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Millersville, Pennsylvania

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Millersville, Pennsylvania

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Purdue University
West Lafayette, Indiana

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Kutztown University of Pennsylvania
Kutztown, Pennsylvania

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Central Bucks School District
Warrington, Pennsylvania

Milton Shinberg
Shinberg.Levinas Architects
Bethesda, Maryland

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Charter High School for Architecture + Design (CHAD)
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INTRODUCTION

The world is shrinking! The connectivity of communications is bringing us all together. No longer can we think of ourselves as members of a tribe, village, city or nation, but rather we are facing the dilemmas and opportunities of becoming citizens of the entire planet. In this expanded context, we look at ourselves and wonder about the role that we should play, how best to make a contribution and how to keep pace with constantly accelerating change. We realize that the implementation of another version of an accepted practice is no longer enough, but rather that we must learn to find something new, to change the framework and think in new and unexpected ways. Creativity and design must be added back into education to make this happen.

We must continue to teach young people in the best traditions of invention, engineering and science, to become expert innovators and rigorous thinkers, but at the same time we need to help them develop the subtleties of the arts, able to harness the power of intuition and lateral thinking, moving fluently from one side of the brain to the other. This is where creativity and design go hand in hand, as design and design thinking provide a bridge between logical and intuitive thinking, between objective and subjective, between the reasonable realm of explicit knowledge and the fuzzy soup of tacit understanding. Successful concepts mix creative “Aha” moments of inspiration with careful analysis and structured development processes. This yearbook explains how to combine creativity and technology, teaching a future generation how to discover what needs to happen next as well as how to enable it.

Four themes inspire the scholarly contributions in the chapters that follow. The first helps us understand how creativity and design are inextricably intertwined, as design processes have evolved over centuries to enhance creativity through lateral thinking, conceptual blockbusting, intuitive problem solving, and subjective synthesis. The second theme looks at how the brain can achieve the partnership between logic and intuition, explaining how we develop into adults, the cognitive activities in the hemispheres of the brain, and the connections between innovation, creativity, and design thinking. The third theme looks at the physical and cultural conditions that are needed to educate successfully, showing that physical environments are important and that a culture that embraces qualitative attributes is essential. The fourth
theme is a call for action, looking at the ways and means of promoting creativity and design in technology education, as well as professional development for technology teachers.

This yearbook provides a guide and inspiration to help a new generation find a creative and sustainable place in a high technology and socially connected planet.

Bill Moggridge,
Director of the Smithsonian’s Cooper-Hewitt National Design Museum
Joseph McCade, Ed.D.
Professor
Millersville University of Pennsylvania
Department of Applied Engineering, Safety, and Technology
Millersville, PA 17551
Joseph.McCade@millersville.edu

Kerri L. Myers
Technology Education Teacher
Central Bucks School District
Warrington, PA 18976
Kmyers05@gmail.com

Martin Rayala, Ph.D.
Assistant Professor
Kutztown University of Pennsylvania
Department of Art Education and Crafts
Kutztown, Pennsylvania 19530
andDESIGNmagazine@gmail.com

Milton Shinberg, AIA, NCARB, LEED AP
Adjunct Associate Professor,
Catholic University of America
Partner, Shinberg.Levinas Architects
Bethesda, MD 20814
Milton@shinberglevinas.com

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Think of the last time you were in an elementary school. What did the classroom look like? You probably saw bright colors, reading areas, posters, student work, and resources throughout the room. If you travel to a middle school or high school and walk down the halls what do you see? Most likely the classroom environment changed drastically. Colors disappear or become muted and desks are arranged into rows, but why? As students progress through the grades it seems that fewer teachers and administrators put much thought into how the classroom environment can affect students’ learning, engagement, and creative output.

Research (Gallagher, 1993; Chism, 2002) indicated that the physical environment in which young people are taught and learn can significantly influence not only their behavior but also their creative output. Creativity and design are the foundation on which technology education is taught and learned (International Technology Education Association [ITEA], 2000; ITEA, 1996). Though technology education teachers expect their students to be creative, support is needed to help enhance the physical environment to stimulate that creativity.

As will become evident to the reader, the classroom atmosphere has an extremely important impact on student learning and success. This chapter focuses on the importance of the relationship of that physical environment to students’ creative output. How the physical environment influences students, a broad history of the development of the
technology education classroom, and the nature of contemporary technology education facilities will be discussed. The heart of the chapter is devoted to an explanation of the eight major physical environmental variables, which can affect the creative potential in all classrooms and especially the technology education facility.

**IMPORTANCE OF THE PHYSICAL ENVIRONMENT**

The physical surrounding and environment affects people psychologically in different ways. Gallagher (1993) explained how our surroundings shape our thoughts, emotions, and actions. In her book she stated,

> Throughout history, people of all cultures have assumed that environment influences behavior. Now modern science is confirming that our actions, thoughts, and feelings are indeed shaped not just by our genes and neurochemistry, history, and relationships, but also our surroundings. (p. 12)

Therefore, our surroundings can have a great impact socially. Think about experiences you have everyday and how you change depending on your surroundings. Rob Walker of the Centre for Applied Research in Education at the University of East Anglia in England described the following example:

> We know that we avoid looking directly at people in a crowded lift or a rush-hour tube train and that we calculate how close to sit to others in a public space, a cinema or on a beach. We tend not to be specific about these things, but we know when we feel comfortable or uneasy in the presence of others. Classrooms are no different. (2007, p. 25)

Many different aspects of the classroom environment affect students. Graetz and Goliber (2002) noted, “that the physical classroom environment can facilitate or inhibit learning, both directly (through noise, crowding) and symbolically (as when students attribute poor classroom design and maintenance to lack of respect on the part of the institution)” (p. 15). Teachers prepare their curriculum and lessons diligently and with care, they should do the same with the classroom environment. If teachers spend time on their environment, students will have greater success expressing their creative capabilities, especially in the technology education classroom.
According to Ekvall, “the accumulated body of research on climate and organizations undoubtedly indicates that climate makes a difference in creativity” (as cited in Peterson & Harrison, 2005, p. 9). Historically, technology education teachers have known of the importance of the physical environment toward teaching and learning. This understanding is evident within the work of many of the educators who laid the foundations of technology education. Individuals such as Pestalozzi, Froebel, Salomon (Nelson, 1981; Herschbach, 2009), Woodward (Wright, 1981; Herschbach, 2009), Bennett (Smith, 1981; Herschbach, 2009), and others would broadly address the importance of physical space and place toward the acts of teaching and learning. The importance of the physical environment continued as manual training changed over to industrial arts.

Sanders’ (2001) comparison study of the programs and practices of industrial arts and technology education found that the most common course categories for industrial arts involved wood, metal, and drafting classes. As a result, industrial arts teachers had to arrange their classroom facilities to accommodate the varying needs of those three areas of the curricula (Moon, 1975).

The industrial arts learning environment continued to evolve with the curriculum as technology became increasingly complex. This connection is evident in a program development proposal that was led by William E. Warner. In the proposal, Warner stated that “equipment and facilities must echo the principal elements of the technology; its development and uses of power, its transportation, its construction, including housing and home furnishings, its communication even including the use of such specialized techniques as radar, and its basic types of manufacture” (Warner, 1953, p. 6). A floor plan for a model industrial arts laboratory to address a technological orientation, as proposed by Warner and his graduate students, can be seen in Figure 1 (next page). When industrial arts transitioned toward technology education, especially after the introduction of Standards for Technological Literacy (SfTL; ITEA, 2000), the curricula changed to become a broad study of technology through more creative problem-solving projects.
Figure 1. A floor plan for a proposed industrial arts laboratory to support technological orientation.


With the implementation of these problem-solving activities it is evident that the classroom environment should be reevaluated to aid in the creative process that technology education students explore everyday. In Doyle’s (1991) doctoral research his goal was to “identify, describe, and verify physical facility factors that affect technological problem solving activities in secondary technology education programs” (p. 8). Through his research of literature, teachers, and inventors he identified 74 factors that influence students in the technology education classroom. Doyle (1991) stated that “the environment for defining
technological problems, generating or developing creative ideas for technological problem-solving, or implementing technological solutions require resources that are seldom found in most general public school libraries, classrooms, or technology education laboratories” (p. 130). Therefore, updating technology education facilities to foster creativity and problem solving should be as important as lesson planning and curriculum writing. With the constant state of technological change one could wonder what the characteristics of an ideal technology education facility would be. There are many considerations toward environmental characteristics that can create a beehive of creativity in the technology education classroom/lab. The first step in creating that facility is to focus on curricula.

THE TECHNOLOGY EDUCATION FACILITY

Many technology education programs vary in their curricular focus. Types of program focus include engineering and design, exploring technology, computers, vocational and technical skills, and career training. One approach for a technology education program to embrace creativity and design would be to have the curriculum and classroom/lab facility organized around addressing S/TL (ITEA, 2000). These standards assist in the development of a new or upgraded facility by acting as a philosophical foundation on which the program will be taught.

With the S/TL as a foundation for designing the organization and makeup of the technology education facility, classroom creativity will be enhanced through the change from the traditional shop to a design-based classroom. According to Daugherty, Klenke, and Neden (2008), the essential elements proposed for the modern technology education laboratory should include

- State-of-the-art presentation center to include delivery systems, projections systems and Smartboard technology.
- Multipurpose computer platforms to allow for a variety of computer applications including 3-D computer-aided design, desktop publishing, CNC systems and other specialized computer software.
- Flexible fabrication center that promotes portability and age-appropriate equipment and tooling usage.
- Mobile supply and material platforms that support invention, innovation and testing.
- Multipurpose workstations that provide convenient work centers for projects and activities.
- Supply and equipment storage as well as appropriate safety equipment. (p. 22)

A floor plan for a standards-based technology education laboratory, as proposed by Daugherty, Klenke, and Neden, can be seen in Figure 2.

**Figure 2.** The floor plan for a standards-based technology education laboratory.


Overall, technology education facilities should be created to be flexible, learning-focused, safe, and accessible. Through the implementation of the essential elements, the technology education facility will be a step closer to facilitating creativity and standing up to the test of technological change. The next step towards facilitating the
creative classroom is to recognize the environmental variables that affect students and how they can be used to aid in facilitating the creative learning environment.

Environmental Variables

There are, undoubtedly, a limitless number of environmental variables within a given classroom or laboratory which influence the creative potential of students. Warner and Myers (2010) identified from the literature eight broad categories into which most of these environmental variables would fit. These categories included lighting, color, decorations, furniture, resources, sensory variables, space configurations, and class size. The following sections summarize why these variables are important and how they affect the classroom and students.

Lighting. The vision system provides a physically capable human with a vast amount of information about what is happening in the surrounding environment. According to Hyerle (2000), “Research approximates that between 80 and 90 percent of the information received by the brain is through the eyes” (p. 48). Such a profound dependence on input from this one sense has ramifications toward how people develop their perceptions of the world and how they learn. Dondis (1973) observed that

The first learning experience of a child is through tactile awareness. In addition to this ‘hands-on’ knowledge, recognition includes smelling, hearing, and tasting in a rich contact with the environment. These senses are quickly augmented and superseded by the iconic—the ability to see, to recognize and understand environmental and emotional forces visually. From nearly our first experience of the world, we organize our needs and pleasures, preferences and fears, with great dependence on what we see. Or what we want to see. But this description is only the tip of the iceberg and in no way measures the power and importance the visual sense exerts on our lives. We accept it without realizing that it can be improved just in the basic process of observation or extended into an incomparable tool of human communication. We accept seeing as we experience it—effortlessly. (p. 1)

According to Graetz and Goliber (2002) there is “an ongoing debate in environmental psychology pertaining to the merits of full spectrum or daylight fluorescent lamps versus the more common cool white
fluorescent lamp” (p. 16). However, based on their review of research on this subject the authors would later summarize their findings by stating, “the optimal choice for collaborative classrooms may be normal intensity, full-spectrum or daylight fluorescent lighting” (p. 17).

The most basic lighting issue, and the one easiest to solve is general illumination level. Poor lighting, primarily the absence of sufficient illumination with or without attendant glare, is arguably the greatest environmental hindrance to learning. The overall goal is soft, diffuse light without glare. Another important goal is providing light “designed” to support a range of activities with different types, orientations, and levels of light. The small number of lighting options in a given context may limit opportunities for creative work. Painters, for example, generally prefer north facing, sky lit studios, because that type of daylight is nearly without shadow and, with proper positioning of equipment, glare free.

The creative process does not require perfect conditions, as history shows in the life stories of artists such as Georgia O’Keeffe (“Georgia O’Keeffe,” 2002), Frida Kahlo (“Frida Kahlo,” 2002), and Andy Warhol (“Andy Warhol,” 2002). However, where it is possible to enhance conditions, it is desirable. A sufficient quantity of light is not enough. The quality of light matters as well. A single level of light in a room renders objects in a flattened, abstracted way. Variations of light level and direction at the perimeter of a space will conversely enhance the special qualities of the different objects and people that are the subject of attention. Different light levels can be used to create different zones of activity in which one activity is more favored, or rather supported by the resulting character of the light (Madsen, n.d.; Osterhaus, n.d.). A creative student can therefore seek out a space that suits his or her particular agenda, whether that space is selected consciously or unconsciously.

Color. Color has meaning. While there is, has been, and probably always will be debate about what particular colors arouse in the viewer, there are nonetheless associations that indicate an underlying order for color response (Birren, 2003; Albers, 1975). There is no truly neutral color. Paint manufacturers typically have a broad range of “white” paints, normally categorized as “off-white.” Studies of landscape paintings show consistency in positive preferences for particular greens and blues, and such are then connected to evolutionary advantages in terms of associations with environments that support survival, due to the presence of vegetation, water, and bright, non-threatening skies. These
“environmental” colors are, in varying degrees of saturation, often used in schools generally, and classrooms in particular. More saturated colors tend to be used with younger students, and so-called “refined” colors, (i.e., some reduction of saturation and value) are sometimes used in environments for older students.

Use of a single color for all walls of classrooms creates a monotone that suggests there is only one activity that can take place at a time. However, teaching in a creative environment inevitably involves not only full-class activity, but also individual, team, and small group processes.

As variation in light brings vitality to the teaching environment, so does variation in color. Use of an “accent” color on one wall can identify a “teaching wall” where the teacher may stand for talks and demonstrations, the location of the interactive white board, and an area for displaying projects. While classroom environments need flexibility, specific categories of activities that are identifiable in advance with specific subject areas can be reflected in the physical planning of the space, naturally including color.

As a licensed, practicing architect co-author Milton Shinberg has noted that the energy level for students can be manipulated in a school by increasing the intensity of color in the highest movement areas (e.g., stairways) and then stepping down the color intensity in hallways, and providing mild saturated colors in classrooms to calm the students. The higher saturated colors stimulate movement in the passageways while less saturated hues enable focus on the teacher/leader inside the classroom. As an example of how this dynamic use of color can work, in 1997 Milton’s firm of Shinberg.Levinas Architects used colors in the large stairways, hallways, and classrooms to manipulate the energy levels of highly distractible students in their design of the Maya Angelou Public Charter School in Washington, D.C.. As reported by teachers, this color scheme worked exactly as intended.

Pytel (2006) described the potential effects that different colors have on students in the school environment (see Figure 3, next page). Note that green inspires creativity while other colors may add excitement or a calming effect.
Figure 3. How Colors Affect Student Perceptions and Behaviors

The Colors of the Classroom

Pale yellow/almond
- Best colors for not irritating anyone
- Good general color for school hallways

Light pink/rose
- Very soothing
- Suitable for a room where the activity is high

Green
- Creativity…is inspired by the color green
- Green is a great color for an art room
- An excellent choice for a creative writing center

Blue
- The color of academics
- Best color for a science or math room
- Light blue is a good overall classroom color…it is calming

Orange, yellow and red
- Bright yellow excites the brain and body
- The color orange seems to agitate


DISPLAY OF STUDENT ACHIEVEMENTS AND RESEARCH

Creativity is promoted by the excitement engendered by exchange about good work and ideas. While that happens in verbal exchange, physical display of good work is also part of that cultural environment. Making the work visible and attractive can likewise encourage inspiration and some creative competitiveness. Most students will naturally want to have their work admired. Putting work on display shows that the teacher values the work and can strengthen student
teacher relationships. According to Boynton and Boynton (2005), a teacher should remember

The displayed work does not have to be perfect and should show a significant cross section of the students you have in your class.

Putting the work of students who have a history of low achievement up on a bulletin board often helps to build their self-esteem and pride and encourages them to do better work in the future. (p. 16)

A display can be more than a surface with pins to hang images and papers. It can be a dynamic system of images that change regularly. Students can have “their day” when the work they have invested in is realized and shared, within their class or more broadly by use of screen displays. The display can be interactive and invite participation in research. As an example, a touch-screen display can ask questions and provide a place to record answers, both regarding preference or to participate in testing a hypothesis. Whereas, achievement may be the main course, display can be dessert and an inducement toward experimenting on new dishes.

**Furniture.** Learning is focus. Discomfort is distraction. Cornell (2002) described furniture as “both tool and environment” (p. 33). Cornell elaborated on the many aspects of these dual functions by noting

Most furniture design focuses on functional need, such as flexibility, mobility, and wire management. It focuses on helping the user achieve a goal, be it relaxation, entertainment, education, or work. In a user-centered approach, functionality is just one of at least four dimensions to consider. Another design objective is comfort, safety, and health. The design should maintain if not promote well-being and quality of life. No design should be harmful. A third dimension is usability. The intended purpose and operation should be obvious to all users, hopefully with little or no training. The intention is to prevent accidents and optimize use. And fourth, the design should have psychological appeal. The user should feel motivated to use the design over and over again.

Unlike Maslow’s, this is not a hierarchy of needs. The dimensions are not additive but multiplicative—poor performance on one undermines the performance of the overall system. Furniture must address all four simultaneously or the efficacy of the design is in question. (p. 35)

The chair is the one piece of school furniture that clearly requires the full measure of the design dimensions discussed by Cornell (2002).
It is said that students can sit still one minute for each year of age. That may be stretching things for teenagers. *VS America*, a division of a German manufacturer of educational furniture, offered the argument that dissipating the excess energy that contributes to distractibility can be achieved by proper furniture design (*VS America*, in press). Their version and vision of *ergonomics*, the study of the fit between human anatomy and the designed world, includes chairs that wiggle. According to company representative Amanda Wiegel (personal communication, August 15, 2011) this type of seating design comes in several styles and “Each one functions in a different way to achieve optimized movement and thereby promoting an increase of blood and oxygen to the brain. As a result, attention spans grow longer, and the ability to concentrate improves” (see Figures 4, 5, & 6).

Most chairs are rigid, and do not allow movement in any direction, much less three-dimensional torsion. The chairs that wiggle not only allow the back to push backward, to accommodate a stretching movement, but also allow flexing of the seat and back in all axes. This type of chair is not a prison for sitting. It invites unconscious squirming to be dissipated and thereby becomes a platform for attention and learning.

**Figure 4.** Chairs that Wiggle – The Hokki

![Chairs that Wiggle – The Hokki](image)

*Note.* Designed by John Harding of the UK to be used as a temporary active seating solution for people of every age group.

Source: A. Wiegel of VS America. Copyright 2011 by VS America. Used with permission.
Figure 5. Chairs that Wiggle – The PantoSwing

Note. Originally designed by Vernor Panton, the chair’s frame is a singular tube that is bent to form a cantilever base that is capable of titling both frontwards and backwards.

Source: A. Wiegel of VS America. Copyright 2011 by VS America. Used with permission.

Figure 6. Chairs that Wiggle – The PantoMove Chair

Note. This design offers three motion options including stationary, rocking front to back, and one that allows rocking in all directions.

Collecting the measurements of the human body (anthropometrics) has a long history going back to at least Leonardo da Vinci (Bramly, 1991). This practice continues today through government agencies such as the military and such private groups as the Henry Dreyfus Associates (Tilley, 2002). With all of this information available about the evolving measurements of the “typical” human body it might seem simple to make things the right height for users, but what is the right height? There is no “ideal human,” no Greek perfection to model. Therefore, ergonomic furniture, devices that help students be comfortable enough to give their attention to thinking and being creative, need to be adjustable. Height, width, angle of inclination, support geometry for the back and elbows, distance to allow good contact of foot to floor can all be accommodated by good design. The sociology of the classroom is likewise supported by “group ergonomics,” understanding the geometry of interaction, of *sociopetal* (relating to others) or *sociofugal* (facing away from others) study. Cornell (2002) summarized the importance of good furniture design toward a creative classroom environment when he stated, “If properly designed and placed, furniture is more than a place to sit; it can be a strategic asset” (pp. 41-42).

**Resources.** Motivation has a direct correlation with successful student creativity. Students are not only motivated by the teacher but also by what the teacher gives them to use in their problem solving activities. Having available resources in your classroom that students are free to use facilitates their creative output (Amabile, 1996; Csikszentmihalyi, 1996). One way to organize some resources is to have a “tech box,” like the designers and engineers who work for IDEO, a global design consultancy. “The Tech Box is a valuable resource that designers and engineers use to gain inspiration, break out of a holding pattern, or merely avoid reinventing the wheel” (IDEO, 1999, para. 3). The tech box is an organized set of drawers containing supplies, materials, trinkets, and toys that may be used in the innovation and design of new products. Having supplies, like those in the tech box, can motivate and give students the opportunity to become more creative.

The types of consumable resources made available to students to encourage creativity through design should be as varied as possible to provide rich opportunities for the use of imagination toward solving problems and making design decisions. Kimbell (1982) summarized the role of resources and, by inference, the need for access to a wide range of materials in a design education foundation course when he stated that such a course “should offer [students] opportunities for direct personal...
exploration of materials in the solving of simple design problems. Whether these problems are based on tin cans, or strips of softwood, or elastic bands and cotton reels is of little consequence” (p. 147).

Along with readily available supplies a creative classroom environment must also have easy access to an abundance of rich information. Doyle (1991) found that “factors related to information resources ranked highest in importance” (p. 239) in the results of his research on physical facility factors for technological problem solving in secondary technology education programs. Information resources can be made available to students through books and magazines stored in a reading area of the classroom/lab. Computers with Internet access can also provide a vast amount of information at the students’ fingertips. Other important information related resources include printers, cameras, scanners, and office supplies.

**Sensory variables.** Sensory variables play a large role in the students’ comfort in a classroom. The most important sensory variable is in regard to ambient temperature. Temperature has an impact on the students’ energy and creative output. If a classroom is warm students will most likely be tired and lethargic. According to Gallagher (1993), Lloyd (2001), and Graetz and Goliber (2002), the ideal setting is slightly on the cool side to allow students’ creative energies to flow. Many who write about classroom environments that encourage creativity note that the availability of fresh air is highly important (Lloyd, 2001; Christensen Hughes, 2002; Schoolzone, n.d.). Being able to control the temperature and having a flow of fresh air encourages movement and activity.

The acoustical environment can also affect moods and creative performance. Music is a tool that can be used in the classroom to help with students’ concentration and overall creative performance (Allen, 2011). “Music has the power to affect people’s mood and mood affects performance” (Lloyd, 2001, p. 16). To set the working mood in the classroom, music such as jazz and classical can be played to stimulate concentration, enable creative design, and enhance critical thinking. Jedynak (n.d.) recommended jazz and classical styles of music “because they often do not have lyrics or words, unlike most pop and rock music. Words may actually distract students and limit their responses and interpretive images” (para. 5).

**Space configurations.** The geometry of the classroom matters, and it matters in different ways depending largely on the age of the students and the activities they are pursuing. Relatively few classroom teaching
processes, including the one-teacher active lecturer, actually need or benefit from a fixed geometry of seats and rows. Most classrooms function as arrays of teaching “zones” that are particularly good at supporting one or sometimes two specialized learning activities. This orientation identifies the space as part of the learning environment, rather than the teaching environment. Different kinds of learning need different kinds of space. A creative learning environment can be achieved by having flexible classroom and lab space with furniture, machines, and tools on wheels to be moved depending on the activity or lesson needs.

Teachers sometimes react negatively to spaces that have some odd geometric aspect such as an odd angle; a corner jutting inward; or a wall partly dividing the space into equal or unequal portions. In a number of cases, this negative response reverses when actually laying out the learning spaces. They are usually most successful as sub-spaces with some degree of definition within the larger classroom. Color and light, floor treatment, and arrangement of furniture are usually the devices used to shape sub-spaces. The ideal space would have high ceilings to create a sense of openness.

Another approach is a classroom that literally turns, curves, or is L-shaped. Such geometries actually induce the likelihood of having a variation of activities, of gathering population size and focus. Some schools, using relatively small class sizes of 16 to 18 students, may have a moveable partition that divides that class from an adjacent class of same age students. Usually, in this situation, the two teachers run their classrooms on a coordinated basis and, as circumstances require, open the divider for both groups to work together or to share some results of their work.

There are so many factors involved in successful classroom geometry that it is difficult, if not possible, to isolate one factor and say “it works well if (fill in the blank).” Rather, it is the combination of factors that make a classroom work, from light, to color, to shape, and the rest, all at a threshold whereby they support each other and become home to the creative learning process.

**Class size.** The final significant environmental variable that affects students’ creative energies is class size. Class size may be the most important variable, but in many school districts it is very difficult to control. With the changing economy and the cutting of school budgets controlling class sizes may soon be impossible, unless teachers and school administrators understand and stress the importance of smaller
class size. Research has shown that smaller class sizes are more conducive toward student learning. As an example, Finn and Achilles (1990) and Mosteller (1995) found, through a statewide study performed in Tennessee, that class size does indeed influence student learning and academic performance during the early, formative years of elementary school, and that these influences continue at least for several years. The analysis made by Finn and Achilles for the first phase of the research concluded

> The results are definitive: (a) a significant benefit accrues to students in reduced-size classes in both subject areas [reading and mathematics] and (b) there is evidence that minority students in particular benefit from the smaller class environment, especially when curriculum-based tests are used as the learning criteria.

[Abstract]

Mosteller’s (1995) analysis of the longitudinal aspect of the research concluded “the children who were originally enrolled in smaller classes continued to perform better than their grade-mates (whose school experience had begun in larger classes) when they were returned to regular-sized classes in later grades” (p. 113).

Other research findings indicated that the ideal class size is 25 students or less (Ohio Education Association, n.d.). Many teachers would prefer to lower that number to fewer than 20 students in a classroom to aid with classroom management. Classroom management is improved through fewer learning and behavior problems, which can develop when students are not able to adequately interact with the teacher. Lowering the class size results in improvements in a variety of important learning factors, including creative behavior, problem-solving abilities, retention of material learned, and an increase in opportunities for participation and expression (Ohio Education Association, n.d.; Resnick, 2003).

**CONCLUSION**

Classes in technology education can have a tremendous impact on students and the futures they choose for themselves. Knowing how to use one’s creativity is an asset, which has increasing value in an ever-changing global environment. As a result, teachers have an obligation to help shape their students into creative thinkers who can then actively design their own lives. The implementation of problem solving and team-building activities as well as changing the classroom from teacher-
centered to student-centered are fundamental steps toward achieving this goal. As the first-hand experiences recalled, and the research investigated in this chapter indicated, the physical classroom environment has a direct correlation to the creative output of students. If you truly embrace creativity and design as basic tools for teaching and learning about technology, updating your classroom/laboratory should be on the top of your agenda.

REFLECTIVE QUESTIONS

1. Why is the environment in which we teach and learn so important toward learning and creativity?
2. There are many environmental variables affecting the classroom. Which do you believe to be most important? Are there other variables that could affect students’ creativity?
3. Does your classroom environment enhance the creative potential of your students? If not, what changes could you make to develop a creative classroom environment?
4. What would your classroom and laboratories look like if you were given the opportunity to develop a technology education department that would use creativity and design as the foundation toward teaching and learning about technology?

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