

PEDAGOGY

Physical Education Teachers' Behaviors and Intentions of Integrating STEM Education in Teaching

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Abstract

Integrating science, technology, engineering, and mathematics (STEM) education in physical education (PE) has received increased attention. PE teachers' past behaviors and behavioral intentions of integrating STEM education in their teaching were investigated in this cross-sectional survey via the lens of the theory of planned behavior (TPB). Primary and secondary school PE teachers (n = 165) completed a survey that measured their behaviors and intentions surrounding STEM. The results indicated that only 19.4% of the PE teachers sometimes or often integrated STEM education in their teaching. Attitudes, subjective norms, and perceived behavior control positively predicted PE teachers' behavioral intentions, which was consistent with the TPB. These findings support the utility of TPB in understanding PE teachers' intentions to integrate STEM education in PE classrooms. The findings also provide the first evidence-based data for policymakers to promote STEM education in PE.

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Physical education (PE) classes are possible venues for the integration of STEM education; however, the concept of STEM may be new for some physical educators. The term *STEM* stands for science, technology, engineering, and mathematics. Indeed, PE has a science basis that integrates and applies scientific theories and technologies to improve performance in sports or to enhance physical health via exercise. Studies have shown that STEM education can enhance students' learning (Becker & Park, 2011) and academic performance (Barker & Ansorge, 2007), as well as critical thinking and problem-solving skills (Fortus, Krajcik, Dershimer, Marx, & Mamlok-Naaman, 2005; Mehalik, Doppelt, & Schuun, 2008; Su, 2008). Therefore, many countries, including Australia and the United States, have implemented STEM programs to improve students' achievement and remain competitive in the global economy (Kuenzi, 2008).

In response to the changes of the modern world, the Education Bureau of Hong Kong recommended local teachers integrate STEM education into the school PE curriculum (Curriculum Development Council, 2017). The 2015 Policy Address (Hong Kong Special Administrative Region Government, 2015) stated that the promotion of STEM education is a key emphasis under the ongoing renewal of the school curriculum, including PE. According to the Curriculum Development Council (2017), the promotion of STEM education will provide more opportunities for the innovative integration and application of different subject knowledge and skills in real settings. For example, students can develop health applications (e.g., Spotify Running) via smartphones for exercise programs (Erwin, 2017). In addition, promoting STEM in PE will reduce the marginalization of PE, as it is increasingly being recognized as an academic subject (Johns & Dimmock, 1999).

Despite the benefits of promoting STEM in PE, the integration of STEM education (e.g., integrating one or more STEM components such as mathematics and physics in PE) may pose challenges to PE teachers. Indirect evidence indicates that preservice and in-service science teachers need to expand their knowledge to implement STEM programs (Teo & Ke, 2014). Similarly, mathematics and science teachers note that there are insufficient guidelines on the integration of STEM education in the classroom (Brown, Brown, Reardon, & Merrill, 2011). Unfortunately, there is a lack of empirical

evidence regarding PE teachers' perceptions about the integration of STEM education in their teaching. Since PE is different from other STEM subjects (e.g., mathematics and science), PE teachers may have different views about the integration of STEM education compared with teachers of other subjects. More important, ignoring teacher-related factors (e.g., attitudes, knowledge, and perceptions) may affect the progress of education reform (Van Driel, Beijaard, & Verloop, 2001), including the promotion of STEM in PE. Therefore, it is necessary for researchers to investigate PE teachers' perceptions of STEM in PE. Moreover, it is also important to know how often PE teachers integrate STEM education in their classes; this will provide policymakers with preliminary data that will inform decision making regarding STEM.

The theory of planned behavior (TPB; Ajzen, 1991, 2005) may be a useful model for examining teachers' behaviors when they integrate STEM education into PE classes. According to the TPB (Ajzen, 1991), individuals' behavioral intentions are a salient predictor of human behaviors (e.g., integrating STEM into PE). The TPB also posits that behavioral intentions are shaped by three conceptual determinants: attitudes toward the target behavior, subjective norms, and perceived behavioral control (PBC).

Attitudes are defined as the degree to which a person has a favorable or unfavorable evaluation of the outcomes of a target behavior. For example, if a PE teacher expects the use of mobile applications (e.g., Angry Birds) will increase students' skill achievement (e.g., throwing distance of a beanbag), he or she is more likely to form a positive attitude toward using mobile applications in teaching. *Subjective norms* refer to the perceived social pressure from significant others about whether to engage in a target behavior. In a different behavioral context, significant others or reference groups are different. In the aforementioned example, the significant others may include students, parents of students, colleagues, and school principals. Finally, *PBC* concerns an individual's perceived abilities and resources to perform a target behavior. For example, it is impossible for a PE teacher to use the Angry Birds game to teach beanbag throwing if he or she does not have the resources to purchase it or the expertise to use it, even if the application is accessible. Indeed, the TPB has been tested and supported in different fields, including mobile learning (e.g., Cheon, Lee, Crooks, & Song, 2012) and the

promotion of physical exercise (e.g., Schüz, Li, Hardinge, McEachan, & Conner, 2017). However, the application of TPB to understanding teachers' intentions to integrate STEM education in PE is unknown.

In summary, although there is a call for the implementation of STEM in PE, little is known about teachers' behaviors and intentions to implement STEM. Guided by the TPB (Ajzen, 1991), this cross-sectional survey was therefore developed to understand how often PE teachers integrate STEM education in teaching and their behavioral intentions to integrate STEM education into PE lesson. Based on the tenets of TPB (Ajzen, 1991), it was hypothesized that attitudes, subjective norms, and PBC would be positive predictors of intentions. In other words, PE teachers who have higher levels of positive attitudes, subjective norms, and PBC will have stronger intentions to integrate STEM education into their teaching.

Method

Participants

Participants included 165 PE teachers (40 females, 41 males, 50.9% did not report their gender) who were recruited from primary and secondary schools in Hong Kong. Approximately half (46.7%) of the teachers were recruited from primary schools. The majority of the participants (75.8%) were 26 to 45 years old. All participants had at least a bachelor's degree; the sample varied in their teaching experience. Table 1 presents detailed information about participants' demographics.

Measures

Demographic data including gender, school, age range, education level, and years of teaching were collected. In addition, in accordance with the guideline for constructing the TPB-based questionnaire (Ajzen, 2002), a researcher trained in PE developed the survey items that measured the participants' attitudes, subjective norms, PBC, behavioral intentions, and behaviors regarding the integration of STEM education into PE. Two experts in PE checked the developed items and made minor changes to item wording. The updated items were then administered to 10 in-service PE teachers, who assessed the items and indicated that they were understandable and did not require further changes.

Table 1*Demographic and Other Characteristics of Participants (n = 165)*

Characteristics	Valid frequency (%)
Gender	
Male	41 (24.8)
Female	40 (24.2)
Missing	84 (50.9)
Age	
≤ 25	11 (6.7)
26–30	33 (20.0)
31–35	31 (18.8)
36–40	30 (18.2)
41–45	31 (18.8)
≥ 46	29 (17.6)
School	
Primary school	77 (46.7)
Secondary school	85 (51.5)
Missing	3 (1.8)
Education level	
Bachelor's degree	62 (37.6)
Postgraduate diploma	53 (32.1)
Master's degree	49 (29.7)
Missing	1 (0.6)
Years of teaching	
0–3	33 (20.0)
4–6	12 (7.3)
7–10	23 (13.9)
11–15	26 (15.8)
16–20	32 (19.4)
21–25	15 (9.1)
≥ 26	23 (13.9)
Missing	1 (0.6)

TPB-based variables. The stem “In the coming month, integrating STEM education in PE is...” was employed for the assessment of participants’ attitudes. Their responses were rated on five six-point semantic differential scales: “valuable–worthless,” “beneficial–harmful,” “pleasant–unpleasant,” “enjoyable–unenjoyable,” and

“good–bad.” The items measuring subjective norms (three items; e.g., “The people in my life whose opinions I value would approve of me integrating STEM education in PE”), PBC (five items; e.g., “I have complete control over integrating STEM education in PE”), and intentions (three items; e.g., “I intend to integrate STEM education in PE”) were rated on a 7-point Likert scale ranging from *strongly disagree* (1) to *strongly agree* (7).

An exploratory factor analysis (principal axis factors) was conducted and the factorial validity of the items examined. According to the TPB (Ajzen, 1991), a four-factor solution with direct oblimin rotation was used in the extraction of the data (Costello & Osborne, 2005). The four-factor solution explained 80.6% of the variance in the data set. Table 2 presents the item loadings. The item PBC1 was removed because it failed to load on the target factor. The Cronbach’s alphas for the four subscales were .95 (attitudes), .92 (subjective norms), .92 (PBC), and .96 (behavioral intentions). A mean score for each subscale was calculated for subsequent analyses.

Behavior. In Hong Kong, there are two to three PE lessons per week and each lesson lasts about 35 to 40 min. Participants were asked about how often they integrated STEM education into their teaching during the last month. Participants rated their response on a 5-point Likert scale ranging from 1 (*almost never*) to 5 (*almost always*).

Procedure

The institutional review board at the Education University of Hong Kong granted ethical approval for the study. The survey was conducted during the Summer School for PE Teachers held in June 2017. The Summer School was a 1-day event with the theme “Nurturing Positive Values and Attitudes Through PE.” PE teachers ($N = 303$) who participated in the Summer School were invited to complete this survey. The second author provided the PE teachers with information about the study in a large lecture hall. The PE teachers were then asked to sign the informed consent form, and, if they agreed to participate, were asked to complete the survey at that time. The second author also encouraged the participants to answer the questions honestly. The survey took approximately 10 min to complete; 166 participants completed the survey, with a response rate of 54.8%.

Table 2*Item Factor Loadings of TPB-based Variables after Direct Oblimin Rotation*

Item	Factor 1	Factor 2	Factor 3	Factor 4
AT Item 1		.64		
AT Item 2		.84		
AT Item 3		.87		
AT Item 4		.99		
AT Item 5		.98		
SN Item 1				.67
SN Item 2				.94
SN Item 3				.91
PBC Item 1	.35			.32
PBC Item 2			.69	
PBC Item 3			.97	
PBC Item 4			.84	
PBC Item 5			.79	
INT Item 1	.78			
INT Item 2	.75			
INT Item 3	.96			

Note. Factor loadings < .30 have been omitted for clarity. TPB = theory of planned behavior; AT = attitude; SN = subjective norm; PBC = perceived behavioral control; INT = intention.

Data Analysis

One participant only completed half of the survey form and was excluded from the data analysis (Hair, Black, Babin, & Anderson, 2010). In addition, there was one missing data point for attitudes, which was imputed by the mean (Hair et al., 2010). Descriptive statistics (means, standard deviations, or percentage) for all of the

study variables were computed. Zero-order correlations between demographic variables (i.e., school, gender, age range, years of teaching, and education level) and TPB-based variables (i.e., attitudes, subjective norms, PBC, and intentions) were examined. Hierarchical regression analyses were adopted and the effects of attitudes, subjective norms, and PBC on behavioral intentions examined. In Step 1, demographic variables were entered if they significantly correlated with attitudes, subjective norms, PBC, and/or intentions. In Step 2, attitudes, subjective norms, and PBC were added to the model. All statistical analyses were conducted with SPSS 24.0; the significance level was set at .05.

Results

Descriptive Statistics

For target behavior, the participants reported that during the last month they almost never (50.9%) or occasionally (29.1%) integrated STEM education in PE; only 19.4% reported that they sometimes or often integrated STEM education into their PE lessons. The participants reported a moderate level of attitudes ($M = 4.15$, $SD = 1.09$), subjective norms ($M = 3.86$, $SD = 1.27$), PBC ($M = 4.01$, $SD = 1.19$), and behavioral intentions ($M = 4.18$, $SD = 1.36$).

Zero-Order Correlations

Table 3 presents the zero-order correlations among the study variables. Age was significantly correlated with attitudes ($r = -.31$, $p < .01$), subjective norms ($r = -.28$, $p < .01$), and intentions ($r = -.26$, $p < .01$). Years of teaching was negatively related to attitudes ($r = -.30$, $p < .01$), subjective norms ($r = -.34$, $p < .01$), and intentions ($r = -.31$, $p < .01$). The rest of the demographic characteristics (i.e., gender, school, and education level) were not significantly related to TPB-based variables (attitudes, subjective norms, PBC, and intentions). Thus, age and years of teaching were entered in the regression models as control variables. In line with the hypothesis, attitudes, subjective norms, and PBC were positively associated with intentions ($rs = .67$ to $.76$, $ps < .01$).

Table 3
Zero-Order Correlations Among the Study Variables

Variable	1.	2.	3.	4.	5.	6.	7.	8.	9.
1. School	—								
2. Gender	.06	—							
3. Age	-.28**	-.00	—						
4. Years of teaching	-.31**	.08	.93**	—					
5. Education level	-.01	.07	.01	.04	—				
6. Attitudes	.13	-.08	-.26**	-.30**	.04	—			
7. Subjective norms	.15	-.04	-.28**	-.34**	.06	.56**	—		
8. Perceived behavioral control	-.05	-.19	-.09	-.10	.07	.56**	.59**	—	
9. Intentions	.15	-.19	-.26**	-.31**	.10	.67**	.76**	.68**	—

** $p < .01$.

Regression Analyses

Table 4 shows the results of the hierarchical regression analyses. In Step 1, years of teaching ($\beta = -.50, p = .02$) was a significant predictor of intentions. In Step 2, years of teaching ($\beta = -.16, p = .19$) was no longer a predictor of intentions, while the newly added variables were significant and positive predictors of intentions (attitudes, $\beta = .26$; subjective norms, $\beta = .43$; and PBC, $\beta = .28$; $ps < .01$). Attitudes, subjective norms, and PBC explained an additional 61% of the variance in the prediction of intentions on top of the two demographic variables (i.e., age and years of teaching). In total, all predictors accounted for 71% of the variance in the model.

Table 4

Hierarchical Regressions of Age, Years of Teaching, Attitudes, Subjective Norms, and Perceived Behavioral Control on Intentions

Predictor	β (Step 1)	β (Step 2)
Step 1		
Age	.20	
Years of teaching	-.50*	
Step 2		
Age		.11
Years of teaching		-.16
Attitudes		.26**
Subjective norms		.43**
Perceived behavioral control		.28**
R^2	.10	.71
ΔR^2		.61**

Note. β = standardized regression coefficient; R^2 = coefficient of determination (variance explained); ΔR^2 = change of coefficient of determination. * $p < .05$. ** $p < .01$.

Discussion

This research investigated the role of PE teachers' past behaviors and intentions to integrate STEM education in their teaching. Most of the participants reported that they seldom integrated STEM education into their classes, even though the STEM in PE program has been implemented in Hong Kong since 2015. These findings suggest

a need for the provision of sufficient guidelines to PE teachers about how to integrate STEM education into their teaching. According to earlier research (e.g., Brown et al., 2011; Teo & Ke, 2014), mathematics and science teachers also need similar guidelines on how to integrate other STEM components into their subject.

This study also examined whether TPB is applicable to further understanding of PE teachers' behavioral intentions to integrate STEM education into their teaching. The results of the regression analyses support the tenets of TPB in the context of STEM in PE. This finding extends the applicability of the theory and is consistent with research in other domains, including physical activity (Martin & Kulinna, 2005) and technology use (Teo & Lee, 2010). The findings of this study indicate that PE teachers who report higher levels of attitudes, subjective norms, and PBC are more likely to integrate STEM education into their classes.

According to Ajzen (1991), the three determinants of behavioral intentions vary across different study contexts (e.g., education, health, and volunteerism) and groups (e.g., teachers, patients, and volunteers). For example, PBC was a stronger predictor of intentions to help others than attitudes and subjective norms in the context of volunteerism (Hyde & Knowles, 2013). However, subjective norms was a stronger predictor of behavioral intentions than the other two predictors in this study (i.e., an educational and collectivistic setting). As Hong Kong is a society that is predominantly collectivistic, PE teachers' perceived social pressures (i.e., subjective norms) may be intensified (Ham, Jeger, & Frajman Ivković, 2015). In addition to cultural influences, PE teachers may be more willing to comply with referents' opinions than other groups of people. These may explain why subjective norms was the strongest predictor among the three determinants of PE teachers' intention to integrate STEM education in this study.

Limitations and Future Research Directions

This study had a few limitations. First, while the sample size was relatively large, the use of convenience sampling limits the generalizability of the findings. Future research should examine whether the findings can be replicated in other samples or contexts. Second,

the study used a cross-sectional design; therefore, readers should be cautious about inferring causation between the three belief-based variables and behavioral intentions. In addition, the data were self-report, which may contribute to shared method bias. Thus, future research in this area should implement longitudinal studies with objective measures. Third, participants were asked to report their behaviors and intentions of integrating STEM education as a whole rather than each of the STEM components (e.g., integration of mathematics into PE). To provide more information for stakeholders to promote STEM in PE, future investigations need to address this limitation. Finally, attitudes, subjective norms, and PBC explained 61% of the variance in the prediction of intentions; however, the integration of other theories such as self-determination theory (Ryan & Deci, 2000) and the health action process approach (Schwarzer, Lippke, & Luszczynska, 2011) may provide additional explanations for the prediction of intentions.

Implications

Despite the outlined limitations, several practical implications can be derived from this research to promote STEM in PE. The majority of PE teachers responded neutrally about integrating STEM education into their teaching. Therefore, it is necessary for policymakers and stakeholders to take action to improve local PE teachers' attitudes. In addition to attitudes, PE teachers' behavioral intentions are strongly influenced by subjective norms. As such, significant others' (e.g., principals, parents, and students) perceptions should also be enhanced. For example, messages about the benefits of integrating STEM education into PE should be disseminated among teachers and significant others. Moreover, for an enhancement of PE teachers' PBC, financial support and resources should be allocated to schools for STEM integration into PE. Finally, there is a need for PE teachers to expand their knowledge about how to implement STEM in PE programs. A detailed guideline (e.g., analyzing fitness scores using software, using accelerometers, applying mobile applications, and employing Newton's laws of motion) about the implementation of STEM in PE should be prepared.

Conclusions

PE teachers seldom integrate STEM education into their PE lessons in Hong Kong. This survey provided initial empirical evidence that could guide policymakers and stakeholders to promote STEM in PE. This study extends the application of the TPB to the context of STEM in PE. It is hoped that the findings of this study spur further research on STEM in PE.

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