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Policy Paper: Designing Classroom Space to Better Support 21st Century Learning

Reimagining the Classroom: Opportunities to Link Recent Advances in Pedagogy to Physical Settings

By

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Center for Building Knowledge

The Center for Building Knowledge is a 15-person, nationally focused, multidisciplinary research and technical assistance institution affiliated with the School of Architecture at the New Jersey Institute of Technology. Established in 1989, the Center's mission is to create new knowledge that will help individuals and communities make better-informed decisions concerning the built environment.

Introduction

Is the typical classroom today designed to support 21st century instructional practices and educational outcomes? This is an important yet largely overlooked question in the current context of public education reform.

In principle, classrooms are intended to support the delivery of effective educational models. In practice, most existing classroom designs in the U.S. — square or rectangular units adjacent to each other and organized in rectilinear rows on one or both sides of a narrow traffic corridor — reflect a "factory model" of education that was popular at the turn of the 20th century but has long since been eclipsed by new and more progressive forms of pedagogy.

The factory model thought of education in terms of mechanically turning out educated students, so schools resembled factories turning out products in industrial America. This model gave us what we can, even today, refer to as the "typical" classroom: lined-up rows of utilitarian students' desks and chairs in front of a blackboard or a whiteboard behind a raised teacher's desk, fluorescent lighting, minimal windows and uninspiring interior colors, furnishings and design.

This basic organizational model has survived, with only minor improvements, while dramatic changes in educational theory, practice, technology, and demographics have been accelerating in the U.S. since the mid-20th century.

The permanence of a single, familiar model in classrooms over generations and throughout the country has meant that both educators and students tend to take the physical classroom space completely for granted. But it has also influenced a cultural adaptation to the notion that the place where teaching and learning occurs has little to do with the process of education. Indeed, an elementary teacher interviewed on the subject commented, "All I need is a blackboard," and a former student noted, "My high school was in a run-down trailer and it did not prevent me from learning." A counter argument could be: "Yes, a good teacher can teach in a barn and a good student can learn there; but most of us could live in a barn, too, if we had to. How much more effective could a teacher and student be in a classroom designed specifically to optimize teaching and learning?"

Nevertheless, both interviewees were responding to a basic idea rooted in their own experience. Both firmly believed that the place where you experience education, the school's physical setting — especially the classroom's size, shape, finishes, equipment and furniture — is not a critical factor for teaching and learning engagement.

This core assumption — while prevalent among many as a default position — is nonetheless beginning to be called into question. Partially the questions are a consequence of schools struggling to incorporate new technology into old classroom models. But there is also a growing recognition of a simple fact, aptly expressed in a 2005 publication of the UK Design Council: "Learning in the UK schools is evolving fast, but the environments where the learning happens are essentially the same as they were 100 years ago" (UK Design Council, 2005).

To date, however, the impacts — positive or negative — of implementing new pedagogical models in "old" classrooms are not clearly understood. The issue has simply not, with few exceptions, been the focus of sustained research within the educational community.

By way of example, the book *Theoretical Foundations of Learning Environments* (Jonassen and Land, eds., 2000)[1] presents a number of essays about interpretations and developments of cognitive theories since the 1990s that promoted an educational paradigm shift. A more social and constructivist view of student-centered learning is replacing past instructional views. In essence, the selected essays by Jonassen and Land sustain the argument that the shared meaning of "learning environment" is the operational framework of a student-centered pedagogy. But even in this relatively recent publication, the term "learning environment" does not — explicitly or even implicitly — encompass the physical environment of the classroom.

[1] Jonassen, D.H. and Land, S.M. (eds.). *Theoretical Foundations of Learning Environments*. Mahwah, NJ: Lawrence Erlbaum Associates, 2000.

Similarly, in the essay *Student-Centered Learning Environments* (Land and Hannafin, 2000),[2] the authors discuss five core foundations for effective learning environments: psychological, pedagogical, technological, cultural and pragmatic. Not mentioned is *physical*. Missing from the discussion is any possible relationship between pedagogy and the physical organization of space so that it facilitates rather than hinders pedagogy.

The essay makes only an unspecified reference to the "context" in which learning occurs, and the only reference to the physical organization of the learning environment is focused on how technology, such as computers, can provide opportunities for learners to develop cognitive capabilities. While the essay reviews multiple forms of learning and underscores a renewed interest in student-centered teaching and learning, it consistently — like the overall book itself and many others like it — interprets the phrase "learning environment" from a psychosocial perspective, with virtually no acknowledgement of the potential role that the physical setting might play in learning and educational outcomes.

This short white paper seeks to give this long-overlooked issue greater prominence and to help begin a national dialogue on how a classroom's physical environment (as defined by its design, layout, furnishings and space utilization) can be manipulated to enhance its learning environment (as defined by its pedagogical model).

To accomplish this, the paper will:

- Present three exceptional case studies: schools where the physical environment has been purposely designed to facilitate a pedagogical model, with marked success;
- Reflect on why the potential for utilizing a classroom's physical setting to optimize its pedagogical model for delivering education has not been studied more rigorously; and
- Consider what can be done to enhance the knowledge base in this emerging area of study.

Pedagogy-Driven Classrooms: Three Short Case Studies

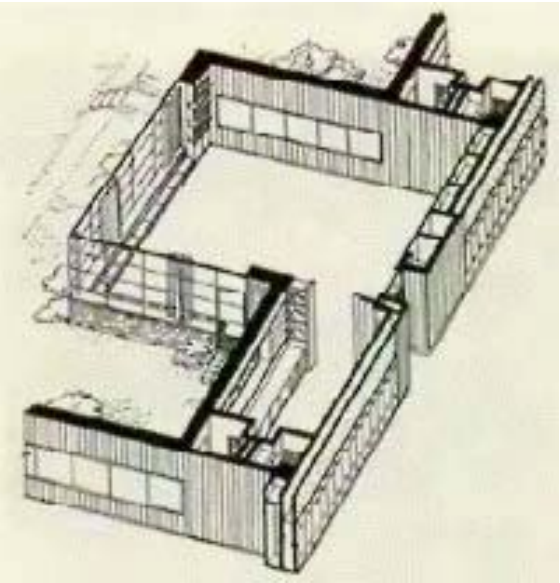
A Pioneering Classroom Innovation

One of the earliest examples (1940) of exceptional departures from the typical classroom is at the Crow Island School, an elementary public school in Winnetka, Ill., a suburb of Chicago. The school is the architectural expression of John Dewey's progressive educational philosophy, based on children's need for self-expression, the development of their attitudes, and their emotional and social adjustment.

The modular classroom setting of this school can be described as an L-shaped, multifunctional and adaptable physical component of a fully-integrated learning environment. The design concept for the classroom originated from an early understanding of the nature of learning, following to the end a coherent logic. Because studies and observation showed that people learn in different modes, the physical environment of the classroom had to be adaptable and organized to promote the various ways in which a person primarily acquires knowledge: visually, by listening, by reading or by solving problems and experimenting "hands-on," individually or in cooperative projects.

[2] Land, S.M. and Hannafin, M.J. "Student-Centered Learning Environments." In Jonassen, D.H. and Land, S.M. (eds.).., *Theoretical Foundations of Learning Environments.* Mahwah, NJ: Lawrence Erlbaum Associates, *1–23*, 2000.

The L-shaped classroom of Crow Island School, which is organized as a flexible multifunction unit, sets forth the dominant pattern of the entire school facility.



Figures 1 & 2 — Crow Island School, Winnetka, Ill. The classroom:
1) Left. Axonometric view. 2) View of movable furniture and the outdoors through the expanse of corner windows.

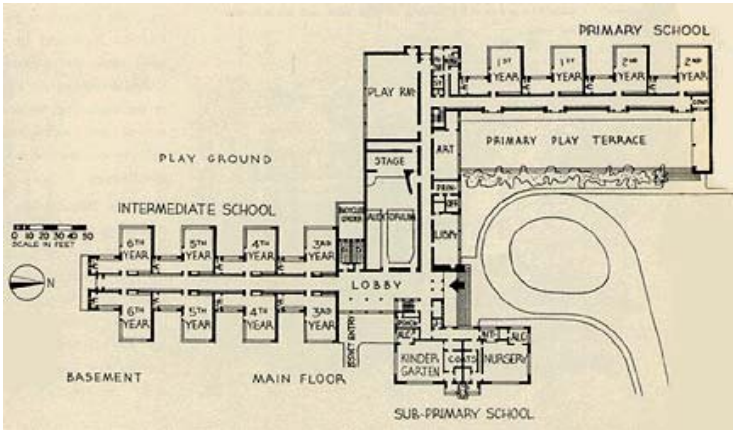


Figure 3 — Crow Island School, Winnetka, Ill. Floor Plan.[3]

The wings of the facility develop as a linear series of adjacent classroom modules. Movable tables, a large corner window-wall with full-length window seat, a well-furnished workroom's space in the short wing

[3] Photos 1, 2 and 3 retrieved from http://rogershepherd.com/WIW/solution5/crow2.html.

of the L-shaped room, overall details scaled to the size of children. These features plus a dedicated small outdoor garden directly accessible from the classroom represent the most notable parts of an integrated learning environment with flexible conditions for optimizing teaching and learning in different modes.

The design of the classroom — in essence, the crystallization of a progressive pedagogical model — resulted from a "meeting of the minds" between an educator, Superintendent Carleton Washburne, and an architect, Eliel Saarinen. They developed a collaborative discourse leading to a carefully planned innovative design.

Washburne applied and developed John Dewey's philosophy of progressive education to the Winnetka public school system. Of his books on education, one in particular narrates the experience of developing his own interpretation of Dewey's educational philosophy. His approach included a deep commitment to the importance of the school's physical environment for meeting pedagogical needs and supporting the school's learning climate. Washburne had a direct impact on the general concept for Crow Island School and the classroom in particular, which he described in detail in his book *A Living Philosophy of Education* (1940).

Eliel Saarinen, the famous Finnish architect who moved to the United States to lead the architecture department at the Cranbrook Academy in Dearborn, Mich., was joined in his task of designing the new school by his wife (a textile designer) and his son, architect Eero Saarinen. Other noted designers were also involved in the effort, including Lawrence Perkins of Perkins, Wheeler and Will of Chicago.

The classroom organization of Crow Island School exemplifies a successful solution of enduring significance to the relation between the physical environment of the school and the process of teaching and learning. Elizabeth Herbert, a former principal of the school, noted in an interview[4] concerning the power of Crow Island's classroom spaces:

"It's like having a menu of possibilities. So, if I would have to mention a place, though, I would say it is the workroom (the smaller space which forms the foot of the L shape), both because of its size, it is intimate, and it has everything you need. It has the bathroom, it has the sink, it is kind of a quintessential place. Everything is within reach, within possibilities. So that space becomes created and recreated, depending on the imagination of the teacher and the children. Of course it is available for the children to go to, but often times it takes on its own being, where it might be a museum, or it might be a display area for the large projects they are working on, so it does not intrude in the classroom space…Every one of the 22 classrooms has this feature."

This successful classroom type has been replicated in many public and private schools in the United States and abroad, attracting interest and experimentation by educators and architects. But its lessons are becoming even more important today. Crow Island School's flexibility and creativity are in clear contrast to the functional limitations of today's "typical" classroom. Over 70 years after its construction, it remains a fruitful example of how flexible arrangements and innovative design provide for more effective variable teaching and learning activities.

[4] See excerpts of the interview in Appendix B.

The Harkness Table: Classroom Organizer and Metaphor of an Educational Philosophy

The Harkness Table is a large conference table, usually oval in shape. It was originally devised for high school classes at the Phillips Exeter Academy in Exeter, New Hampshire in 1943. It took its name from Edward Harkness, a philanthropist and an alumnus of the Academy, who suggested the idea to the principal of the school for a method that would engage all, not just the brightest students of the class, and particularly that would engage the "middling students,"[5] as he himself had been.

Figure 4 — Phillips Exeter Academy, Exeter, N.H. Typical Harkness Table. Photo: A. De Gregori

Students sit around the table and discuss the assignment of the day. They must be prepared to enrich the dialogue or lose the trust of their peers. The teacher's role is primarily to observe, listen, ask questions, explain and give assignments. The table alone becomes the core of the classroom, supporting teaching and learning. Its successful application as a teaching and learning tool has expanded first among private high schools, and has recently caught the attention of superintendents and principals of public schools, where its experimental use for advanced classes represents a departure from a typical classroom organization. In several private schools, the table is normally adopted for all types of classes, including science labs where it is placed in a corner of the classroom, or in the instructor's adjacent office, separated by a glass wall.

[5] As described by Jack Herney, a teacher of Modern European History at Phillips Exeter Academy, in the course of my interview (De Gregori, 2007). See excerpts of the interview in Appendix C.

Figure 5 — (Left) Phillips Exeter Academy, Exeter, N.H., Harkness Table adapted to a narrow rectangular classroom.
Figure 6 — (Right) Round "Harkness Table" adapted to a large square classroom. Photos: A. De Gregori

Ideally, the table should accommodate about 12 students and the teacher, but there are exceptions in shape and size, for adapting the table to the shape of an existing room, or for experimenting with a different number of students. The larger class sizes often found in public schools may restrict wide diffusion of "Harkness Table classrooms." However, where the concept has been used, it is often an environmental eye-opener due to the positive changes it brings about in the classroom. Even limited use in public schools could act as an incentive toward adoption of more effective classrooms in the eyes of the community of students, teachers, parents and school administrators.

Speaking of the advantages — and challenges — for students that the Harkness Table represents, Jack Herney, a teacher of Modern European History at Exeter, noted:

"If it's happening correctly, students when they walk in the door they know immediately that they must participate, they know that the responsibility for what happens in the next 50 minutes, if it is successful or not, rests partially with them. They are prepared and they have a responsibility to the group. Second, they know that their responsibility takes a variety of forms. It takes the form of saying what's in your mind, it takes the form of being directly honest and disagreeing with somebody if you do, or supporting him, it takes the responsibility of listening carefully and not dominating the discussion, of looking for a better idea and championing that idea if you hear it. It includes asking questions more than giving answers, and saying what I don't understand, as much as what I do understand. It's surrendering the notion of being the expert and being the correct student, and accepting the notion of being the confused student or the incomplete student and saying, 'Help me out here. I really do not understand this.'"

The Classroom as a One-Room Schoolhouse

The Discovery Charter School in Newark, N.J., a middle urban school for mostly underprivileged children, has an enrollment of about 75 students in the fourth through eighth grades. The mission of the school is "to use the students' natural curiosities and to develop their workplace readiness skills." The founders and co-leaders, Dr. Irene Hall and Barbara Weiland, advocate the importance of the physical environment of the school in support of teaching and learning. What is noteworthy in their approach is how they envisioned the organization of the overall facility: one extended classroom consisting of a

central open space, a great room that gives access to small workrooms for arts and crafts, a couple of offices and a food-serving kitchen.

Figures 7–9 — The Discovery Charter School, Newark, N.J. Views of the "schoolhouse" great room. Photos: A. De Gregori

Walking past the attended entrance room, the visitor is immediately introduced to a vast scenario. Here, students from different grades sit at small, individual, easily movable tables, forming groups around their teachers. Student tables and other elements are painted in various bright colors, and they become purposeful, cost-effective components of the larger classroom space, contributing to its vitality. A variety of plants are also installed in the room, providing a link between the man-made and natural environments.

The room, occasionally divided with a few transferable low partitions, is full of activity. There are students sitting, reading and writing at workstations along the walls. Laptops are noticeable, but not as much as voices. Questions and answers fly across the room. It could be described as a choral humming

interspersed with solos. However, the noise and movements of people appear not to distract from the various learning activities.[6]

This may at first seem surprising. Here, we are faced with an example that appears to contradict common views about distracting factors, such as movement and noise. The Discovery Charter School model strongly suggests that the minds of students and teachers in this stimulating, carefully thought-out environment easily adapt and concentrate on the tasks at hand.

From online commentaries, students and parents' experiences of Discovery Charter School are excellent and their positive attitudes are confirmed by the educational outcomes. Parents, in particular, are encouraged to be involved in the program, as Dr. Irene Hall, co-founder of the school, recently noted[7]:

"The biggest thing is that parents must feel welcome. So, the classroom is open and they are invited in anytime. How much more welcoming can you be? Parents may feel better about the school. Lots of parents come in and say: 'Oh, I feel good about this space.' So, in terms of the parents, the feeling of the space makes a difference."

Interestingly, the organization of this state-of-the-art extended classroom offers a reinterpreted model of the old one-room schoolhouses that were once commonplace in American communities. Hence it seems that under certain conditions, and despite the changes in education, technology and demographics, something at the core of the successful learning environment remains timeless. Perhaps we have more to learn from those one-room schoolhouses than from the factory models that have prevailed in the meantime.

Underlying Commonality: A Process that Links the Physical and the Learning Environment

What these three schools have in common — despite clear social, cultural and pedagogical differences — is that the physical environment has been intentionally designed to support each school's model for teaching and learning. The physical environment — in this case, the classroom — is not treated simply as a background setting within which teaching and learning occur, but as an active variable that supports and enhances both. In these instances, the physical environment is no longer distinct and somehow separate from the learning environment; it is an integral and, in fact, critical component of that environment.

Equally important, all three environments were created with the active involvement and commitment of educators. They were not lucky accidents where a talented design team simply "got it right."

On the contrary, they were the result of very deliberate and structured processes that were driven by a pedagogical vision that was also rooted in the firm belief that the physical environment — whether a completely new building like Crow Island, a newly furnished existing facility like Discovery or even an experimental teaching tool like the Harkness Table — can and should directly support teaching and learning; in other words, there is a belief that "space matters."

[6] Author's Note: When I visited the school, except for the student giving me the tour and a couple of teachers nodding at me, I was almost completely ignored, everyone apparently absorbed in what they were doing.
[7] See excerpts of the interview with Dr. Hall in Appendix D.

Challenge: Applying this Process More Broadly

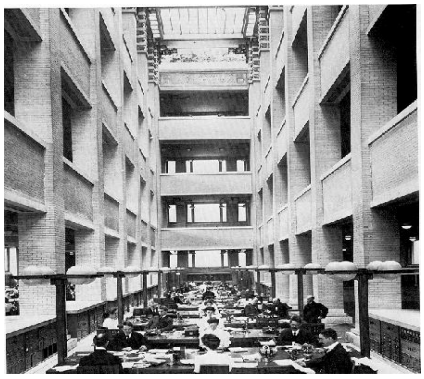
This belief — and the collaborative process between educators and designers that it stimulated in our three case studies — can clearly produce significant benefits. The question is how this process and its attendant benefits can be effectively applied to the "typical classrooms" found in many of our schools. In other words, what needs to be done in order to facilitate a broad "re-imagining" of how classroom spaces can be optimized to meet pedagogical goals?

A critical first step will be to create basic benchmarks on how to analyze and manipulate a classroom space to optimize teaching and learning — in effect, to decipher and make replicable processes such as those exemplified in our three case studies. While there are, no doubt, numerous examples in every school district of how teachers and students have adapted their classrooms to meet pedagogical needs, formal guidance on how to systematically create and implement such adaptations is lacking. Research has simply not been done in this area, primarily because it falls somewhere between the core competencies of several disciplines.

Architects and interior designers have considered these issues, but primarily from a design perspective, with a particular focus on new schools and not on how teachers in existing "typical" classrooms can adapt and optimize their own learning environments. Formal research on the topic has not been undertaken by either profession, so neither has a strong, evidence-based research tradition in this area.

Educators, on the other hand, who have a long and venerable tradition of evidence-based research, have largely ignored the physical environment as a topic of investigation. The reason may be a question of semantics. In the educational literature, and in the way educators generally understand it, the term "learning environment" refers primarily to theoretical foundations for and methodologies applied to the process of interactions between teachers and students within the context of the curriculum's instructional delivery and learning outcomes. For example, as we have seen in Jonassen and Land (2000), the term is not being used in relation to the physical place of teaching and learning, such as the classroom.[8]

In marked contrast, one space type that has undergone considerable advancement in terms of its functional optimization is the standard commercial office space.



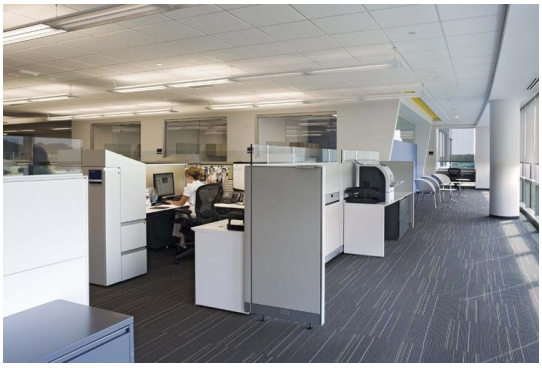


Figure 10 — Larkin Building (1906), Buffalo, N.Y.[9] **Figure 11** — Novo Nordisk, Princeton, N.J.[10]

[8] However, school administrators, parents and the media, referring to run-down conditions of schools, expand the connotation of the term used in the educational context, by denoting such facilities as "learning environments at a disadvantage."

[9] Retrieved from http://www.terrastories.com/bearings/frank-lloyd-wright-and-his-forgotten-larkin-building.

[10] Retrieved from: http://www.dvgbc.org/green_resources/projects/novo-nordisk-inc-office-building-and-training-center/

Looking back, for example, at Frank Lloyd Wright's iconic Larkin Building from the turn of the 20th century, we can see a then-current model of "knowledge work" clearly and directly reflected in the physical layout of the desks and other furnishings within the great hall space. Fast forward to a contemporary office with its varied spaces for individual and group work, located on a modular raised floor and tied together with advanced, interlinked technology, and we can see how new models of knowledge work are being supported by new models of interior furnishings, layout and design. (Figures 11–14).

Figure 12

Figure 13

Figure 14

Figures 12–14 — Model of multifunctional and collaborative office work.[11] Three working functions organized in the same office floor space.

The Way Forward

Advances in commercial office space optimization resulted from rigorous analysis, sustained over long periods of time, on what knowledge workers actually do and how their physical environment — the office — can help them do it. Such an analysis for K-12 schools — one that looks at what different pedagogical models are trying to do and then investigates how the physical environment can help them do it — is long overdue. The results could include significant interventions like making better use of movable partitions, tables and desks — elements so common in today's office environments — to create multiple learning "scenarios" within one space (as illustrated in Figures 16 and 17, Appendix A). Or, the results could be much more basic and essentially no-cost: simple instructions on how to use color, lighting and furniture to delineate different learning zones — for example, "quiet zones"— within a classroom space. But almost certainly, many of the results will be discoveries we cannot foresee with our current knowledge. What will drive such solutions will be new knowledge based on a coherent body of research.

[11] Retrieved from http://www.fastcompany.com/1638692/11-ways-you-can-make-your-space-as-collaborative-as-the-dschool.

Learning environments with integrated technologies

The central argument of this paper has been the importance of linking the classroom's pedagogy to physical settings, involving space, furniture and learning tools. To encompass the concept of what all these settings represent, a fitting term is **"physical technology"** of the classroom. Among the components of such fundamental technology, the table emerges as the connector for engaging learning activities and even collaborative student-driven interactions, as described in the Harkness Table case (p. 5).

Concurrently, with the impetus brought by the introduction of **"digital technology"** in academic programs and secondary school education, the opportunity to re-imagine classrooms is open to new possibilities for creating more effective learning environments. A work-in-progress climate has contributed to renovate the discourse on innovation, where the quest is on "how" to better design learning environments using digital technology at the expense of equal attention due to the physical technology of the classroom. By focusing on digital technology, researchers and educators may overlook past solutions to the underlying core issue: the effectiveness of the learning environment achieved, as this paper reviews, through the optimization of the classroom's physical technology. The point is that the opportunity is available and necessary for investigating, designing and measuring the effectiveness of learning environments in classrooms where digital and physical technologies are integrated parts of the solution.

A related case of innovation in the use of digital and physical technologies in a classroom environment that supports interactive and collaborative learning has been developed by Dr. Robert Beichner, professor of physics at North Carolina State University. Dr. Beichner's project is called SCALE-UP, standing for "Student-Centered Active Learning Environment for Undergraduate Programs."[12] The project was initiated over 10 years ago to promote active learning in classrooms with large numbers of students enrolled in university physics courses. Since then, over 100 institutions in the U.S. and abroad have adopted or adapted the SCALE-UP classroom design and pedagogy. Currently, the approach is used to teach many different content areas to classes of all sizes.[13] "Physics, chemistry, math, biology, astronomy, engineering and even literature courses have utilized this approach" (Beichner, 2008).

The innovation of the SCALE-UP approach has resulted from a long-term experimentation of the idea to merge in one single research project the application of digital technology and that of the best physical settings of the classroom that could facilitate group interaction and collaboration.[14] Dr. Beichner recently described the key unit of the SCALE-UP approach.[15] It is a round table accommodating 9 students. They sit in three groups, or teams of three students each around a table of 7 feet in diameter. The students are given plenty of opportunity to interact with each other and with an instructor who moves from table to table. Whiteboards are nearby. Each team uses a networked laptop for searching information online.

[12] A comprehensive report is available online in the following publication:
Beichner, R.J. http://www7.nationalacademies.org/bose/Beichner_CommissionedPaper.pdf
an invited white paper for the National Academy of Sciences, September 2008.
[13] Among the institutional adopters and adapters of the approach are MIT, the University of Minnesota, University of Pittsburgh, American University., Clemson University, Penn State/Behrend University and Florida State University. More information is available from en.wikipedia.org/wiki/SCALE-UP.
[14] Here lies a conceptual parallel with the Harkness table approach.
[15] Presented on September 28, 2011, at the Innovation in Education Summit in New York City sponsored by The McGraw-Hill Research Foundation.

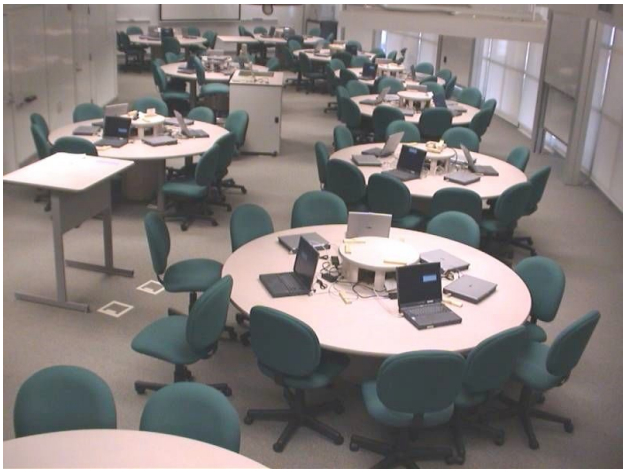


Figure 15 — A SCALE-UP classroom at North Carolina State University. The teacher station is visible near the center of the room. Retrieved from http://www.ncsu.edu/PER/scaleup.html

High School Applications. In reply to my recent inquiry, Dr. Beichner explained that the SCALE-UP classroom approach also works well in secondary schools. The adoption of the SCALE-UP approach by secondary schools has recently begun. "There are currently half a dozen high schools using the approach," he stated, adding that two other high schools, Scholar's Academy in New York City and the Windward School in Los Angeles are planning to move all their classrooms to the SCALE-UP model.

I see the use of this approach in high schools as a breakthrough, a true innovation versus current practices that use digital technology in secondary education. The large-scale reproducibility of this approach deserves further investigation in regard to the specific conditions of secondary schools' classroom design and pedagogy.

This paper hopes to help catalyze this much-needed research by starting a national conversation between designers and educators on the role of the physical environment in optimizing the learning environment. Given the potential benefits illustrated here, the time for exploring rich opportunities for using the physical environment to enhance teaching and learning is long overdue. Or perhaps, within the current revolutions in technology, social networking, gaming, distance learning and many others throughout society, the perfect time has finally come.

For additional information please visit: http://bit.ly/ReimaginingClassroomsInterviews

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APPENDIX A

CLASSROOM SETTINGS
Flexible Approach to Teaching and Learning Practices with the Support of Movable Furniture: Examples.

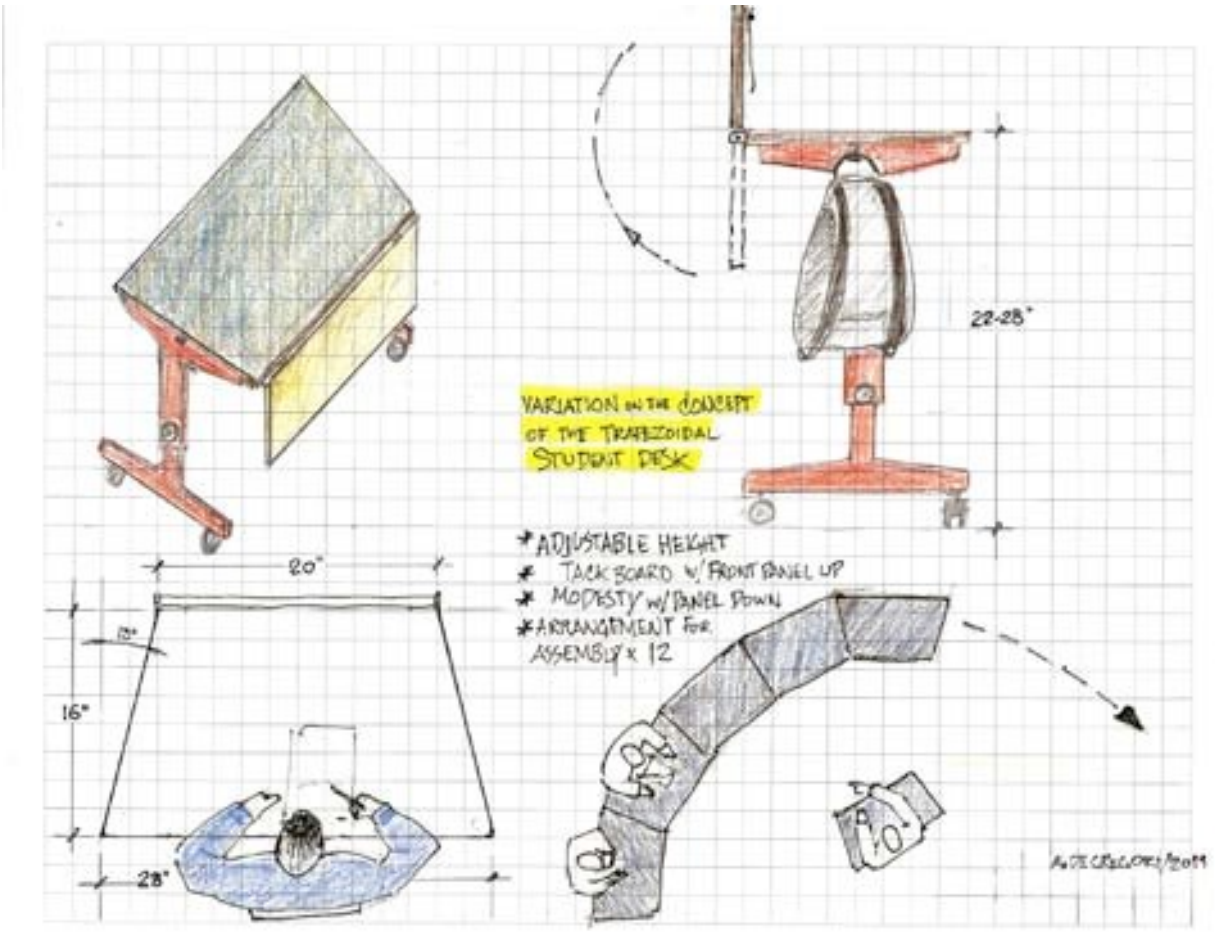

Figure 16 — Variations on the concept of the typical trapezoidal student desk. Notice the additional panel that with a hinge mechanism can be locked in position down (i.e., as a "modesty" panel) or up (i.e., as a tack board). The panel can also be used in horizontal position as an extension of the work surface. The selected trapezoidal top allows 12 tables to form an uninterrupted circular conference table. Concept: A. De Gregori

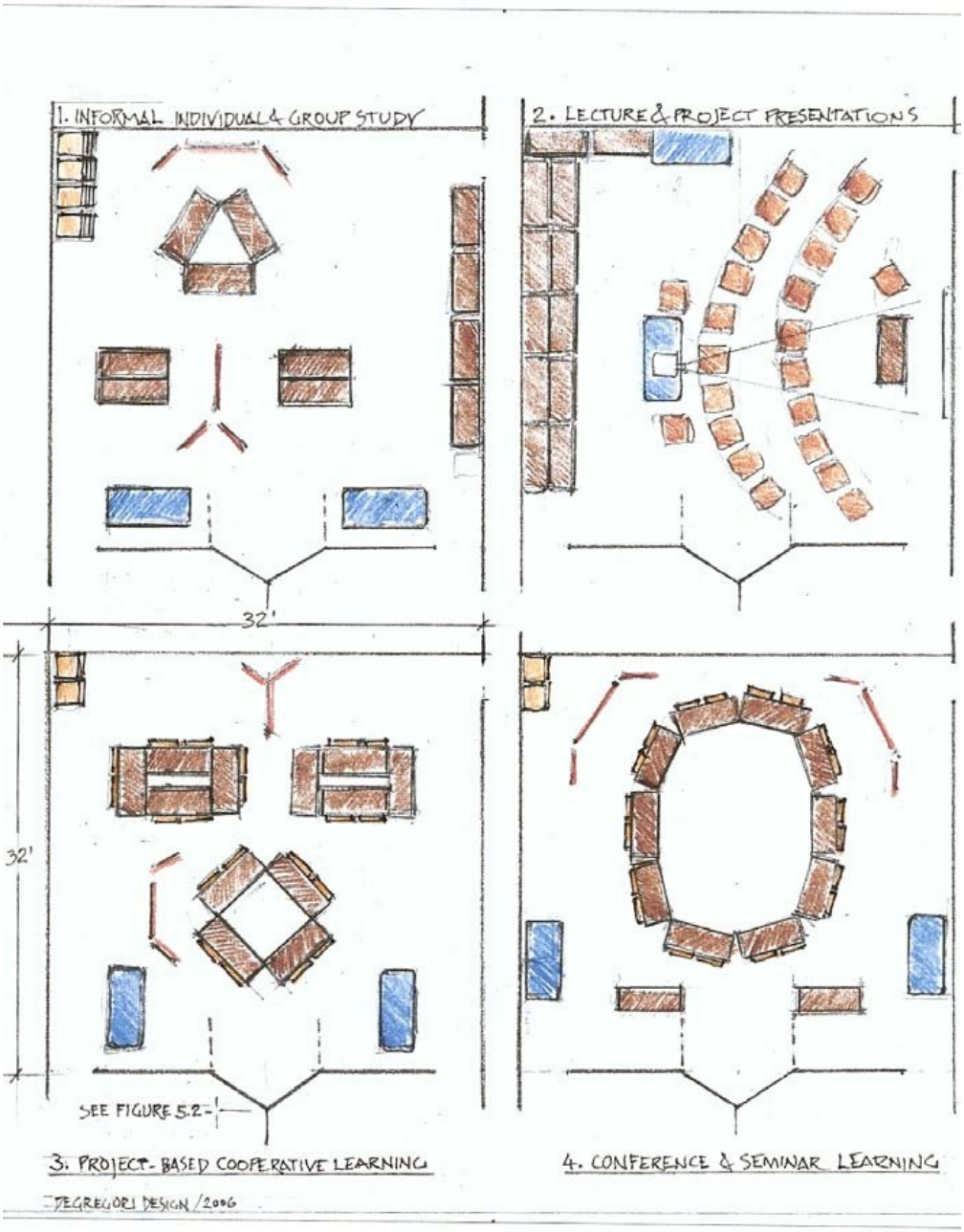

Figure 17 — Sketch of a multipurpose classroom for 22 students: 4 views of teaching and learning situations; flexible use of space with movable furniture; standing height light-storage/working tables (in blue); use of partitions for project presentations; and creating special purpose spaces. Concept: A. De Gregori

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