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Abstract

While there is a growing interest in infusing engineering into elementary classrooms, very little is known about how well positioned elementary teachers are to teach engineering. This study examined elementary teachers' perceptions of and familiarity with design, engineering, and technology (DET). We collected data from 192 elementary teachers using the DET teacher survey. While these elementary teachers thought teaching DET was important (Mean = 3.46; SD = 0.43), they were relatively unfamiliar with DET (Mean = 2.01; SD = 0.65). Years of teaching experience did not affect teachers' familiarity with teaching DET and their perceptions of how importance DET was. Moderately experienced teachers showed stereotypical views of engineering. Furthermore, teachers' motivations to teach DET differed based on their ethnic backgrounds. The results suggest a need to improve elementary teachers' familiarity with design, engineering, and technology. Professional development activities should be guided by research on teacher knowledge, and establish an alignment between motivations of teachers and expectations of their schools to ensure administrative support.

Keywords: Elementary teachers, teacher perceptions, teacher familiarity, teacher DET survey

Introduction

The importance of teaching engineering and promoting technological literacy at the K-12 levels has received significant attention in recent years in the U.S. (National Academy of Engineering, 2006; National Academy of Engineering & National Research Council, 2009). Today about twenty-five states explicitly discuss engineering in their standards (Purzer, Strobel, & Carr, 2011) and technology and engineering education are emphasized in the recently developed framework for K-12 science education (National Research Council, 2011). Although debates concerning technology and engineering are ongoing, the terms, technology and engineering have been synonymously used in the National Science Education Standards with an emphasis on design (National Research Council, 1996). To avoid the ambiguous differences and capture the broader meaning of engineering and technology, we will use the term design, engineering, and technology (DET), which was formerly introduced by Yasar and her colleagues (Yasar *et al.,*2006).

DET education has several benefits for children including improved technological literacy. According to the International Technology and Engineering Educators Association (ITEEA), students, as early as in elementary school, need to develop technological literacy including a broader understanding of how technologies develop, make evaluations on the effects of technology, and understand how technology relates to other fields of study and affects society (International Technology and Engineering Education Association, 2007). In addition to enhancing children's technological literacy, DET education can also enhance student learning in science and mathematics and support the development of skills such as problem solving. For example, Eshach (2006) found that when a design-based learning approach is used in the classroom, students develop problem solving skills that are critical in dealing with ambiguity and solving open-ended and ill-defined problems. Moreover, other studies show that engineering design projects not only improve problem solving skills, but also enhance students' science content knowledge (Apedoe *et al.*, 2008; Fortus *et al.*, 2004; Kolodner *et al.*, 2003; Mehalik, Doppelt, & Schunn, 2008; Wendell & Lee, 2010) as well as knowledge and skills in mathematics (Hjalmarson, Diefes-Dux, & Moore, 2008). Studies also show that through engineering design, students develop more positive attitudes towards engineering as a career (Cunningham & Lachapelle, 2010; Kolodner *et al.*, 2003; Mehalik *et al.*, 2008).

Despite the indication of the positive impact of DET on student learning and skill development show by these studies, our knowledge of K-12 teachers' knowledge, skills, and readiness to teach DET is still limited. Current studies show that both teachers and students have limited understanding of design, engineering, and technology (Ganesh, 2010; Knight & Cunningham, 2004) as many view engineers as construction workers, automobile mechanics, and train drivers, among other things. These views are very narrow considering that engineers design many products and processes that we use in our daily lives.

In 2006, Yasar and her colleagues published a paper on the development of the Design, Engineering, and Technology (DET) teacher instrument. Their study showed that K-12 teachers had low self-rated familiarity with DET and low confidence in teaching DET (Yasar *et al.*, 2006). Although this study surveyed a large sample of K-12 teachers, only a small number of them ($N = 13$) taugh at the elementary level. Our work expands upon this prior research by specifically focusing on elementary teachers. Despite the increasing emphasis on DET education at the elementary school level, benefits of DET education for children, and the urgent need for research-based teacher professional development, we know little about elementary teachers' perceptions of DET, their motivations to teach DET, and possible differences based on demographic factors such as gender, ethnicity, and teaching experience. Hence, in our study, we surveyed the characteristics of a large sample of elementary teachers and their perceptions of DET based on their gender, ethnicity, and teaching experience.

The Relationship between Teacher Knowledge, Beliefs, and Teaching Practices

There is a direct correlation between teachers' knowledge about technology and their students' knowledge of and attitudes towards technology (Rohaan, Taconis, & Jochems, 2010). A qualitative study on elementary teachers in the U.K. found that teachers held misconceptions about design, engineering, and technology (DET) mirroring that of their students' (Jarvis & Rennie, 1996). These teachers who identified constructing and building as the primary focus of DET also reported making and building prototypes the focus of their classroom activities. This is consistent with the Knowledge, Attitudes and Behavior framework (Schrader & Lawless, 2004), which suggests that a person's knowledge impacts his or her behavior. Similar misconceptions of engineering were found with U.S. elementary teachers (Cunningham, Lachapelle, & Lindgren-Streicher, 2006) and students (Capobianco *et al.*, 2011). While building and prototyping are important parts of design, a more complete view of engineering that includes problem scoping, planning, analysis, and iteration is necessary (Hsu, Cardella, & Purzer, 2010).

Previous studies have also explored K-12 teachers' beliefs and perceptions of teaching and learning design, engineering, and technology. Interviews with teachers revealed that secondary school science and mathematics teachers related teaching of DET to the subject matter they taught, while elementary teachers, who are generalists, were not influenced by a single subject (Jones & Carr, 1992). Nathan and colleagues found the largest influence of teachers' decisions to endorse a student for engineering courses was academic achievement. They also state the socioeconomic status of the student could have also played a role in teachers' decision making process (Nathan *et al.*, 2010). These studies support the argument that teachers' perceptions influence their teaching practice. Moreover, the views that K-12 DET education is a pathway to higher education and that DET as a derivation of science and mathematics are reflected in the results of prior studies and more likely to be manifested in secondary school teachers than elementary teachers (Jones & Carr, 1992). Therefore, elementary education might provide an opportunity to serve the purpose of promoting technological and engineering literacy in general. As previous research has shown, teachers' knowledge and beliefs impact their teaching practice (Jarvis & Rennie, 1996; Rohaan *et al.*, 2010). We can better understand teachers' DET teaching practices by systematically examining their perceptions of DET.

Teacher Characteristics and Views of Design, Engineering, and Technology

Oftentimes professional development programs approach teachers as a homogenous group with similar motivations, background knowledge, and expertise. Hence, these programs result in varying levels of influence on teachers (Baker et al., 2009). Research on teachers' perceptions and motivations based on demographic characteristic can help guide the development of effective professional development.

For example, previous research shows teachers from underrepresented ethnic groups are motivated by social factors and have a great interest in improving their students' future lives and helping them develop successful careers (Su, 1997). Other studies show gender-based differences in teachers' perceptions of importance of DET (Yasar *et al*., 2006) as well as their definitions of DET (Zoller & Ben-Chaim, 1994). Female teachers are more likely to define technology as artifacts such as tools, appliances, computers, and electronics compared to male teachers who are more likely to define technology as the application of science. Teachers also approach DET education based on the content they teach. Generalists such as elementary teachers emphasize the link between everyday experiences and DET while secondary teachers use DET as a way to promote learning in their subject area (Jones & Carr, 1992). There are also differences in teachers' willingness to learn about DET based on years of teaching experience, where moderately experienced teachers (6–10 years of experience) are most willing (Yasar *et al*., 2006).

These studies suggest that teachers' knowledge, perceptions, and motivations can differ based on diverse factors such as gender, ethnicity, and teaching experience. A better understanding of these differences is imperative to the development of more effective teacher professional development programs that address these diverse perceptions and motivations.

Research Questions

As discussed in the previous sections, previous studies indicate that K-12 teachers have limited familiarity with DET education in addition to misconceptions of design, technology, and engineering. Furthermore, teachers have different perceptions of DET based on demographic characteristics and the grade level and subject they teach. However, there is a paucity of research on elementary teachers' perceptions of DET. To help fill this void, we conducted a survey study with elementary teachers from a national sample representing eighteen different states in the U.S to ascertain answers to the following four research questions:

1) What are elementary teachers' familiarity with and perceptions of engineering?
2) Does elementary teachers' familiarity with and perceptions of DET differ based on their gender?
3) Does elementary teachers' familiarity with and perceptions of DET differ based on their ethnicity?
4) Does elementary teachers' familiarity with and perceptions of DET differ based on their teaching experience?

Table 1
How DET is addressed in participants' state standards

DET in standards (Purzer, Strobel, & Carr, 2011)	States that participants were from
Explicit engineering standards	California, Connecticut, Indiana, Massachusetts, Maryland, New York, Texas
Engineering standards in the context of technology design	Colorado, Illinois, Kansas, Wisconsin
Engineering components	Michigan, Pennsylvania
Technology design components	Arizona
None	Florida, Louisiana, Missouri, New Mexico

Note: The information about state standards were driven from a study by Purzer, Strobel, & Carr (2011)

Methods

Setting and Participants

INSPIRE, a P-12 engineering education and research institute at Purdue University, conducted six different week-long elementary teacher professional development academies between 2006 and 2008. The DET survey was administered to teachers at the beginning of each academy before they were introduced to any engineering content. Elementary teachers were recruited to these summer academies through national advertisements disseminated via listservs, professional organizations, and other networks. Teachers who submitted applications to attend the workshop were selected to participate in the academy based on the strength of their application materials, considering the diversity of applicants such as geographic location and school's socioeconomic make-up.

A total of 192 elementary teachers participated in the study. These teachers represented eighteen different states throughout the U.S. Please refer to Table 1 for information regarding the participants' states, and the degree of engineering standards in place at these states. The mean age of the teachers was 41.5 (SD = 11.38) years. The average full-time teaching experience was 14.12 (SD = 10.58) years. The remainder of the demographic information is presented in Tables 2 and 3.

We used the DET survey instrument designed and validated by Yasar *et al.* (2006) to collect data on teacher perceptions. The DET is a four-point Likert scale instrument, which was initially tested with data collected from teachers from Arizona. We conducted the reliability analysis for the whole survey as well as each factor with the new

Table 2
Participants' gender and ethnicity

	African American	Hispanic	Caucasian	Non-respondent	Total
Male	1	5	20	1	27
Female	14	4	144	3	165
Total	15	9	164	4	192

Table 3
Participants' full time teaching experience and highest degree received

	1–5 years	6–15 years	More than 16 years	Non-respondent	Total
BS	42	23	11	0	76
MS	10	40	61	1	112
PhD	1	1	0	0	2
Non-respondent	0	1	1	0	2
Total	53	65	73	1	192

data we collected from our sample ($N = 192$). The overall internal consistency estimate of reliability (Cronbach's α) of the 41-item instrument was 0.86 (Cronbach, 1951). The reliability of the four factors and short explanation of each factor are as follows:

1. *Importance of DET* (Cronbach's $\alpha = 0.88$) included 18 items on what aspects teachers perceived to be important to teach related to DET, their motivation to teach DET, and their preferences in respect to the methods with which they receive professional development in DET.
2. *Familiarity with DET* (Cronbach's $\alpha = 0.81$) included 12 items on confidence in teaching DET, perceptions of barriers, and past experience in DET training and teaching.
3. *Stereotypical characteristics of engineers* (Cronbach's $\alpha = 0.72$) included five items measuring teachers' perceptions relating to characteristics typically linked with engineers (such as being good in mathematics and science), contributions of DET to society, and stereotypical views of engineers.
4. *Characteristics of engineering* (Cronbach's $\alpha = 0.68$) included six items on teachers' perceptions of traits of engineers that were often not associated with the engineering profession (e.g. communication skills, people skills) and views of how well female and minority students perform in DET.

Data Analysis

The responses were analyzed using the factors yielded in the original study (Yasar *et al*., 2006). Scores of four negatively-worded items, such as teachers' perceived barriers in integrating DET which loaded onto the *familiarity* factor, were inverted before further analysis. In addition to exploring the overall results of the survey, we examined whether there were differences based on gender, ethnicity, and years of full-time teaching experience. We examined the normality of the composite factor scores, the distribution of the data, and conducted a Shapiro–Wilks test. Based on these analyses, we decided to perform a series of non-parametric tests: the Mann–Whitney test and the Kruskal–Wallis test.

We used the approximate Mann–Whitney test in SPSS version 17 to explore differences in teachers' responses based on gender and ethnicity. To analyze the ethnic differences, we grouped participants into two groups (majority and minority). The majority category included teachers who were Caucasian. The minority category included 15 African American and nine Hispanic teachers. To explore differences based on teaching experience, we grouped teachers into three groups based on their years of full-time teaching experience: new teachers (1–5 years), moderately experienced teachers (6–15 years), and expert teachers (more than 16 years). We investigated whether there were differences between teaching experience levels by performing a Kruskal-Wallis test. For the follow-up *post-hoc* test, we used a Mann–Whitney test with a Bonferroni correction.

Results

Results of the Entire Survey

Overall, teachers thought teaching DET in K-12 was important; however, their familiarity with DET was low indicating these teachers did not feel fully prepared to teach DET (see Figure 1). As revealed by item means of 3.00 or higher (where 4.00 was the maximum possible mean), teachers strongly believed that DET should be integrated into the K-12 curriculum. The teacher sample as a whole thought DET was important (Mean = 3.44, SD = 0.36). The teachers also thought that when teaching science it was important to include: a) project planning and b) the use of engineering in developing new technologies.

Teachers also agreed that their motivation for teaching science was to promote an enjoyment of learning; to develop an understanding of natural and technical world; to prepare young people for the world of work; to promote an understanding of how DET affects society; and to develop scientists, engineers, and technicians for industry. They also wanted to teach their students about the types of problems DET is applied to, design process, the use and impact of DET, the science underlying DET, and how to communicate technical information. An examination of individual items related to the importance of DET revealed that all but one item had a mean above 3.00. Participants

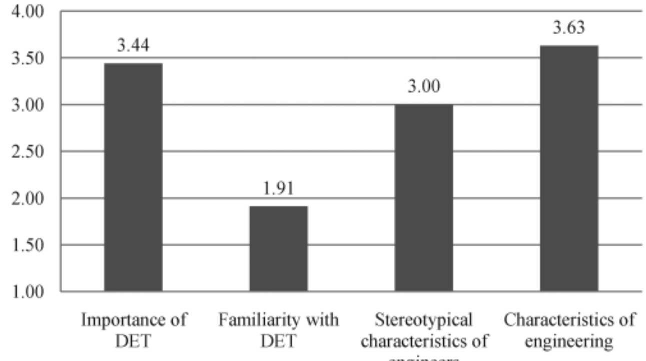

Figure 1. DET mean scores for each factor

were neutral concerning their interest in learning about DET through college courses (Mean = 2.64, SD=0.96), while they held high interest in learning through peer training, in-service training, and workshops.

Despite the fact that teachers rated the importance of DET highly, they displayed low self-rated familiarity with DET (Mean = 1.91, SD = 0.45). Teachers were neutral in regard to their confidence in integrating DET into their curriculum. This is not surprising considering that they also indicated not having received adequate DET education either during their pre-service or in-service training. Additionally, they saw lack of time, training, and knowledge as barriers to integrating DET.

The overall sample did not show stereotypical views of engineers (Mean = 3.00, SD = 0.51). Teachers agreed that typical engineers had good verbal, writing, and people skills. They agreed that most people felt that minorities and females can do well in DET. As for the characteristics of engineering, the mean score over 3.5 (Mean = 3.63, SD = 0.33) showed that participants strongly agreed that engineers had good mathematics and science skills, liked to fix things, and earned good money. Also, they agreed that DET had positive consequences for society.

Results by Gender, Ethnicity, and Full-Time Teaching Experience

Gender

The independent samples Mann–Whitney test at a significance level of 0.05 did not reveal differences between male and female participants in any of the four factors: importance of DET ($U = 2053.50$, $p = 0.52$), familiarity with DET ($U = 2015.50$, $p = 0.43$), stereotypical characteristics of engineers ($U = 2109.50$, $p = 0.66$), and the characteristics of engineering ($U = 2219.00$, $p = 0.97$) (see Figure 2 and Table 4).

Ethnicity

The Mann–Whitney test exhibited a significant difference in the *importance* factor based on ethnicity ($U = 1184.00$, $p < 0.01$, $r = -0.23$). The minority teachers rated the importance of DET significantly higher than majority teachers, with a small effect size (Cohen, 1992). Examining individual items that loaded onto this factor revealed that three out of eighteen items showed significant differences based on ethnicity after Bonferroni correction ($p < 0.01$). In Table 6 we report the items that were significant, the means and standard variations, and the statistics from Mann–Whitney test.

There were no significant differences between the two groups of teachers (majority and minority) regarding their familiarity with DET, stereotypical characteristics of engineers, or characteristics of engineering (see Figure 3 and Table 5 for descriptive statistics of respective groups). Furthermore, examining individual items loaded onto these three factors showed no significant differences.

Full-time teaching experience

There were no significant differences between importance of DET factor and teachers' full-time teaching experience. Similarly, in regard to the familiarity factor, the Kruskal–Wallis test revealed no significant difference based on teaching experience. However, according to descriptive data, experienced teachers were more likely to agree that lack of time, training, and knowledge were more formidable barriers to integrating DET than new teachers. Also, experienced teachers were more likely to agree that the lack of administrative support was more of a barrier than moderately-experienced teachers according

Table 4
Comparison based on gender

Factor		Mean	SD
Importance of DET	male	3.46	0.43
	female	3.44	0.35
Familiarity with DET	male	2.01	0.65
	female	1.89	0.41
Stereotypical characteristics of engineers	male	3.03	0.58
	female	2.99	0.49
Characteristics of engineering	male	3.62	0.35
	female	3.63	0.33

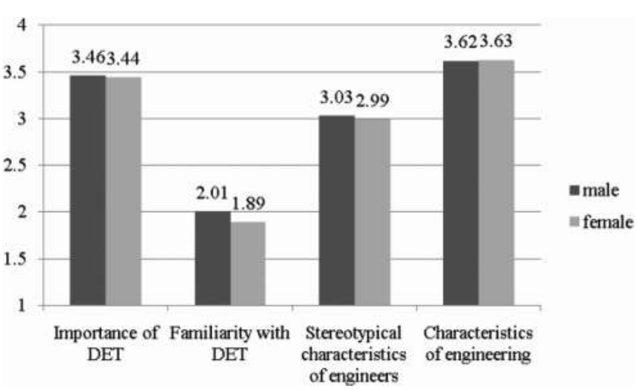

Figure 2. DET score comparison by gender

Table 5
DET score comparison by ethnicity

Factor		Mean	SD
Importance of DET*	minority	3.65	0.31
	majority	3.41	0.36
Familiarity with DET	minority	1.90	0.53
	majority	1.91	0.44
Stereotypical characteristics of engineers	minority	3.01	0.54
	majority	2.99	0.51
Characteristics of engineering	minority	3.52	0.37
	majority	3.64	0.32

(*) indicates the significant factor

Table 6
The importance factor that showed significant differences based on ethnicity

Survey Items	Ethnicity Category	M	SD	U	p	r
Interested to learn more about DET through college courses	minority majority	3.13 2.56	1.12 0.92	1268.5	0.00	−0.21
My motivations for teaching science are to develop scientists, engineers and technicians for industry	minority majority	3.75 3.29	0.44 0.64	1209.0	<0.01	−0.25
My motivations for teaching science are to promote an understanding of how DET affects society	minority majority	3.83 3.36	0.39 0.63	1122.5	<0.01	−0.26

to descriptive data. For the fourth factor, characteristics of engineering, none of the survey items displayed significant differences based on teaching experience.

We also found a significant difference between teaching experience and the stereotypical characteristics of engineers, $H(2) = 6.28$, $p = 0.04$. A follow-up Mann–Whitney test was used to further investigate this finding. A Bonferroni correction was applied, so we are reporting all effects at a significance level of 0.02. New teachers had less stereotypical views of engineering than moderately experienced teachers ($U = 1282$, $p = 0.02$, $r = -0.22$). There were no differences between the other pairs.

Examining individual items loaded into this category revealed that experienced teachers (Mean = 2.93, SD = 0.79) tended to agree that most people felt female students can do well in DET more so than moderately experienced teachers (Mean = 2.52, SD = 0.81) ($U = 1727.50$, $p < 0.01$, $r = -0.25$). This indirect measure of gender bias indicates a possibility of higher bias toward girls by moderately experienced teachers when learning DET. The new teachers (Mean = 2.83, SD = 0.73) did not differ significantly from the other two groups on this item. Please refer to Figure 4 and Table 7 for descriptive statistics of respective groups.

Discussion and Conclusions

This study indicated that elementary teachers believed design, engineering and technology (DET) was important and that DET should be integrated into K-12 school curriculum. However, these teachers also exhibited low familiarity with DET and were neutral in their confidence in their ability to teach DET. Most of these teachers did not receive any in-service professional development in DET. Additionally, their pre-service training was not sufficient to help them prepare to teach DET. Hence, it is not surprising that they indicated limited use of DET activities in their classrooms.

The elementary teachers, especially those who were experienced, identified lack of time, training, and teacher knowledge as barriers to integration of DET into their

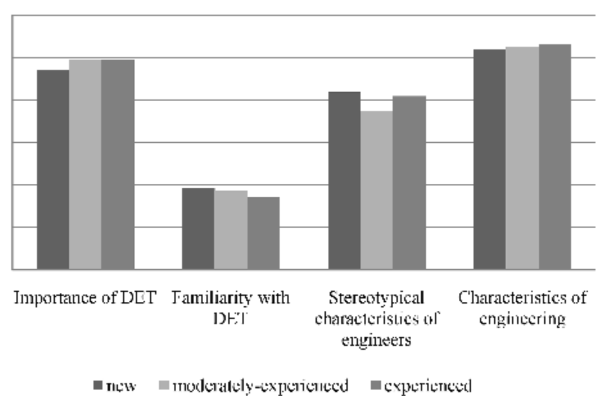

Figure 4. DET score comparison by full-time teaching experience

Table 7
DET score comparison by full-time teaching experience

Factor	Category	Mean	SD
Importance of DET	new moderate experienced	3.35 3.47 3.48	0.38 0.35 0.35
Familiarity with DET	new moderate experienced	1.97 1.93 1.85	0.43 0.45 0.47
Stereotypical characteristics of engineers	new* moderate* experienced	3.09 2.87 3.04	0.44 0.48 0.56
Characteristics of engineering	new moderate experienced	3.60 3.63 3.65	0.35 0.30 0.35

(*) indicates groups with significant differences.

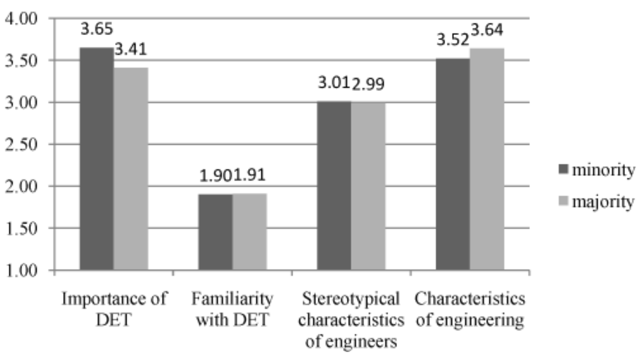

Figure 3. DET score comparison by ethnicity

Table 8
Comparison of the INSPIRE sample and the Arizona sample

	INSPIRE elementary teachers (n = 192)		Arizona elementary teachers (n = 13)		
Factor	M	SD	M	SD	effect size d
Importance of DET	3.44	0.36	3.14	0.59	0.79
Familiarity with DET	1.91	0.45	2.05	0.51	−0.31
Stereotypical characteristics of engineers	3.00	0.51	2.55	0.50	0.88
Characteristics of engineering	3.63	0.33	3.57	0.31	0.18

curriculum. Despite all the indications of lack of familiarity, teachers felt somewhat confident in their ability to teach DET. A promising finding was that teachers showed interest in learning more about DET through workshops, in-service training, and peer training. College courses might be too much of a time commitment for most in-service teachers, and were therefore not a preferred form of professional development. Opportunities such as summer institutes, along with year-long support, can provide a knowledge base for teachers and familiarize them with DET content and processes.

Comparison to the Arizona Sample

When compared to the study conducted with the Arizona teachers (Yasar *et al.*, 2006), our study revealed different results in various aspects (see Table 8). Compared to the elementary teachers within the Arizona teachers, INSPIRE elementary teachers placed more importance on DET; they also held less stereotypical views of engineers. We attribute these differences to diversity within the teacher populations. For example, our study included only elementary teachers. Our data was also from teachers who volunteered to participate in the INSPIRE Summer Academies. The teachers in the Arizona sample represented a K-12 population who did not necessarily attend DET professional development programs. Therefore, it is not surprising that the INSPIRE sample had higher interest in DET and recognized the importance of DET more profoundly than the Arizona sample. However, it is also possible that teachers' general views of DET may have changed since 2006 as a result of an increased focus on technological literacy and engineering education throughout the U.S. While sampling from professional development workshop participants presents an interesting opportunity for examining teacher perceptions of DET, it is also limits our study as we examine a group of teachers who are already interested in learning more about DET.

While the previous DET study conducted by Yasar *et al.*, (2006) found differences in the level of importance attributed to DET between genders, we found no such differences for elementary teachers. There was also one new factor (ethnic background) that was not examined in the previous study due to the small sample of elementary teachers. These differences are discussed in the following sections.

Male Teachers Compared to Female Teachers

The previous study found differences in the amount of importance attributed to DET between genders; we did not find such a difference among elementary teachers. This is probably because the INSPIRE teacher sample was more homogenous including only elementary teachers with strong interest in learning and teaching DET.

Minority Teachers Compared to Majority Teachers

Minority teachers rated the importance of DET significantly higher than majority teachers though there were no demographic differences in familiarity with DET. Specifically, minority teachers were more likely to agree that their motivations to teach science were to develop scientists, engineers, and technicians for industry in order to promote an understanding of how DET affects society.

Based on these results, it seems that minority teachers focused more on the societal influence and career aspiration standpoint of DET than the majority teachers. This is congruent with previous research indicating that minority teachers were motivated by social factors (Su, 1997) and by the opportunities to make a difference in their students' lives.

Teaching Experience

Results comparing teachers with different teaching experiences showed significant differences concerning teachers' knowledge of the stereotypical view of engineers. Teachers with moderate experience (6–15 years) were least familiar with the characteristics of engineers and were likely to have bias against girls' ability to learn DET. These results may be attributed to these teachers' lower level of awareness of gender inequalities in the classroom and society compared to new teachers, but also to limited strategies they may have in managing these issues compared to more experienced teachers.

Moderately experienced teachers were also less likely to identify lack of administrative support as a barrier than experienced teachers. Experienced teachers were perhaps better able to identify the barriers they may face in integrating DET and hence were more likely to agree that lack of time, training, and knowledge were barriers to integrating DET.

IMPLICATIONS

Design, engineering, and technology education is a new topic for many teachers. Changing teachers' knowledge in and attitudes towards teaching DET would be a gradual process. Our results indicate that elementary teachers believe teaching design, engineering, and technology in K-12 classrooms is important; however, they do not feel prepared to teach DET. Aligned with the findings of prior studies (Cunningham *et al*., 2006; Yasar *et al*., 2006), our results show that the vast majority of teachers, regardless of their backgrounds and teaching experiences, have limited understanding of DET. This limited understanding is of great concern considering the emphasis on engineering in the newly developed K-12 science education standards (National Research Council, 2011) and the increasing number of states adding engineering to their science content standards (Purzer *et al.*, 2011). There is an increased need for research on teachers' familiarity with and perceptions of DET and research on teacher professional development that would inform both in-service and pre-service education.

Our results provide insights on what the focus of these professional development programs should be. First, we suggest that professional development programs should enhance teachers' familiarity with design, engineering, and technology. The professional development activities should be guided by prior research on teachers' and students' misconceptions of engineers and engineering (Capobianco *et al*., 2011; Cunningham *et al*., 2006; Ganesh, 2010). For example, the importance of problem scoping and planning should be emphasized more profoundly than building and testing (Hsu, Cardella, & Purzer, 2010). DET activities that make the relationship between engineering, science, mathematics, technology, and everyday life more explicit should be developed and emphasized.

Second, these programs should consider the diverse motivations teachers have to teach DET. These motivations include: a) broadening students' knowledge of engineering and technology careers; b) supporting science and mathematics learning through engineering design; and c) improving students' 21st Century skills such as problem solving, teamwork, and decisions making. Often professional development programs address one of these aspects or introduce them in a blended manner. All of these aspects are important and should be addressed carefully; however, more importantly the motivations of school districts should be examined when determining on which of these areas to place the most emphasis. Such an alignment between professional development program goals and school district goals should result in higher administrative support and fewer barriers to teaching DET in the classroom.

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