# Pedagogical Uses of Technology in Physical Education

SUSANA JUNIU

*Choose your technology to aid your teaching, rather than designing your lesson to fit the available technology.*

The effective preparation of teachers in the use of educational technology has been extensively discussed by researchers in the past few years (Koehler & Mishra, 2008; Liang, Walls, Hicks, Clayton, & Yang, 2006; Settlage, Odom, & Pedersen, 2004; Smerdon et al., 2000). Questions such as how to teach a subject with technology in a pedagogically appropriate way and how to develop the knowledge base to design and implement technology-infused lessons in physical education are often addressed in preservice teacher education programs (Kirschner & Sellinger, 2003).

The literature suggests that effective technology integration with specific subject matter requires teachers to apply their knowledge of curriculum content, general pedagogies, and technologies (Koehler, Mishra, & Yahya, 2007). This approach, known as the "technological pedagogical content knowledge" model (TPCK, Koehler & Mishra 2008), is grounded on Shulman's (1987) idea that teachers should be able to apply their content knowledge in a pedagogically sound way that is adaptable to the characteristics of students and of the educational context (e.g., the gymnasium).

Because physical education is usually taught in a gymnasium or outdoors, it is important for teacher education programs to prepare teachers to infuse technology in a way that will support the pedagogical strategies used in those settings. Teachers need to learn and practice teaching skills in a context as similar as possible to the one they will teach in later. Teachers are expected to know how computers and other technological devices can contribute to data collection for the analysis of sport skills, to the assessment of student learning, and to the evaluation of health-related physical fitness. This includes using exercise equipment to assess physical activity (e.g., accelerometers, heart rate monitors, pedometers, interactive dance machines), body composition (e.g., bioelectrical impedance devices, electronic skin-fold calipers), and movement and motor-skill performance (e.g., Dartfish). There are also a number of software packages used to record and analyze physical fitness, physical activity levels, and nutrition habits, such as TriFit, Fitnessgram, and Activitygram. PE Manager is another application used in physical education to track student performance via rubrics, tests, and assignments on a mobile device (Woods, Karp, Miao, & Perlman, 2008).

These expectations are reflected in the National Educational Technology Standards (NETS), established by the International Society for Technology in Education (ISTE), and in the physical education teacher education (PETE) standards of the National Association for Sport and Physical Education (NASPE, 2009). As stated in the ISTE standards, "Effective teachers model and apply the National Educational Technology Standards for Students (NETS•S) as they design, implement, and assess learning experiences to engage students and improve learning; enrich professional practice; and provide positive models for students, colleagues, and the community" (ISTE, 2008). Bechtel (2010) explored the use of technology in the PETE program at her university while addressing national standard 3, outcome 3.7 for physical education teacher education: "Teacher candidates will: Demonstrate knowledge of current

technology by planning and implementing learning experiences that require students to appropriately use technology to meet lesson objectives" (NASPE, 2009, p. 6). She found that technology was not being effectively infused across the PETE program. These results prompted changes in the program in order to address the need to prepare preservice teachers to use various forms of technology in their teaching practice. Bechtel recommended that technology be taught across the curriculum using progressive learning experiences that incorporate pedometers and heart rate monitors.

This article uses the TPCK framework as a way to prepare physical educators to employ a variety of instructional approaches that use technology to teach a subject matter effectively. The purpose is to present examples of learning activities that could be easily integrated across the physical education curriculum and to describe a project-based learning experience as an alternative to preparing preservice PETE majors.

## Designing Technology-based Learning Activities

An effective curriculum that is facilitated by the use of digital tools should link instructional approaches and learning outcomes to the goals of the lesson (Koszalka & Ganesan, 2004). According to Niess (2005), learning activities should take into account student needs, the content being taught, and other contextual variables. The instructors should choose the appropriate educational technology after identifying the learning goals and developing the learning activities, rather than planning the instruction around them (Hofer & Harris, 2009). Thus, using a framework for teaching with technology could guide and support teachers' development of learning materials. For instance, Morrison, Kemp, and Ross (2000) developed a nine-step instructional design model (used in the design of the activities presented in the next section) that deals with the role of technology in both the design and delivery of knowledge and in the alignment of the learning outcomes to materials and assessments.

It is important to understand that technologies have specific affordances and constraints (Koehler & Mishra, 2008) that may partially determine their use in a given educational context. The function of the technology depends on the context in which it is used and should be thought of in those terms. For example, the purpose of a productivity tool such as a spreadsheet is to provide basic database functionality, along with spreadsheet and calculation functions for financial uses, but it can also be used in education as a cognitive tool (Jonassen, 2000) to conduct statistical analysis and for problem-solving activities. Physical education teachers could use this tool for data collection and to track their students' progress on individual fitness exercises such as the mile run, sit-ups, sit-and-reach tests, and push-ups. After the testing is completed, the students can view their personal data and use the statistical functions of the spreadsheet graphs to see their individual progress. Other technologies and collaborative tools—such as online file sharing, discussion boards, chat records, and wikis—may facilitate teamwork and group learning and allow the teacher to assess individual contributions and team functioning (Barcelona & Rockey, 2010). Thus, the creative use of certain technologies allows educators to repurpose existing tools for pedagogical ends (Koehler & Mishra).

## Learning Activities

This section presents two learning activities and the technologies that may be used as cognitive tools to support problem solving in a health and physical education class. These activities were designed using the Morrison, Kemp, and Ross (2000) nine-step instructional design model and Harris and Hofer's (2009) five basic steps for planning a learning event (table 1). They are grounded in several questions. What do the individual students need to reach their goals? What strategies are appropriate for this particular lesson? What teaching strategies are being used? What digital technologies are pedagogically appropriate? Table 2 (adapted from Velazquez, 2009) presents a series of questions about each component of the TPCK framework, which supports the planning of the learning activities.

The learning activities are designed using the taxonomy for activity types developed by Harris and Hofer (2009) to provide scaffolding for teachers to support teaching and learning with educational technologies. These activities are geared to helping students build their knowledge about physical fitness content, concepts, procedures, and application. The objectives are grounded in the conceptual and procedural knowledge-building and knowledge-expression model through the demonstration and application of concepts in a real-life situation (Harris & Hofer). The learning activities meet national standards 1, 2, 4, 5, and 6 for K-12 physical education students (NASPE, 2004) and the NETS•S standards (ISTE, 2007).

The first example is a lesson on heart rate (table 3) designed to (1) introduce the students to the concept of heart rate, (2) help them understand the relationship between exercise and heart rate, (3) assess the various types of heart rate, (4) teach them about how to maintain a target heart rate, (5) create a target heart-rate report, (6) set goals based on pre-assessment results, and (7) present the results and recommendations on how to improve target heart rate. The second example, presented in table 4, is geared to developing and analyzing the performance of a selected sport skill (e.g., dribbling a basketball, forehand stroke in tennis). The purpose of these learning activities is for the students to (1) identify the critical elements of a given sport skill; (2) describe proper techniques including stance, execution, and follow-through in order to develop a checklist to analyze the skill performance; (3) perform the skill; (4) do peer observation; (5) analyze the skill performance of a peer; and (6) provide feedback on skill performance based on the data collection. Each lesson begins with a question that will trigger students' curiosity and set the stage for building their knowledge through reflection, construction, exploration, application, and/or visualization.

## Table 1. Basic Planning Elements for Developing a Unit Plan with Technology

| Planning Element | Steps |
|---|---|
| Instructional Problem: Essential Question | 1. Instructional problems |
| | a. What are the needs? |
| | b. What I am going to teach (topic)? |
| | c. Scenario to trigger students' inquiry |
| | d. Provide a background to students |
| | 2. Identify subject matter. |
| | 3. State instructional objectives. |
| Analysis of Context | 4. Examine learner characteristics. |
| | a. Social aspects |
| | b. Learning styles |
| | 5. Consider classroom structure and configurations of the educational context. |
| | a. Organization of material |
| | b. Space |
| Pedagogical Decisions | 6. Design instructional strategies (pedagogical decisions). |
| | a. Student centered or teacher centered |
| | b. Previous experience |
| | c. Duration/time (allocation of time for each activity) |
| | d. Structure learning configurations (individual, groups, etc.) |
| | e. Convergent or divergent learning (hands-on or abstract) |
| Learning Activities and Implementation | 7. Select and sequence appropriate learning activities. |
| | 8. Plan the instructional implementation and delivery. |
| | a. Group based/computer based |
| | b. Face to face, online |
| Assessment | 9. Develop evaluation instruments to assess objectives. |
| Resources | 10. Select resources (i.e., technological tools) to support instruction and learning activities and attach them to the learning goals, content, pedagogy, and context. |

*Adapted from Morrison, Kemp, & Ross (2000) and Harris & Hofer (2009)*

## Table 2. Technology Integration Worksheet

What knowledge do the teachers need?

What, how, why, who, where, and when to teach?

| Content | Pedagogy | Technology | Is It Effective? |
|---|---|---|---|
| • What are the desired learning outcomes for the content being taught?<br>• What is the core curriculum objective you plan to target with this technology? | • What pedagogies/ teaching strategies are being used?<br>• (i.e., active engagement, group work, practice and feedback, reflection, authentic hands-on experience, etc.)? | • What digital technologies are being used in teaching and learning?<br>• What digital technologies are pedagogically appropriate?<br>• What are the functions, affordances, and constraints? | • How effectively does the technology integration enhance or support the pedagogical strategies being used?<br>• How does the technology integration improve or detract from the learning experience?<br>• How will the students understand the concepts in the technology-enhanced learning activity? |

*Adapted from Velazquez (2009)*

## Preparing Preservice Teachers

As discussed in a previous section, technology alone does not ensure quality of education, and it is essential to design educational experiences that promote the construction of applicable knowledge and prepare preservice teachers to understand the fundamentals of teaching the subject matter while integrating technology. This raises the question: how will preservice teachers develop TPCK for teaching in their discipline? This question challenges PETE programs to create an environment that encourages innovative uses of technology through hands-on experiences.

For teachers, it is not enough to discuss technology integration in generalized terms or to attend a traditional workshop to acquire basic technological skills; rather, what is most needed is a more holistic approach such as the "learning technology by design" model (Koehler & Mishra, 2005),

**Table 3. Learning Activities for a Lesson on Heart Rate**

What is heart rate?
How does exercise affect heart rate?
What is target heart rate?

Determine your target heart rate for exercising.
NASPE K-12 Standards: 2, 4, 5, 6
ISTE NETS•S Standards: 1, 2, 3, 4, 5, 6

| Learning Activities | Pedagogical Uses | Technologies | Results in Learning by | Performance Standards |
|---|---|---|---|---|
| Learning Category: Knowledge Building | | | | |
| Explore and research the concept. | Students gather information from lectures, presentations, and/or group work. | Web search engines, the Internet, Wikipedia and other information databases, DVDs, videoconferencing, class web sites | Reflecting | NASPE 2<br>ISTE 3 |
| Discuss and evaluate information. | Students engage in dialogue with one or more peers. | Discussion board, email, chat, videoconferencing | • Reflecting<br>• Active engagement | NASPE 2, 5<br>ISTE 2, 5 |
| Take notes and respond to questions. | Students respond to questions posed by the teacher. | Word processors, Wikis | Reflecting | NASPE 2<br>ISTE 4 |
| Learning Category: Procedural Knowledge (Hands-on/Lab) | | | | |
| Learn procedures. | Students learn how to safely and appropriately handle equipment | • Real-time data-collection devices (heart rate monitors, accelerometers, pedometers)<br>• Fitness-assessment reporting software<br>• Statistical software (spreadsheets and databases)<br>• Video, demos, written instructions | Visualizing | NASPE 2<br>ISTE 6 |
| Practice procedures. | • Students practice using equipment, software, measuring, testing what they have designed, etc.<br>• Students run trials and carry out steps for investigations (e.g., heart rate monitor). | • Real-time data-collection devices (heart rate monitors, accelerometers, pedometers)<br>• Fitness-assessment reporting software<br>• Statistical software (spreadsheets and databases)<br>• Video, demos, written instructions | • Practicing<br>• Simulation | NASPE 4<br>ISTE 6 |
| Collect data. | • Students work in groups to collect data using electronic devices (i.e., heart rate monitor). | • Real-time data-collection devices (heart rate monitors, accelerometers, pedometers)<br>• Handheld computer, tablet computers | • Active engagement<br>• Applying<br>• Planning | NASPE 4, 5<br>ISTE 2, 6 |

which combines practical knowledge of technology tools with a pedagogical understanding of how technology can support problem solving and enhance collaborative learning. This approach creates a learning environment that promotes learning by doing, constructing, reflecting, and visualizing; facilitates problem-solving activities; and provides educators with an opportunity to learn from a student's perspective (Juniu, 2005). Most significantly, by participating in the design process, teachers build something that is sensitive to the subject matter and specific to the instructional goals (Koehler & Mishra, 2005).

One alternative that could be easily used is the project-based learning (PBL) model (Moursound, 1999). Project-based learning has been widely used in teaching to facilitate problem-solving activities for students and to promote learning by doing, constructing, reflecting, and visualizing.

| Learning Activities | Pedagogical Uses | Technologies | Results in Learning by | Performance Standards |
|---|---|---|---|---|
| Collect data. *Continued* | • Students record data in tables and lab notes. | • Fitness-assessment reporting software<br>• Statistical software (spreadsheets and databases) | | |
| Analyze data. | • Students work in groups to enter data from data-collection devices to address the different components of the test to be measured.<br>• Students calculate heart rate results.<br>• Students work in groups to conduct queries to answer the problem of the investigation, sort and regroup data, perform calculations, compare and contrast categories of data, look for relationships between categories, and make projections.<br>• Students assess their physical fitness status in terms of cardiorespiratory endurance. | • Real-time data-collection devices (heart rate monitors, accelerometers, pedometers)<br>• Fitness-assessment reporting software<br>• Statistical software (spreadsheets and databases) | • Active engagement<br>• Applying<br>• Constructing<br>• Collaborating<br>• Reflecting | NASPE 4, 5<br>ISTE 2, 4 |
| Learning Category: Knowledge Expression | | | | |
| Write a report on the findings. | Students work in groups to write a laboratory and research report. | Word processors, presentation software, videos, wikis, podcasts | • Constructing<br>• Collaborating | NASPE 5<br>ISTE 1, 2 |
| Perform concept mapping. | Students develop graphic organizers, semantic maps, etc. | Inspiration, MindMap, interactive whiteboards, drawing software | • Collaborating<br>• Visualizing | NASPE 5, 6<br>ISTE 1, 2, 4 |
| Present and communicate the research findings. | Students work in groups to design and construct a product to share with other students to represent their acquired knowledge. | Multimedia (PowerPoint), collaborative podcasting (http://voicethread.com) | • Constructing<br>• Collaborating | NASPE 5, 6<br>ISTE 1, 2, 4 |
| Conduct a debate. | Students discuss opposing viewpoints embedded in science content knowledge. | Videoconferencing, discussion board, blogs | • Reflecting<br>• Feedback | NASPE 5, 6<br>ISTE 1, 2, 4, 5 |

This approach to learning allows preservice teachers to assume the role of designer as well as learner. The students work together to find solutions to "real-world" problems and apply the most effective combinations of pedagogy, course content, and technological tools to specific learning situations. In this way, all participants "learn technology by design" and consider which technologies best support the pedagogical representation of the concepts. The goal is for preservice teachers to experience the use of technology through an instructional model that blends knowledge of

**Table 4. Learning Activities for a Lesson on Learning and Developing a Motor/Sport Skill**

How to perform a particular sport skill?
What are the critical elements of a particular sport skill?

NASPE K-12 Standards: 1, 2, 4, 5, 6
ISTE NETS•S Standards: 1, 2, 3, 4, 5, 6

| Learning Activities | Pedagogical Uses | Technologies | Results in Learning by | Performance Standards |
|---|---|---|---|---|
| **Learning Category: Conceptual Knowledge Building** | | | | |
| Explore and research the correct form of performing a sport skill. | Students gather information from lectures, presentations, and/or demonstrations. | Search the Internet, Wikipedia and other information data bases, DVDs, videoconferencing, class web sites | Reflecting | NASPE 2<br>ISTE 3 |
| Discuss and evaluate information. | • Students engage in dialogue with one or more peers.<br>• Students identify proper techniques including the stance, execution, and follow-through for the selected skill (i.e., dribbling a basketball, forehand stroke in tennis). | Discussion board, email, chat, videoconferencing | • Reflecting<br>• Active engagement | NASPE 2, 5<br>ISTE 2, 5 |
| Take notes. | Students develop an assessment tool to assess the critical elements for each criterion (i.e., rating scales, scoring rubrics, checklist). | Word processors, wikis | Planning | NASPE 2<br>ISTE 4 |
| **Learning Category: Procedural Knowledge (Technology Lab)** | | | | |
| Learn procedures. | Students learn how to safely and appropriately handle equipment. | • Real-time data-collection devices (videotape)<br>• Video capturing and analysis software<br>• Video, demos, written instructions | Visualizing | NASPE 2<br>ISTE 6 |
| Practice procedures. | Students practice using equipment and software. | • Real-time data-collection devices (videotape, digital camera)<br>• Video capturing and analysis software | • Practicing<br>• Simulation | NASPE 4<br>ISTE 6 |
| **Learning Category: Procedural Knowledge Building (Performance)** | | | | |
| Do drill and practice skill. | • Students practice individual techniques for sport skill.<br>• Students interact with live or digital simulations to learn the skill. | • Video, demos, written instructions<br>• Practice software | • Practicing<br>• Simulation<br>• Imitation<br>• Visualizing | NASPE 1, 2<br>ISTE 4 |
| Perform skill. | • Students demonstrate technique and perform the skill to peers.<br>• Students apply sport skill in a real life game. | • Real-time data-collection devices (videotape, digital camera)<br>• Video capturing software | • Executing<br>• Applying | NASPE 1, 2<br>ISTE 4 |

the subject matter with teaching and learning.

The preservice teachers are given a fictitious scenario to elicit questions that will trigger their interest and initiate their inquiry on the topic. Once they have been introduced to the topic, they formulate various ideas and with the instructor classify them into categories. They work in groups to brainstorm and select questions and problems on which they would like to focus their lesson planning. The steps lead them through the process of investigating the subject matter, organizing their ideas, identifying pedagogical ways

| Learning Activities | Pedagogical Uses | Technologies | Results in Learning by | Performance Standards |
|---|---|---|---|---|
| Conduct peer observation. | Students observe a student's performance, compare and contrast the performance against the criteria (critical elements). For example, students watch a student during a tennis game; using a criteria task sheet, five forehand strokes are observed. | • Real-time data-collection devices (videotape, digital camera)<br>• Video capturing software<br>• Spreadsheets and/or databases<br>• Handheld computer, tablet computer | • Active engagement<br>• Applying | NASPE 1, 2<br>ISTE 4 |
| Collect data. | • Students work in groups to collect data using electronic devices (i.e., video cameras).<br>• Students use different tools to record information about their peer's performance or behavior (i.e., live observation or video analysis, rating scales, scoring rubrics, checklist). | • Real-time data-collection devices (videotape, digital camera)<br>• Video capturing software<br>• Handheld computer, tablet computer | • Active engagement<br>• Applying | NASPE 4, 5<br>ISTE 2, 6 |
| Analyze data. | • Students work in groups to analyze a particular student's performance, compare and contrast their performance against the criteria (critical elements). For example, students watch a student during a tennis game; using a criteria task sheet, five forehand strokes are observed.<br>• Students identify positive and negative aspects of performance based on the critical elements and record data in tables. | • Video analysis software<br>• Statistical software (spreadsheets and databases) | • Active engagement<br>• Applying<br>• Constructing<br>• Collaborating<br>• Reflecting | NASPE 4, 5<br>ISTE 2, 4 |
| Learning Category: Knowledge Expression | | | | |
| Write a report on the findings. | • Students work in groups to present their findings.<br>• Students create a digital video about the particular skill observed. | Word processors, presentation software, videos, wikis, podcasts | • Constructing<br>• Collaborating | NASPE 5<br>ISTE 1, 2 |
| Present the research findings. | • Students work in groups to design and construct a product to share with other students to represent their acquired knowledge.<br>• Students draw conclusions and communicate results to the student observed (verbal, nonverbal, or written feedback). | Multimedia (PowerPoint), collaborative podcasting (http://voicethread.com) | • Constructing<br>• Collaborating | NASPE 5, 6<br>ISTE 1, 2, 4 |
| Conduct a debate. | • Students discuss opposing viewpoints embedded in science content knowledge.<br>• Students discuss appropriate practice sessions to improve performance. | Videoconferencing, discussion board, blogs | • Reflecting<br>• Feedback | NASPE 5, 6<br>ISTE 1, 2, 4, 5 |

to represent the content, and selecting the most appropriate technologies. These activities require that preservice teachers plan and design a unit that focuses on developing health-related physical fitness and motor skills while assuming the roles and responsibilities necessary for successfully completing assigned tasks. Once they have developed a progressive set of lessons, the students present their work and implement the unit plan during their student-teaching experience. During this project the preservice teachers may combine some of the learning activities presented in tables 3 and 4 or design new ones based on the learning objectives.

## Conclusion

This article is intended to serve as a guide for developing learning experiences for preservice teachers related to various technologies, pedagogical considerations with digital tools, and teaching and learning with technology. During this experience, the preservice students explore a variety of activities that could easily be used across PETE programs, design technology-based lessons that address specific goals and objectives in the physical education curriculum, and teach the lessons during their student-teaching experience.

Using the PBL instructional approach not only allows the students to gain technological skills through a collaborative activity, but helps them apply this experience to the "problem" of how to find the best balance of technology and pedagogy in their teaching. The primary goals of the program are to (1) provide preservice teachers with an opportunity to experience problem-based learning that requires the training in and application of several digital instructional tools, including data collection devices and multimedia applications; (2) engage preservice teachers in authentic discussion about the pedagogical uses of digital tools; and (3) explore new instructional models that provide technical and instructional support throughout the process of integrating curriculum and technology.

Since knowledge is an essential element in making proper decisions regarding the implementation of new technologies in education, teacher preparation programs should focus on the development of preservice teachers' knowledge of the subject matter in conjunction with how best to structure and support their teaching and learning activities with technology. Educators are models to students, and to be models of innovation they need to experience educational innovation in their own preparation. The role of instructors is to challenge preservice teachers to incorporate educational technologies effectively and efficiently into the education process, but most essentially to refocus their teaching philosophy and adopt new approaches to teaching.

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*Susana Juniu (junius@mail.montclair.edu) is a professor in the Department of Exercise Science and Physical Education at Montclair State University, in Montclair, NJ 07043.*

## Chen

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under challenging conditions can we really tap into our potential for learning. While challenging students, the coach or teacher should also be sensitive to the age, skill level, and special needs of the student, and remember to encourage enjoyment in both practice and performance.

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