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Demographic Predictors of Teachers' Stages of Concern for STEM Education in Hong Kong

Wilfred W.F. LAU[a*], Morris S.Y. JONG[a], Gary K.S. CHENG[b], Samuel K.W. CHU[c] & X WANG[a]

[a]*Department of Curriculum and Instruction,*
The Chinese University of Hong Kong, Hong Kong SAR, China
[b]*Department of Mathematics and Information Technology,*
The Education University of Hong Kong, Hong Kong SAR, China
[c]*Teacher Education and Learning Leadership Unit,*
The University of Hong Kong, Hong Kong SAR, China
*wwflau@cuhk.edu.hk

Abstract: This study explored the demographic predictors of teachers' stages of concern (SoC) for science, technology, engineering, and mathematics (STEM) education in Hong Kong. Results of multiple regression analysis demonstrated that teaching sector and participation in STEM education training predicted four SoC, whereas teaching subject area predicted two SoC. We discussed the significance of these findings by adopting a personalized approach to teacher professional learning.

Keywords: Demographic predictors, stages of concern, STEM teachers, STEM education

1. Introduction

Science, technology, engineering, and mathematics (STEM) education has received increasing attention worldwide; in particular, enhancing the quality of STEM education is a challenge faced by teachers, school leaders, and policymakers. Extensive research has been conducted on supporting STEM teaching and learning through integrated pedagogical practices (Kelley & Knowles, 2016); however, relatively little is known regarding teachers' concerns about STEM education. This paper reports ongoing research that aims to explore the demographic variables predicting teachers' stages of concerns (SoC) for STEM education in Hong Kong. We first present the method of our study and then the results based on a territory-wide survey of STEM teachers. Next, we discuss the significance of the findings by adopting a personalized approach to teacher professional learning (Rodman, 2019). As a way forward, we'll analyze teachers' responses from the open-ended questions of the survey to help overall interpretation. It is suggested that more studies are needed to understand teachers' concerns about STEM education in other cultural contexts.

2. Method

2.1 Procedure

Data were collected from STEM teachers in late April 2020. Our original intent was to select regionally representative primary and secondary schools from the main regions of Hong Kong and invite their STEM teachers to respond to an online, self-reported survey. However, classes were suspended because of the impact of the novel coronavirus. By using the school information available from the website of the Committee on Home-School Co-operation (https://chsc.hk/main.php?lang_id=1), we sent emails to all primary (n = 510) and secondary schools (n = 444) in Hong Kong to recruit research participants. International schools were excluded from our study because their curricula are typically different from those of local schools that follow the Hong Kong science, technology, and mathematics education curricula. Additionally, we invited the schools that our investigators knew personally. Finally, we received completed questionnaires from 370 STEM teachers; after invalid questionnaires had been omitted, 331 valid responses were obtained.

2.2 Participants

The participants comprised 132 female and 199 male STEM teachers. This study collected demographic data from these teachers, including their gender, age, teaching experience, class size, highest education level, professional teaching qualifications, school type, school region, teaching sector, teaching subject area, and participation in STEM education training. With the exception of age, teaching experience, and class size, all the variables were categorical and those with more than two levels (school type and school region) were coded into corresponding dummy variables. On average, the STEM teachers were 39 years old, had 15 years of teaching experience, and taught a class size of 29 students. The majority of them had obtained postgraduate degrees (54%) and postgraduate diploma of education for teaching (70%), and they primarily taught in subsidized schools (88%) in the New Territories and the Outlying Islands region in Hong Kong (56%). Most of the participants were secondary school teachers (63%) and taught subjects related to science, technology, and mathematics education (84%). The vast majority of the teachers had received some form of training in STEM education, including workshops, seminars, courses, and field trips (96%).

2.3 Measures

Teachers' concerns about STEM education were measured with the 19-item SoC questionnaire, using a 5-point Likert scale (Geng, Jong, & Chai, 2019). Readers may refer to their paper for the full set of items. The questionnaire had been validated by STEM teachers in Hong Kong prior to use in this study. The questionnaire targeted the following five SoC: evaluation (3 items), information (5 items), management (4 items), consequence (4 items), and refocusing (3 items). The evaluation items measured the value teachers attach to implementing STEM education in schools. The information items measured teachers' needs concerning the teaching practice of STEM education and the availability of pedagogical resources. The management items measured teachers' concerns regarding the practical problems encountered during the delivery of STEM lessons in classrooms. The consequence items measured teachers' concerns regarding the impact of STEM education on how students learn and how teachers grow professionally. The refocusing items measured teachers' concerns regarding the development of STEM education in the future. In terms of reliability, Geng et al. (2019) found these five dimensions of SoC to have satisfactory Cronbach's alpha values ranging from 0.70 to 0.83.

3. Results

Confirmatory factor analysis was conducted on the data collected from the SoC questionnaire to assess the validity of the 5-factor model. The model fit indices suggested an acceptable fit between the model and the data (χ^2/df = 2.391, CFI = 0.954, TLI = 0.945, and RMSEA = 0.065) (Hu & Bentler, 1999). The teachers reported high levels of concern for STEM education, with mean ratings of over 4 for items in all five SoC. Additionally, multiple regression analysis was conducted to evaluate whether the aforementioned demographic variables could significantly predict teachers' SoC for STEM education. The regression models yielded statistically significant results for four SoC, with the exception of management (see Table 1). Gender and school region were significant predictors of refocusing (β = 0.146, $p < 0.05$) and consequence (β = 0.204, $p < 0.05$), respectively. Teaching subject area was a significant predictor of both evaluation (β = 0.135, $p < 0.05$) and information (β = 0.146, $p < 0.05$), indicating that teachers involved in science, technology, and mathematics education demonstrated more concerns in these two stages than teachers involved in nontraditional STEM education areas such as Chinese and English education. Both teaching sector and participation in STEM education training were significant predictors of evaluation, information, consequence, and refocusing, suggesting that primary school STEM teachers expressed more concerns in these four stages than did secondary school STEM teachers. Additionally, STEM teachers who had received training in STEM education expressed more concerns than did those who had never been trained.

Table 1. *Multiple Regression Analysis for Predicting Teachers' SoC for STEM Education*

	Evaluation	Information	Consequence	Refocusing
	β	β	β	β
Gender	ns	ns	ns	0.146^{*}
School region	ns	ns	0.204^{*}	ns
Teaching sector	-0.184^{**}	-0.128^{*}	-0.148^{*}	-0.243^{***}
Teaching subject area	0.135^{*}	0.146^{*}	ns	ns
Participation in STEM education training	0.200^{***}	0.232^{***}	0.248^{***}	0.245^{***}
F	3.620^{***}	3.932^{***}	3.620^{***}	5.289^{***}
R^2	0.141	0.151	0.141	0.193

Note. $*p < 0.05$. $**p < 0.01$. $***p < 0.001$. ns: not significant.

4. Discussion and Conclusions

The different concerns, as predicted by different demographic variables, indicate individual differences among STEM teachers. Primary school STEM teachers should urgently be provided with professional learning opportunities that are different from those offered to secondary school STEM teachers (Margot & Kettler, 2019). Similarly, STEM teachers who have received training in STEM education require different kinds of professional learning than the untrained ones. More support should be provided for STEM teachers involved in science, technology, and mathematics education because they show more concerns than teachers involved in nontraditional STEM education areas such as Chinese and English education in the evaluation and information stages. The results from the multiple regression analysis highlight the need to adopt a more personalized approach to professional learning of STEM teachers (Rodman, 2019). Our next step is to analyze teachers' responses from the open-ended questions of the survey for their concerns about STEM education to help overall interpretation. Also, future research should be conducted to understand teachers' concerns about STEM education in other cultural contexts.

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