing on hearing parents' voices for the future pre-college engineering education.

Theoretical Background

A. The Importance and Status of P-12 Engineering Education

In recent years, the importance of engineering education has been emphasized by a variety of groups, such as educators and policymakers. A rationale for the phenomenon is that as the world becomes increasingly dependent upon advanced technology, the engineering workforce becomes essential to maintain and develop, in order to preserve competitiveness in the global society[7, 8, 9]. However, research has shown that the number of engineers is decreasing, and the image of engineering is not that positive[10, 11, 12]. Therefore, not only have concerns about the 'quantity' of engineers been raised, but also issues over the 'quality' of engineering education[13, 14]. Along the same line, the community reached to a consensus that the presence of engineering education in classrooms is crucial but weak. This naturally leads many educational parties to focus on recruiting and retaining future and current engineers. Among these efforts, it has been claimed that exposing children to engineering concepts in early education is the most effective way to increase their interest in the field[15, 16]; hence, more focus has been placed on motivating young learners for the future of engineering.

Since the acknowledgement of the importance of pre-college engineering, subsequent reports have been released concerning the current status and future directions of engineering education. Most recently, a report, *Engineering in K-12 Education: Understanding the Status and Improving the Prospects*[17] was released, in which they conclude that the presence of engineering education in K-12 classrooms is very important in order to improve students' learning and achievements in other school subjects such as science, technology, and mathematics. In 2008, the National Academy of Engineering's report, *Changing the Conversation: Messages for Improving Public Understanding of Engineering*,[11] also presents an alarming message to the engineering community about the lack of understanding of what engineers do. Likewise, many academic researchers have shown that early engineering education provides diverse benefits to students, and ultimately to the engineering community by stimulating interests in engineering from early childhood.[4, 18, 19, 20, 21]. Among the many benefits that engineering can provide, one consensus is that pre-college engineering can be a catalyst for improving other related subjects such as science, technology, and mathematics. Moreover, through the engineering design process, learners can utilize other concepts and knowledge to solve problems, which will be practically helpful in solving the real-world problems.[18, 22, 23]

While efforts to include engineering education in P-12 classrooms grow, challenges and concerns about the inclusion have also increased. One of the biggest obstacles mentioned is the teacher's lack of knowledge about engineering concepts, which inherently entails a challenging time in developing their curriculum related to engineering learning.[4, 17, 24, 25, 26] Teachers' attitudes towards engineering pose another issue. Though teachers seem to have positive attitude toward engineering, their confidence level in teaching engineering concepts is substantially lower[27, 28]. In order to reduce these gaps, many practitioners and educators have focused on developing pedagogical strategies and professional curriculum developments to provide adequate engineering knowledge and to increase teachers' confidence in teaching engineering concepts.[3, 25, 29, 30] In addition to these concerns, rationale for engineering education's position in existing school subjects is also largely discussed, arguing for either integrating into or separating engineering from existing subjects[31]. The key here lies in focusing on opening pathways for children into engineering through early awareness of engineering careers and better understanding of what engineers do.[32, 33] Not only does familiarity with engineering knowledge from early childhood increase the chance for children to consider engineering as their future career, but engineering concepts also help students improve achievements and performance at school.

The goal of engineering education should lie in how engineering education can help students learn STEM education in order tofurther open their eyes to future careers in related fields instead of forcing students to be engineers. By cultivating the natural interests in engineering, students can have a positive perception of engineering, and also obtain future benefits by utilizing engineering knowledge in their daily life.

B. Parents' Influence on Engineering Education

It is evident that students are influenced by factors in their surrounding environment.; Among these factors, parents/caregivers are one of the strongest influences in forming students' interests in learning and success in school. Not only does parental involvement help students improve their academic achievement,[34, 35, 36, 37, 38] but also parents' influence on students' decisions in choosing their major and future career.[39, 40, 41] Teachers also benefit from parental involvement; parents can help increase school-to-home communications, which ultimately help teachers gain more insights into their students' learning needs.[42] Beyond the education, strong parental support helps children self-regulate behavioral and social skills.[43] The motivation behind the parental involvement is derived from parental role construction and parental sense of efficacy for helping their children.[1, 44, 45] Extensive studies have shown, however, that the impact of parental influence varies according to other factors, such as demographic characteristics and types of involvement.[46, 47, 48]

In the same vein, research studies in engineering education indicate that engineering students and professionals are highly influenced by their parents when deciding whether to enter an engineering field.[49, 50, 51, 52] Many studies also found that parents play an important role in introducing engineering to their children, developing an interest in STEM related careers, and further sustaining success in engineering careers.[53, 54, 55] Moreover, parental involvement has significant effects on students' attitudes towards STEM education, and promotes pathways in STEM related careers.[56, 57, 58] These benefits will ultimately help foster diversity in STEM workforces. According to Fitzpatrick and Silverman,[59] parents, as a role model, are the strongest influence on women's selection of careers in engineering. Therefore, parental involvement is viewed as a booster in the success of bringing engineering to the classrooms.

In spite of the important role of parents in engineering education, studies show that parents and teachers have insufficient knowledge and familiarity in engineering, which can limit students' potential pathways to STEM careers.[60] Furthermore, few empirical studies have addressed those issues and analyzed parents' concerns and thoughts of the inclusion of engineering education in classrooms. However, considering the importance of pre-college engineering education, and many efforts and movements in progress to meet the goals, it is important to investigate parents' opinions about engineering inclusion in P-12 classrooms. Thus, this study seeks to investigate parents' voices regarding the engineering education in P-12 classrooms.

C. Content Analysis

Academic researchers in the social sciences have discovered the value of content analysis as it provides much flexibility and a systematic approach to analyze written, verbal, or visual communication messages.[61, 62 63] Particularly, content analysis has been widely used in communication research due to the nature of available data within the field; for example, there is much written data, such as interview transcriptions and media product, in communication research.[58] In 1952, Berelson[61] originally defined content analysis as "a research technique for the objective, systematic and quantitative description of the manifest content of communication" (p. 55). This is reinforced by a variety of researchers in many fields.[61, 62, 64] Krippendorf[65] also cited content analysis as "a research technique for making replicable and valid inferences from texts (or other meaningful matter) to the contexts of their use" (p. 18). In spite of many definitions of content analysis that can be slightly different among researchers, one consensus is that the key of this analysis lies in unlocking underlying information that is not discovered by numerical data. The following are key words and principles in content analysis: objective, systematic, and replicable.

As the use of content analysis increases, researchers have paid more attention to its validity and reliability as well as the development of sound procedure of content analysis. Although some computer-aids are available for content analysis, it is true that the method itself still largely involves human's decisions during the process of analyzing non-numeric data. Particularly, the trustworthiness of content analysis has been a prominent issue. In order to improve the trustworthiness in research using content analysis, the development of analytic procedure and a good coding scheme are key recommendations for researchers in their studies.[65, 66, 67] Accordingly, reporting appropriate intercoder reliability is the most recommended way to present the internal consistency and credibility as evidence of trustworthiness.[68, 69, 70] As intercoder reliability estimations, there are several indices available: percentage agreement, Holsti's method, Scott's Pi (π), Cohen's Kappa (κ), and Krippendorff's alpha (α). In addition to sound planning of content analysis procedure, choosing the appropriate index of intercoder reliability is also critical to constitute a sound foundation. Typically, coefficients of .90 or greater would be acceptable, but the criteria vary slightly according to the reliability indices and the characteristics of study areas.

There are two approaches to content analysis based on whether a theory or model exists: inductive and deductive. Inductive content analysis is used when there is not sufficient prior knowledge of the phenomenon, while the deductive approach begins with comprehensive literature and earlier theories[71, 72]. In other words, the textual data is inductively analyzed for qualitative content analysis, and deductively analyzed for quantitative methods. When distinguishing between the classifications ofqualitative and quantitative content analysis, quantitative analysis of content analysis typically concerns frequency counting of units (e.g., a word, phrase, sentence, paragraph, and whole text) of context in textual material, while qualitative analysis is used to examine latent meaning of the data[69, 73]. However, there is no definitive way to decide which approach is more appropriate; it predominantly depends on the purpose of the study and its characteristics of the available data. Along the same line, in order to resolve the trustworthy issue of content analysis, many content analysis experts suggest using both qualitative and quantitative methods to constitute sound results of content analysis study[74, 75].

In educational research, content analysis has also been used in a way that researchers intend to discover distinctive patterns or trends of educational studies from published journals or existing curricula by analyzing the context[76, 77]. Considering the characteristics of educational research, there is much information collected from written data, such as responses of open-ended survey questions, transcripts of interviews and discussions, and curriculum development materials. Moreover, any types of observational materials, such as photographs and videos, can be analyzed through content analysis by coding them into textual data. These types of data are well suited to content analysis. Engineering education researchers have also begun to use content analysis methods. For example, there have been 13 articles published between 1994 and 2011 that have used content analysis methods within the *Journal of Engineering Education*. The search was processed by using a key word, content analysis, as a predominant research method in each paper. The papers utilize content analysis to analyze open-ended survey questions, interview transcripts from teachers and students, graphics, and published documents to identify underlying themes and patterns as well as to evaluate courses and/or programs[78, 79]. However, the issues of validity and reliability of content analysis were not clearly addressed in those 13 papers. Therefore, thorough review and disseminations of content analysis is necessary in order to improve engineering education research practices.

The Purpose of Study

The primary purpose of this paper is to provide insights into parents' thoughts about children's engineering learning, particularly about the inclusion of engineering education in P-12 classrooms. This study was initiated from two simple, yet important, questions, "Are parents aware of engineering education? What do they think about engineering learning in classrooms for their children?" The answers to these questions will help researchers, educators and policymakers in considering the role that parental involvement plays in motivating students towards engineering. The following research questions guided this study:

a) Are parents aware of the inclusion of engineering learning activities in any P-12 classrooms?
b) Are parents interested in receiving any information regarding engineering education for their children? If yes, by what means do they prefer to receive that information?
c) What kinds of concerns and suggestions do parents have regarding the inclusion of engineering in P-12 classrooms?

Method

Participants of this study were parents who currently have children in P-12, and online survey was used to collect the data. The survey was composed of four sections: parents' awareness, interests, concerns and suggestions, and demographic questionnaire. There are two methods used in this study: descriptive analysis for research question (a) and (b), and content analysis for research question (c). In order to find parents' awareness and interests in pre-college engineering education, two dichotomous questions (1 = 'Yes' and 0 = 'No') were asked. Each question had an additional question for respondents to describe how they obtained their knowledge and what kinds of methods that they prefer to receive the information related to engineering education. The data were analyzed using Statistical Package for the Social Sciences (SPSS), version 19.

The question about parents' concerns and suggestions was composed of open-ended questions in order to not constrain their answers. The textual data were systematically analyzed through both quantitative and qualitative content analysis. In particular, a summative content analysis approach using manifest content analysis, rather than latent content analysis, was selected due to the characteristics of the data and the validity. Manifest content analysis refers to analyzing a particular word or content by counting the usage frequency of that keyword or content, while latent content analysis focuses on underlying meanings of the words or the content[80]. Based on the guidelines set by Neuendorf [69] and Krippendorf [65], the process of content analysis was composed as shown in Figure 1. Not only did this study use the steps, but it would also provide general guidelines for other researchers who plan to use content analysis for their research. Since the research questions of this study were already discussed in the previous section, the details from defining the population are described in the following as well as reporting some results of each step in the results section.

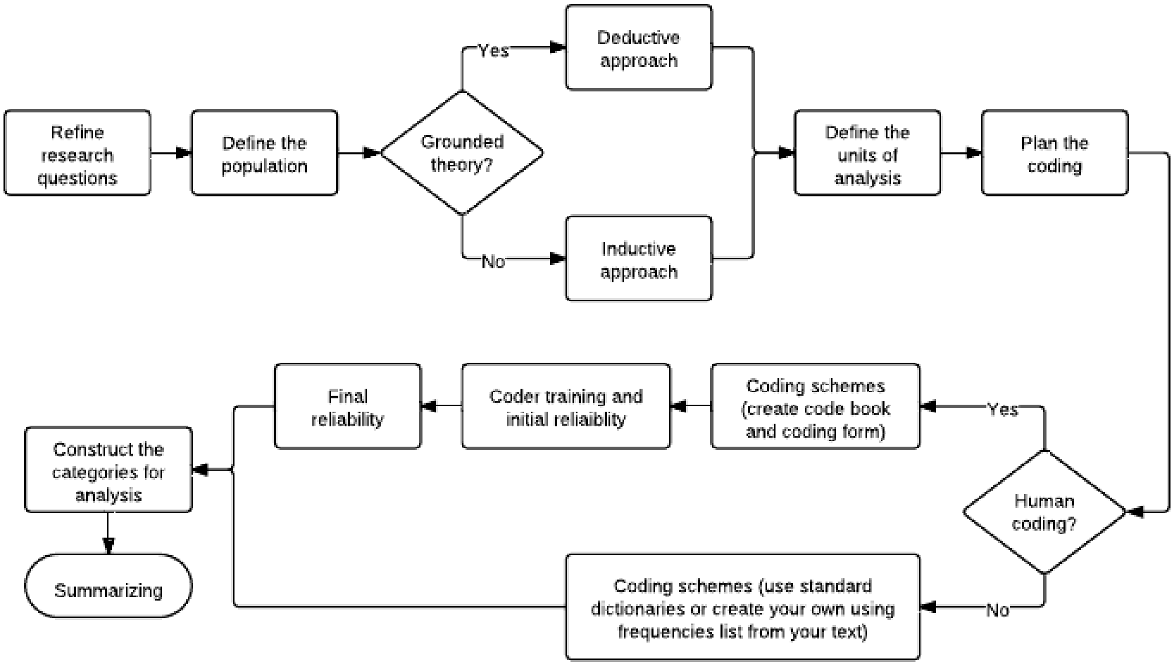

Figure 1. Flow Chart for the Process of Content Analysis

Results

A. Parents' Awareness and Interests in Pre-college Engineering Education (Descriptive Analysis)

The descriptive summary of the sample is presented in Table 1. Respondents were predominantly female (84.44 %) and 'White/Caucasian' (83.15 %). Moreover, the household type mostly appeared to be married families (82.22 %). Nearly half of the respondents were in their 40's with two children (56.67 %). Over half of respondents had 'Bachelor's' (43.33 %) or 'Master's' (27.78 %) degree, and had non-STEM background (55.56 %).

Table 1. Descriptive Summary of Participants

Socio-demographic variables	n	%	Socio-demographic variables	n	%
Gender			Household type		
Male	14	15.56	Married, children living at home	74	82.22
Female	76	84.44	Other	16	17.78
	90	100		90	100
Age			Number of children		
≤ 29	1	1.11	1	24	26.67
30 – 39	26	28.89	2	51	56.67
40 – 49	47	52.22	3	12	13.33
≥ 50	16	17.78	4	3	3.33
	90	100		90	100
Income			Ethnicity		
≤ $49,000	16	20.25	White/Caucasian	74	83.15

	$50,000 – $89,999	22	27.85		Latino/a	6	6.74
	$90,000 – $129,999	20	25.32		Asian	4	4.49
	≥ $130,000	21	26.58		Others	5	6.74
		79	100			89	100
Education				STEM background			
	High school	5	5.56		Degree in science	16	17.78
	Associate's degree	6	6.67		Degree in technology	3	3.33
	Some college	9	10.00		Degree in engineering	19	21.11
	Bachelor's degree	39	43.33		Degree in mathematics	2	2.22
	Master's degree	25	27.78		Non-STEM	50	55.56
	Doctorate	6	6.67			90	100
		90	100				

Note: N = 90

For the response to the question regarding parents' awareness of any engineering related activities in their children's classrooms, only 36% answered "Yes" to the question. Not many respondents were aware of engineering related activities at school. However, the majority (71 %) of respondents expressed their willingness to learn more about engineering education. Concerning methods to receive further information about engineering education, parents prefer "Materials sent home from school (24.26 %)," followed by "Web sources (18.72 %)," and "Workshops for parents (17.45 %)." Figure 2 shows the summary of preferred ways of receiving engineering related information.

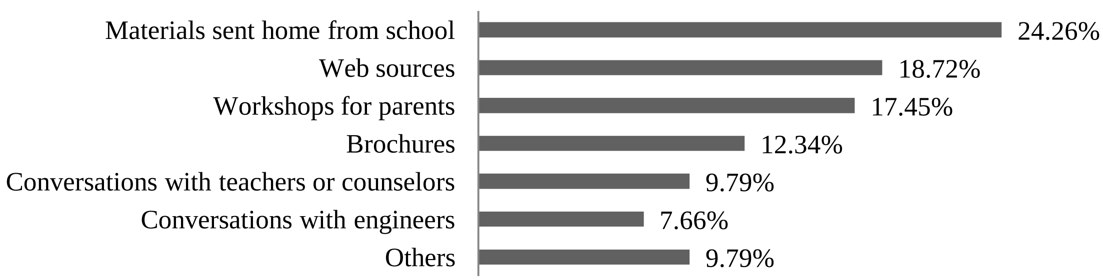

Figure 2. Preferred Ways of Receiving Engineering-related Information

B. Parents' Concerns about the Inclusion of Engineering Education (Content Analysis)

Step 1: Define the population

The population of this study was quite simple: parents who have children currently in P-12 grades. Because there is not enough preexisting literature directly related to the research topic of this study, an inductive approach of content analysis was used. In order to design an instrument for data collection, semi-structured interviews with parents/caregivers (*N*=10) from a wide range of geographic and socioeconomic backgrounds were conducted. Results from the interviews were used to refine the survey questions. Through open-ended survey questions, parents' concerns and suggestions regarding the inclusion of engineering education in classrooms were mainly collected. Those responses are the primary target of the content analysis. In total, 90 parents/caregivers participated in the survey during spring and summer in 2011. The survey was composed of four sections: awareness of engineering education learning in classrooms, preferred methods of receiving engineering related information, concerns and future suggestions for engineering education, and demographic questionnaire.

Step 2: Define the units of analysis

The purpose of determining the units of analysis is primarily to reduce text materials to manageable proportions for analysis. Moreover, unitizing is important because it not only defines the scope of analysis in the text, but also impacts validity of content analysis. Units can be established at various levels, such as a word, phrase, sentence, paragraph, whole text, and theme. According to Krippendorff [65], there are three distinctive units: sampling units, recording/coding units, and context units. Sampling units are those units determining selective inclusions in an analysis, while recording/coding units are specific information within sampling units. Context units are used to delineate the scope of information that coders need while characterizing the recording units. Unlike mass communication research where researchers study a large volume of text, such as newspapers and books, this study was pretty straightforward in terms of determining the units of analysis. In particular, open-ended survey questions are the sampling unit of this study. Among survey questions, the question regarding parents' concerns and future suggestions for engineering education was selected as the coding and context unit. Furthermore, a syntactical approach was used in identifying the units.

Step 3: Plan the coding

It is vital to report information about the training of the coders and the coding process because a clear and transparent coding procedure can guarantee the quality and the reliability of the research[65]. In order to constitute a valid coding plan, there are two components that needed to be determined prior to the actual coding: coder qualifications and coding methods. When it comes to the coding, it is very important to select coders suitably qualified to the study because it directly links to the validity of coding. According to Krippendorff [65], the coders must have the necessary cognitive abilities and appropriate backgrounds with sufficient familiarity of the research topic. In this study, there are three coders including two authors of this study and one volunteer; all are currently work in the field of engineering education as researchers. Furthermore, the raw data collected by survey was screened to verify whether the response is properly addressed for each question. This screened data, particularly the responses for parents' concerns, was the main target of the next step, the coding.

As a first step of coding, two coders conducted a pilot test to build rules for coding, and a sample of text was coded together to check the consistency each other. This step was also to create a coding book for third coder. When it comes to the actual coding, three categories were used: meaning unit, condensed meaning unit, and code. Meaning units of each response were identified to narrow down, literally, the "meaningful" units of the responses. For example, many words (e.g., I, you, my, the, am/are/is, etc.) are not necessary for the analysis to answer the research questions. Condensed meaning unit was defined as condensed unit of meaning unit if applicable, and then the actual code was given to each response. Examples of this coding are presented in Table 2. The initial intercoder reliability, using Krippendorff's α, was 0.943. With an agreement of those two coders, the third coder continued to code the responses using the coding book.

Table 2. Examples of Meaning Units, Condensed Meaning Units and Codes

Text/original response	Meaning unit	Condensed meaning unit	Code
Many teachers don't even know what scientists do – they don't have the skills to teach engineering	Many teachers don't have the skills to teach engineering	teachers' inadequate knowledge in engineering	inadequate knowledge (K)
It needs to be integrated into the existing curriculum. There is already too much schools are being asked to do	It needs to be integrated into the existing curriculum.	integrated into the existing curriculum	integration (INTG)
Lack of teacher training and support making engineering scary rather than exciting	lack of teacher training and support making engineering scary rather than exciting	lack of teacher training and support	teacher training (TRNG)

Step 4: Construct the categories

Categories are the main groupings of constructs. In particular, each coder examines the codes to discover any interesting patterns of the textual data. Table 3 shows the final coding scheme and the categories. Parents' concerns are mainly separated into three categories based on the targets of concerns: (a) concerns for children (40.5 %), (b) concerns for teachers (33.8 %), and (c) general concerns (25.7 %) for engineering education. When it comes to their children, parents most often worried about any challenges with learning engineering and the unfamiliarity of the subject. For teachers, it appeared to be teachers' knowledge and willingness to include engineering concepts and contents in the existing curriculum. Moreover, practical applications for children to solve real-world problems were the most frequent suggestions for pre-college engineering education, followed by creativity and diversity in engineering learning activities.

Table 3. Final Coding Scheme and Categories

Frequency n	Frequency %	Examples	Codes	Category
5	16.7	• Children's low knowledge of engineering as profession • Unfamiliar with engineering concept in general	Knowledge	I. Concerns for children (40.5%)
8	26.7	• Connections to children's interests and life questions	Interests	
15	50.0	• Challenges for children with learning disabilities • Pressures from additional course work • Impediment of core content learning	Challenges	
2	6.7	• Potential for future job as engineers • Benefits of learning engineering concepts	Opportunity	
30				
2	8.0	• Teachers' training	Training	II. Concerns for teachers (33.8%)
8	32.0	• Lack of knowledge or understanding in engineering concepts	Knowledge	
14	56.0	• Teachers' effort and willingness to include engineering into existing curriculum • Engineering mixed with other courses, such as mathematics or science	Integration	

1	4.0	• Additional support for teachers • Encouragement for teachers allocating engineering learning within their classes	Support	
25				
7	36.8	• Creativity • Diversity in engineering learning • Hands-on activities • Design process • Problem solving skills	Content	
11	57.9	• Practical applications for real-world problems • Multisensory approach • Interactive technology • Activities involved with local engineering companies and actual engineers • Fun factors in engineering learning for children's interest • Proper level of engineering learning by children's age and personality • Age appropriateness	Pedagogy	III. General concerns and suggestions (25.7%)
1	5.3	• Cost of learning engineering • Lack of space in current curriculum	Others	
19				

Note: N = 74

Step 5: Calculate reliability

Intercoder reliability is a critical concern in relation to content analysis. Several indices have been presented by content analysis researchers to compute intercoder reliability, such as percent agreement, Holsti's method, Scott's pi (π), Cohen's kappa (κ), and Krippendorff's alpha (α). Each index contains advantages and disadvantages (i.e., limitations); thus, it is researchers' responsible to select a proper measure based on their data. Percentage agreement among coders might be the simplest way to calculate coders' agreement. However, this dichotomous method (1 = agreement vs. 0 = no agreement) has its limitations because it increases the chances for agreement among coders. Kolbe and Burnett[81] indicated that when using the percent agreement index it is easy for coders to artificially inflate reliability by adding categories they know will be used or produce disagreement rarely. Scott's pi (π)[82] and Cohen's kappa (κ)[83] share a similarity in that both indices accounts for chance agreement, but both indices can be used only for nominal level variables. Krippendorff's alpha (α), however, has more attractions to coders in several reasons. The most important feature of this index is that it allows for any number of coders and for variables at different levels of measurement from nominal to ratio. Although there are some tools for calculating intercoder reliability, human intervention still plays an important role in computing these indices.

In this study, Krippendorff's α was used. Since the coded data of this present study is nominal with three coders and missing data, the following formula was used:

$$_{\text{nominal}}\alpha = 1 - \frac{D_0}{D_e} = \frac{A_0 - A_e}{1 - A_e} = \frac{(n-1)\sum_c O_{cc} - \sum_c n_c(n_c-1)}{n(n-1) - \sum_c n_c(n_c-1)}$$ (Source: Krippendorf [65])

where o_{cc} represents the c-c pairs within units, and n_c represents a sum of each raw and column of each o_{cc} unit in reliability data matrix. Table 4 shows the abstract version of the matrix of this study. Based on this matrix, coincidence matrix was created next. Thus, the final intercoder reliability among three coders was 0.879. For those who are interested in reviewing detailed information about Krippendorff's α calculation, we recommend his book, *Content analysis: An introduction to its methodology*[65].

Table 4. Reliability Data Matrix

Units u:	1	2	3	4	5	…u…	74 (N)	
Coder 1:	a	a	b	b	b	…c_{u1}…	b	
Coder 2:	a	a	b	c	b	…c_{u2}…	c	
Coder 3:	a	.	b	b	b	…c_{u3}…	b	
	3	2	3	3	3	… m_u…	3	210

Step 6: Summarize patterns and findings

As shown in Table 2, parents were most often worried about engineering education inclusion into classrooms in their children's perspective (40.5%), followed by concerns for teachers (33.8%). Among concerns for children, the high percentage shows that parents concerns about potential challenges that might confront their children, such as overly strenuous workloads at school, and any potential conflicts with other existing course work. Children's interests in engineering learning was next, since parents are afraid of forcing their children to learn something, natural interests from children would be the best way to attract more engineers. Furthermore, the results show that parents are also concerned about teachers, particularly about teacher's knowledge in engineering concepts and engineering integration.

Conclusion

The results show that parents/caregivers are primarily concerned with any challenges that their children might confront and teachers' content knowledge and ability to teach engineering. This result is consistent with previous studies that reported challenges and concerns for future engineering education[4, 17, 24, 25, 26]. Parents/caregivers also suggested engineering pedagogy that should be integrated into existing courses because they do not want engineering courses to overload to their children's school work. Furthermore, it was evident that parents are not familiar with engineering activities, but parents/caregivers were highly willing to learn about it for their children. This finding implies that educators should remember to include parents in their curriculum, and provide sufficient information regarding pre-college engineering education. As many previous studies found, this can create a sound pathway for children towards engineering in the future. This study has many implications. Not only does this study provide further insights into parents/caregivers' perceptions regarding engineering education inclusion in classrooms, but it also provides examples of both quantitative and qualitative content analysis approaches.

There are some limitations in this study. Primarily, it would be better to have larger sample size to generalize the patterns found in this present study. Many future research interests are also found from this study. It would be interesting to investigate parents concerns by children's characteristics, such as gender, age, and personality. Parents' backgrounds would also be great of interest. For example, parents with engineering background might have different concerns about the inclusion of engineering education in classrooms than parents with a non-engineering background.

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