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Review

Knowledge, transfer, and innovation in physical literacy curricula

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Abstract

Literate individuals possess knowledge and skill and can apply these to perform tasks in novel settings. Knowledge is at the heart of physical literacy and provides the foundation for knowing what to do and how and when to perform. In this paper I argue that physical literacy includes not only knowledge for performance but also the ability to apply knowledge and use knowledge for innovation. Scholars since the 1930s have addressed the role of knowledge in physical literacy designing curricula centered on transmitting knowledge through a range of interdisciplinary approaches to physical education. This emphasis on physical literacy curricula continues today in the *Science, PE, & Me!* and *The Science of Healthful Living* interdisciplinary curricula.

Keywords: Application; Innovation; Interdisciplinary; Learning; Literacy; Transfer

1. Introduction

In simple terms, literacy is the idea that an individual has skills to access knowledge. Literacy assumes a lifelong process of gaining meaning with the goal of acquiring a progression of knowledge and skills that culminates in deep understanding.[1] Literate individuals not only have acquired knowledge and skills but also feel confident to exhibit them without fear of ridicule or accusations of difference. Knowledge, too, is at the heart of physical literacy and provides the foundation for knowing what to do and how and when to perform. In fact, physical literacy cannot occur without knowledge. Knowledge of facts, procedures, principles, and concepts and their cognitive and physical applications permit physically literate individuals to transfer knowledge to new contexts, solving previously unencountered problems in novel situations.[2]

Thus, one criterion of literacy might be context-specific and context-flexible knowledge or the ability to learn knowledge of something in one context and apply it effectively in another. Application or transfer, however, cannot occur without the knowledge, itself. When individuals learn something of value in a literacy-oriented curriculum, they can use it to innovate and create within novel future applications. In this paper, I will first review the theoretical basis for knowledge, transfer, and innovation as essential criteria for physical literacy. In the next section I will provide a brief discussion of knowledge-based, interdisciplinary physical education (PE) curricula that have provided a historical foundation for current conceptualizations of literacy programming. In the final section I will apply the constructs of knowledge, transfer, and innovation to elaborate the potential of physical literacy as a goal of two learning-oriented curricular models: *Science, PE, & Me!* (SPEM) and *The Science of Healthful Living* (SHL).

2. Curriculum for physical literacy

PE and physical activity curricula in the United States and other Western countries often have been permitted to drift away from expectations of knowledge and standards of performance,[3] focusing instead on accommodating vocal, skilled students' interests or enjoyment. Without strong teacher guidance in PE, students can subvert goals associated with in-depth knowledge of the physical and through the physical[4] focusing instead on immediate, short-term rewards.[5] The

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consequences of this negligence have been unskilled children and adolescents who do not demonstrate physical literacy.[6] Further, if physical literacy requires the ability to transfer skills from the school PE context in which they are learned to apply them in previously unencountered settings, then new expectations for physical literacy will stretch our current standards beyond our traditional team sports roots.[7] In fact, when physical literacy requires knowledge application and the ability to perform competently at home, during leisure, in natural environments, or across the lifespan, our current practices of PE as physical activity participation may quickly become antiquated and obsolete.

2.1. Foundations of literacy: transmitting knowledge and skills

Curriculum theorist, Michael Young[8] argues the most critical educational question teachers face is "What do I have the *responsibility* to teach my students?" Although not specifically discussing physical content, Young reminds us that this question is associated with knowledge and skills and the varied way knowledge can be used in the present and the future. Literacy from this perspective requires deep learning of critical concepts, principles, and procedures and the application of knowledge for performance.[2]

Teachers have many and varied responsibilities in schools. Certainly, their second responsibility, after student safety, is a most traditional one. It is the teacher's role as a representative of a culture or society to *transmit* culturally sanctioned knowledge to each new generation of learners.[9] As physical educators, for example, we could argue that one aspect of culturally sanctioned knowledge is associated with skills necessary to project objects through space. Following this premise, we believe teaching all young children to throw objects with opposition and power is as important today as it was a century ago. Certainly, throwing is a foundational or physical literacy skill that once learned, permits students to build their object projection capacities, applying them flexibly to learn other related skills within a range of games and sports. Fundamental physical literacy skills, such as throwing, probably remain relatively unchanged across generations and most would agree that throwing with opposition is a skill essential for every child.[7]

We must, however, look further and perhaps differently to respond to extensions of the responsibility question, such as, "What constitutes essential knowledge, skills, and abilities necessary for learners to move *beyond* current understandings?"[9] Thus, instead of simply learning or reproducing prior performances, individuals can be guided to discover ways to deepen, extend, and apply transmitted knowledge authentically in their lives.[2] In other words, providing students with both access to skillfulness required to participate competently and a level of mindfulness to experience the activity deeply and meaningfully stretches our current definitions of physical literacy and encourages us to explore new educational avenues for students.[10]

The idea that curricula and teaching can involve students in the present *and* prepare them for the future is a highly challenging task. Current approaches to PE curricula need revision to both engage students in physically active school environments and also prepare them to apply and use knowledge and performance skills in their lives after PE.[11] To address this two-fold goal, curriculum designers must be inspired to transform curricula beyond simple reproduction of movement patterns to apply skills in previously unencountered situations, think critically and creatively about when and how to apply skills, and question potential biases and limitations associated with transmitted knowledge.[12]

2.2. Knowledge for application

Young[8] emphasizes that to accept both transmission and application as relevant to the current educational questions associated with literacy is to acknowledge both the *reliability* of knowledge as a foundation for competence and performance and the constantly evolving nature of meaningful life applications of that knowledge. In other words, students who are physically literate not only can demonstrate knowledge and skill but also can transfer well-learned skills to complex, fast-paced games, the progressive overload principle to their daily workout plan, and cooperative skills to solve adventure challenges on the ropes course or on the trail. Physical educators who aspire to instill physical literacy encourage students to make these decisions and choices in a teacher-supportive environment.[13,14]

Cobo[15] argues that literacy includes the ability to apply skills learned in educational contexts flexibility to other more operational or functional contexts. This might mean opportunities to use bicycling skills outside the gym or playground on park and mountain trails or to examine the challenges of bicycle racing such as might be found in sports such as bicycle motor cross (BMX) racing. Knowledge application is critical for problem solving and critical thinking skill development essential both within physical and other forms of educational literacy.

Certainly, physical activity should be enjoyable to all, although it often isn't. Students who are not literate' who have not acquired basic skills and skill themes, or who have not developed an acceptable level of cardiovascular endurance are not likely to value participating in physical activities, regardless of how much they are enjoyed by their vocal, enthusiastic, skilled classmates.[6] It is unlikely, however, that most students will gain a level of physical literacy by participating in loosely organized team activities that often pass for the PE curriculum in the 21st century. Selecting physical activities simply to entertain or to promote target heart rate begs the question of literacy.[16]

2.3. Knowledge for innovation

Cobo[15] affirms the importance of transfer and adds two additional literacy goals: learning "how" in addition to learning "what" and lifelong/"lifewide" literacy. Cobo argues

that literacy must necessarily transcend both disciplinary knowledge and immediate application. His response focuses, instead, on literacy "skills for innovation".[15] He explains that this third literacy category is critical to assist learners to adapt, innovate, and transform their current competencies and understandings to apply them flexibly in the future as their world changes.

2.3.1. Learning how to learn

Cobo[15] suggests that a second skill for innovation involves educational opportunities to move beyond "what we learn, to how we learn". Constructivist approaches to learning focus on the students' experiences within the task.[17] Eisner[18] discusses these types of learning tasks as opportunities for students to learn in a manner consistent with their prior knowledge and experiences. Although each learner, for example, might participate in a gymnastics program presented to parents at a Back-to-School night, each child likely experiences a different and perhaps novel outcome. Some children may overcome nervousness to perform competently, while others may realize, albeit belatedly, that they should have paid attention to instructions or practiced more frequently to avoid mistakes when performing for an audience. Designing open outcome tasks that require learners to engage deeply and independently in tasks often leads to a range of diverse outcomes and innovations matched with the child's prior knowledge, experience, and interests. This flexibility to challenge how students learn can lead to innovative and mindful experiences. Cobo explains:

> The added value of these flexible approaches is not only the possibility of learning in multiple spaces but also the possibility of developing different types of skills and expertise. The challenge is to find the mechanisms to develop skills, capacities and techniques that facilitate *learning to learn* in a continuous, incremental and efficient process, free from restrictions of any specific discipline or teaching programme. (italics in the original; p. 73)[15]

2.3.2. Lifelong and lifewide literacy

How students learn can easily transcend the formal school environment. In Castell's[19] *An introduction to the Information Age*, he describes learning concepts within a "timeless time" and a "space of flows". Deep engagement in the learning process permits learners to examine physical literacy content mindfully within a futuristic lifelong and "lifewide" educational approach.[20] This approach places a focus on context as the center of the learning experience, arranging and rearranging elements within the complexity of competition, leisure, and health enhancing experiences; confirming yet again that deep learning occurs across settings and involves diverse age and cultural groups. Certainly, these timeless and flowing physical experiences occur as learners innovate with knowledge, applying it in previously unencountered situations such as those found in games, sports, adventure, and other challenging venues. Likewise, learners may immerse themselves in the transfer of well-learned skills to new sports or fitness challenge environments. Providing on-going learning experiences and opportunities to reskill or "upskill"[15] their competencies encourages learners to take a fresh approach to their own personal quests for physical literacy.

Although skills necessary to compete expertly in team sports will continue to be an important component of physical literacy, additional opportunities to explore a range of physical activities of interest to students will challenge PE educators through this decade and beyond.[10,21,22] In each instance physical competence to perform safely and with enthusiasm must be paired with knowledge, social justice, and innovative competences to enhance access and design new opportunities. In the next section, I will discuss several innovative curricula that have served as foundations for knowledge-based, multidisciplinary approaches to PE.

3. Historical approaches to knowledge-based curricula

Literacy as a goal for PE is not new and in fact has been discussed as a foundational focus of United States PE programs since the early 20th century.[23] Wood and Cassidy[24] argued "older beliefs (about physical education) were composed mainly of hopes and fears and speculations, not attempts at scientific explanation of any objective world" (p. 25). They pointed out in their text, *The New Physical Education,* that a scientific knowledge base for PE was essential for developing modern programs:

> When PE presents a program which is psychologically and physiologically sound and therefore pedagogically acceptable, it will find itself in organic relationships with education as a whole and with the other subjects or departments.[24]

Rosalind Cassidy's[25–27] curriculum writings further developed this scientific knowledge-oriented PE theme over the next 40 years of her career.

Other American scholars during the mid-20th century continued to repeat this call for an emphasis on disciplinary knowledge. Franklin Henry,[28] for example, was adamant that PE must embrace the developing research-based knowledge if it was to be included and respected in public education. Likewise, Jewett et al.[29,30] argued for scientific knowledge as a centering point for a balanced, futuristic approach to PE. Her work discussing meaningfulness as a primary motivator for physical activity participation is echoed today in achievement theories such as those associated with expectancies and task values.[31,32] Similarly, Corbin and colleagues'[33] focus on a concept-based approach to fitness-based PE has developed over the last 40 years into the *Fitness for Life* series now in its sixth edition.[34]

4. Interdisciplinary kinesiology knowledge as the curricular focus

The theme of meaning and relevance in knowledge-oriented approaches to PE expanded to encompass an interdisciplinary focus in the 1980s. An emphasis on research informed practice combined results from several kinesiology disciplines. Beginning in 1981, Marion Kneer led an

AAHPERD initiated book series entitled *Basic Stuff.*[35–37] This multi-volume practical guide to teaching provided the knowledge base essential for teachers to implement a multi-disciplinary approach to PE. The *Basic Stuff* series laid the foundation for later knowledge-to-application oriented texts, such as, *Concepts and Principles of Physical Education: What Every Student Needs to Know,* first published in 1995.[38]

Lawson and Placek[39–41] produced one of the first modern multi-disciplinary curriculum approaches to PE in their text, *Physical Education in the Secondary Schools: Curricular Alternatives.* This exceptionally innovative perspective provided a highly conceptualized rationale and guidelines for interdisciplinary PE. Other scholars have followed the knowledge-integration format both in the United States[42] and in the United Kingdom.[43,44] Additionally, in the United States, the Maryland State Department of Education,[45] following the perspectives developed by Lawson and Placek[39] and Mohnson,[38] accepted a PE curriculum based on four disciplinary standards (exercise physiology, biomechanics, motor learning, social-psychological) as developed in two application standards (skillfulness, fitness) dramatically revising the state level curriculum beyond the traditional sports and games multi-activity approach. Each of these knowledge-to-application oriented perspectives demonstrated the centrality of knowledge in physical literacy. Knowledge partnered with skills and physical activity applications provide the core of the physical literacy curriculum in the 21st century.

5. Knowledge based curricula for the 21st century

Between 2003 and 2016, the United States National Institutes of Health funded two large curriculum design, testing, and dissemination projects to provide health-related science-enriched curricula for PE. Curricula were designed by a team of PE and science education master teachers working with university project teams to align knowledge and applications in a meaningful progression. In this section, I will describe the design, development, and testing protocols for these curricula and emphasize how they reflect physical literacy goals of transmission, transfer, and innovation.

5.1. Science, PE, & Me!

The SPEM curriculum (2003–2008; US$1.4 million, Ennis and Chen, PIs) sought to engage 3rd–5th grade (ages 8–11) students in a new science-enriched form of PE. In this curriculum, students study fitness components (e.g., cardiovascular, muscular strength and endurance, flexibility and nutrition — in lieu of body composition) and apply related fitness concepts, principles, and procedures to physical activity, nutrition, and health. Teachers receive professional development training to understand and teach the curriculum to their students. The curriculum materials include an extensive *Teachers Manual* consisting of 90 model lessons structured using the 5 Es learning cycle strategy and organized into three units for upper elementary level students.[42]

5.1.1. The 5 Es learning cycle lesson structure

Each SPEM lesson is structured based on the 5 Es learning cycle strategy to teach scientific inquiry processes. The 5 Es model[46] recommends that each lesson open with a cognitive and physical Engagement to introduce the concepts and principles to students within active games and physical challenges. The lesson continues with the Exploration/Experiment segment in which students explore concept relationships, examining for example, how exercise increases heart rate, the relationship between number of steps and intensity, or how differences in weight lifted and repetitions completed impact muscular fatigue. Following these two physically active sections of the lesson (typically 65%–75% of instructional time), students participate in the third E—Explanation. In this brief cool down phase, students work in pairs using "Think, Pair, Share" strategies to discuss teacher-posed questions. Teachers use the fourth E, Elaboration, to check for student understanding and emphasize connections between knowledge learned in the PE lesson and other life science content, and how content can be used at home, in sport, and recreational settings. The final E, Evaluation, involves students answering short essay questions, completing simple calculations, or graphing their findings in their *Student Science Journals*.

5.1.2. Curricular knowledge

The SPEM units, *Dr. Love's Healthy Heart* (cardiovascular concepts, principles, and procedures), *Mickey's Mighty Muscles* (muscular strength and endurance), and *Flex Coolbody's Fitness Club* (flexibility and nutrition) provide opportunities for students to experience each fitness component, observe and monitor the effects of exercise on their bodies, and observe the physiological changes that occur as they exercise. Students also record physiological measurements (e.g., heart rate, respiration, fatigue, *etc.*) in their individual *Student Science Journals,* providing a permanent performance-based fitness record. Parents are invited to back-to-school events in which their child leads them through eight experiments they performed in PE. Each family member records their health/fitness data in their *Family Lab Notebook*. Teachers receive numerous resource materials in the form of task cards, charts, tables, and posters to assist in teaching the curriculum.

The SPEM curriculum was tested in a randomized controlled clinical trial in 30 elementary schools in a large urban school district. Clinical trial results with over 12,000 students in 15 experimental and 15 control elementary schools indicated that students significantly increased their knowledge of fitness in each unit at each grade. Additionally, accelerometer data confirmed that students were physically active at a moderate level of intensity (>3 METs) for each lesson. Thus students were able to increase their knowledge of fitness components and their ability to apply concepts as they participated in a constructivist-oriented PE curriculum.

5.2. The Science of Healthful Living

Following the success of SPEM the National Institutes of Health funded a second large curriculum design and testing

project. The SHL middle school curriculum (2011−2016; US$1.3 million, Ennis and Chen, PIs) targets students in 6th−8th grades (ages 11−14). The goals of this curriculum are to extend and transfer students' understandings of cardiorespiratory fitness and nutrition. Additionally, content includes health-related science/fitness concepts such as stress management, media influences on health, and goal setting.

5.2.1. Curricular knowledge base

The SHL curriculum consists of 120 lessons in two units. The units, *The Cardio Fitness Club* and *Healthy Lifestyles,* articulate a specific content emphasis for each grade level. In 6th grade, students are introduced to essential fitness concepts (e.g., frequency, intensity, type, and time (FITT), progressive overload, energy production for anaerobic and aerobic activities, calories, caloric consumption and expenditure, caloric balance) establishing a foundational knowledge base. Seventh grade students review the knowledge content from 6th grade and experience opportunities to extend and apply the concepts, principles, and procedures (e.g., heart rate, perceived exertion, pedometry) to daily workouts. In 8th grade, students examine diverse applications and consider opportunities to build concepts into a long-term fitness program. Similar to the SPEM curriculum, PE teachers implementing the SHL curriculum receive a *Teachers Manual* with detailed model lessons, teacher resources in the form of differentiated fitness task cards, and professional development training to use the curriculum. Each lesson incorporates the 5 Es learning cycle strategy at a level appropriate for young adolescents. Students record their findings from each lesson in their *Student Science Journals* available in hard copies or electronic formats when students have access to tablets or laptops.

5.2.2. Research design

The SHL research design and timelines followed closely those developed in the SPEM randomized controlled clinical trial. Specifically, in the middle school design, 73 teachers at 24 middle schools received professional development to teach the curriculum. Students completed one knowledge-based pretest prior to the units and a posttest after each unit. A representative sample of students (e.g., school, grade, gender, body type) was selected to wear accelerometers to measure the physical activity intensity levels for each lesson. Lessons ($n = 120$) were sampled purposefully so that each lesson was assessed at different schools and with different teachers. Additionally, students wearing accelerometers were interviewed prior to and after completing each unit to monitor knowledge growth on several questions representing concepts and principles taught in the SHL curriculum.

6. Curricula for knowledge transmission, transfer, and innovation

Innovative approach to physical literacy curricula integrating physical activity with conceptual understanding of concepts, procedures, and principles have proven immediately beneficial both within and outside the PE classroom. These knowledge-based, academic approaches to PE permit students to gain deep understandings that can be applied outside of PE across a range of physical activities in many different venues.

Similar to other multi-disciplinary, knowledge-based programs, the SPEM and the SHL curricula promote physical literacy through transmission, transfer, and innovation, engaging students meaningfully in content that is relevant now and in the future. Transmitting essential knowledge is a cornerstone of these effective, learning-based, physically active programs. As students learn concepts, principles, and procedures, teachers assist them to recognize applicable future settings for transfer. The large number of lessons (SPEM 90 lessons; SHL 120) in each curriculum ensures that students overlearn concepts, developing a solid, integrated knowledge foundation for future innovation. Both curricula provide students with evidence-based knowledge from fitness and exercise physiology along with unique opportunities to engage actively, transferring knowledge to a range of diverse fitness tasks in which they experience the effects of exercise on their bodies. Through homework and other application and transfer experiences, they engage with the multidimensional nature of this knowledge as it becomes central to their understandings of physical activity.

7. Transmitting knowledge about fitness and nutrition

If literate individuals are those who possess skills to access knowledge and a comfortable, working understanding of valued content, then students who experience curricula such as the SPEM and the SHL are becoming physically literate. These curricula for 8−14-year-old children and young adolescents provide a first step in a lifelong process of gaining meaning and acquiring a progression of fitness skills culminating in deep personal understandings of healthy nutrition and the positive effects and benefits of regular exercise on their bodies. Students completing these programs also have gained a deeper understanding of the scientific inquiry process through their experiences with the 5 Es learning cycle strategy.

Physically literate individuals confidently exhibit and apply their knowledge to perform skillfully in a range of physical activities. They are able to revise effective exercise programs as their life circumstances evolve. Because their needs and interests will change multiple times throughout their lives, they can apply this information to make independent, evidence-based decisions to improve their lives and those of their families. A lifespan approach to innovative change in fitness activities, workout plans, and recreational settings can encourage and sustain physical activity. From this perspective physical literacy transcends the physical, relying on a sound foundation of knowledge to guide and lead physical activity choices and participation practices across one's lifetime.

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