Willingness to Engage Predicts Physical Activity Participation in Physical Education among Students

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***Abstract*—Cognitive processes influence students' engagement and learning. This study examined students' cognitive processes and their physical activity in physical education (PE). The participants were 211 students enrolled in three middle schools. The Cognitive Processes Questionnaire in Physical Education was used to measure students' cognitive processes. ActiGraph GT3X accelerometers were fitted on students' waists during PE classes to gather physical activity data. Students spent relatively short amount of time in MVPA in PE classes (M/SD = 12.79/6.21 minutes). Subsequent regression analysis found that these cognitive process variables collectively accounted for 11% of the variances in MVPA time and 14% in step count, respectively. Willingness to engage (i.e., a cognitive process variable) was the only significant positive predictor for in-class MVPA and step count. The findings suggest that there is a need to create amenable learning environments that foster students' willingness to participate in PE, and that researchers and practitioners should recognize the impact of students' willingness to engage on their physical activity participation in class.**

***Index Terms*—cognitive process, adolescent, step count, middle school, MVPA, motivation**

I. Introduction

Students are not cold objects passively waiting for content delivery; rather they are active learners who have their own thoughts/cognitive processes actively seeking to engage in learning activities [1]. It is believed that students who are actively engaged in class are likely to have better learning outcomes than those who are not or less engaged [2], highlighting the importance of stimulating students' cognitive processes. Cognitive process refers to student thoughts or the processes of thinking imbedded in the instructional contexts which influences engagement and learning [3], [4]. Important cognitive processes studied in education include but are not limited to students' confidence-efficacy, attention-concentration, self-regulation, willingness to engage, and use of strategies [4]. Research in multiple educational domains have focused on the impact of cognitive processes on learning outcomes [5], [6], but further research is needed to explore the association between cognitive processes and physical engagement such as physical activity participation in Physical Education (PE) classes.

Physical activity participation has been an important focus of many contemporary PE programs to prevent and curb childhood obesity [7]. Review of the existing literature has shown that it is difficult for students to engage in moderate-to-vigorous physical activity (MVPA) for a minimum of 50% of the instructional time in PE classes [8], which is an important criterion for quality PE from the public health perspective [9]. According to the constructivist learning theories, it is important to view and recognize students as active agents whose cognitive thoughts are capable of making decisions for their course of actions. In the context of PE, it seems evident that the role of students' cognitive processes in relation to their in-class physical activity participation is not fully understood, which warrants more empirical research.

Only a handful of studies in PE research have examined students' cognitive processes. Solmon and Lee (1997) first developed the Cognitive Processes Questionnaire in Physical Education (CPQPE) to measure students' cognitive processes and to explain the interrelation between teacher's instruction and students' behavior [10]. Specifically, they conceptualized cognitive processes in PE to include five elements: confidence-efficacy, attention-concentration, self-regulation, willingness to engage, and use of strategies. Confidence-efficacy refers to students' perceived level of confidence in completing given physical tasks in PE. Attention-concentration describes the extent to which students pay attention to the teacher and instructional tasks. Self-regulation refers to the reported behavioral regulation toward participation in and completion of these tasks. Willingness to engage refers to the extent to which students feel they would like to participate in tasks and PE in general. Finally, use of strategies refers to the

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extent to which students use strategies to learn physical skills in PE.

From an instructional perspective, Students' cognitive processes when interacting with the content and the teacher are essential for engagement and learning [11]. Cohen and colleagues (2003) posited that the learner, content, and instructor form an instructional triangle. The triangular interactions among the learner, content, and instructor may dictate the degree of the educational outcomes sought after. The students' cognitive processes such as confidence-efficacy, attention-concentration, self-regulation, willingness to engage, and use of strategies not only impact the learner per se, but also the interaction relationship constructed by the learner, content, and instructor triangle, which would influence their educational outcomes [12].

Previous research has demonstrated the positive associations of students' cognitive processes with engagement, effort, and achievement in multiple educational domains. For example, self-efficacy and use of strategies were found to be direct predictors and mediators (for autonomy support and) for achievement in English classes [5]. In PE, it was reported that students as early as fourth grade were able to identify their cognitive processes [13]. Through videotaping of student practice trials and interview of their thought processes, Lee et al (1992) found a significant positive association between students' skill-related cognitive processes and successful performance. Zhu and colleagues (2009) reported that cognitive engagement in PE significantly predicted elementary students' health-related fitness knowledge gain [14]. The cognitive processes such as attention, use of strategies, and motivational levels impact student engagement, effort, and skill learning achievement in sixth grade PE classes [6].

The current policies and law mandates for school PE stress the importance of physical activity engagement in and out of PE classes [15]. One study that examined high school junior and seniors has shown that cognitive processes (i.e., self-regulation, use of strategies, and willing to engage) mediated the relationship between the perceived learning climate in PE and physical activity intention, which is an important predictor of physical activity participation after graduation [16]. However, the direct relationship between cognitive processes and in-class physical activity during PE classes has not been documented in the literature. Therefore, the purpose of this study was to investigate the association between cognitive processes and students' physical activity participation in PE classes. This study is significant in light of the current societal effort and curriculum shift towards youth physical activity promotion. The findings from this study would shed light on providing effective instruction and physical activity promotion strategies within PE classes. Based on the previous findings, we hypothesize that cognitive processes including confidence-efficacy, attention-concentration, self-regulation, willingness to engage, and use of strategies would be significantly associated with students' physical activity participation in PE classes.

II. Methods

We used a correlational naturalistic study design to examine the association between cognitive processes and physical activity in PE. Within the research context, PE classes were taught by certified specialists following the state and national standards. The physical educators were mostly using a command teaching style, where the instructor determined and directed all instructional tasks. The physical activities focused in the curriculum mainly included individual sports, team sports, and fitness activities, a sample of which was listed to provide some flexibility for the teacher to select for instruction. During the study period, the teachers were teaching one individual sport or team sport (varied across schools) coupled with some station-based fitness tasks. The participating schools had the A/B day alternating block schedule for PE, with 50 minutes per session for every other day (two or three PE classes per week).

The participants were seventh grade students (N = 211) from three co-educational middle schools in a suburban school district located on the east coast of the United States. The sample was evenly represented by boys and girls (52% girls) and averaged 12.11 years old for age (SD = .34), ranging from 11 to 13 years old. For ethnicity composition, the sample consisted of 4.54% Asian, 12.43% African American, 18.86% Latino, 62.26% Caucasian, and 1.88% others, representing a relatively diverse local population. The study protocols were reviewed and approved by the Institutional Review Board at the lead author's institution. Prior to the data collection, the participants submitted signed assent form and their parents/guardians submitted signed consent form to voluntarily participate in the study.

Cognitive processes. We used the CPQPE [10] to measure students' cognitive processes in PE. Questionnaires and surveys are commonly used in cognitive engagement and cognitive process studies [12]. The variables assessed by the CPQPE include: self-regulation, confidence-efficacy, attention-concentration, willingness to engage, and use of strategies. In total, the CPQPE has 33 items on the five-point Likert type scale, with seven items for confidence-efficacy, six items for attention-concentration, 10 for self-regulation, five for willingness to engage, and five for use of strategies. An item measuring self-regulation reads: "I work hard during practice in PE class." An example item (reversely coded) measuring confidence-efficacy reads: "When I can do a new skill in PE, I think it is because I am lucky." To measure attention-concentration, an example item states: "When I practice, I try to think only about the skill I am working on." To measure the use of strategies, an item reads: "I talk to myself during practice to help me do better." An example item measuring willingness to engage states: "I would rather stay in the classroom than go to PE class." For this reversely coded item, students are provided with five options forming a continuum from "not like me at all" to "very much like me." Using a factorial analytic approach based on a large sample size, it was reported the Cronbach alpha coefficients of .87, .75, .79, .72, and .66 for the five variables, respectively [10].

Physical activity. We used the ActiGraph GT3X (ActiGraph, Pensacola, FL) tri-axial accelerometers to assess students' in-class physical activity level. The Actigraph GT3X is a small and light monitor that is widely used in physical activity research, and it has shown to have good validity to capture MVPA and energy expenditure [17]. The accelerometers were set up as 10s epoch for sampling frequency during program initialization. Raw physical activity counts were reduced to activity time by intensity. The following intensity cutoff points [18] were used to determine MVPA (⩾ 500 counts/minute), light (150-499 counts/minute), and sedentary (<149 counts/minute) time. The step count function was also activated to measure the number of steps taken during each class. During the research period, students wore the programmed GT3X accelerometers as they entered the gymnasium, and returned them immediately after the class dismissal.

After the study protocols were approved by the university IRB and the school district's administrative office, we explained to the students the purpose and procedure of the study, and then introduced the accelerometers to the participants in their health classes. Specifically, we explained the utility of the accelerometer and demonstrated example physical activity data that could be collected by the monitor. We also described the CPQPE to familiarize the students to the questionnaire. Consent and assent forms were handed out at end of the introduction for permission granting and then the signed forms were collected before the study commenced. In the next week, we distributed the accelerometers to the participants for them to wear for a week to mitigate potential reactivity effect (reduce the novelty effect). Data collected during this week were not used for analysis. In this trial week, we administered the CPQPE in a PE lesson to assess the students' cognitive processes. The participants continued to wear the accelerometers for two additional PE lessons in the following week and physical activity data collected during these PE lessons were recorded and processed for analysis.

Following the procedures below, data were reduced for subsequent analysis. We first reverse coded several CPQPE items and then computed aggregated composite scores for the five CPQPE variables. We also computed the aggregated average for physical activity data (both step counts and activity time for MVPA, light intensity physical activity, and sedentary behavior) for the two assessed PE lessons. We next checked the internal consistency reliability of the CPQPE variables in the current research context and then conducted descriptive analyses on the cognitive processes and physical activity variables. Skewness and kurtosis values of each variable were obtained to examine their distribution property. Pearson product-moment correlation analyses were conducted to examine the bivariate correlation coefficients between the variables. Finally, we ran two multiple regression analyses, using cognitive processes as independent variables to predict student MVPA and step count, respectively. The above statistical significance tests were conducted in SPSS 24.0 (IBM, New York) and α was set to be .05 for the correlation and regression analyses.

III. Results

Table I shows the descriptive results for the variables of cognitive processes and in-class physical activity. The Cronbach alpha values range from .66 to .84 for the cognitive processes variables, which were similar with previous finding [10] demonstrating adequate internal consistency for the CPQPE measure in the current research context [19]. Data for these variables had absolute values of skewness and kurtosis smaller than or close to 1, confirming the univariate assumption of normal distribution. In general, the students reported moderate levels of cognitive processes (see Table I). On average, the students spent 12.79 min, SD = 6.21 in MVPA (i.e., 25.58% of the class time), while the rest of the class time was either sedentary (M = 11.21 min, SD = 5.54) or engaged in light intensity of physical activities (M = 23.34 min, SD = 9.52). They accumulated on average 1324.77 steps, SD = 415.87 per class period.

TABLE I. Descriptive Statistics of Cognitive Process Variables and Physical Activity

Variable	M	*SD*	Min.	Max.	Skewness	Kurtosis	*α*
Confidence-Efficacy	26.56	4.53	12.00	35.00	-.60	-.08	.84
Attention-Concentration	22.06	3.95	11.00	30.00	-.31	-.35	.71
Self-regulation	37.42	5.57	18.00	50.00	-.58	.43	.73
Willingness to engage	16.52	2.96	6.00	20.00	-1.02	.85	.73
Use of Strategies	16.37	4.08	5.00	25.00	-.15	-.57	.66
Sedentary$^+$	11.21	5.54	2.00	28.00	.56	-.30	—
Light activity$^+$	23.34	9.52	4.00	44.00	-.17	-.95	—
MVPA$^+$	12.79	6.21	1.00	31.00	.44	-.20	—
Step count	1324.77	415.87	217	2755	.78	1.40	—

TABLE II. PEARSON PRODUCT-MOMENT CORRELATION COEFFICIENTS (R) BETWEEN VARIABLES

Variable	1	2	3	4	5	6	7	8
1. Confidence-Efficacy	1							
2. Attention-Concentration	.37	1						
3. Self-regulation	.32	.48	1					
4. Willingness to engage	.60	.38	.37	1				
5. Use of Strategies	.23*	.38	.61	.18	1			
6. Sedentary	-.15	.00	.01	-.24	.03	1		
7. Light activity	.09	-.08	-.07	-.02	-.04	-.51	1	
8. MVPA	.13	.19	.15	.28	.16	-.13	-.60	1
9. Step count	.17	.22	.25	.34	.19	-.15	-.40	.79

The Pearson product-moment correlation coefficients between variables are displayed in Table II. The five cognitive processes variables were positively correlated to each other, showing low to moderate correlations, with r values ranging from .18 to .61. Sedentary behavior time had a low negative correlation with willingness to engage. Step count and MVPA had positive low correlations with attention-concentration, self-regulation, use of strategies, and willingness to engage, with correlation coefficient r ranging from .17 to .34. Step count was highly correlated with MVPA (r = .79), which was negatively correlated with light physical activity time (r = -.60) in PE.

TABLE III. MULTIPLE REGRESSION MODELS PREDICTING MVPA AND STEP COUNT

Model	B	$SE(B)$	β	t	p
Model 1: Predict MVPA (R^2 = .11; MS = 109.44, $F_{5, 205}$ = 3.09, p < .05)					
Self-regulation	-.15	.14	-.14	-1.05	.30
Use of strategies	.30	.17	.19	1.71	.09
Confidence-Efficacy	-.09	.14	-.07	-.66	.51
Willingness to engage	.63	.22	.31	2.84	.01
Attention-concentration	.14	.16	.09	.83	.41
Model 2: Predict Step Count (R^2 = .14; MS =602.69, $F_{5, 205}$ = 4.22, p < .05)					
Self-regulation	1.63	9.23	.02	.17	.86
Use of strategies	11.55	11.09	.12	1.04	.30
Confidence-Efficacy	-4.62	8.71	-.05	-.53	.60
Willingness to engage	42.62	14.02	.33	3.04	.00
Attention-concentration	4.32	10.39	.04	.42	.68

To further determine the association between cognitive processes and physical activity in PE, we conducted two multiple regression analyses with MVPA and step count as dependent variables (one after the other), and cognitive processes as independent variables. As shown in Table III, cognitive processes explained 11% of the variance in MVPA, and 14% of the variance in step count, respectively. According to Cohen (1988), these regression results (f^2 = .11, f^2 = .16) indicate a borderline medium effect size ($f^2 \geq$ .15) of the cognitive processes predictability on MVPA and step count [20]. Specifically, willingness to engage emerged as the only significant positive predictor for MVPA (β = .31, p < .05) and step count (β = .33, p < .05) in the two regression models. Other cognitive processes such as attention-concentration, confidence-efficacy, self-regulation, or use of strategies showed no significant prediction for MVPA or step count in PE.

IV. DISCUSSION

The purpose of this study was to examine the association between students' cognitive processes and accelerometer-determined physical activity in PE. The students reported moderate levels of cognitive processes, but their MVPA time was low. The regression results partially supported our hypothesis that willingness to engage was the only significant predictor for MVPA and step count. The findings provide preliminary evidence for the association between students' cognitive processes and their physical activity participation in PE classes, and have implications for PE research and practices as well as for physical activity promotion.

The results demonstrated that students spent, on average, approximately a quarter of the class time (25.58%) in MVPA, while most of the class time was spent on light physical activity or sedentary behaviors. This finding is consistent with prior research that also found that students in many PE programs across the world fail to meet the recommended level of in-class physical activity ($\geqslant$ 50% of class time on MVPA; [8]). Traditionally, PE is a school subject with the mission of educating students for multiple goals and objectives [7]. The public health concern regarding the rise of childhood obesity ratio and physical inactivity level over the past three decades has pressured PE researchers and teachers to reconsider the main outcomes of school PE [21], [22]. The national initiatives from the Centers for Disease Control and Prevention [23] and the Institute of Medicine (IOM, [24]) have acknowledged and championed the central role of school PE and PE teachers in helping students meet the recommended level of daily physical activity (60 minutes per day). As such, keeping students physically active during PE classes is not only an educational and public health goal [25]; it is also a foundation on which a lesson accomplishes other instructional objectives [26]. Empirical evidence supports the feasibility of accomplishing multiple educational goals in PE. For example, it has been found that elementary school students were able to learn essential fitness knowledge in a physically active learning context [27]. Both preservice teachers (through teacher education program) and in-service PE teachers (through professional development opportunities such as the Physical Activity Leader training) may receive specific training on how to focus on higher-order cognitive learning such as learning knowledge, skills, tactics, and strategies through carefully intertwined active movements. The inadequate level of MVPA found in the present study points out the need to enhance physical activity demand of the instructional tasks in PE classes. In fact, the students examined in the study spent most of their class time in light intensity of physical activity and little time in sedentary behavior. These results demonstrate there is room for converting light physical activity to MVPA.

According to Cohen *et al.*'s (2003) theory about the instructional triangle of the learner, content, and instructor, instructional tasks and the structure they were set up could have played a role in the student physical activity in the research context. For instance, students had to take turns to participate in the team and individual activities when the one scored a certain points so there was a structured "down" time in the tasks. In addition, the fitness stations were structured based on instructional time (e.g., x minutes), not the amount of activities such that students were freely and loosely conducting the fitness activities. Even though this observation was not a means of data collection, the observational anecdotal evidence helped to partially explain the relatively low amount of MVPA. In this instructional triangle, the physical educators have the leverage to engineer the content and structure to promote physical activity in PE.

The descriptive data showed that students reported moderate levels in the cognitive process variables. The regression models showed that students' cognitive processes predicted their step count and MVPA time accumulated during the PE lessons, explaining 14% and 11% of the variances in these two physical activity indicators, respectively. Of the cognitive processes variables, students' willingness to engage emerged was the only significant predictor of in-class physical activity, while other cognitive process variables such as self-regulation, or use of strategies did not show statistical significance. The importance of stressing students' cognitive processes in PE was acknowledged in previous studies that showed a positive association between cognitive processes and physical activity intention [5], [16] or the role of cognitive processes in eliciting learning achievements (e.g., [13]). However, to our knowledge, this present study was the first to examine the direct relationship between cognitive processes as measured by CPQPE and directly measured physical activity behavior. We used an objective measure (i.e., ActiGraph GT3X) to assess students' in-class physical activity, which is strength of the study. In addition, the earlier studies have mainly investigated the differences across learning groups for achievement and did not examine the direct predictability of cognitive process variables to the outcomes. The operation of variables as employed in different studies could have rendered the variation of the findings.

Cognitive engagement has long been documented as a determinant for student academic success [28], [29]. In the present study, we found moderate-to-low correlations between MVPA and cognitive processes. This finding suggests that the students' cognitive processes were inadequately tied to their physical activity participation. The data originated from this present study are limited to elucidate the true reasons for these specific moderate-to-low correlations, but it certainly has to do with the learner, content, and context, as well as the interactions among these factors [11]. From the pedagogical perspective, it all boils down to how the PE teacher develops content that is both cognitively and physically engaging, and whether the educational context created by the teacher and his students affords the students the opportunity to attach their cognitive thinking through their lived kinesthetic experiences in each lesson.

The findings are limited in several aspects. The regression models explained only a moderate amount of variances in student physical activity. A larger amount of variances was not explained by cognitive processes, which may attribute to other pedagogical factors such as the instructor and curriculum content or personal factors such as interest in sports or actual competence in the chosen activities, which were difficult to control in a naturalistic study such as this. The sample size was relatively small considering the number of the variables involved in the study, which may limit its generalizability. Nevertheless, the present study generated findings supporting higher willingness to engage eliciting higher levels of physical activity participation. It is particularly important for the PE teacher to create nurturing learning environments where students are viewed as active thinkers versus "cold objects", their thoughts and opinions are respected, and they are empowered with a voice as to what and how to learn, so that we could increase their willingness to engage in the chosen tasks within the context, which in turn would lead to positive learning behaviors and outcomes.

V. Conclusion

The findings in this study provide empirical evidence that students' willingness to engage is an important correlate of their physical activity participation in PE classes, which does not rely solely on the curriculum content (e.g., sports) or the physical educator, illuminating that the unique and significant impact of student cognitive processes. Theoretically, this finding can be supported by the instructional triangle, which posits that the class outcome, in this case physical activity (as one learning outcome), is a function of the simultaneous interactions between the learner, teacher, and curricular content within the instructional context [11]. The findings suggest the need to create amenable learning environments in PE to increase students' willingness to participate in the physical activities. A resourceful PE teacher with competent pedagogical content knowledge (i.e., knowledge of the learner, content, and pedagogy) and other professional knowledge (e.g,. knowledge of the context, knowledge of curriculum, etc.) would exhibit the capability to stimulate students' willingness to engage as well as other cognitive processes. Furthermore, researchers and practitioners should recognize the impact of students' willingness to engage on their physical activity participation during class [30].

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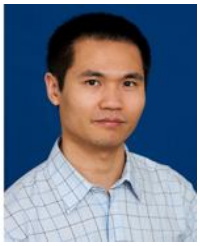

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