Power of the Curriculum: Content, Context, and Learning in Physical Education

Tan Zhang, Yubing Wang, Sami Yli-Piipari & Ang Chen

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ABSTRACT

Purpose: It is argued that the constructivist physical education has the potential to overcome socioeconomic (SES) constraints and promote learning. The purpose of this study was to determine the extent to which school SES-related class environmental factors influenced student learning in a constructivist physical education context. Methods: Students in 8th grade (N = 1,256) from 10 middle schools with varied SES were tested on exercise knowledge before and after a constructivist physical education intervention. School SES was determined using free and reduced meal ratio (FARM) and physical education related factors. Data on lesson frequency, length, facilities, equipment, and class size were collected from teachers. Results: Hierarchical linear model analyses reveal that SES is not predictive of intervention induced learning (γ = 0.73, t = 0.91, p = 0.37). Lesson frequency (γ02 = -0.52, t = -3.31, p < 0.01), length (γ03 = 0.03, t = -1.82, p = 0.07), facilities (γ04 = -0.11, t = -4.99, p = 0.003), equipment (γ05 = -0.36, t = -1.36, p = 0.18), and class size (γ06 = -0.05, t = -1.36, p = 0.18) are not predictive of learning. Student prior knowledge (γ = -0.59, t = -18.37, p < 0.001) and teacher factor (γ = 0.04, t = 3.72, p < 0.01) are predictive of learning. Conclusion: The findings suggest that school SES’s detrimental impact on learning in physical education could be overcome by the power of a constructivist curriculum.

Since the legislation of No Child Left Behind (NCLB) and Race to the Top, U.S. schools have been investing almost all curricular and financial resources in tested subject areas to prevent students from failing standardized tests. The increase of instructional time and resources in these subject areas has led to drastic reduction of the instructional time and resources for physical education. The situation is particularly dire in schools that serve low socioeconomic (SES) communities, as they face additional challenges with various school-level barriers, including but not limited to, high teacher burnout, facility, and equipment shortage, and lacking physical activity-supportive practices (Carlson et al., 2014; Dworkin & Tobe, 2014; Peralta et al., 2019).

SES is manifested in many aspects in schools. A widely used indicator at the school level is the Free and Reduced-Price Meal Rate, known as FARM. Although FARM can be a barometer for a school’s SES status, it could be a vague measure of the contextual support and resources a school might provide to physical education. It is commonly acknowledged by physical education professionals that space, facilities, equipment, curriculum materials, and professional development opportunities are among the most crucial resources needed for physical education programs to function. A recent large-scale (41 elementary and 45 secondary schools) survey study in Australia (Peralta et al., 2019) has identified fewer curriculum and teaching enablers in low SES schools than in high SES schools. In addition, low SES schools were facing “numerous curriculum and teaching barriers and restrictions with the amount, standard, and availability of facilities, equipment, and other resources available for PA” (Peralta et al., 2019, p. 464). In the U.S., Ennis (2006) observed: (N)one of the elementary schools built in the last 10 years has included a gymnasium. To magnify this problem, these schools host extensive feeding programs for children who qualify for free and reduced breakfast and lunch assistance, meaning that the multi-purpose rooms, which also serve as cafeteria, are unavailable for physical education during most of the school day. This means that during inclement weather, literally thousands of young children spend their physical education instructional time sitting quietly in their home rooms or performing jumping jacks behind their desks. Ever tightening budgets and reallocation of staff and training resources to literacy and mathematics means that physical educators receive minimal staff development updates on new techniques and technology and increasingly serve larger and multiple classes of students. Not only are they not held accountable for quality physical education programs, they are often ignored entirely. (p. 53)
In a large-scale survey investigation, Carlson et al. (2014) observed that only 63.2% of the low SES elementary schools hire a physical education teacher while 93.8% high SES schools do. The researchers also reported that the physical education programs in the low SES are rarely relevant and meaningful to students. The SES differences here, however, do not seem to associate with the accelerometer-measured physical activity time and behavior throughout the school day (Carlson et al., 2014). Although the findings provide useful evidence regarding physical education in relation to children’s overall physical activity throughout the school day, the association of school SES with student learning experiences and learning achievement in physical education remains unclear.

To provide meaningful and active physical education in these schools requires determined effort in that the curriculum needs to be robust and educational for children to not only be active but also learn scientific knowledge about the principles and benefits of physically active lifestyles. Emerging research findings have shown when physical education lessons are long enough (45-to-60-minute-long) and provide focused learning experiences on skill and fitness development, students can learn substantial amount of knowledge and skill while remaining physically active with moderate and/or vigorous physical intensity (Chen et al., 2012).

The findings briefly reviewed above have laid out an imperative need for research on the association between school SES and physical education resource disparities reflected in curricula, space, facilities, equipment, and schedule. In addition, research evidence is needed on the specific impact of these resources on physical education outcome reflected in student learning achievement. This type of research may provide valuable information and evidence to help physical education teachers, scholars, and school administrators to identify immediate needs in resources such as the curriculum, teacher training, facility improvement, and equipment. Based on these needs and the conceptualization of the challenges facing low SES school physical education, the purpose of this study is to determine the extent to which the SES-related contextual factors in physical education impact student learning and the extent of whether a constructivist physical education curriculum can overcome the influences to narrow the learning gap due to school SES-related factors.

**Constructivism and learning**

We use the constructivist learning theory to conceptualize the relationship between knowledge, learning behavior, and achievement (Von Glasersfeld, 1984). A basic tenet of the constructivist learning theory is that the learner is an active agent of knowledge construction rather than a passive recipient of information (Alexander, 2006). Such a perspective emphasizes on delivering holistic learning experiences in congruency with learning context and learners’ characteristics (e.g., prior knowledge/conceptions). As Von Glasersfeld (1984) acknowledged that from the very beginning of learning,

(1) learners construct understanding. They do not simply mirror and reflect what they are told or what they read. Learners look for meaning and will try to find regularity and order in the events of the world even in the absence of full or complete information.. (p. 21)

The constructivist perspective, therefore, requires teachers to transform students to active learners by linking prior knowledge, new knowledge, and the learning processes (Coley, 1992).

In most traditional curricula, the teacher plays a role of active transmitter of knowledge and the curriculum is merely a tool for the teacher to use (Posner, 1982). In such curricular contexts, the content is static on granting limited space to meet students’ diverse individual needs and learning styles. While a few students can navigate through the context successfully, the rigid “sink or swim” approach to curriculum presents hurdles to most learners who do not have the “correct” prior knowledge and skills.

To address the issues associated with learning experiences, the constructivist learning theory proposes drastic changes in the curriculum to provide a context in which students can connect their prior knowledge and skills with what they learn in class through real-life type learning experiences. The role of the curriculum, then, is to provide a learning environment in which each learner can find meaningful experiences that support and facilitate their learning. The key to maximize students’ engagement in learning is to help them develop a sense of ownership to the learning goal and a feeling of authenticity and meaningfulness throughout the learning process (Karagiorgi & Symeou, 2005). To accomplish the goal of learning, the constructivist learning theory requires the curriculum to provide authentic learning experiences to the learner in an authentic learning environment. Here, the authenticity means (a) that learning tasks must reflect the external world so that the learner can engage in a personally relevant interpretation of the world (Karagiorgi & Symeou, 2005); (b) The curriculum must be able to address naïve conceptions and misconceptions in the learner’s prior knowledge formed before entering the
learning environment (Zhang et al., 2019). It is a common practice of the learner to simply assimilate or blend new “knowledge” into their existing prior knowledge that contains naïve conceptions and/or misconceptions. The resulting knowledge often contains scientifically incorrect components that still need to be clarified. A constructivist curriculum should be able to lead the learner out of the jungle of naïve conceptions and misconceptions in order to construct scientifically correct knowledge repertoire.

Implementing a constructivist curriculum also requires the teacher to overcome many challenges to make autonomous learning possible for students. Autonomous learning is the cornerstone of the constructivist learning theory that allows learners with different learning styles learn at different paces. It is crucial, though, to realize that the less-structured, self-directed autonomous learning processes may not benefit all students in SES schools. For instance, low SES schools often have a high student–teacher ratio that prohibits individual students from choosing the most relevant task (Finn et al., 2003). Moreover, used to structured and teacher-directed learning approaches, the students may not be ready to learn in autonomous learning environment. Implementing constructivist curriculum demands solutions to address these issues so that each learner can construct authentic knowledge meaningful to him/herself.

Constructivist physical education

Students in low SES schools are more likely to have low-quality curriculum (Darling-Hammond, 2001), and less exposure to experiences needed for adopting healthy behaviors (Hart et al., 2002). As adolescents are attracted to different social cues of physical activities embedded in traditional physical education curriculum, these cues often deviate them from learning knowledge and receiving health benefits from physical activities (Tergerson & King, 2009). The combination of lacking relevant learning experiences and focusing on irrelevant cues (e.g., team sports and socializing) may contribute to a lack of motivation for physical education and physical activities.

In physical education, constructivist efforts have been made in curriculum development and improvement. For instance, in the Science PE and Me! curriculum (Ennis & Lindsay, 2008), elementary school students assume the role of “junior scientists” in learning to conduct experiments with physical activities to observe and record their body physiological responses as benefits of physical activity. The curriculum provides numerous authentic learning experiences to study important physical activity concepts such as cardiovascular fitness, Target Heart Rate Zone, fatigue, and overload. In learning, students document their physiological changes along with physical activities of varied intensity levels.

Based on the constructivist learning theory, constructivist physical education combines both cognitive and physical tasks to provide authentic learning experiences for the learner to construct knowledge regardless of SES. The curriculum allows the teacher to connect tasks performed in the gymnasium to real life so to provide meaningful and authentic physical activity experiences to the learner. In this learning environment, meaningful learning will stem out of authentic learning tasks. Students are physically engaged in various physical activities at different intensity levels, and cognitively engaged to conduct observation and systematic recordings of physiological changes. Through these constructivist learning tasks, students are scaffolded to understand and practice the scientific principles of exercise (Ennis, 2017).

Emerging research findings have shown robust evidence on using constructivist approach in physical education curriculum intervention. Zhang et al. (2014) reported a positive impact on students’ cardiovascular fitness knowledge. Chen et al. (2014) observed a positive impact on adolescents’ motivation for physical education and after-school physical activity participation. In a longitudinal study, Wang et al. (in press) and Wang and Chen (2020) noticed that knowledge learned through constructivist physical education guided learners to engage physical activities both during and beyond school hours. Although these findings are encouraging, the role of SES is not clearly identified either as a facilitator or an impediment to students’ learning.

To determine possible impact of SES-related factors on the effect of a constructivist physical education curriculum, we designed this curriculum intervention research to focus on the following specific research questions: (a) SES status serves as an antecedent predictor to student prior knowledge. We hypothesize that students in high SES schools would be better equipped with prior knowledge on cardiovascular fitness. (b) The constructivist curriculum can overcome the influence from specific SES factors related to physical education to help students in different SES schools learn and achieve. We hypothesize that the constructivist curriculum would enable student learning across different socioeconomic contexts. (c) Selected individual factors (e.g., prior knowledge) and SES-related class factors (e.g., schedule, class size, equipment, facilities, and teacher) can impact knowledge gain. We hypothesize that
students with better prior knowledge, more frequent class schedule, longer class period, smaller class size, better equipment and facilities, and more motivated or competent teachers would learn better through intervention.

Addressing these research hypotheses will enable us to determine the power of a constructivist physical education curriculum in tackling inequality in learning the knowledge and adopting behaviors for healthful living. The findings from the study may allow us to evaluate the theoretical tenets as manifested in an actual constructivist curriculum to provide theoretical insights that might enrich the constructivist learning theory.

Method

The study is part of a large-scale physical education curriculum intervention research that targets improving middle school students’ knowledge about healthful living. The research involved a random sample of 24 middle schools matched on cascading standardized science test scores and SES status measured on percentage of students eligible for FARM program. The matching and randomization resulted in 10 schools being assigned in the Intervention condition and 14 in the Comparison condition. Given the purpose of the current study, we conducted an antecedent analysis to compare student overall knowledge gain between the Intervention and Comparison conditions to establish the efficacy of the intervention curriculum. Then, we built three unique hierarchical linear models (HLMs) to address the research hypotheses using the data from the Intervention condition. This design should allow us to evaluate the curriculum efficacy as associated with the school SES.

The research context

The study was conducted in a central region of a southeastern coastal state of the United States. Overall, the state was ranked 39th in the U.S. in per student expenditure. Compared with the poverty level of the state (16.4%) and the nation (14.5%) the region observed a higher level of poverty (20%) in its residents and K-12 student population. As a result, per student expenditure was lower than the state average. The teacher turnover rate was higher than the state average. The region was also in dire needs to renovate its school buildings in most urban schools.

Teaching schedules and lesson lengths of the participating schools varied significantly as consequences of SES-related academic performance (e.g., physical education schedule had to be shifted in non-essential periods to make way for academics due to the “at risk” designations based on NCLB and Race to the Top). Two schools provided physical education on a daily basis. Four schools follow A/B day schedule—A-day students had classes on Monday, Wednesday, and Friday, while B-day students had classes on Tuesday and Thursday. In the following week, the A-day and B-day students rotated the days of physical education classes. Other four schools followed A/B week schedule, which meant each group of students had a week of physical education every day in every other week. The lengths of class across schools range from 36 to 55 minutes. As a result, the schools progressed at different paces in teaching the curriculum. The time needed to complete the intervention ranged from approximately two months to a semester.

Participants

The study was approved by the university Institutional Review Board. Prior to data collection, we received informed consent from the teachers and parents/guardians of the students. We also received assent from students whose parents/guardians had consented their participation.

The sampling unit was the school. The sampling pool included 75 middle schools in the region. They were matched on school FARM rate and state standardized science test scores, then were divided into 12 sampling brackets with schools with similar FARM rate and test scores grouped together. The top and bottom brackets were not used because the FARM rate and test scores might be considered unrepresentative with extremely high or low FARM rate and test scores. Two schools in each of the remaining brackets were randomly assigned to either the Intervention or Comparison condition. We visited each sampled school to recruit teachers and students and secure principals’ commitment to the research. Back-up schools (n = 4) were later added to the Comparison condition to ensure future data integrity.

The sampling procedure resulted 10 middle schools in the Intervention condition and 14 in the Comparison condition. We compared the FARM rate and student ethnicity data with the national middle school data. According to National Center for Education Statistics (2011), the national FARM rate range of 0–25 to 76–100%, the FARM rates of participating schools ranged from 22% to 78%, which mirrored the national range.

The student participants (n = 1,256) from whom the data for this study were collected came from 63 eighth grade physical education classes in the 10 schools in the
Intervention condition. The classes were taught by 23 certified physical educators with teaching experiences ranging from about 10 years \((n = 6)\), to 10 to 15 years \((n = 11)\), and to more than 15 years \((n = 6)\). The teachers received 18 hours of initial professional development prior to teaching the intervention curriculum and constant fidelity-of-implementation support throughout the semester.\(^1\) During the initial professional development workshop, teachers first observed a presentation highlighting the curriculum features, and were taught as “students” by two teachers who participated in writing the curriculum, then conducted mock teaching to their peers. During the mock teaching, each teacher had opportunity to teach a few lessons on different topics. The teachers were assigned to “learning communities” to discuss issues that arose in teaching, such as insufficient equipment, large class size, student workbook management, and transition between activity tasks and workbook tasks. In the subsequent workshops throughout the semester, they peer-taught and shared individual experiences in solving these issues.

**The intervention curriculum**

The curriculum, *Cardio Fitness Club*, has 20 sequenced lessons on cardiorespiratory fitness. The goal is to help students learn knowledge on cardiorespiratory fitness and the science of physical activity about how to improve their cardiorespiratory fitness. Scientific (exercise physiology) concepts are sequenced to connect all lessons coherently. For instance, following the lesson on the Principle of Overload is the lesson on Exercise Intensity and the lesson on the Principle of Progression. The sequence assists student to understand (a) what constitute cardiorespiratory fitness; (b) how to choose and monitor the levels of exercise intensity; and (c) how to improve cardiorespiratory fitness through progressively overload exercises. The teachers taught the lessons from the curriculum in a successive order to create a conceptually coherent learning context for optimal learning achievement.

A priority of the curriculum is learning cognitive knowledge without jeopardizing participation in physical activities. Throughout the learning process, students move across the entire gymnasium to conduct exercise experiments on their bodies with equipment such as pedometers, medicine ball, BOOSU discs, fitness ball, and so on. Overall, the curriculum aims at devoting at least 50% of the instructional time to medium-to-rigorous physical activities while emphasizing cognitive learning of exercise science.

A unique learning experience for the student is the use of workbook throughout physical activity experiences. Before and immediate after exercise, students record physiological responses on an assignment page in the personal workbook. The workbook assignments guide students to do particular exercises, participate in class/group discussion, listen to teacher’s explanation, and analyze the data they collect. The curriculum adopts the 5E instruction model, which includes engagement, exploration, explanation, elaboration, and evaluation (Bybee et al., 2006). Each of the five element contains both physical and cognitive components. For instance, engagement provides students an opportunity to bring up their prior knowledge. At the same time, engagement also serves as a physical warm-up for students. Evaluation is for teachers and students, via “think-pair-share,” to examine knowledge gains and to reflect on their learning through small group activities, discussions, and completion of workbook assignments.

**Variables and measures**

Because the intervention was applied to the teachers who taught the curriculum to intact classes of students, using individual student variables for analysis would lead to erroneous findings due to possible intra-correlations in responses of students in the same class (cluster effects). In adopting the HLM design (Raudenbush & Bryk, 2002), we were able to include both individual (student) variables and institutional (school/class) variables in one analytical model to address the research hypotheses with minimal possibility of statistical errors. In this study, we included three types of variables: student knowledge gain (the outcome variable), student predictors (individual/level-1 variables) and class-level predictors (institutional/level-2 variables). This conceptualization of the variables allowed us to organize a two-level HLM model for testing (see Analysis for details).

**Student knowledge gain**

Learning outcome was operationalized as students’ knowledge gain scores (regression residual adjusted) from pre- to post-intervention test. Students took a standardized test before the intervention and took it again immediately after finishing the intervention. Students’ pre- and post- test answers were scored then coded, with correct answers as “1” and the incorrect answers as “0.” Total pretest and posttest scores were aggregated. Learning achievement was inferred from students’ knowledge gain score from the pre- to posttest. The knowledge tests were validated with evidence

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\(^1\)The teachers in the Comparison condition received the same hours of placebo professional development on instructional strategies for traditional physical education.
of content validity, difficulty index (ranging from .45 to .65), and discrimination index (greater than .40).

**Level-1 predictors**
Student level predictors included gender, race, and student prior knowledge. Gender and race were collected using self-report mechanisms included in the knowledge tests packages. Prior knowledge was inferred from students’ performance on the pre-intervention knowledge test that was given before the intervention. The questions tested students’ understanding of scientific vocabulary, major principles for exercise science, measurement of physiological responses to physical activity, inference of exercise intensity, and benefits of physical activity. A sample question in the knowledge tests is:

Regularly exercising at an overload pace makes my body become used to that level of work, which is called (a) rate of exertion, (b) physiological adaptation, (c) intensity, (d) circulation.

**Level-2 predictors**
Level 2 predictors included SES, class environment, and teacher characteristics. Class SES was the school average FARM percentage obtained from the state education agency. Classes nested in the same school shared the same FARM rate.

**Class environmental factors.** Physical education teachers from the participating schools completed a Curriculum Ease of Use survey after they implemented the intervention curriculum. In the survey, teachers reported the availability of facilities and equipment at three levels (not sufficient, sufficient, and more than enough), the teaching schedule, and lesson length in minutes and class frequency per week. According to physical education schedules, classes were assigned dummy codes from 1 to 4 according to their class frequency. Number 1 indicated that the class had daily physical education, 2 indicated every other day; 3 indicated daily physical education every two weeks, and 4 indicated every other day in every two weeks. Class size was measured using class rosters collected directly from the teachers.

**Teacher.** Because teachers can influence students’ learning, we included teacher as a class-level predictor. During the intervention, 23 teachers taught students in 66 classes in 10 schools. As a result, each teacher taught an average of three classes. In this study, however, the identity of a physical education teacher was conceptualized as a complex entity in the gymnasium (Armour & Yelling, 2007). This concept of “Teacher” was not merely a person or “who” but a collective representation of authority, resources, experiences, values, knowledge, level of training in teaching the Intervention curriculum, and educational values. This conceptualization acknowledges the characterization of teachers as representative of his/her current environment defined by job demands and resources (Zhang & Chen, 2017) and his/her educational values (Ennis et al., 1992). To reflect this conceptualization, we assigned an identity code to each teacher to represent an aggregated “teacher characteristics” variable for the purpose of associating the teacher with his/her students and the teaching environment in the subsequent data analyses.

**Data collection**
Pre- and post-intervention knowledge tests were given through online Qualtrics system. Prior to each testing day, the teachers reserved the computer lab in their respective schools. The researchers sent the Qualtrics links to the teachers the day before the test. On the test day, a trained data collector went to the school to supervise the test, to address student questions, to ensure independent responses, to assure no penalties of any kind if a student decided to drop out of the test, and to assure students that the test was not part of their grade.

**Data analysis**
The data analysis followed three logical steps. First, we conducted an independent samples t-test to determine that the students in the Intervention condition did gain more knowledge on physical activity than their counterparts in the Comparison condition. This t-test would provide important antecedent evidence to guide the decision whether the subsequent HLM analysis was needed. That is, if there was no statistically significant difference on knowledge gain between the two conditions, the HLM analysis should not be conducted because the results would be misleading. If the students in the Intervention condition did gain more knowledge than those in the Comparison condition, the evidence is indicative of the efficacy of the intervention curriculum.

After testing the regression residual normality assumption of the prior knowledge scores and knowledge gain scores using the quantile-quantile plot method (Raudenbush et al., 2004), we conducted HLM analysis to address the three research hypotheses. We first tested the degrees that participating classes varied in students’ prior knowledge and knowledge gain in terms of the SES status. Particularly, we wanted to find out whether classes with higher SES (lower FARM rates) had better prior knowledge
and knowledge gain. Then, we included class-level SES factors in the models, such as class size, lesson length and frequency, equipment, facility, and teacher characteristics, to identify their possible influence on student knowledge gain. In the end, with the class-level factors identified to be significant predictors and individual-level predictors, we built another model to estimate their collective impact on knowledge gain. The HLM models being tested are as follows:

**Hypothesis 1.** We adopted a one-way ANOVA model (HLM 1) with random effect to test whether SES was predictive for prior knowledge and knowledge gain. The Level 1 (student-level) model was built as $Y_{ij} = \beta_{0j} + r_{ij}$ where $Y_{ij}$ was the response of student $i$ in class $j$, $\beta_{0j}$ was the mean knowledge gain for each class, and $r_{ij}$ was residual variation of student $i$ in class $j$. At Level 2 (class-level), the mean of knowledge gain of each class $\beta_{0j}$ was expressed as $\beta_{0j} = \gamma_{00} + u_{0j}$, where $\gamma_{00}$ was the grand mean across all classes; $u_{0j}$ was the unique effect of being in class $j$ (the deviation from the grand mean). The full model was expressed $Y_{ij} = \gamma_{00} + u_{0j} + r_{ij}$.

**Hypothesis 2.** We adopted the Means as Outcome Model (HLM 2) (Raudenbush & Bryk, 2002) to test impact of class level SES predictors (lesson length and frequency, equipment, facilities, class size and teachers) on knowledge gain. The formulated student-level model was: $Y_{ij} = \beta_{0j} + r_{ij}$. The class-level model was expressed as: $\beta_{0j} = \gamma_{00} + \gamma_{01}W_j + u_{0j}$. Where, $W_j$ represented the class $j$ characteristics, $u_{0j}$ was the residual of the class mean. When the class-level factors were included in prediction, the formula read: $Y_{ij} = \gamma_{00} + \gamma_{01}W_j + u_{0j} + r_{ij}$.

**Hypothesis 3.** Lastly, we adopted the Random Coefficient Model (HLM 3) (Raudenbush & Bryk, 2002) to determine the extent to which prior knowledge and SES-related class factors impact knowledge gain. This model was built by combining prior knowledge (student-level factor) and class factors (class-level factors) that were identified to be significant in HLM 2. At the student-level, the model was formulated as $Y_{ij} = \beta_{0j} + \beta_{1j}W_j + r_{ij}$. On the class-level, the model was formulated as: $\beta_{0j} = \gamma_{00} + u_{0j}$ and $\beta_{1j} = \gamma_{10} + r_{ij}$. The completed HLM was $Y_{ij} = \gamma_{00} + u_{0j} + \gamma_{10}W_j + r_{ij}$. The test for data normality rendered a satisfactory result. As described in Figure 1, both the quantile-quantile plots resemble an overall straight 45-degree line with little deviation, suggesting the random effects were normally distributed (Raudenbush et al., 2004).

**Results**

The knowledge of the students in the Intervention condition grew 10% (residual adjusted mean = .10, SD =.29) while the knowledge of the students in the Comparison condition grew 2% (residual adjusted mean = .02, SD =.24). The difference is statistically significant ($t = 8.82$, $p < .001$, Cohen’s $d = .30$). The results indicated that the students in the Intervention condition gained more knowledge about physical activity than those in the Comparison condition. The small effect size indicates the curriculum made limited but significant contribution to the difference in knowledge gain. The result suggested that it was productive to conduct HLM analyses to determine the SES-related class factors influence on student knowledge gain.

The test for data normality rendered a satisfactory result. As described in Figure 1, both the quantile-quantile plots resemble an overall straight 45-degree line with little deviation, suggesting the random effects were normally distributed (Raudenbush et al., 2004).

**HLM results for hypothesis 1**

The one-way ANOVA model indicated that student prior knowledge (pretest scores) varies significantly by class. The grand percent correct mean score for pretest is 3.38 with a standard error of .06 ($p < .001$). The intraclass correlation (ICC) is .08, indicating 8% variance of student prior knowledge between classes. Then, results from the Means-as-Outcomes model indicate that FARM rate significantly predicted the prior knowledge ($\gamma_{01} = -1.75$, $t = -5.98$, $p < .001$). The results suggest a reverse relation between FARM rate and prior knowledge, students with high FARM rate (low SES) possessed low prior knowledge about physical activity and health. In addition, class means of the pretest scores varied significantly when FARM rate was controlled ($\gamma_{01} = 4.43$, $t = 28.30$, $p < .001$). Computed ICC was .04, showing 50% (.04/.08) of the between class variance of pretest can be explained by the rates of FARM.

The one-way ANOVA also shows that knowledge gain scores vary by class. The grand mean for knowledge gain is 1.30 with a standard error of .10 ($p < .001$). Estimate of covariance indicated that 12.8% of knowledge gain varied cross class. The Means-as-Outcome model shows, however, that the FARM was not a significant class-level predictor for knowledge gain ($\gamma_{02} = 0.73$, $t = .91$, $p = .37$).

**HLM results for hypothesis 2**

The HLM 2 model identified teacher ($\gamma_{01} = .06$, $t = 6.11$, $p < .001$) as the only significant class-level predictor for knowledge gain. Other class level predictors, including class frequency ($\gamma_{02} = .52$, $t = .31$, $p = .06$), lesson length
HLM results for hypothesis 3

After identifying “teacher” to be the only significant class-level predictor, we used a random coefficient model to determine the extent to which teacher (class-level) predictor and prior knowledge (student-level predictor) predicted knowledge gain with fixed slopes and intercepts. Results, as reported in Table 1, confirmed that both prior knowledge and teacher were significant predictors for knowledge gain. The coefficient of prior knowledge is −.60 (p = .00), suggesting that students with higher prior knowledge gained less in studying the curriculum. To further confirming the findings, we allow the intercept to vary so that the hierarchical

(\gamma_{03} = −.03, t = −1.82, p = .07), space (\gamma_{04} = −.11, t = −.49, p = .63), equipment (\gamma_{05} = −.36, t = −1.36, p = .18), size of class (\gamma_{06} = −.05, t = −1.36, p = .18), appeared to be not significant.

**Figure 1.** Normal quantile–quantile plots for prior knowledge and learning.

<table>
<thead>
<tr>
<th>Fixed effect</th>
<th>Coefficient</th>
<th>Standard error</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average school mean (\gamma_{00})</td>
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<td>.24</td>
<td>.00</td>
</tr>
<tr>
<td>Prior knowledge</td>
<td>−.60</td>
<td>.03</td>
<td>.00</td>
</tr>
<tr>
<td>Teachers</td>
<td>.03</td>
<td>.01</td>
<td>.00</td>
</tr>
<tr>
<td>Random effect</td>
<td>Variance component</td>
<td>Standard error</td>
<td></td>
</tr>
<tr>
<td>Level-1 effect, \epsilon_i</td>
<td>3.02</td>
<td>.12</td>
<td></td>
</tr>
<tr>
<td>Model fit</td>
<td>\chi^2 = 4660.30</td>
<td>AIC = 4670.30</td>
<td></td>
</tr>
</tbody>
</table>
nature of the data (prior knowledge varied across the classes) was assumed. As shown in Table 2, the effects of prior knowledge and teachers on knowledge gain remain.

Conclusion

The purpose of this study was to determine the extent to which the SES-related contextual factors in physical education impact student learning and the extent of whether a constructivist physical education curriculum can overcome the influences to narrow the learning gap due to school SES-related factors. Constructivist learning theory carries the potential to unleash students’ autonomous learning ability by engaging them in knowledge construction as active agents rather than passive information recipients. Despite the tremendous potential it carries, the constructivist learning theory faces challenges, including low students’ prior knowledge, over-structured learning processes, and high demand on teacher-directed student-task interaction. These challenges are often more evident in low SES schools. With providing solutions to these issues, curriculum interventions designed to promote student learning in high SES schools can fail in low SES schools. Therefore, implementing curriculum based on constructivist learning theory with little regard to the schools’ SES and environmental variations may not be productive, as it may widen the existing achievement gap between high and low SES schools. This study operationalized a general SES indicator, FARM rate, into specific content-specific factors to clarify SES impact in physical education.

The role of SES

The findings of this study enrich the literature by expanding our knowledge about the role of SES in physical education. The evidence that built on the specific measures of physical education allows scholars, teachers, and administrators to focus on specific resource issues—teacher quality and student prior knowledge. The findings, in particular, are consistent with physical education research literature in the following regards.

Literature has suggested that knowledge differences resided among students from different SES backgrounds. The differences further contribute to physical activity and health disparities (Lie et al., 2012). Facing this inequality, public schools carry the potential to narrow the difference across SES categories through providing students with high-quality learning experiences. Nevertheless, the schools that serve the students in high-needs are often subjected to various contextual limitations, such as scheduling, facilities, equipment, and class size. These limitations are associated with school SES and cast doubts on whether the curriculum can achieve the goals it is designed to accomplish.

Instead of defining learning achievement differences only on the school level, scholars argue that it is “a conglomeration of social and economic practices that operate on different levels” (Portes, 2005, p. xiv), suggesting that the learning difference could be related to both individual and school level factors. Clearly, the findings from this study support this general observation with evidence showing that students’ prior knowledge about physical activity and benefits was influenced mostly by SES of the school. When a constructivist curriculum provided learning opportunities, the teacher became the most influential SES-related factor that dictated knowledge gain. Through a series of hierarchical linear model analyses, we produced strong evidence that the constructivist physical education curriculum effectively reduced the learning achievement gap due to the gap of prior knowledge across SES categories (HLM 2 results).

It is clear from the findings that the specific, physical education related SES factors were a significant predictor of student prior knowledge but not a significant predictor of knowledge gain. The students learned significantly regardless their class schedule, class sizes, and the conditions of equipment and facilities. Research indicated that low SES schools, especially urban schools, face various institutional and social challenges, all of which contribute to shorten instructional time—a barrier to student achievement (Smith, 2000). However, we believe that this finding has a particularly unique significance; it suggests that a well-designed, constructivist curriculum and sufficient support to teachers can overcome the impacts from SES, enabling all students to learn.

To explain the inconsistency between the findings of this study and the literature, we argue that a strong curriculum may offset the negative effects from low SES

| Table 2. Results of random coefficient model (intercepts allowed to vary). |
|-----------------------------|-----------------|-----------------|-------|
| Fixed effect               | Coefficient     | Standard error  | p value |
| Average school mean, $\gamma_0$ | 2.14            | .36             | .00   |
| Prior knowledge            | −.59            | .03             | .00   |
| Teachers                   | .04             | .01             | .00   |
| Random effect              | Variance        | Standard error  |       |
|                           | component       | error           |       |
| Level-1 effect, $e_i$      | 2.74            | .12             |       |
| Class                      | .29             | .08             |       |
| Model fit                  | $\chi^2 = 4612.90$ | AIC = 4622.90  |       |
and unfavorable contextual factors. A curricular context created by a strong learning-oriented curriculum has been anticipated as an integral and influential knowledge force that attracts learners to invest their effort in the learning process (Ennis, 2017). The values, beliefs, norms, strategies, and process associated with a constructivist curriculum can positively impact student learning behavior. The student-centered curricular context that values students’ experiences and provides meaningful, mindful, and motivational experiences can help students develop and sustain a sense of ownership that leads them to accomplish the learning goal (Ennis, 2017). We speculate, theoretically, that the constructivist curricular context in the study promoted student learning through enhanced student autonomy and ownership of learning.

**The role of prior knowledge**

An important finding of the study is about the role of student prior knowledge. As pre-conceived cognition, prior knowledge is relatively stable, but it often contains naïve and misconceptualized knowledge (Vosniadou, 1994). A fundamental task of a constructivist curriculum is to carefully create cognitively enabling context in which the naïve and misconceptualized knowledge can be corrected in such a way that scientifically correct knowledge can be integrated into the existing knowledge structure. The findings from this study have shown the difficulty to accomplish this task. Each of the lessons in the Intervention curriculum includes tasks structured on the 5E learning strategy. The very first, Engagement, was designed to address naïve and misconceptualized prior knowledge so that the new scientific knowledge can take hold and be reinforced in the rest of Es. The engagement component of each lesson refreshes students’ memory as well as builds connection even between what they already know to what to be learned. Yet, the prior knowledge seems to be exerting significant impact on interest in learning (Zhang et al., 2016), and the construction of naïve conceptions and misconceptions throughout the learning experiences (Zhang et al., 2019). Although we can assume that the prior knowledge in this study may not be naïve or misconceptions, further research is necessary to clarify the role of prior knowledge, especially naïve conceptions and misconceptions embedded in prior knowledge, in learning in physical education.

One critically important finding is that the students with lower prior knowledge demonstrated more knowledge gain than those with higher prior knowledge. This finding is contrary to the notion that prior knowledge functions as a scaffold for new knowledge acquisition. In other words, students with better knowledge are expected to be more “ready” for learning new knowledge. We speculate that this finding may signify two possibilities, both of which carry important implications for future curriculum design. The first possibility is that the Intervention curriculum is particularly relevant to schools with low SES. The disadvantageous SES influences are likely to be suppressed by the learning friendly curricular context created by the Intervention curriculum. The second possibility is that the Intervention curriculum serves as an equalizer for learning in a way that allows teachers and students in low SES schools to overcome the impact of undesired contextual factors to better pace their learning experiences. Our data show that all students have gained the knowledge. It can be speculated that the 5E system gave the students an opportunity to better pace their learning (Bybee et al., 2006). Coupled with “teacher” as the single contextual factor identified in HLM 3, future research needs to explore these two possibilities by clarifying the relation between SES context and the curriculum.

**The role of teacher**

A unique finding of this study is about the role of the teacher in predicting students’ knowledge gain. “Teacher” in this study was not merely a person or “who” but a collective representation of authority, resources, experiences, values, and knowledge. In short, the “teacher” represented the teacher’s experiences, training, educational values, and his/her environment that was partially defined by the SES-related factors (schedule, equipment, facilities, class size, etc.). The finding suggests, when the teacher variable was built in the model, it overrode the impact from the contextual variables such as schedules, lesson length, equipment, facilities, class size, etc.). The impact from these variables might have been moderated by the teacher whose determination and strategies to implement the Intervention curriculum might have either amplified or suppressed their impact on student learning.

Teaching a constructivist physical education curriculum is physically and cognitively challenging, especially for teachers who have limited resources and supports (Ennis, 2017). The curriculum often challenges the teacher to invest significant amount of time and effort on lesson preparation and interaction with students. The effort to meet the challenge can yield significant learning achievement in physical education (Loflin, 2013). Loflin (2013) reported that the teacher’s effort in preparation and implementation of a constructivist physical education curriculum accounted for as much as 74% of the
variance in student knowledge growth. The findings from this study reiterate the importance to assist teachers to preparing and implementing the educational physical education curriculum (Ennis, 2017).

What does this article add?

The findings of this study extend our knowledge about the impact of SES on physical education learning by operationalizing SES as specific contextual factors such as curriculum, facility, equipment, scheduling and teacher, and linking them directly to student knowledge gain through constructivist physical education curriculum intervention. While much evidence associate school level of SES (e.g., FARM) to student physical activity behavior, the findings of this study specifically ruled out its impact on many factors in physical education but highlighted the impact associated with students’ prior knowledge when they come to physical education and teacher factors. Most importantly, the findings show that despite school SES and environmental constraints, the constructivist approach to physical education can significantly enhance student knowledge about physical activity and benefits. In addition, the power of the constructivist curriculum enables the students to overcome SES-related barrier prior knowledge to turn around in learning and gain necessary knowledge in the physical education experiences. In other words, the constructivist curriculum empowered the students to reverse the impact from their disadvantageous prior knowledge and prevail in learning. Consistent with the findings from pedagogy research, the study also reveals that, among the various environmental factors, teachers are the most prominent factor to influence student learning. Taken together the findings continue to show the power of a well-planned constructivist physical education in developing children’s scientific knowledge about physical activity and its health benefits.

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ORCID

Tan Zhang http://orcid.org/0000-0001-6359-3796
Ang Chen http://orcid.org/0000-0002-1352-7384

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