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Using Profiles of Person—Thing Orientation to Examine the Underrepresentation of Women in Engineering in Three Cultural Contexts*

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Personal interests are a key element in encouraging careers in engineering. Evidence suggests that a lack of interest may contribute to the underrepresentation of women in engineering. The purpose of the current research was to examine differential orientations to people and things among college students and their relations to academic majors and career choices across cultures; to explore the effects of sex differences among these orientations and the relation to major and career choices; and to examine the predictive validity of the instrument used to measure these orientations across cultural contexts. Data were collected from 511 engineering and non-engineering university students in Greece, Turkey and the United States regarding their current and prospective majors, their intention to pursue careers in various fields, their endorsement of gender role, and their differential orientations to mastery of objects or interpersonal interaction. Thing orientation was a predictor of the interest in engineering majors and careers in all three cultural contexts. When only engineering majors were considered, thing orientation was a stronger predictor of interest for women than for men, suggesting that women may need special focused motivation to pursue a career that is not in accordance with traditional gender roles. The manipulation of messages about engineering to describe it as being both person and thing focused may make it more attractive to women.

Keywords: interest; person–thing orientation; underrepresentation in engineering; vocational choice

1. Introduction

The underrepresentation of women in various science, technology, engineering, and mathematics (STEM) fields has emerged as a significant challenge. This underrepresentation is present across the globe, including in most western countries [1–4]. Women have outnumbered men in undergraduate education since 1982, with women in the United States now earning close to 60% of all undergraduate degrees. However, the opposite is true in most STEM fields, especially in engineering. Women are earning only 19% of engineering and computer science degrees, and 21% of physics degrees [5]. The representation of women in engineering has remained low for over a decade, despite consistent efforts to raise their participation.

The same trend can be seen in most European countries. The percentage of female engineering students in Greece averages about 25% [6], in Turkey the average is 19% [7], whereas in the United States the average is around 19% [5]. The current research explores the role of interest in the underrepresentation of women in STEM, specifically engineering, in three contexts: Greece, Turkey and the United States. Interest is an important factor in career choice because it influences attention, goals, and retention in STEM [8–11].

The position of women in Greece has changed significantly over the last 30 years. Changes in attitudes and behavior in post- World War II Greek society caused by social pressures, globalization, and the influence of membership in the European Union have resulted in a shift towards gender equality. This has been supported by the new Family Law Legislation enacted in 1983 [12]. Women in Greece have gained significant opportunities to go to college, with the percentage of women in higher education reaching 54%. Women are also well represented in the Greek workforce, comprising approximately 40% [13, 14]. These opportunities, however, are still influenced by traditional notions of gender [13, 14]. Independent of their level of education, women commonly occupy fewer major professional positions and are generally paid approximately 25% less than men [15, 16].

Research has revealed conflicting views on the position of Greek women, especially among younger generations, with both men and women holding on to traditional notions of femininity,

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while at the same time trying to redefine traditional gender roles to recognize the importance of careers among women [17]. This confusion about the role of women has extended to engineering fields with significant underrepresentation in much of engineering, but with considerable feminization in other sectors. The percentage of women in the engineering workforce is higher in Greece (28%) than in many other countries, but the absolute number of female engineers remains low. The number of female graduates in STEM is decreasing with 25% graduating in engineering, 31% in mathematics, science, and computing compared to 52% in humanities; only 11% of the highest ranking academic personnel are women. Conversely, at 90%, the percentage of women in medical research is very high, indicating that it is possible to raise rates of representation of women in STEM [6].

The percentage of women in engineering in Turkey remains low, but they are comparatively well represented in STEM fields as a whole [18]. This may be a result of familial encouragement for women to pursue these careers, especially among the elite, coupled with political pushes for modernization, rather than feminist or egalitarian motives. This trend is arguably an attempt to preserve separation between different socioeconomic classes. Additionally, the introduction and evolution of the sciences is relatively new in Turkey and happened in parallel with this social revolution, which allowed flexibility within the cultures of these departments to allow women to enter more easily [7].

Though women are comparatively well represented in some STEM fields in Turkey, there are significantly fewer women than men working in these fields. Approximately 36% of those graduating with doctorate degrees in engineering are women, with the average percentage of female students in engineering departments being 25% to 38% compared with 35% in the humanities [6]. Twenty-eight percent of senior academic staff are women. Turkey is one of the few countries where more women than men participate in scientific research but, on the other hand, there are very few women in medicine (5%), though growth rates are high.

The position of women in the United States has changed significantly over the last 50 years with women now earning the majority of undergraduate degrees (60%) [5]. This change was supported by legislation such as the Equal Pay Act in 1963 and the Civil Rights Act of 1964. Even though women now make up the majority of the workforce, they still generally earn 20% less than men [19] and discrimination still exists, especially in STEM fields.

In elementary and high school, girls pursue science and mathematics courses at approximately the same rate as boys, but by college the number of women in STEM majors has dropped significantly [20]. The number of women in STEM has remained relatively stable with women making up 21% of graduates in engineering, 38% in mathematics, science, and computing compared with 65% in the humanities [5, 6]. Only 8% of senior academic staff are women and less than 25% of jobs in STEM fields are held by women [5, 20].

2. Culture and vocational interest in STEM

Culture plays a major role in the underrepresentation of women in STEM fields. Penner [21] found that international sex variation can be attributed more logically to social differences than biologically based aptitude. Ceci and colleagues [3] reviewed the existing literature and concluded that cultural factors play a significant role in contributing to the underrepresentation of women in STEM, though how and why this occurs remains unclear. Various reasons have been put forward to explain the disparity in representation and, given that interest is a major influence in vocational choice [22], interest has emerged as important among these. Here vocational choice is used to refer to the decisions that individuals make towards their pursuit of certain careers, including their choice to pursue education in an STEM field and related extracurricular activities. Interest may be one of the mechanisms through which culture influences underrepresentation. Interest is often viewed as a disposition, remaining relatively stable and reflecting an individual's preference for activities and outcomes associated with certain behaviors or contexts [23]. The formation of interest is believed to require exposure and relevance [8].

Vocational interest, the preference for specific career paths, has been defined as the expression of personality in one's selection of work and recreational activities [24]. In the US context, interests have been found to be critical to career development because individuals' preferences are viewed as part of their identity and are therefore a strong influence on their goals and values. Individuals tend towards environments in which they can express their identity through their preferences [23]. Whether this holds true across other cultures is questionable, because the opportunities for and ways that exposure is experienced conceivably vary from culture to culture. Likewise, the conceptualization of relevance would vary depending on cultural conceptions. It would therefore follow that the formation and expression of interest and its relationship to career choice would vary across cultures [25].

There is contradictory evidence regarding the structure of vocational interest across cultures. Some evidence indicates that the structure is similar across cultures [26]. Fouad and colleagues compared American and Mexican engineering students and professional engineers and found that the cross-cultural structure of vocational interest remained the same. This cultural similarity was attributed to the professions studied, (i.e. highly technical STEM professions), that remain fairly similar across cultures. A study of more culturally based professions, for example law, revealed differences in the structure of vocational interest [27]. Though vocational interest has a strong influence on career related choices, culture has a significant effect on vocational choice and the role that interest plays in that choice [22]. Vocational choice research often assumes that all individuals have comparable access to the same opportunities and that the choice of one's career is an individual one based on interest and ability. These assumptions are especially commonly held in the United States [25]. In many cultures however, these assumptions do not hold true, especially across gender lines. It is important to remember that an "individual's culture, their ethnic-racial background, language, socioeconomic status, sex, and religious affiliation all affect self-perception and view of career options" [28].

In principle, the importance of interest in gaining and retaining students is relevant in all professional fields. Little is known, however, about the role and structure of interest in enrollment and persistence in science, technology, engineering, and math (STEM) fields, particularly engineering. In recent years interest has emerged as a significant factor in encouraging students to pursue careers in STEM fields [3]. Interest plays a large role in the prediction of major and career choice [22, 24, 29, 30] and an expression of a person's identity [31]. Research on occupational choice suggests that vocational interest is a strong determinant of entry into and persistence in a career path [22]. Students who choose a field aligned with their interests are more likely to remain and be successful in that field. On the other hand, students who choose fields outside of their interests often become bored and frustrated and are more likely to leave [11]. The question of interest is an important one, particularly in encouraging underrepresented groups to pursue STEM fields.

Interest can be conceptualized as situational or dispositional [32]. In the current research interest is conceptualized as dispositional. That is, a person possesses a disposition that can be expressed as a preference for certain activities or situations. Past research has characterized vocational interest in terms of two fundamental dimensions: a Person-Thing dimension (PT), and an Ideas-Data dimension (ID) [23, 29, 33]. Sex differences in occupational preferences occur primarily along PT and not along ID [34]. Therefore, in the current research we focus on the person–thing dimension (PTO). Person and Thing Orientation (PO/TO) has been conceptualized as a motivational process based on individual differences in preferences for interpersonal relations and mastery over objects, respectively [35]. These orientations are not dichotomous; in fact research has shown that engineers are often above average in both [36]. In the same vein, careers could traditionally be classified as person oriented or thing oriented. Careers that deal primarily with the creation and manipulation of human-made artifacts, such as engineering and mechanics, were considered thing oriented careers. These are generally technology focused fields that were considered masculine because technology has traditionally been culturally constructed as masculine [37, 38]. Careers centered on interpersonal interactions were considered to be person oriented careers and generally comprise such traditionally female fields as social work, nursing, and teaching. However, while engineering may be perceived as being thing oriented there are components of person orientation present. A recent study demonstrated that professional engineers considered interpersonal communication to be the most important skill necessary for engineering practice [39]. There is growing interest in exploring the acquisition of interest in Science, Technology, Engineering, and Math (STEM) careers based on PTO.

PTO is made even more relevant to the consideration of underrepresentation in STEM because there are large sex differences in interest, with the largest sex difference occurring across the person–thing dimension [33]. Men are more interested in thing oriented careers and women in person oriented careers [33, 36]. This notion was first put forth almost 100 years ago when Thorndike argued that the greatest differences between men and women lie in their differential interest in things and people [40]. A closer examination of sex differences in interest reveals that these differences parallel the breakdown of men and women in various occupations, with the percentage of each sex expressing strong interest in each field closely mirroring the actual sex distribution in that field. A study by Eccles [41] concluded that these sex differences in interest were an important reason for the difference in men's and women's occupational choices, particularly those in STEM. In the same vein, additional studies have shown that a lack of interest is a key factor in women leaving STEM fields [11, 42]. It could be assumed that if engineering were more widely perceived to be both a person and thing oriented discipline, women, who tend to be higher in person orientation, would find it more attractive.

In making a case for person–thing orientation as a motivational variable, in no way do we intend to imply other cognitive and experiential variables, such as aptitudes and opportunities, could not also affect choices. There are, of course, constraints on interests just as there are on choices and preferences. The student who is intensely interested in a career as a professional athlete or brain surgeon may lack the requisite physical skills to be selected for training, much less be successful. Furthermore, constraints may be unrecognized because they are hidden beneath implicit norms, stereotype threat, and social expectancies like gender roles [32, 43–45]. The position advocated here is that person–thing orientation is part of a motivational complex that contributes, but does not exhaustively determine, the expression of a wide range of cognitive and social activities.

This raises the question of whether these sex differences in interest occur across cultures. Before this can be examined, the structure of vocational interest across cultures must be explored. A US sample was used in this study since the majority of vocational interest research focuses on that population. Greece and Turkey were used to provide the cross-cultural comparison for several reasons: 1) they were accessible to the researchers; 2) substantial records exist tracking the participation of women in STEM; and 3) the combination of proximity and disparate cultures in the two contexts allows for an interesting dichotomy.

As a first step to examining the role of person–thing orientation (PTO) in career choice, we first examined the relations among person orientation (PO), thing orientation (TO) and interest in related careers particularly in STEM fields. A preliminary analysis of these data, results of which were reported at the 2010 *Joint International IGIP-SEFI Annual Conference,* found that interest was similar, though not identical, by sex across cultures and was related to career choices [46]. This paper extends these analyses examining the structure of PTO across cultures and how the relationship between PTO and sex affects career choice. The purpose of the current research was threefold: 1) to further examine differential orientation to persons and things among college students and their relations to academic majors and career choices in three cultural contexts: Greece, Turkey and the United States; 2) to explore the effects of sex differences among these orientations and the relation to major and career choices; and 3) to examine the predictive validity of the instrument used to measure PO/TO across cultural contexts.

3. Method

3.1 Participants

This study included participants from three universities: a university in Greece, one in Turkey, and one in the United States. The participants from Greece were students at the Democritus University of Thrace, located in North-Eastern Greece. This sample consisted of 60 (25 female) engineering students, primarily from the Department of Civil Engineering, and 60 (55 female) non-engineering students from the Department of Education. These students were in their first through fourth year of college and had an average age of 23.4. The participants from Turkey were students at Bogazici University, an elite public university in Turkey that accepts only the top 1% from a nationally held entrance examination. This sample consisted of 124 (30 female) engineering students and 71 (60 female) non-engineering students. The engineering students came from various engineering departments whereas the non-engineering students were in Liberal Arts departments such as Psychology and Sociology. These students were in their first through fifth year of college and had a mean age of 21. The participants from the United States were students at Purdue University, a large Midwestern university. The sample consisted of 103 (16 female) engineering students and 93 (42 female) non-engineering students primarily in their first year of college. The non-engineering sample comprised primarily Psychology students. Table 1 shows the distribution of participants by major and sex in the three samples.

3.2 Procedure

Data were collected from students to determine their current and prospective majors, their intention to pursue careers in various fields, and selected personality variables. Data on personality variables included students' gender role endorsement, assessed using the Personal Attributes Questionnaire (PAQ), originally developed by Spence and Helmreich [47]. This scale asks respondents to indicate where they fall on a five point scale comparing two contradictory characteristics, for example, very rough vs. very gentle; and not at all artistic vs. very artistic. Students' differential orientations to object mastery or personal interaction were mea-

Table 1. Sex distribution of participants

	Engineering		Non-Engineering		
	Male	**Female**	**Male**	**Female**	**Total**
Greece	35	25	5	55	120
Turkey	94	30	11	60	195
United States	87	16	51	42	196

Table 2. Mean person orientation and thing orientation score measured on a Five Point Likert Scale as a function of Sex and Major

	Women	Men	Engineering majors	Non-engineering majors
Person orientation	2.72	2.11	2.16	2.66
Thing orientation	2.02	2.28	2.35	1.93

sured using the person–thing orientation scale originally developed by Little [35] and revised by Graziano, Habashi and Woodcock [36]. This scale asked students to indicate how much they would enjoy a series of activities such as "stopping to watch a machine working on the street" and "listening in on a conversation between two people in a crowd" and uses these responses to assign them a person orientation score and a thing orientation score. Additional personality data were collected but are not relevant to the current study. All these scales used five point Likert-type items. Data regarding interest in various careers were collected using the Occupational Scale [48]. Careers were characterized as either person centered careers (e.g., social work, teaching) or thing centered careers (e.g., auto mechanic, engineer). Demographic data were also collected for all participants.

In the US sample, students from various departments participating in an introductory psychology class completed these scales as part of a pre-testing session of the psychology pool. In Greece and Turkey these measures were translated into each respective language by native speakers who were fluent in English, then translated back into English and compared with the original measures by native English speakers to test the validity of term equivalency. They were then administered in pencil and paper format to students from various departments participating in psychology courses.

4. Results

4.1 Sex and cultural differences in PTO

To examine cultural differences in person–thing orientation, data from the three samples were compared and multivariate analysis of variance (MANOVA) was conducted with person orientation and thing orientation as dependent measures. The test statistic (F) representing the multivariate effect was significant (probability of similarity in means is low, p-value below 0.05) emerged for Sex, $F(2, 491) = 11.76$, $p < 0.001$, eta-squared (η^2, i.e., effect size) = 0.05, Culture, $F(4, 982) = 25.98$, $p < 0.001$, $\eta^2 = 0.09$, and Major, $F(2, 704) = 33.81$, $p < 0.001$, $\eta^2 = 0.12$. A significant combined multivariate effect of Sex and Culture also emerged, $F(4, 982) = 2.96$, $p = 0.01$, $\eta^2 = 0.012$. Follow-up univariate analyses were conducted to examine these effects more closely.

A significant main effect of sex emerged for both person orientation, $F(1, 491) = 9.06$, $p < 0.01$, $\eta^2 = 0.02$, and thing orientation, $F(1, 491) = 6.51$, $p < 0.01$, $\eta^2 = 0.01$. Consistent with prior research in the United States, women were significantly higher in person orientation than men, regardless of culture. Men however, were significantly higher in thing orientation than their female peers across all three cultural contexts (Table 2). Results also revealed a significant main effect of culture on both person orientation, $F(2, 491) = 42.86$, $p < 0.001$, $\eta^2 = 0.15$, and thing orientation, $F(2, 491) = 32.5$, $p < 0.001$, $\eta^2 = 0.12$. Greek students were higher in person orientation than were both Americans and Turkish students. Greek students were also higher in thing orientation than their American and Turkish peers (Table 3).

There was also a significant main effect of major on both person orientation, $F(1, 491) = 24.07$, $p < 0.001$, $\eta^2 = 0.05$, and thing orientation, $F(1, 491) = 20.5$, $p < 0.001$, $\eta^2 = 0.02$. Individuals with a major in engineering were lower in person orientation than individuals with a major in a non-engineering field. Consistent with expectations, students in engineering majors were higher in thing orientation than individuals in non-STEM majors (Table 2).

A combined effect of Sex and Culture emerged and follow-up univariate analyses examined this trend more closely. Results revealed a significant combined effect of Sex and Culture on thing orienta-

Table 3. Mean person orientation and thing orientation score measured on a Five Point Likert Scale as a function of Sex and Culture

	United States			Turkey			Greece		
	Males	Females	All	Males	Females	All	Males	Females	All
Person orientation	2.04	2.42	2.16	1.96	2.50	2.21	2.76	3.19	3.05
Thing orientation	2.27	1.59	2.07	2.00	1.71	1.87	3.10	2.71	2.83

Note: Numbers are standardized regression coefficients. $^{+}p < 0.10$; $^{*}p < 0.05$; $^{**}p < 0.01$.

tion, $F(2, 491) = 4.89$, $p < 0.01$, $\eta^2 = 0.02$ (See Table 3). Greek students were higher in thing orientation than students from either the United States or Turkey. American and Turkish female students did not differ from each other in thing orientation, but American male students were higher in thing orientation than were their Turkish peers. There was no evidence that person orientation differed as a function of Sex and Culture.

4.2 Predictive validity of PTO across cultures

To examine the predictive validity of person orientation and thing orientation for male and female students across culture, centered cross-product regression analyses were conducted for each country separately with self-rated interest in person- (i.e., social work and teaching) and thing oriented careers (i.e., engineering and mechanics) as the dependent measure. Examination of Table 4 reveals that sex, person orientation, and thing orientation are most closely tied to career interest in the Greek sample. More specifically, in Greece, and to a lesser extent the United States, sex, person orientation and thing orientation were related to interest in both person oriented and thing oriented careers. Consistent with past research on PO/TO [36] female students showed more interest in person oriented careers than did men, standardized regression coefficient (β, i.e., slope of regression line) = –0.34, $p < 0.001$, whereas male students showed more interest in thing oriented careers, $\beta = 0.35$, $p < 0.001$. This was also true for both Greek female and male students. More importantly however, in the United States, person orientation and thing orientation were both related to interest in pursuing person oriented and thing oriented careers. Person orientation was positively related to interest in personoriented careers and negatively related to interest in thing oriented careers. Thing orientation was positively related to interest in thing oriented careers and negatively related to interest in person oriented careers. This was not true for Greek students. Person orientation was related only to interest in person oriented careers and thing orientation was related only to thing oriented careers. There was no strong evidence in the Turkish sample that sex or individual differences were related to interest in careers. In fact, there was no relationship found between individual differences in interest and thing oriented careers, and person oriented careers were only marginally related to individual differences in interest. This would suggest that, consistent with previous research, interests, but not sex, may be more influential for career and vocational choices in the United States than in other cultural contexts.

When only the engineering sample was considered, both person- and thing orientation were found to be related to interest in thing careers in the US sample (Table 5). Thing orientation was found to be strongly related to interest in thing careers in both women and men in Turkey and person orientation was found to strongly relate to interest in person careers in men in Turkey. In the Greek sample, only the correlation between thing orientation and interest in thing careers among women was found to be significant. In all three cultural contexts, the correlation between thing careers and thing orientation was stronger in women than men in STEM, suggesting that women needed special, focused motivation in the form of interest to pursue these careers.

4.3 Traditional masculinity and femininity and PTO

A relationship between sex and career interest was found in all three cultures as well as a variation in PO and TO by sex, with men being consistently higher in thing orientation and women consistently higher in person orientation. To explore this relationship and examine how interest in person or thing careers can be explained more clearly by sex than by person orientation and thing orientation, measures of traditional masculinity and femininity were analyzed. To examine cultural differences in the endorsement of traditional masculinity and femininity a MANOVA was conducted with the Spence–Helmreich [47] masculinity and femininity scores as dependent measures. A significant multivariate effect emerged for culture $F(2, 491) = 10.28$, $p < 0.001$, $\eta^2 = 0.04$ and major $F(1, 149) = 13.81$, $p < 0.001$, $\eta^2 = 0.05$. Follow-up univariate analyses revealed a main effect of culture on masculinity $F(2, 496) = 17.93$, $p < 0.001$, $\eta^2 = 0.07$ and femininity $F(2, 496) = 7.81$, $p < 0.001$, $\eta^2 = 0.03$. Employing a Bonferroni post hoc test revealed significant differences in masculinity (all $p < 0.01$) among the US

Table 4. Self-rated Interest in Pursuing Person and Thing Oriented Careers as a Function of PTO and Culture

	United States		Turkey		Greece	
	Person careers	Thing careers	Person careers	Thing careers	Person careers	Thing careers
Sex	–0.32**	0.35**	0.15$^+$	0.06	–0.44**	0.41**
Person orientation	0.42**	–0.21**	0.18$^+$	0.04	0.38**	–0.21
Thing orientation	–0.06	0.34**	–0.19*	0.01	0.00	0.28*

Note: Numbers are standardized regression coefficients. $^+p < 0.10$; $*p < 0.05$; $**p < 0.01$.

Table 5. Self-rated interest in pursuing person and thing oriented careers for engineering students as a function of PTO, Sex and Culture

		United States		Turkey		Greece	
		Person careers	Thing careers	Person careers	Thing careers	Person careers	Thing careers
Women	Person orientation	0.15	0.41*	0.21	0.29	0.15	–0.06
	Thing orientation	–0.08	0.49*	0.24	0.70**	–0.08	0.47**
Men	Person orientation	0.15	0.02	0.49**	0.22*	0.30	–0.09
	Thing orientation	0.03	0.17	0.16	0.62**	0.33	0.01

Note: Numbers are standardized regression coefficients. $^{+}p < 0.10$; $*p < 0.05$; $**p < 0.01$.

Table 6. Correlations between PTO, femininity, masculinity, and interest in person and thing careers

	Person orientation	Thing orientation	Femininity	Masculinity	Person career	Thing career
Person orientation	1	0.32**	0.31**	0.01	0.38**	–0.15**
Thing orientation		1	0.02	0.09*	–0.04	0.41**
Femininity			1	0.24**	0.27**	–0.02
Masculinity				1	0.04	0.12*
Person career					1	–0.09*
Thing career						1

$*p < 0.05$; $**p < 0.01$.

sample (Mean (M) = 3.61) the Turkish sample (M = 3.33) and the Greek sample (M = 3.40). Post hoc tests also revealed a significant difference in femininity ($p < 0.01$) between the US (M = 3.95) and Turkish samples (M = 3.70) samples. Men were significantly higher in masculinity (M = 3.52) than women (M = 3.37) in these samples, indicated by a significant test statistic, i.e., $t(503) = 3.22$, $p < 0.001$, but women were significantly higher in femininity (M = 3.95) than men (M = 3.73), $t(503) = –4.32$, $p < 0.001$. There was also a significant main effect of major on femininity $F(1, 496) = 16.94$, $p < 0.001$, $\eta^2 = 0.03$ and a significant effect of major on masculinity $F(1, 496) = 5.01$, $p = 0.02$, $\eta^2 = 0.01$. Person orientation was correlated with femininity $r(500) = 0.31$, $p < 0.01$ and person careers $r(501) = 0.38$, $p < 0.01$, whereas thing orientation was only weakly correlated with masculinity $r(499) = 0.09$, $p < 0.05$, but more strongly correlated to thing careers $r(503) = 0.41$, $p < 0.01$ (Table 6).

5. Discussion

Interest, conceptualized as person and thing orientation, has been suggested as a significant factor in the choice of careers. However, the influence of culture on interest as a vocational driver needs to be examined. Taken together the outcomes of the present research suggest that person–thing orientation is an important predictor of differential interest in careers. Thing orientation especially is a strong predictor of interest in engineering careers. This study further suggests that women needed special, focused motivation in the form of interest to pursue these careers. These findings are consistent with previous studies that concluded that the structure of interest influences vocational choice [29, 33, 34]. However, previous studies have not addressed the interaction between culture and person–thing orientation in vocational choice. This study addresses three questions that have not been directly addressed in previous studies, namely, is the person–thing dimension consistent across cultures, does this person–thing dimension influence vocational interest across cultures, and does this influence vary by sex?

A main effect of culture on person orientation and thing orientation was found. This suggests that culture plays a role in the construction of person and thing orientation. A closer examination revealed that the pattern of differentiation in person orientation and thing orientation in all three contexts was similar by sex with men being higher in thing orientation (TO) and women higher in person orientation (PO). There were, however, significant differences in PO and TO scores across the three contexts. Scores in Greece were higher than the scores in the US and Turkish samples in both PO and TO. This could be attributed to a fundamental difference in the nature or expression of interest in these cultures. Women scored higher in person orientation in all three cultural contexts suggesting that women in these samples report more interest in interpersonal relations than do men. Women also reported greater interest in person oriented careers. This outcome aligns with

culturally constructed notions of traditional femininity prevalent in all three cultures that expect women to be caring and communally oriented [49]. Men on the other hand scored higher in thing orientation.

The relationship between person and thing orientation and interest in person oriented careers (such as nurses and teachers) and thing oriented careers (such as mechanics and engineers) also varied across cultures. In the US sample person and thing orientation exerted both a push and a pull, attracting students to the matching career and repelling them from the converse. In the Greek sample, person and thing orientation had a purely attractive effect; and in the Turkish sample, person and thing orientation were not strongly related to career interest. However, when only engineering students were examined, in all three contexts thing orientation was strongly related to interest in thing careers especially among women. This suggests that women need to be high in thing orientation both to pursue an engineering degree and to pursue an engineering career. This may be because engineering is widely perceived to be a thing oriented career necessitating a strong interest in things. More widespread awareness of the aspects of engineering requiring interpersonal interaction could serve to attract women who are higher in person orientation. This also suggests that culture plays a role in the construction of person and thing orientation and the role that these orientations play in interest in person and thing careers. These outcomes are consistent with the view that the meaning, value, and expectations regarding who participates in different types of work and why they do so are socially, and therefore culturally, constructed [50].

The predictive power of traditional masculinity and femininity scores was analyzed to explore whether these person–thing orientation findings could be explained more simply as the result of gender role endorsement. Traditional femininity was significantly correlated with person orientation and interest in person careers, but masculinity was correlated only slightly with thing orientation and interest in thing careers. This suggests that while gender role based differences in person and thing orientation do occur, interest in person and thing careers is probably not due solely to these gender role differences. It can be inferred, therefore, that while these culturally constructed notions of appropriate gender roles play a significant role in the construction of interest, other motivational factors also come into play.

Thing orientation was found to vary by both culture and sex. This outcome is open to multiple interpretations. First, cultures may differ in how they promote interest in things, or how they conceptualize things. Cultural differences of this sort would have large implications for instruction and vocational choices, especially in science and engineering, and the issue warrants further research. Culture constructs what is perceived as natural as well as what is perceived as appropriate use of things (and people). These perceptions extend beyond the culture of the society into that of the field itself. STEM fields involve specific tools and objects that are perceived as not normatively suitable for or interesting to women [37, 51]. Engineering in particular, with its origins in agriculture and the military, is often perceived as involving things and activities better suited to men than to women. A second possibility is related to the first. Occupational opportunities in different cultures channel personality and interests towards available employment [52, 53]. A third possibility is related to the first two. It involves the "dynamics of acculturation" [54]. This possibility focuses on inter-group relations within cultural groups. With engineering majors and related vocations, women may represent a minority group whose personal choices and aspirations may or may not be accepted by the majority group of men, depending on larger cultural values. Brown and Zagefka [54] argue that to understand minority acceptance, and by inference the process of academic and vocational choice, it is important not only to examine the preferences of the minority but also the beliefs of the majority about acceptance of the minority. This approach represents a new avenue of research for increasing women's participation in engineering majors and vocations. A fourth, less substantive possibility, is that this culture by sex effect is an artifact of selection differences within cultures. In this research, participants were not randomly sampled from their respective cultures. If the universities situated within their specific cultures differed in selection criteria for admitting students to engineering programs, the outcome could appear in the form of an interaction. In the absence of representative sampling, this possibility is difficult to eliminate definitively.

Several theoretical approaches may be considered to explain how culture affects interest. Hidi and Renninger [55] offer a process model that might be used to explain both inter- and intra-cultural variation. In their Four Phase Model of interest development, progress from the first phase of interest, "Triggered Situational Interest" into the second phase "Maintained Situational Interest" generally requires opportunity or exposure and external support. Transition toward the third phase "Emerging Individual Interest" generally requires external support and encouragement as well as positive feelings resulting from engagement with the object of developing interest. Within engineering, if cultural and sub-cultural norms promote the view that women

are less competent, especially in the areas of math skills and mechanical manipulations [56], then a vicious cycle could emerge. The perception of lower competence in women could lead to fewer opportunities to develop and use these skills. Given that interest is connected to exposure and experience, cultural perceptions influence the development of interest in engineering careers. In their meta-analysis of career aspirations, Fouad and Byars-Winston [50] found no evidence that ethnicity made a significant difference in students' initial dreams for their careers. However, by the time students were thinking seriously about careers, their choices had changed to reflect social and cultural norms more closely. This suggests that culture does not act directly but rather creates perceptions of acceptable gender roles and perceptions of acceptable careers and opportunities [57].

These perceptions extend beyond acceptability and influence students' perceptions of competence. The question of differential sex competence in STEM has been examined and several studies have shown that cross-national differences in STEM competence between men and women cannot be attributed to biological differences in aptitude [58, 59]. However, even when individuals reject claims of biological differences in aptitude, a belief may still persist that others hold these perceptions and that they will therefore be judged according to them [54]. To fall in line with this belief and therefore not bear the cost of swimming against the tide, women *learn* to be interested in careers that are considered to be gender role appropriate so their personal interest may differ from their expressed vocational interest. This would explain the observed relationship between career interest and femininity.

Looking at PO and TO by major, it is clear that engineering students score significantly higher in TO than non-engineering students. This suggests that interest in mastery over objects may be an important characteristic of students who select engineering majors. On the other hand, non-engineering students score significantly higher in PO, suggesting a greater interest in interpersonal relations. This is consistent with intuitions that engineering majors and careers are highly thing oriented, whereas non- engineering careers are person oriented [29]. These findings also contribute to the explanation of the underrepresentation of women in engineering careers. Thing orientation is generally correlated with interest in thing careers and engineering careers are perceived as being thing careers. It seems to follow, then, that women are perceived as being less suited and less interested in engineering majors and careers. When the correlation between orientation and careers is considered among engineering majors by sex in each cultural context, the correlation between thing orientation and interest in thing careers is higher among women than men. This would suggest that women need special, focused motivation to pursue a career that is not consistent with traditional gender roles.

To increase women's participation in engineering, the perception of engineering careers as being highly and exclusively thing oriented needs to be addressed. Many engineering careers are thing focused, but they are not exclusively so. Important engineering skills include interpersonal communication and engineering practice includes consideration of the needs of the product end-users [39]. To increase women's participation in engineering, research might explore the possibility that person aspects of engineering majors and careers could be made more salient. This could be done by manipulating the messages women receive about engineering careers to emphasize person oriented goals and processes that female students might find more appealing.

6. Limitations and future work

The samples used in this study were limited to students at three universities. Therefore results might be influenced by selection effects resulting from the nature of students admitted to these programs. Future investigations should include a more diverse and representative sampling of the populations in the three countries, and would in particular include practicing members of the professions. This study also assumes some similarity in the characterization, requirements, and responsibilities of the different occupations considered in the different countries. A major limitation of the current study is the consideration of the underlying structure of person–thing orientation across the three cultures. It is possible that the three samples differ from each other in terms of the fundamental nature or expression of interest. A forthcoming paper will further explore the structure of interest in the three contexts. Finally, while this paper provides strong evidence for the influence of culture on vocational interest, further investigation is required to determine how culture acts to influence person–thing orientation and the interest in person and thing oriented careers.

7. Conclusion

Personal interests are an important factor in encouraging careers in engineering. This study uses the person–thing orientation (PTO) construct to examine the structure of vocational interests across three cultural contexts, viz. Greece, Turkey, and the United States. This study confirms the predictive validity of the PTO instrument across

cultures. This study also confirms that the structure of vocational interest is closely related to, and influences, vocational choice across cultures. Findings demonstrate that sex differences in person–thing orientation are consistent across cultures, with men being higher in TO and women higher in PO, and that PTO is an important predictor of vocational interest in all cultural contexts, especially among engineering students. Thing orientation especially is a strong predictor of interest in engineering careers. Strong evidence is provided that while the structure of vocational interest is closely related to and influences vocational choice, both are influenced by the cultural context in which they exist. Culturally constructed notions of appropriate gender roles play a significant role in the construction and pursuit of vocational interest, especially among women. As such women require a stronger, more focused interest to pursue choices inconsistent with traditional gender roles. Thing orientation is commonly perceived to align with notions of masculinity, making thing focused disciplines appear more appropriate for and therefore more attractive to men. Engineering as a discipline has been historically viewed as being highly thing focused, contributing to the significantly higher proportion of men. The manipulation of messages about engineering to describe it as being both person and thing focused would therefore make it more attractive to women who tend to be higher in PO than men. The findings suggest that deeper investigations into the interactions between culture, sex, and interest are necessary to understand the underrepresentation of women in engineering.

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