Future Learning Environments for Tomorrow's Schools

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Abstract

Teachers who want to prepare their students to cope with an unknown future, must equip them with a set of competencies that are essential for success in society in general and in any enterprise or organizational unit. Therefore, in today's reality, real-life scenarios should dictate the pedagogy and the design of learning environments that will meet the standards of modern working environments. In this paper, we attempt to reexamine content, pedagogy and learning environments in the current era. Based on our experience, we recommend that educational institutions adapt their classrooms by turning them into unique learning environments which will allow for a pedagogy that combines content which has been adapted to the 21st century with advanced and innovative technology in the most appropriate way for acquiring the necessary skills. The goal is that eventually educational systems will affect the real world by introducing innovative pedagogies and learning environments which will make an impact on working environments. This paper focuses on the work that has been carried out over the past three years geared at proposing new characteristics for learning environments in colleges of education.

Keywords: Interdisciplinary Teaching, Pedagogy, Learning Environment

Introduction

Teachers who have just completed their training must express their capabilities and skills in a way that will enable them to educate and prepare their students to cope with an unknown future. In today's world, we must cope with constant and extremely rapid changes in all areas and aspects of life. In addition to educating students to be good citizens, imparting universal values and providing abundant knowledge, the education system today must teach its graduates to look ahead and cope with this unknown future. Therefore, while continuing to focus on knowledge disciplines and pedagogy, teacher training must direct its primary attention toward creating an atmosphere of openness in the learning environment, coping with changes occurring now and in the future and being open to a different type of learning that will lead to success in meeting future challenges. This paper focuses on work over the past three years geared at proposing new characteristics for learning environments at colleges of education.

Competencies of Graduates of the Educational System in the 21st Century

Amar and Bar David (2016) identified a number of skills that meet the needs of the 21st century economy and that should be required of every graduate of the educational system. In addition, many scholars in the fields of education and occupational studies (Claro & Ananiadou, 2009; Bybee & Fuchs, 2006; Boyles, 2012), have identified a number of competencies that all agree are required and essential for success in society in general and in any enterprise or organizational unit in particular. Among these competencies are pro-active social awareness, involvement, motivation, initiative, creativity and innovation, strategic thinking, collaboration, openness and flexible thinking, critical thinking, independence and accountability, social empathy and more. Today it is the obligation of educational institutions at all levels to provide their graduates opportunities to acquire and express these competencies during their studies and to practice them before joining the employment market and embarking upon their lives.

TPCK Model

To meet this need and as part of their work at a teacher education college, the writers of this paper together with other colleagues have created a structured framework for teacher training adapted to this goal. This framework is based on the Technology, Pedagogy and Content Knowledge (TPCK) model (Mishra & Koehler, 2006). After years of work with a company called Steelcase Education, the model was extended to include active observation in a learning environment adapted to the learning content.

In this paper, we propose a new look at the components of the TPCK model. We attempt to reexamine content, pedagogy, technology and learning environments in the current era, in which we in the educational system must do our best to prepare our students for the larger world that is waiting for them when they complete their studies in the sheltered environment of school.

Content – The Importance of Interdisciplinary Teaching

The content taught in the schools today is based upon unidimensional teaching according to knowledge disciplines and does not facilitate high-level thinking unless it is supported by advanced or innovative pedagogy, such as research-based learning or problem-based learning. Students taught according to existing teaching methods are unable to connect or attribute a particular area of knowledge to broader topics originating in other knowledge areas or disciplines. This also finds expression in programs for training teachers. Pre-service teachers are required to study one or sometimes two teaching disciplines and for the most part are not trained to create the interdisciplinary links required for high-level thinking and synthesis between different fields. When subject areas are taught in isolation from one other, learners cannot synchronize and synthesize between fields of knowledge, as is required by the natural cognitive processes occurring in our brains (as opposed to artificial cognitive processes that take place with the help of computerized systems). The many attempts to introduce innovative pedagogies have had limited success and have not yet become accepted teaching procedures in the educational system. Thus, we must ask the following question: How can we elevate teaching and learning to high levels of cognitive perception and processing?

Subjects taught in school need to be divided into various groups according to the optimal way of teaching them. The first group should include the linguistic subjects, which we will continue to teach through classical frontal methodology that integrates knowledge transfer with individual practice and experience. This group includes teaching the native language of each country (English, French, Hebrew, Arabic, Russian and more). The group also includes foreign languages as appropriate for each country (e.g., Spanish or German in France, Chinese or Japanese in the United States, Arabic and English for Hebrew speakers), arithmetic, mathematics, art, music, dance and movement, and social, national and international values. These subjects should be taught from an early age, and not when students are older, as is customary today. They should be adapted to the children's age and their progression in school.

The second group should include subjects that can be taught in an interdisciplinary manner, that is, subjects that are profoundly and genuinely interconnected (interconnected disciplines). Learning these subjects is divided into a number of sub-groups: i) phenomenon-based learning; ii) problem-based learning; iii) research-based learning; and iv) process- and project-based learning. To each of these sub-groups we will assign a number of subjects that will be taught in an interdisciplinary manner while using different pedagogies, different technologies and sometimes even different and adapted learning environments.

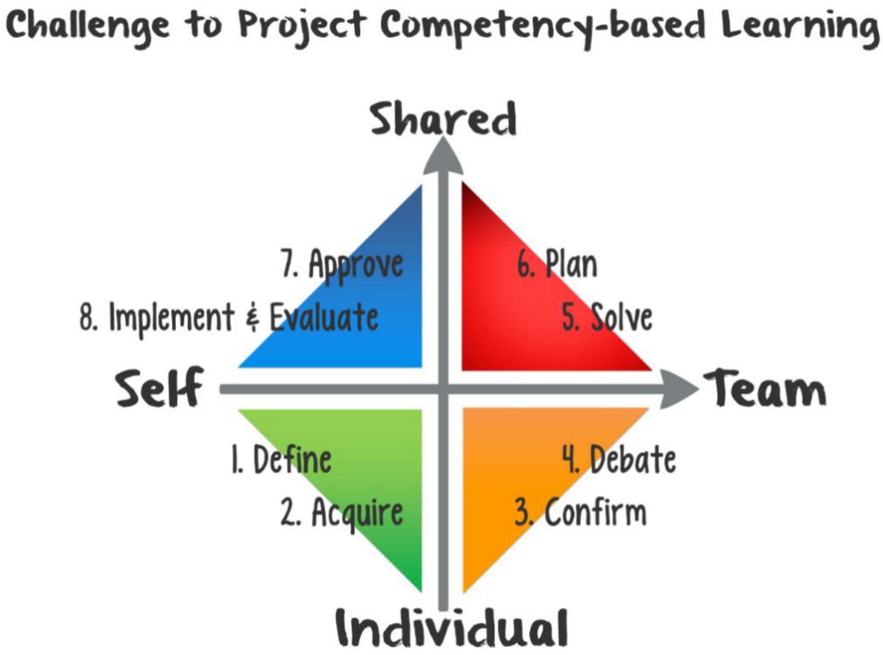
i) Phenomenon-based learning: geography, history, civics, government, economics, sociology and anthropology

ii) Problem-based learning: mathematics, physics, robotics, geometry, computational thinking, data processing
iii) Research-based learning:
a. Biology, chemistry, geography, biotechnology, biophysics, information systems
b. Judaic studies, Bible, philosophy, sociology, history, art, theology
iv) Process- and project-based learning: logical combination of all the above subjects based on new or innovative projects and processes.

These are only suggested lists. Their content can be changed in accordance to age level, and areas of study can be added or removed to match their development or disappearance from the landscape of human achievement and creativity. Also, the same areas of interest can be taught using different teaching methods. For example, geography can be taught in depth using phenomenon-based learning. Yet it can also be taught through research-based learning, in the case of scientific topics such as global warming or population migration or even when studying the exodus from Egypt or ecological models/problems influenced by a tropical or a temperate climate. This will undoubtedly facilitate in-depth understanding of a particular field, its practical implementation, and most important, synthesis resulting from high-level thinking. All this serves to provide students with skills and competencies that will enable them to use and implement the knowledge they have acquired. Students who understand how to use specific knowledge in a broad and holistic manner will certainly have a better understanding of other relevant and related disciplines and will thus be able to draw conclusions and arrive at profound and intelligent insights.

Pedagogy

In most schools, frontal teaching is still the norm. This method is based on the teaching methods practiced in most schools since the Industrial Revolution (Russell & Greenberg, 2008). We and many other researchers worldwide (Prince, 2004; Terenzini, Cabrera, Colbeck, Parente, & Bjorklund, 2001) have described the transition from traditional frontal teaching and learning to active and collaborative learning whose goal is to facilitate a shift from generating personal and individual learning products to collective and collaborative learning products. In an article published in 2016, Amar and Bar David described a new pedagogical model they referred to as P2PBE (Problem- to Project-Based Education). Since then this name has changed, and today it is the subject of renewed consideration based on a more general name: Challenge to Project Competency-based Education. This model incorporates phenomenon-, problem-, research-, project- and process-based learning. Its major goal is to facilitate learning that will ultimately provide students with knowledge, skills and abilities suitable for the needs of the 21st century.



This eight-stage model incorporates familiar and known learning and work processes. The model moves along two main axes. On the horizontal axis, the learner moves from individual work to teamwork, while on the vertical axis the learner is asked to move within the learning settings from individual products to shared products. In the following, we outline the eight stages of teaching/learning in initial chronological order that does not necessarily require continuing with individual or group learning.

Challenge Definition: Teaching every subject must begin by defining the challenge facing us, whether phenomenon, problem, research, project or process.

Knowledge Acquisition: Learners work independently or in pairs by searching computerized data bases, reading articles or books from the bibliography or searching for relevant human and professional sources of knowledge in the area being studied.

Knowledge Confirmation: This stage takes place vis- à-vis other learners who have derived similar or different information. Comparing the results of the initial work will lead to additional improvement before final confirmation by the teacher or by experts in their field.

Debate: The members of the team sit together and discuss the knowledge that each of them acquired and brought up for debate. The accumulating knowledge among all the team members makes it possible first to agree on what is common and to disagree on what is different.

Solution: The team members together arrive at a solution or a number of agreed-upon solutions that solve the problem defined in the problem definition stage. This stage marks the beginning of producing one or more collaborative products of all the team members.

Planning: The team members plan a project to implement the problem solution creatively, using existing technology intelligently and efficiently. During the planning, each team member must have an assigned role so that the work will be collaborative and complementary.

Approval: The team members prepare and present the plan and reach agreement on the proposed solutions. Project presentation will be debated by all the learners and approved by the lecturer/teacher.

Implementation and Evaluation: Presentation of the implemented projects to all members of the class ends by comparing outcomes, receiving feedback and assessing and reflecting based on the feedback.

These eight stages occur at different periods of time, as determined by the lecturer/teacher and the progress rate of the individual and group work. The lecturer/teacher can decide to implement the entire model or only parts of it, in accordance with the sequence that seems most appropriate to the study content.

The model proposed above should bring about a complete change in the role of the teacher. The teacher remains a central and significant figure in the teaching and learning process. The teacher's presence in every stage of the process is essential. The teacher becomes an educator, director, moderator, advisor and trail guide. From the stage of presenting the problem or phenomenon or learning topic, the teacher directs and helps by clarifying understanding, asking relevant questions and sharpening the learning objective. Later the teacher helps the students search for and locate knowledge sources, filter the knowledge, assemble the information required for learning and present it. The teacher moderates group debates, listens to various proposed solutions, examines and assesses, and directs the students towards learning processes that provide the desired skills. In the transition to implementation and evaluation, the teacher acts as a coach, a counselor and even as another learner among the students, as someone who learns from the process and from the resulting variety of learning outcomes proposed by the students.

Learning Environments

The classrooms in most schools have not changed much over the past one hundred years. The content, pedagogy and technology we have described in this paper have attributes that are not compatible with classrooms as they exist today. In the concept of the classroom prevalent today, each student is allocated a limited amount of space, with more space allocated to the teacher. Anyone entering the classroom understands that there is a clear hierarchy, knows who possesses the knowledge and the power and sees how the lesson or knowledge transfer is supposed to take place. Teaching and learning in traditional classrooms cannot continue when we must provide learners with new skills using innovative pedagogies and technologies. Classrooms must be turned into learning environments in which teachers and students can move around freely without any functional or territorial delineation. These environments will allow for a pedagogy that combines content adapted to the 21st century with advanced and innovative technology in the best and most appropriate way for imparting the required skills. Since the system must enable students to acquire unique skills, it must incorporate various models of learning environments that are suited to diverse content and learning methods. Based on our experience, we recommend that educational institutions adapt some of their classrooms by turning them into unique learning environments dedicated to the different subjects being taught. Further, they should impart the skills described in the paper by Amar and Bar David (2016). In the following section, we describe some examples of learning environments currently operating in our institution.

Dynamic Learning Environment

A dynamic learning environment is one that serves the needs of collaborative pedagogical activities, as described above. The environment consists of different learning areas in which one or more of the stages of the learning model take place. These areas are equipped with various means (Steelcase) that facilitate convenient and rapid transition from individual work to group work or teamwork. These include technological means for working with laptops, tablets or PCs, smartboards that provide access to technological accessories, collaborative and internet tools, as well as individual and group whiteboards and various software packages that facilitate the presentation of individual and group learning output.

These learning environments are situated in various rooms that are adjacent to one another and that allow students to move freely from one room to another as needed for their assignments. Another available option is that the entire class works with a teacher/lecturer in one room for the entire lesson and then moves to another room as necessary for the pedagogy and content being studied or in order to use technology.

The learning environment in this figure comprises four rooms at the teacher education college where we work. Each area in this environment contains different parts of the pedagogical model.

Besides these separate yet complementary spaces, it is also possible to design a larger and more meaningful space in which all the pedagogical activities take place in a single space that allows for constant movement in accordance with the lesson's pedagogy and ongoing needs.

Another example at the teacher education college is a space called "the Learning Space of the Future". Here the different learning areas are located in one large space that allows for all the stages of the pedagogical model to take place without leaving the room. Furthermore, this space facilitates cooperation between a number of different lecturers who can teach multidisciplinary content. The learning areas in this space are as follows:

Frontal area (1): problem definition, initial discussion and project presentation.

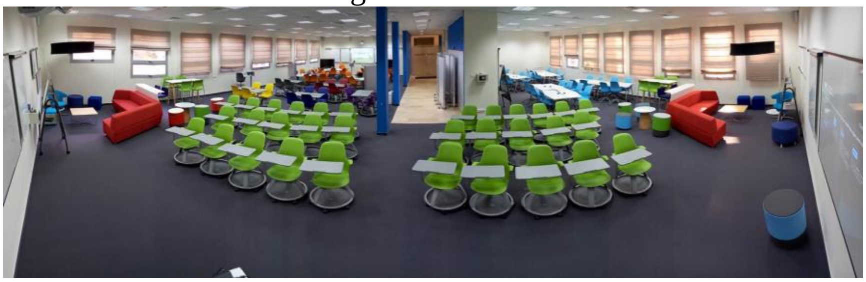
Technological area (2): immediate or ongoing knowledge acquisition.

Debate area (3): discussion and debate, solution presentation and project planning.

Instruction and guidance area (4): approval and confirmation within small and heterogeneous groups.

Areas for instilling knowledge (5): for teams the lecturer wants to offer enrichment.

Quiet area (6): for lecturers or learners to be by themselves for a short period to hold individual meetings.

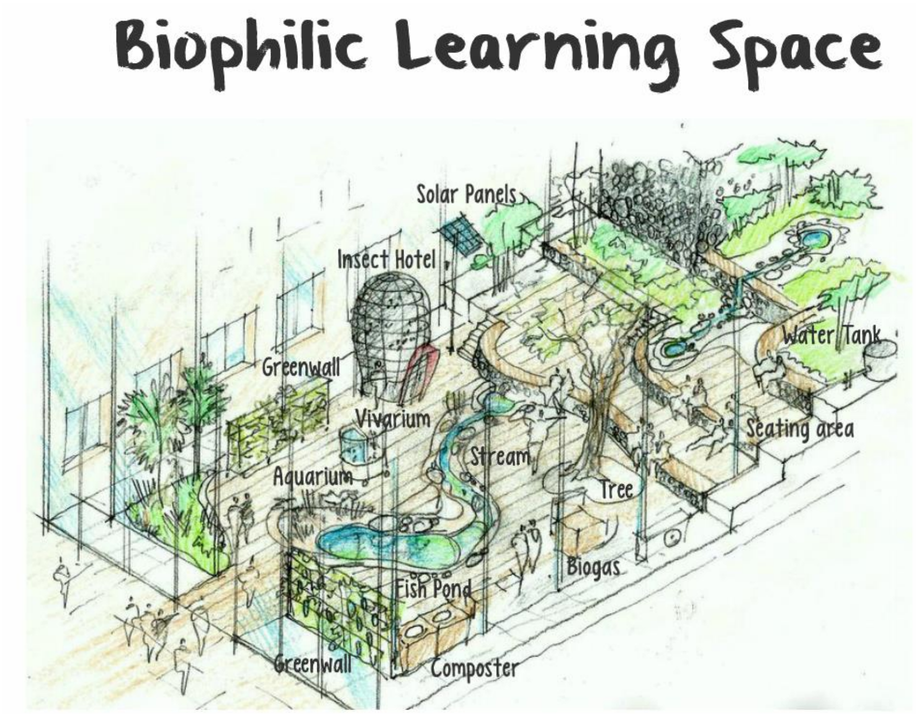


This kind of space is also appropriate for phenomenon-based learning or problem- or project-based learning.

Biophilic Learning Environment

In most educational institutions, knowledge areas such as biology, zoology, botany, ecology, entomology and the like are usually taught in frontal lessons integrated with traditional laboratories. In these labs, students experiment with and investigate different individual topics, with the results of these experiments known in advance. Natural processes that take a long time (e.g., reproduction, photosynthesis, flowering) are taught in theory and separate from parallel processes that take place in nature. These various processes influence one another and all the study topics exist in amazing harmony: The environment influences reproduction and growth, insect life affects flowering, environmental conditions go together with alternative sources of energy, and more. Yet the average school graduate who majored in biology or environmental studies is not given the opportunity to understand the interaction between these processes. Inherent in these processes is synthesis and a particularly high level of thought.

In response to this problem in teaching the natural sciences, we decided to establish a unique learning environment called the Biophilic Learning Environment. In this space, all components of nature have been brought within the grounds of the academic institution. The learning and experimental space is situated inside a closed, transparent and controlled structure forming an ecosystem encompassing various processes from the animal and vegetable world and environmental activities. The space contains an ecological pond with fish and marine life, aquatic plants and three different depth areas, including a swamp and all types of swamp life. There is also a swamp water canal in which the water undergoes purification by microorganisms found in the soil and the roots of plants; an aquarium for observing fish and a vivarium for raising reptiles; a center for raising and observing insects; a nursery that includes all the components, from germination to mature plants. The space also serves as an ecological laboratory for teaching processes of conserving and preserving energy: a composter to produce biogas that will supply energy for lighting, cooking and other purposes and plant fertilizer substances; an instructional solar energy system; a natural water cooling system in which the water flows from a large coiled hose buried deep in the ground; and green walls that demonstrate possibilities for growing hydroponic vegetables and plants on horizontal surfaces while using recycled materials.



The biophilic learning environment is totally monitored by different sensors that display climatic data in real time, such as temperature, humidity, light, amount of oxygen in the water and more. The space features a climate control system based on air-conditioning units for cooling and heating together with a cooling system that operates by adding moisture to the air and a dimming system that is automatically controlled according to the amount of light required at different times of the day and seasons of the year. These computer-controlled systems lead to a reduction in energy costs. In addition, an air bellows operated by instructions from the control system is installed in a chimney on the ceiling of the structure. The space also features an irrigation system for watering the plants and water reservoirs with a total volume of 4500 liters containing recycled water or rainwater. The water is mainly rainwater from drainpipes or condensation water from air conditioners. Water level meters installed in the tank provide information on the amount of water collected. Personal tablets (Einstein) that are also programmed for data processing can be used to operate, control and collect data from all the systems connected to the computer.

Learning in the biophilic learning environment involves collecting information, solving problems and planning projects while working with advanced technological tools. Because the natural processes occur simultaneously, we have proposed a learning method called process-based learning. In this method, small groups investigate and learn about certain processes at different workstations. After the students have worked and experimented at all the workstations and have collected complementary data and created Big Data bases, representatives of the groups meet with their counterparts from other groups. In these meetings, they report on their observations, compare their results and discuss the implications of the processes and phenomena they have observed. In this way, all the students obtain a holistic picture of the various factors in the environment and how these factors are affected by the climate conditions during the lesson. When this type of learning takes place over time, learners can understand how every climatic change affects the plants and animals in the environment. As part of the learning experience, the learners also develop various tools that improve their processes of learning in the environment. To this end, a workshop is available to them containing tools appropriate for production and manual labor.

Makerspace Environment

In recent years, a movement of amateur producers has begun to emerge. These producers design and produce almost everything according to the do it yourself (DIY) method using technologies that in the past were available only to businesses and now are accessible to everyone. Many refer to this as the Third Industrial Revolution. Across the world, makerspace environments are being established. These are places where producers meet and share their ideas and materials. This trend is slowly penetrating education as well, with municipalities and schools setting up makerspace areas within their jurisdictions.

Promoting and leading this trend in the educational system requires training teachers in the field and establishing makerspace centers in teacher education institutions. This concept turns teachers into "doers." It significantly improves their creativity and their ties to the technological world surrounding them and therefore to their students. A productive space for independent work and teamwork will enable pre-service teachers to turn ideas into reality using a wide variety of technological tools. This space will put into practice the theoretical knowledge acquired in the various courses by creating games and learning aids with the goal of making the learning process more enjoyable, experiential and meaningful for the students. The productive process will reinforce future teachers' skills in problem solving, teamwork and creative thinking.

Creative and practical independent work in these spaces will bring back the shop classes and workshops of the 1970s. Teachers trained in using the makerspace will be able to introduce the schools and the students to additional skills involved in manual thinking and manual work and the use of basic tools and technologies that are still in use.

Gaming Environment

Gamification involves the application of game design, thinking games and game mechanics to improve non-game contexts. Gamification takes advantage of the human psychological tendency to play games. In education, the goal of gamification is to encourage students to carry out assignments they usually perceive as boring by making these assignments more exciting. Furthermore, various attributes of gamification can encourage users to engage in desired behaviors or develop desired skills.

The game space we are aiming at does not involve classical computer games in which a player stares at the computer screen and concentrates on playing with himself. The academic institution attributes great importance to social interaction among the students and to the social skills we expect them to acquire. Hence the game space must encourage social games such as those played on a large board, whether physical or projected by a computer, that promote teamwork and collaborative problem solving.

Virtual Environment

Learning spaces in the virtual world, such as Second Life or OpenSim, provide teachers with a great deal of flexibility in creating or choosing the type of learning they would like to promote. In addition to the clear advantage of an environment that allows for distance learning, such a learning space also enables students to do assignments that cannot necessarily be carried out in physical learning spaces. The teacher can meet the students and tour with them anywhere in the world. They can enter and learn about some other period in history. Students can enter a virtual laboratory where they conduct physical experiments that would otherwise be impossible due to the need for expensive instruments and the lack of a place to carry them out.

Conclusion

We believe that contemporary and multidisciplinary contents, innovative pedagogies and advanced technologies are integral to the future of schools but they are not the only essential components. Rather, diverse learning environments that are adapted to learners' needs and that replicate current reality in 21st century workplaces also constitute an essential aspect of tomorrow's schools. Just as during the Industrial Revolution schools were planned according to the available workplaces in the communities that sent the children to these schools, schools built in the future must be based on this notion of learning environments.

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