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Use of Technology for Constructivist Learning in a Performance Assessment Class

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The use of educational technologies in teaching and learning presents pedagogical concerns and challenges to educators. Combining multimedia technologies with the Web has created new possibilities for the development of instructional materials to deliver course content. However, this use of technology continues to represent traditional conceptions regarding the use of computers. The question remains as to when and how to use various forms of educational technology and how to best integrate them into the classroom. Disciplines such as measurement and evaluation are not free from these challenges, especially when instructors are looking for ways to improve learning of statistical concepts that are hard to retain. Using educational technology as a constructivist tool could aid students to represent their ideas, articulate what they know, and explore, manipulate, and process information, while actively collaborating with each other (Jonassen, Peck, & Wilson, 1999). The purpose of this article is to describe constructivist uses of technology and to present a curriculum unit for a performance assessment class in health and physical education, which is presented as an example of a project-based learning activity that exemplifies a constructivist use of software to support problem solving.

Key words: educational technology, project-based learning, health-related physical fitness

The evolving information technology era has become a major challenge for higher education institutions. Instructors are compelled to incorporate educational tech-

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nology in the classroom, but often these technologies are used as productivity tools to deliver information rather than as cognitive means to support learning. Questions such as how educational technology impacts teaching and learning and how to best integrate it into the classroom present pedagogical concerns. Disciplines such as measurement and evaluation are not free from these challenges. Instructors look for ways to improve learning considering that statistical concepts are hard to retain and the students often find it difficult to make connections between the concepts and their own reality (Looney, 2000). Thus, creating a context that emulates real-life problems and settings is fundamental in helping students integrate, analyze, and apply concepts of statistics. Educational technology has the potential to support this approach if used to encourage the construction of knowledge through activities that are socially situated in a meaningful and authentic context (Palincsar & Klenk, 1993; Reid, 1993).

CONSTRUCTION OF KNOWLEDGE

The concept of meaning making is the essence of the constructivism philosophy of learning. Constructivists believe that students construct their own meaning through active engagement and by constructing their own representation of what they know. Students learn from thinking and doing, and thinking results from an activity (Jonassen, Peck, & Wilson, 1999). In the constructivist classroom, students interact with the environment and create their own interpretation of the world instead of being mere recipients of information transmitted by the instructor (Jonassen, 2000). The instructor motivates students by proposing a topic or presenting a case with emphasis on the big concept. The purpose is to trigger students' curiosity to investigate and learn more on the topic.

Edelson, Salierno, Matese, Pitts, and Sherin (2002) proposed a "learning-for-use" model to encourage the learner to develop useful knowledge and provide guidance to instructors on how to design learning activities that foster useful understanding. This approach, closely related to the constructivist views, offers students an opportunity for acquiring knowledge that will be applied to practical situations and for reflecting on the content learned (Bazilion & Braun, 1998; Jones, 1996).

Collaboration is another element in the learning process. The combination of doing and learning and the value of teamwork have the potential to elicit changes within the individual. The construction of meaning through project-based learning is an approach that facilitates problem-solving activities among learners, and it is viewed as a process that is problem oriented and encourages collaboration (Moursound, 1999). Students are presented with activities that reflect the complexity of the environment and the problems they will encounter in the real world

(Jones, 1996); thus, creating an activity that encourages inquiry and collaboration is the key to engaging students in meaningful learning.

With this premise in mind, the following sections of this article describe constructivist uses of educational technology and present a curriculum unit for a performance assessment class in health and physical education using a project-based learning activity that exemplifies uses of software to support problem solving.

USE OF EDUCATIONAL TECHNOLOGY IN CONSTRUCTIVIST LEARNING

Educational technology plays an important role in meeting the goals and objectives of project-based learning and facilitates the students' exploration and reflection on the content. Using the power of the Internet to distribute courseware is one example of how technological tools have been applied in academic settings. Combining multimedia technologies with the World Wide Web has created new possibilities for the development of instructional materials as well as for the delivery of instruction; however, these technologies are often used as productivity tools to disseminate knowledge through lectures, drill and practices, and tutorials. In this case, the technology drives the curriculum rather than being integrated into the existing curriculum. Simply using technology tools does not ensure a quality education; how educators use technology is more important than whether they use it. The question is when and how to use educational technology. According to constructivist theory, various technologies may be used to promote learning.

Computer software used as Mindtools support interactive, collaborative, and student-centered classrooms. Jonassen et al. (1999) indicated that "the concept of Mindtools describes a way to use computer programs to foster critical thinking" (p. 156). Mindtools are computer applications that facilitate cognitive processing and engage students in critical, higher order thinking about the content (Jonassen, 2000). For example, the learner is responsible for recognizing and organizing patterns of information, whereas the computer performs the calculations, and stores and retrieves the information necessary to create and reflect on the patterns. In this way, the students "learn with technology" rather than receive information from the computer (Jonassen et al., 1999). Software for inquiry-based activities such as databases, spreadsheets, simulations, and multimedia support thinking activities and help students to express and articulate what they know by doing and creating their own representation of the problem.

Access, a Microsoft program for creating and maintaining databases, is a computer tool used to store and organize information, but how could it be used to promote problem-solving and critical-thinking skills? Databases enable the learner to create and/or customize information such that it can be organized and

sorted to answer queries. Having students create databases and reports and later relate them to the concepts studied is an example of purposeful learning that requires higher order thinking skills. Students use databases or spreadsheets to collect data to answer their research questions. This activity is primarily constructive, and it is best accomplished by having the students define the structure of the database based on the important information they need to collect. The information obtained is later sorted and organized to answer queries based on the questions of investigation.

Spreadsheets such as Excel, another Microsoft product, also support higher order quantitative thinking, if used as cognitive tools (Jonassen, 2000). As with the databases, the students have to design the data-collection forms to address the different components of tests to be used in various forms of assessment. Jonassen suggested that using spreadsheets is an important activity that enables learners to identify variables and information, to develop formulas, and to use them to perform data analyses to answer their inquiries. Learning about the components of the spreadsheet and how these components help answer the investigation questions provides feedback and encourages the students to reflect on what they are trying to construct.

Brainstorming software such as Inspiration supports the process of concept mapping and planning. Through concept maps, the students visualize their ideas and organize their thoughts to begin planning a project or activity. This constructive activity enables the students to evaluate the strategy they would use to solve the problem of investigation. They create a visual diagram or concept map with a center node (i.e., main concept) and interrelate ideas with multiple links to elaborate on an outline of the plan of action.

Activities using Internet browsers (i.e., Netscape and Microsoft Internet Explorer) encourage learning through exploration by searching the World Wide Web and deciding which information is appropriate and reliable to answer the questions of inquiry while students are working on their critical-thinking skills. For example, while using a search engine, learners select keywords that provide information about the topic of interest. This activity also serves as a constructive method for self-assessment because the students reflect on the information obtained and on the different search strategies used to meet their goal.

Other technological tools such as multimedia programs are used to assist students in creating a product of what they learned. PowerPoint, presentation software created by Microsoft, is an example of these programs and is widely used in the schools. PowerPoint is a good visualization tool given that it incorporates media such as audio, video, pictures, and animation. The students control their production by using action buttons to navigate the presentation and highlight the main points. This technology is a good motivational tool that allows learners to be designers and instructors by constructing a product and by sharing their expertise with their peers (Budin, 1999).

Video software such as iMovie is another powerful medium that is used in education to convey information, to make statements, and to present what was learned on a given topic. The process of creating the presentation and the film is a critical factor in that it involves exploring, thinking, constructing, and reflecting on the topic. The final product is the visualization of the process that offers the learner a tangible sense of accomplishment and achievement.

In summary, educational technology facilitates alternative pedagogical models of guided and reflective inquiry through extended projects that generate complex products and results in the assimilation of information. Table 1 identifies various technological tools and their uses as either productivity or cognitive devices. The knowledge continuum represents how the use of these software applications determines whether the student is a consumer or producer of knowledge.

DESIGNING AN INQUIRY-BASED CURRICULUM UNIT

Based on principles of the constructivist-learning model and the use of educational technology as a Mindtool to support problem-solving activities, a curriculum unit was designed for a Measurement and Evaluation in Health and Physical Education class in an undergraduate teacher education program in physical education. The goal of this unit is for the students to (a) understand the relation between physical activity and health-related physical fitness, and (b) apply the concepts learned during the Performance Assessment course, such as conducting statistical tests, interpreting and evaluating the results, and making recommendations based on results.

As future teachers, the students need to understand the fundamentals of measurement and evaluation as well as to critically analyze information to make decisions when it comes to selecting the appropriate assessment tools and to providing recommendations for maintaining good levels of physical fitness. Other purposes of the unit are to (a) recognize the significance of health-related physical fitness in quality of life, (b) select practical and economical tests in the various performance areas that can be used by physical educators, and (c) develop an understanding of basic statistical concepts and techniques used for the presentation and the interpretation of results of the measurements.

The premise of the curriculum unit is that students have been asked by a local primary care clinic to identify the level of obesity in a given high school and relate these findings to physical activity. For example, before initiating the activity, the instructor presents to the students the following scenario on the public health importance of physical activity:

> The Center of Disease Control (CDC) has claimed that lack of physical activity has implications for health and wellness. Decreased levels of physical activity and exercise, together with poor diet, is the second actual leading cause of death in the United

TABLE 1
From Productivity to Cognitive Tools

	Instructor-Centered[a]		*Student-Centered*[b]	
Technological Tools	*Productivity Tool Activities*	*Results in*	*Cognitive Tool Activities*	*Results in*
Excel	Create a spreadsheet	Learning by memorization, repetition, recalling, and listing	Conduct queries to answer problem of investigation.	Learning by reflecting and exploring
SPSS	Conduct statistical computations		Sort and regroup data and perform calculations.	
Access	Store data		Compare and contrast categories of data. Look for relationships between categories. Make projections from given data. Make hypotheses based on the data obtained.	
Internet browsers	Browse and search for information		Search the Internet and decide which information is needed to answer the questions of investigation. Select keywords that provide information about the topic.	
Inspiration	Create outlines		Brainstorm and create concept maps to represent concepts.	
	Create flow charts		Arrange ideas visually using nodes and lines to demonstrate their interrelation. Arrange ideas and create storyboards.	
PowerPoint	Present acquired information	Learning by reproducing	Design and construct a product to share with peers.	Learning by constructing and visualizing
iMovie Web page (HTML Editors)			Represent acquired knowledge.	

Note. [a]Student is a reproducer of knowledge. [b]Student is a constructor of knowledge.

> States. (McGinnis, & Foege, 1992). There is ample evidence that physical activity is important for maintaining good health, improving psychological well-being, and preventing premature death (Amesty, Juniu, & Boccher-Lattimore, 2003). Physical activity has been associated with lower death rates for adults of any age, has been identified as an independent risk factor for cardiovascular disease, and has been found to reduce the risk of developing osteoporosis. It also enhances psychological well-being and appears to reduce symptoms of depression and anxiety and to improve mood. People who exercise less have a higher probability of being depressed (U.S. Department of Health and Human Services, 2000).

The previous statement raises the following questions: Why does the CDC claim that implications for health and wellness are due to lack of physical activity? How do we know in fact that there is a lack of physical activity among the U.S. population? What can we do about it? What is the relation between physical and social characteristics of neighborhoods and physical activity? Students can be asked to hypothesize about the relations and what the major problems are.

The project focuses on developing an understanding and appreciation of the need and the application of tests and measurements in the evaluation process. The curriculum unit is divided into the three phases.

Phase I: Planning and Preparation

The planning and preparation of the project begins with a theme that the instructor introduces to initiate a class discussion. The purpose of this activity is to elicit questions that will trigger the students' interest and initiate their inquiry on the topic.

Once the students have been introduced to the topic, they formulate various ideas and together with the instructor classify these ideas into categories to form groups based on subtopics of interest. The students start their group-project activity by brainstorming and deciding the questions and problems on which they would like to focus their investigations. The students organize their ideas and plan their courses of action using concept-mapping software such as Inspiration. This constructive activity enables the students to develop a plan and evaluate the strategy they will use to answer the question of their investigation. They create a concept map with a center node and relate multiple links to elaborate an outline of the plan of action including the main steps for administering psychomotor and affective tests. During this process, the teacher interacts with the students and provides feedback to their inquiries and asks them questions about the plan they are trying to develop. The teacher coaches the groups in the use of the concept-mapping software but lets the group construct their own semantic networks.

Another part of this brainstorming activity is to decide how to gather information to learn more about health-related physical fitness and the tests that measure

health-related physical fitness. This planning phase also entails selecting the population and developing guidelines on how to administer the tests. The students could also represent their plan by drawing a spatial network of the different stations in the gymnasium as they prepare them for the test administration activity. Once the students have put their ideas in the computer or on paper, they share this concept map with the class by displaying the information on the screen. This activity serves as a constructive method for self-assessment because the students reflect on the information obtained and on the different search strategies used to meet their goal. Because the students will be working with human participants, the teacher must direct part of the activity by explaining the guidelines for testing human participants.

Phase II: Tasks and Action

Data collection. The data collection phase includes various approaches to data collection such as searching the Internet, conducting interviews, mapping national statistics, and administering health-related physical fitness tests. The following technologies are suggested to students as part of the data collection process:

1. Internet. Students may choose to use the Internet to search for data on the physical level of various populations, to obtain national statistics, and to collect information on health-related issues. Another purpose for this activity is to explore different test protocols and instruments used to assess physical fitness. A good site to initiate the search is the American Alliance for Health, Physical Education, Recreation, and Dance (www.aahperd.org). This site provides the students with resources to begin their quest. The focus of this activity is to encourage learning through exploration by searching the Internet and deciding which information they need to answer the questions of investigation. For example, by using a search engine, the learners select keywords that provide information about the topic. In addition, the students could search for national statistics to include in the project for comparison and analysis purposes. Once they find information on their selected problem, they must critically evaluate it and decide whether the information is valuable. This activity serves as a method for self-assessment because the students reflect on the information obtained and on the different search strategies used to meet their goal. The instructor facilitates this activity by interacting with the groups and providing them with suggestions on appropriate ways to use search engines and offering ideas on the issues of investigation. Some of the criteria that the instructor uses to assess this activity focuses on the process the students followed to conduct their investigation, the relevance of the topic they searched, the accuracy of the information selected, the thoroughness on the topic, and the skills developed during this activity.

2. Interviews. Interviewing individuals on their physical activity experiences is another suggested activity for learning about the health-related physical fitness topic. Students design a survey based on the questions of investigation and determine the items that would provide the information needed. This process involves decision making in terms of whom, when, and how to interview, the type of questions to use (i.e. Likert scale, categorical, open ended), and the means to collect the information (i.e. audio, video, paper–pencil, digital survey).

3. Statistical data. After students administered a series of tests to measure health-related physical fitness levels in a group of subjects, the data are organized using tools such as databases or spreadsheets (e.g., Access and Excel). This activity is primarily constructive, and it is best accomplished by having the students define the structure of the database based on the important information they need to collect and how this information relates to the tests they administer (i.e., student's name, height, weight, age). The information collected is later sorted and organized to answer queries based on the questions for investigation. Having the students create databases and reports and later relate them to the concepts studied is another example of purposeful learning that requires higher order thinking skills. Learning about the components of the spreadsheet and how these components help answer the investigation questions provides feedback and encourages the students to reflect on what they are trying to construct. The instructor assesses this learning experience by observing and by using a list of questions that evaluate the group performance: Is the information in the spreadsheet consistent with the goals of the tests? Have all the indicators been identified? Can the spreadsheet information answer all the questions for later analysis?

Data analysis. Once the students have collected the data, they have to interpret and reflect on this information to answer the questions developed during the brainstorming and planning activities. This is a collaborative activity that involves thinking skills, such as summarizing the data, recognizing patterns, finding relations, extrapolating results, and drawing conclusions. Problem-oriented spreadsheets such as Excel assist the students in determining descriptive statistics, such as summarizing the data using frequency distributions and measures of central tendency. Working in collaborative groups, the students identify the variables that they would like to analyze and graph the relations among these variables to represent the participants' performance and their physical fitness levels. In this activity, the students answer questions regarding differences between physical activity levels in men and women and relations between physical fitness and quality of life. The instructor coaches the learners in the use of the formulas and functions to compute descriptive statistics and to compare the information to health-related physical fitness standards.

Phase III: Presentation of Results

The presentation and interpretation of the results is the final part of the project. It entails making a presentation to the class about the findings of the investigation. This presentation summarizes all the data collected, analyzed, and interpreted. Educational technology is an excellent tool to assist the students in completing this part of the project. The students design their final project using multimedia software such as PowerPoint or by creating a Web site using Hypertext Markup Language (HTML) editors (e.g., Dreamweaver) to present their findings. This activity is a good tool for the formative evaluation of the students, providing feedback on an ongoing basis. The instructor evaluates the group-project multimedia presentation by using questions, such as: How is the presentation organized? Does the group apply appropriate statistical techniques to analyze data (e.g. central tendency, correlation)? Does the group use tables and graphics to report statistical results? How valid and reliable is the information? Does the group interpret the results appropriately, and are these results and interpretations clear for the audience? Does the group make proper recommendations as to what should be done or changed?

Table 2 summarizes the project elements and the use of educational technology to support the students' construction of knowledge. The project includes three phases: (a) the preparation phase, which consists of brainstorming and developing a plan to answer the problem; (b) the tasks and action phase, which involves developing tools for data collection and selecting statistical tests for data analysis; and (c) the presentation of results phase, which entails the interpretation of the findings and conclusions.

ASSESSMENT OF LEARNING

What makes the learning process a successful experience for the students? The assessment of the students' learning takes place throughout the entire project. This project-based learning is the assessment tool used to evaluate the students' conceptual understanding of measurement and evaluation. During this process, the students reflect on their own learning, incorporate feedback into their planning, and explain why changes were made to meet their goals. The instructor coaches the students, provides constant feedback on their work, and poses specific questions. Additionally, each group compiles the work produced during their investigation and creates a digital file to be submitted and presented at the end of their assignment. This is another authentic assessment that provides the instructor with examples of the students' learning. Notes from the students' and instructor's journals also serve to summarize the experiences the students and instructor encounter throughout the duration of the process.

TABLE 2
Project Phases and Elements

Project Phases	*Elements*	*Technological Tools "Mindtools"*	*Critical-Thinking Activities*	*Results in Learning by*
Preparation	Brainstorming and planning	Inspiration	Create concept maps Outlines Flow Charts	Reflecting
		Internet Search Engines	Search the Internet and decide which information they need to answer the questions of investigation. Select keywords that provide information about the topic.	Exploring and reflecting
Tasks and action	Data collection	Access Excel Spreadsheet Data storage	Design the data collection forms to address the different components of test to be measured. Define the structure of the database or spreadsheet based on the important information they need to collect and how they relate to the tests they administer.	Constructing
	Data Analysis	Access Excel Statistical computation	Conduct queries to answer problem of investigation. Sort and regroup data and perform calculations. Compare and contrast categories of data. Look for relation between categories. Make projections from given data. Make hypotheses based on the data.	Reflecting
Presentation of results	Presentation and interpretation of results	PowerPoint Web Site (HTML Editors)	The students design and construct a product to share with peers.	Constructing and visualizing

CONCLUSION

The project presented in this article is an example of how technology can be integrated into a curriculum unit to support student learning. The challenging task for the instructor is to create a context that resembles an authentic environment in terms of social, cultural, and physical characteristics. During this project-based learning, the students are active, constructive, and cooperative as they conduct an authentic research activity. They formulate their own questions based on the topic provided, select ways to answer their inquiries, collect and analyze information, and present their interpretation of the results. It is important for the student to experience this process of learning to achieve a sense of flow and mastery.

The key challenge for instructors is to effectively and efficiently incorporate educational technology into the education process, but most essentially it is to refocus their teaching philosophy and adopt new approaches to teaching. This transition requires experience and accepting new models of learning.

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