Teacher Influences on Child Interest in STEM Careers

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Abstract: *Recent research on career interest in children and college students (Evangelou et al., 2008) has identified large gender differences in how interested men and women are in person and things (person-thing orientation, PTO, Little, 1972). These differences lead to differences in interest in STEM and nonSTEM careers for men and women. The current research examines the role elementary and middle school teachers play in these differences in PTO. Taken together, results indicate that teachers are able to translate students' interest in person and things into career interest better than 3rd graders, but not 6th graders. These results provide additional evidence that interventions targeted at increasing the number of women (and men) in engineering should start early developmentally, when students' interests are plastic and able to be shaped. Results examining the influence of teacher self ratings on student's self ratings are also discussed.*

Context

Decreasing numbers of students in majors that deal with Science, Technology, Engineering, and Mathematics (STEM) has been reported across the United States as well as other countries (NSF, 2006). Under-enrollment statistics, based on general population demographics, point to specific underrepresentation with regards to racial and gender minority populations. More specifically, a recent report states that women in the United States earned more than half of all bachelor's degrees in 2002 (NSF, 2006). In psychology women earned 78% of the degrees awarded, 55% of the degrees awarded in the social sciences, but only 21% of the degrees awarded in engineering and 27% in computer sciences. Clearly, there are deficits in the number of women entering the fields of science and engineering relative to other fields of study.

Research Question

Recent research on career interest in children and college students (Graziano, Habashi, Evangelou, & Ngambeki, under review) has identified large gender differences in how interested men and women are in person and things (person-thing orientation, PTO, Little, 1972; 1974). These differences lead to differences in interest in STEM and nonSTEM careers in men and women as early as 3rd grade (Graziano et al., under review). The current research examines the role elementary and middle school teachers play in these predicting interest in people and things in elementary and middle school aged children.

Theoretical Framework

One important source of achievement motivation—personal interests—is commonly overlooked. With a few notable exceptions, the general, personal interests of students as a motivational influence on academic performance, especially in STEM activities, are unknown terrain (Sodano & Tracey, 2007). This oversight is noteworthy because general personal interests are widely recognized as a major determinant of adult occupation and career choice (e.g., Holland, 1997; Hough & Ones, 2002).

Using first year college students, Ackerman et al. (2001) reported that several individual differences associated with interests in persons (e.g., social closeness/femininity) "broadly impeded" knowledge in physical science and technology. Gender differences in skills that may be required for engineering ability (i.e., problem solving ability [Hyde, Fennema, & Lamon, 1990] and spatial ability [Linn & Petersen, 1985]) have been found, but these differences in ability are too small to account for the large deficit of women in engineering (Halpern, 2004). Data show that college females do differ systematically from males in the structure of their interests, hobbies, and preferred recreational activities (e.g., Lippa, 1998, 2005). Specifically, the available evidence suggests that females have less interest in science and technology, but have no greater interest in people than do males. Ackerman et al. (2001) assert that the root of gender differences in achievement in STEM is partially determined by different interests in social closeness and femininity. This account does not explain how or why such interests impede other knowledge, or how they are acquired. How such processes work in children during development is unknown.

Recent research on PTO identified significant gender differences in males and females as early as 3rd grade (Graziano et al., under review). In 3rd and 6th grade students, boys were higher in thing orientation than girls, and girls were higher in person orientation than boys. These differences are similar in university aged students. These interests appear to be consequential because they are systematically linked to engineering and STEM-related academic choices and preferences, and to career goals. As early as 3rd grade these interests in people and things predict interest in STEM (i.e., engineer, mechanic) and nonSTEM (i.e., school teacher, nurse) careers.

According to Graziano and his colleagues these interests in people and things can be thought of as an influence on motivation to engage in STEM or nonSTEM careers. Students who display higher levels of thing orientation should also display behaviors related to interest in

STEM careers, such as choice of the activity and achievement. Students may be interested in a topic for intrinsic or extrinsic reasons (Schunk, Pintrich, & Meece, 2008). One extrinsic motivator for interest in persons and things, and consequentially interest in STEM and nonSTEM careers are educators. Ultimately, the goal of educators is to develop students' interest and motivation in learning. The current research examines how teachers affect interests in persons and things in the male and female students across 3rd and 6th grade.

Methodology

Participants.

Data were collected from suburban Indiana (USA) children in 3rd (N = 130; 59 girls) and 6th grade (N = 103; 55 girls) at the students' schools. All students had parental permission to participate.

Materials.

Data were collected on laptops using the *MediaLab* (2004) data collection software. Children completed a revised, child-appropriate version of the PTO scale (Little, 1974), and measures assessing interest in STEM- and non-STEM related classes and career. Students also completed demographic information.

Teachers were asked to rate each of their students by completing an adapted version of the PTO scale (Little, 1974) and measures assessing the student's interest and achievement in a variety of classes. Teachers completed a packet containing these measures for each child at their convenience. Packets were returned from 15 teachers for 203 children. Following the completion of student ratings each teacher was invited to complete self ratings of person and thing orientation (N=13). (See Table 1 for correlations between student and teacher ratings of PTO).

	1.	2.	3.	4.	5.	6.
1. Student Self-rated PO	*.61*					
2. Student Self-rated TO	.14*	*.72*				
3. Teacher-rated Student PO	.18**	-.12^{+}	*.93*			
4. Teacher-rated Student TO	-02	.30**	.04	*.88*		
5. Teacher-rated Self PO	-.09	-.09	.25**	.22**	*.63*	
6. Teacher-rated Self TO	-.11	-.06	.29**	.25**	.40**	*.72*

Table 1. **Correlations Between Student and Teacher Ratings of Self and Other Person and Thing Orientation.** *Note*: PO = Person Orientation TO = Thing Orientation. Numbers in italics along the diagonal represent scale reliabilities. $^{+}p<.10$, $*p<.05$, $**p<.01$

Findings and Conclusions

MANOVA analyses revealed a significant multivariate main effect of student's sex on teacher ratings of student PTO, $F(2, 198) = 52.61$, $p < .01$. Follow up univariate ANOVAs revealed that teachers rated girls higher in person orientation ($M = 2.67$) than boys ($M = 1.98$), $F(1, 199) = 32.24$, $p < .01$, $\eta = .37$. Teachers rated boys higher in thing orientation ($M = 2.14$) than girls ($M = 1.86$), $F(1, 199) = 46.02$, $p < .01$, $\eta = .43$. A significant multivariate main effect of grade also emerged, $F(2, 198) = 4.39$, $p < .02$. Mirroring the students' self-ratings of PTO, follow up univariate ANOVAs revealed that teachers rated 3rd graders higher in thing orientation ($M = 2.14$) than 6th graders ($M = 1.86$), $F(1, 199) = 3.90$, $p < .03$, $\eta = .03$. There was no evidence that teachers viewed 3rd and 6th graders differently on person orientation.

To determine whether teacher ratings of student person and thing orientation predicted the student's self rated interest in careers, regression analyses were conducted. Results indicate that overall teacher ratings of the student's person orientation and thing orientation were significant predictors of student self rated interest in person oriented and thing oriented careers, all *p*s <.01. More importantly, teachers' ratings of 3rd graders PTO emerged as better predictors of students self-rated interest in career better than the students self ratings of PTO. This pattern was reversed for 6th graders. That is, students' self-ratings of PTO emerged as better predictors of self-rated interest in careers than teacher ratings of student PTO (See Table 2 for summary of statistics).

	3rd Graders		6th Graders	
	Person Oriented Careers	Thing Oriented Careers	Person Oriented Careers	Thing Oriented Careers
Self-rated Person Orientation	.23**	-.24**	.31**	-.25**
Self-rated Thing Orientation	-.16+	.23**	-.35**	.43**
Teacher-rated Person Orientation	.33**	-.24**	.23**	-.22*
Teacher-rated Thing Orientation	-.41**	.35**	-.22*	.14

Table 2. **Summary of Regression Analysis for Variables Predicting Students' Self-rated Interest in Careers.** *Note*: All presented statistics are standardized regression coefficients. $^{+}p<.10$, $*p<.05$, $**p<.01$

To examine the effects of teachers' self reported PTO on students' self-reported interest in careers, preliminary analyses using Structural Equation Modeling was conducted. Teachers' self reported person and thing orientation were exogenous variables, student person and thing orientation (both self rated and teacher rated) were mediating variables, and interest in person oriented and thing oriented careers were endogenous variables. Teacher's self reported PTO was related to their ratings of their students. More specifically, teachers with higher levels of person orientation rated their students as higher in both person orientation, $B = .36$, $p = .03$, and thing orientation, $B = .27$, $p = .06$. Teachers with higher levels of thing orientation also rated their students higher in both person orientation, $B = .45$, $p < .01$, and thing orientation, $B = .32$, $p < .01$. Replicating regression results, these teacher ratings of student PTO were related to interest in person and thing oriented careers (See Table 2.). Most importantly, teachers seem to be having an indirect affect on career interest in students across both 3rd and 6th grade. There was no evidence that teacher's self reported PTO was related to student's self reported PTO in 3rd graders, all *p*s > .28. In 6th graders however, teacher's self reported thing orientation emerged as a significant predictor of the students self rated person orientation. More specifically, teachers with higher levels of self reported thing orientation had students who self-reported lower levels of person orientation, $B = -.52$, $p = .02$, but only in the 6th grade. These results provide preliminary evidence that students' interests may be directly affected by the interests of their teachers in 6th grade.

We next examined the affects of teacher and student ratings on achievement ratings (done by teachers) in 5 different classes (i.e., math, science, art, social studies, and language arts). Latent variables were created for thing oriented class achievement and person oriented class achievement. Thing oriented achievement was composed of 2 indicators, math and science achievement; person oriented achievement was composed of 3 indicators, art, social studies, and language arts achievement. Results revealed both self rated and other rated PTO was related to teacher rated achievement in classes. Achievement in person oriented classes was positively related to the student's self rated person orientation, $B = .10$, $p = .08$, and negatively related to the student's self rated thing orientation, $B = -.09$, $p = .03$. Teacher ratings of student person orientation, $B = .24$, $p < .01$, and thing orientation, $B = .09$, $p = .08$, were also related to achievement in person oriented classes. Achievement in thing oriented classes was only related to teacher's rating of their students' PTO. Teachers ratings of student thing orientation was strongly related to their ratings of that students achievement, $B = .71$, $p < .01$, more weakly related to their ratings of students person orientation, $B = .09$, $p = .09$.

Recommendations and Future Plans

Taken together, these preliminary findings suggest that teachers do play an important role in developing interest in careers in their students. Results indicate that teachers' perceptions of students' interest in person and things are more consequential in career interests in 3rd graders than 6th graders. There is also a strong relationship between teachers rating of students' interest

in people and things and their subsequent ratings of achievement in person and thing oriented classes.

These results provide additional evidence that interventions targeted at increasing the number of women (and men) in engineering should start early developmentally, when students' interests are plastic and able to be shaped. Teachers own interests in people and things are indirectly related to students' self-reported interest in STEM and nonSTEM careers. Because of these indirect and direct effects of teacher interest, teachers can be used as tools to increase interest and achievement in STEM related courses and careers.

The current research points to the idea that teachers who show high levels of interest in things have students who report lower levels of person orientation, at least in 6th graders. These data may also suggest that students may interpret teacher's interest in things as steering them towards careers involving things and away from careers involving people. Future research should examine whether training teachers to show interest in thing oriented activities and classes may also lead to an increase in student interest and achievement in these topics.

Understanding the nature of interest development, its interactions with environment and what contributes to its longevity and direction would have significant effects on the design of classroom environments and interventions that should benefit engineering education through increased participation of diverse populations who are well informed and supported in their choices.

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