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School Structures that Support 21st Century Learning

In this report, Hanover Research looks at school design measures that contribute to developing 21st century skills in preK-8 students. Themes covered include: flexible learning spaces, sustainable design, community engagement, and small schools.

Introduction

> Most new school building construction in the United States and the United Kingdom today is still pouring "old wine into new bottles," replicating the 30-student, 900-square-foot classrooms that both support and often dictate teacher-directed whole-group instruction. These environments will not support student learning of 21st century skills and will be seen in the coming years as outmoded learning spaces requiring a building retrofit.[1]

As the above quote illustrates, school design in the United States and other countries has reached a crossroads. There is a growing belief amongst policymakers, architects, educators, parents, and students that **traditional models of school design are not conducive to teaching and learning the skills necessary for success in the 21st century.** 21st century societies and the knowledge economy will demand higher levels of cross-cultural understanding as well as higher levels of competency in collaboration, persuasive communication, and critical thinking than was demanded of any past generation. Traditional school features, such as long corridors and fixed, immovable classroom objects are believed to inhibit the types of interactions that develop these skills. Additionally, poorly designed and maintained schools – lacking natural light, clean air, and a comfortable temperature – are also detrimental to learning. In response, school districts and partnering organizations are rethinking current design paradigms as well as the relationship between school structures and learning outcomes. There is now consensus that learning, not teaching or other factors, must dictate school design if current and future students are to develop 21st century skills.

21st century skills have garnered significant attention in recent years as schools strive to prepare their students for careers in the modern knowledge economy. While there may be competing opinions regarding which skills should be considered fundamental for 21st century success, any mentions of specific skills or competencies in this report either refer to the **"21st century student outcomes"** identified by the Partnership for 21st Century Skills or skills that are closely related to them. This includes improving competency in traditional core subjects as well as in more specialized subject areas such as global awareness and media literacy. To our knowledge, these outcomes, which feature in the Partnership's "Framework for 21st Century Learning," are the most widely accepted conceptualization of the skills required for 21st century success.

The impact of school design on student learning is now well established. Georgetown University researchers, for example, found that **improving a school's physical**

[1] Pearlman, B. "Designing New Learning Environments to Support 21st Century Skills." Chapter 6 in *21st Century Skills: Rethinking How Students Learn*, 2010, p. 144. http://files.solution-tree.com/pdfs/Reproducibles_21CS/chap6_designing_new_learning_environments.pdf

environment can raise test scores by as much as 11 percent.[2] This report looks into specific design approaches found to promote 21st century learning in elementary and middle school students. It is broken down into four sections – each discussing design measures that contribute to 21st century learning. Following the fourth section is an appendix which outlines the contents of a school design planning model. Most of the information discussed was obtained from reports by the Partnership for 21st Century Skills and the American Architectural Foundation – two leading organizations in the push to design 21st century learning environments. The next section outlines this report's key findings.

[2] "21st Century Learning Environments." Partnership for 21st Century Skills, p. 7. http://www.p21.org/documents/le_white_paper-1.pdf

Key Findings

Flexibility

- School and classroom design should accommodate diverse learning needs. Space should be large enough and furniture and other classroom objects should be easily reconfigurable to allow multiple learning activities to occur simultaneously.
- Space should be designed in anticipation of evolving learning needs, as both student populations and the relevance of specific subjects change over time.
- Flexible learning spaces allow for interactions and collaborative work, which are fundamental to the development of several 21st century skills. Such skills include: leadership, communication, teamwork, and interpersonal skills.
- Flexible schools provide space outside of classroom for collaborative work. Such spaces include: project rooms, atriums, and courtyards.

Sustainability

- Environmental factors such as lighting, air quality, and temperature affect student learning and should be incorporated into school design.
- Money saved from efficient lighting, ventilation, and temperature control can be reinvested in other things that directly contribute to student achievement, such as support staff or technological upgrades.
- Schools designed according to principles of environmental sustainability can serve as a laboratory for students to observe the application of environmental concepts and principles. This can help develop environmental literacy – a 21st century skill.

Community Engagement

- Opening the design process up to community members and school stakeholders can bring in fresh ideas and perspectives. It also lends a greater sense of legitimacy to expert opinions.
- As demands for accountability in public spending and community investments mount and the percentage of the population that has no direct connection to schools grows, experts agree that districts should design schools for community benefit rather than just student benefit.
- 21st century schools are partnering with community organizations – such as local branches of the YMCA and public libraries – to provide essential services, allowing for the creation of more flexible learning spaces.

Small Schools

- A significant body of research has found that small schools contribute to improved student achievement.
- The American Architectural Foundation and the communications director of Smart Growth America warn that the movement toward large consolidated schools could isolate schools from their communities.
- One study of eighth- and sixth-grade student achievement in Chicago schools found that teachers in small schools felt a greater sense of collective responsibility for student learning than their peers in medium-sized and large schools, and that student math scores were better among students in small schools than their peers in medium-sized and large schools.

Flexibility

Incorporating flexibility of use into the design of learning spaces is a recurring recommendation in the literature on modern school design. In this section, we discuss two ways in which spatial flexibility promotes 21st Century Learning. First, we analyze the importance of spatial flexibility to meeting diverse and evolving student needs. We then follow with a discussion on how the flexible use of space can promote specific learning goals outlined in the Framework for 21st Century Learning.

Diverse and Evolving Student Learning Needs

There is growing recognition that the methods by which students comprehend information ranges substantially. Differentiated instruction is an approach to teaching that attempts to account for students' different learning needs. It is based on the notion that students with varied needs can thrive under the same curriculum. The design of learning space is central to teachers' ability to provide differentiated instruction. According to James Seaman, an associate with TMP Architecture, Inc., **a flexible classroom is fundamental to a teacher's ability to adapt to students' needs.** Seaman notes: "If the classroom design is not agile, the space cannot adapt to an individual or groups' specific needs. **The design must allow for a variety of learning environments and grouping formats that take into consideration all learning-style profiles.**"[3]

Seaman lists several learning formats that classroom designers should consider when developing a flexible classroom suitable to differentiated instruction. They include:

- Individual study and reflection;
- One-on-one instruction;
- Peer-to-peer discussion;
- Small group work;
- Large group work;
- Teacher-directed instruction; and
- Student presentation.[4]

A sufficiently flexible classroom would allow for learning to take place through all of the above noted mediums.

Designing classrooms and other learning environments in a way that attends to diverse learning needs was one of the core recommendations that came out of the 2005 National Summit on School Design, convened by the American Architectural Foundation and the KnowledgeWorks Foundation. The summit brought together

[3] Seaman, J. "Agile and Information-Rich Learning Environments." *MASA Leader*, 2009. p. 18. http://edweb.sdsu.edu/schoolhouse/documents/MASALeader_Fall2010_Seaman.pdf
[4] Ibid., 1.

over 200 participants – educators, students, architects, and community members from all over the United States – to foster a national discussion on the principles of school design for the 21st century. The summit's participants assert that attending to diverse learning styles and interests requires a student-centered approach to school design:

> In designing schools, we must reexamine the notion of the traditional classroom setting and focus on new learning environments that are designed to support student achievement. Doing so requires greater flexibility in design to accommodate a range of learning scenarios inside and outside the school.
>
> Participants encouraged school design that reflects research on learning to create environments that are **student centered and driven by the students' interests.** These environments allow for small group discussions and work projects, individual workstations, and distance learning, as well as traditional classroom settings.[5]

Focusing on elementary students in particular, an article from architectural firm EE&K Architects asserts that **space and furniture** are more influential on learning than many would suspect. The article suggests elementary school students need large classrooms to accommodate the diversity of learning activities that (should) occur in the elementary grades. It also claims that classroom furniture should be easily reconfigurable to accommodate these activities as well as a wide range of student sizes and movements. Regarding the latter point, the article points out that some studies have found that 90 percent of students are sitting in chairs and at desks that are either too high or too low for them, highlighting the need for adjustable furniture. It further notes:

> Dieter Breithecker has argued that since children sit ten hours a day on average, **school furniture should also accommodate their developmental need to move**—to shift position, rock, rotate, and roll. He suggests that **these kinds of movements are critical to intellectual growth** since they stimulate circulation and enhance attention and concentration.[6]

The Partnership for 21st Century Skills – the architects behind the Framework for 21st Century Learning – proposes another argument in favor of flexible learning spaces: they allow schools to bend and adapt to meet *evolving* learning needs. In time, skills currently thought of as essential for success in the 21st century may become less relevant, and **it is paramount that schools are able to adjust to new learning demands without significant capital overhaul.** An article by architects Frank

[5] "Report from the National Summit on School Design: A Resource for Educators and Designers." American Architectural Foundation, 2005, p. 17. http://www.archfoundation.org/aaf/documents/nssd.report.pdf
[6] "The Design of Elementary Schools." Ehrenkrantz, Eckstut & Kuhn Architects. http://www.eekarchitects.com/community/4-in-the-news/123-the-design-of-elementary-schools

Locker and Steven Olson uses a hypothetical design consideration to illustrate this point:

> While a "state of the art" Home Economics lab may be needed now, the bigger issue is "Will Home Economics be taught in thirty years, and if so, how?" The space may have more prospects for the future if it can become a science lab or art lab, as program needs change.[7]

Additionally, **spaces must be able to seamlessly integrate new, innovative educational technologies and teaching modalities.** The Partnership for 21st Century Skills finds that "[t]o achieve this flexibility, architects are designing classrooms, or 'learning studios,' with moveable furniture and walls that can easily be reconfigured for different class sizes and subjects."[8]

Flexible design will also help schools accommodate changing student populations – a phenomenon that will affect nearly every school district in the country going forward. According to participants of the American Architectural Foundation's 2006 Design for Learning Forum, the United States is headed toward a drastic decrease in the percentage of the population with children. This will occur concurrently with a sharp increase in the percentage of the population that is over 65. What this means for school districts, according to Forum participants, is that **schools built in the near future must be designed for multipurpose use.** In essence, they must serve their communities in more ways than just educating their youth; they must have facilities and services that appeal to lifelong learners as well.[9] While this idea may seem far-fetched, it is not inconceivable, as **the political landscape** (and consequently control over public school funding) **will be dominated by individuals with no direct ties to public schools** for the foreseeable future.

Flexible Design Promotes the Attainment of 21st Century Skills

According to the Partnership for 21st Century Skills, students will need to hone their communication and collaboration skills to be successful in the 21st century. Leadership and interpersonal skills, as well as respect and appreciation for diversity, are also cited as fundamental skills for future success.[10] According to several sources, school design can either promote or hinder the development of these crucial skills.

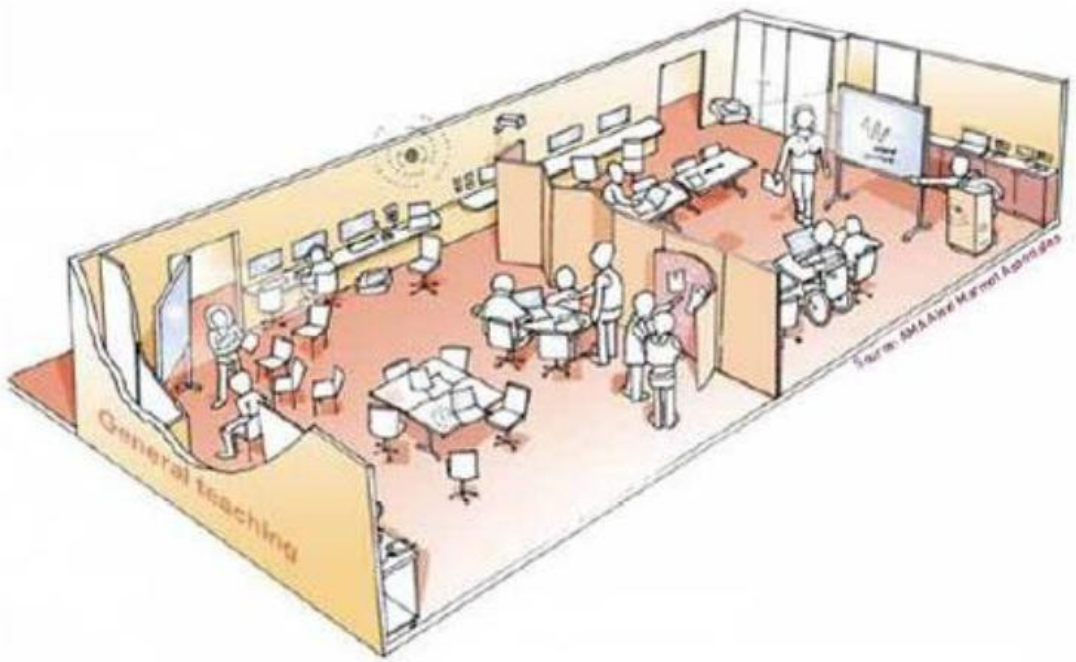
Design and educational experts favor flexible spaces that can be easily manipulated to allow for interactions and collaborative work. According to the Partnership for 21st

[7] Locker, F. M., and S. Olson. "Flexible School Facilities." DesignShare, 2003, p. 1. http://www.designshare.com/index.php/articles/flexible-school-facilities/1/
[8] "21st Century Learning Environments." Op. cit., 7.
[9] "School Design and Student Learning in the 21st Century: A Report of Findings." American Architectural Foundation, 2006, p. 29. http://www.archfoundation.org/aaf/documents/report.designforlearning.pdf
[10] "P21 Framework Definitions." Partnership for 21st Century Skills, pp. 3-7. http://www.p21.org/documents/P21_Framework_Definitions.pdf

Century Skills, **21st century classrooms "flex to accommodate the human relationships that are critical to successful learning."**[11] This means that classrooms are built for multiple uses, with movable objects and open space that allow students to gather, share, and co-produce. Seaman claims: "An agile classroom should be thought of as a stage – a place where things can easily be brought in or moved out to change the learning environment effortlessly and expediently. Moveable components should be emphasized."[12]

The figure below is offered by the Partnership for 21st Century Skills as an example of a flexible classroom. Notice the aspects of the classroom that allow for interaction and shared learning. First, the divider in the middle of the room can easily be reduced or removed to create a larger space for large-group activities or discussions. There are multiple learning stations in the classroom – group tables, presentation facilities, computer stations – each of which facilitates a different type of interaction. Finally, most of the classroom's equipment – including tables, chairs, and whiteboards – are portable, allowing them to easily shift as spatial needs change.

Model 21st Century Classroom



Source: Partnership for 21st Century Skills[13]

[11] "21st Century Learning Environments." Op. cit., 8.
[12] Seaman. Op. cit., 18-19.
[13] Ibid., 8.

Flexible schools also provide space outside the classroom for collaborative learning. Flexibility in this sense is synonymous with variety. Writing in *American School Board Journal*, Susan Black lists several areas in which collaborative learning could take place:

- Learning studios with abundant daylight, flexible furniture, and space for group projects;
- Open areas such as atriums and learning streets – instead of corridors – to encourage social interaction;
- Project rooms with high ceilings, worktables, and specialized equipment for inventing, creating, and building;
- Multiage groups where students mix and match according to interests and aptitudes;
- Outside learning where students work on community service projects and use community sites such as museums and libraries as classrooms.[14]

An important learning space not mentioned by Black is the school library. A flexibly designed, 21st century school library should offer "places for formal learning in which large groups can gather for presentations; places for social learning where teams can collaborate on projects; and places for individual learning where individuals can find a quiet space for reading, reflection, or relaxation."[15]

The AAF and National Summit participants also suggest that school designers should exercise flexibility in site selection, and consider unconventional facilities for school locations. Building schools at or near valuable community resources such as museums, higher education institutions, or research labs can offer opportunities for experiential learning. At the Henry Ford Academy in Dearborn, Michigan, for example, students have direct access to the collections of the Henry Ford Museum, which houses artifacts of American industry. Parts of the school were even created out museum space. For example, classrooms were made from a railroad depot as well as individual railroad cars.[16]

[14] Black, S., "Achievement by Design." *American School Board Journal*, 2007, p. 41.
http://www.asbj.com/TopicsArchive/FacilitiesandSchoolDesign/AchievementbyDesign.aspx
[15] "21st Century Learning Environments." Op. cit., 11-12.
[16] "Report from the National Summit on School Design: A Resource for Educators and Designers." p. 48.

Case Study

J. Lyndal Hughes Elementary School, Texas

The J. Lyndal Hughes Elementary School was the first school in the Fort Worth, Texas district to be built with a flexible design. The school is designed for 650 students in grades K-5 and includes the following flexible features:[17]

- Garage door-like overhead panels that separate classroom spaces from "flex spaces" that connect classrooms. Teachers use the flex spaces for art and science lessons.
- Cafeteria space that opens up to become a performance stage that may be used by students, teachers, and the broader community.
- Natural lighting in corridors, classrooms, offices, and public spaces.
- Age-appropriate storage "cubbies" in classrooms for grades K-3 and in corridors for grades 4-5.
- Grade-level gardens with outside courtyard.
- Canopies at pick-up lanes that double as sun shades for offices.
- Earth burns to keep excavated soil on-site.
- Mechanical VAV boxes placed above corridor ceilings to "simplify maintenance and limit disruption in classrooms."

The total cost of the project was $9,444,651 and was paid for directly by the school district. The pictures below show two classroom views.

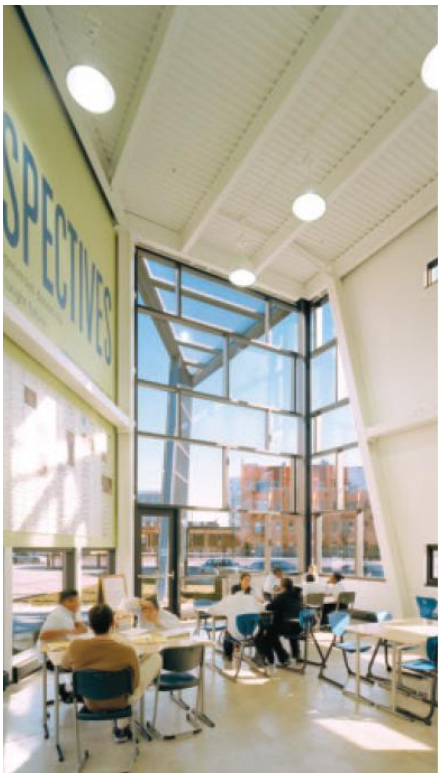
Source: DesignShare

[17] J. Lyndal Hughes Elementary School, DesignShare. http://www.designshare.com/index.php/projects/lyndal-hughes-elementary-school

Source: DesignShare

Sustainability

While many districts are exploring environmentally sustainable design measures to reduce operating costs and trim carbon footprints, research suggests that districts would also be wise to consider the effects of sustainable designed on student achievement. One of the "21st century student outcomes" identified in the Framework for 21st Century Learning is that students master core subjects and 21st century themes.[18] This includes subjects like math and literacy, which are often assessed on standardized tests. The Design for Learning Forum claimed that **daylight and clean air have been proven to contribute to increased student achievement.**[19] The Partnership for 21st Century Skills also asserts that lighting and air quality have "a proven positive effect on learning," and adds temperature to the list of environmental factors that impact learning outcomes.[20]



Source: AAF[21]

Just how large is the effect of sustainable school design on student learning outcomes? Studies have found that **student learning rates have improved between 7 and 26 percent in classrooms that are exposed to adequate day lighting.**[22] Sustainable temperature control measures, such as retrofitting windows and heating appliances to provide a more even and consistent temperature distribution, can also positively impact student teaching and learning. According to an article put out by the National Clearinghouse for Educational Facilities, studies have found that student achievement declined when temperatures fell outside of a comfort zone, believed to be between 68 and 74 degrees Fahrenheit.[23]

Designing schools according to principles of environmental sustainability should thus provide the dual benefit of long-run cost savings (on lighting, heating, and ventilation) and improved student achievement. A further benefit is that districts can reinvest cost savings associated with sustainability measures into expenditures directly

[18] "P21 Framework Definitions." Op. cit., 2.
[19] "School Design and Student Learning in the 21st Century." Op. cit., 32.
[20] "21st Century Learning Environments." Op. cit., 10.
[21] "Report from the National Summit on School Design: A Resource for Educators and Designers." Op. cit., 43.
[22] Madsen, J.J. "Building Better Schools." *Buildings*, July 2005. http://www.buildings.com/tabid/3413/ArticleID/2609/Default.aspx
[23] Schneider, M. "Do School Facilities Affect Academic Outcomes?" National Clearinghouse for Educational Facilities, November 2002, p. 5. http://www.edfacilities.org/pubs/outcomes.pdf

tied to learning and achievement, such as classroom technology or support staff. A 2006 report entitled *Greening America's Schools: Costs and Benefits* even claimed that "for an average conventional school, building green would save enough money to pay for an additional full-time teacher."[24]

To maximize student exposure to natural elements with proven positive effects on achievement, some schools are even building **outdoor classrooms and meeting places.** According to Randall Fielding, founder and chairman of the architectural firm Fielding Nair, innovative school designers are "incorporating outdoor seating and doors that open directly into courtyards and outside areas into their designs."[25]

EE&K Architects claim, however, that **light flexibility rather than light maximization should guide the design of elementary school classrooms.** They note:

> With activities ranging from napping to detailed project-based work and learning media ranging from finger paint to digital audio-visual displays, lighting in the classroom needs to be adjustable to the task. Considering the diversity of activity that can be occurring simultaneously within a classroom, lighting may also need to vary across the room.[26]

Environmental Literacy: A 21st Century Skill

The Partnership for 21st Century Skills identifies environmental literacy as a 21st century interdisciplinary theme students will need to master. **"Green" schools provide the perfect context within which to develop students' understanding of environmental concepts** as they demonstrate the practical application of environmental principles. Since environmental literacy is such a vast interdisciplinary subject, it ties into other 21st century skills and themes. Students exploring environmental issues may also be exposed to topics in economics, politics, history, geography, health, the sciences, and a range of other subjects.

The Partnership for 21st Century Skills points to a school in Southern England as an illustrative example of how environmentally conscious design and construction can be leveraged to promote student learning. **Saint Pancras Primary School** is using the construction of its new addition to develop students' environmental literacy and other 21st century skills. The Partnership notes: "By documenting the planning and construction process, students are deepening their understanding of environmental

[24] Kats, G. "Greening America's Schools: Costs and Benefits." U.S. Green Building Council, October 2006, p. 2. http://www.usgbc.org/ShowFile.aspx?DocumentID=2908
[25] Sack-Min, J. "Building the Perfect School." *American School Board Journal*, 2007, p. 4. http://www.hartfordschools.net/LinkClick.aspx?fileticket=%2FBi3I6tM2nw%3D&tabid=800&mid=3665
[26] "The Design of Elementary Schools." Op. cit.

issues, while gaining IT and video production expertise and honing their narrative skills by documenting their compelling story."[27]

[27] "21st Century Learning Environments." Op. cit., 11.

Community Engagement

Experts agree that community engagement in the school design process is fundamental to building schools that support 21st century learning. Schools are a central part of any community and all community members, including those with no direct ties to the school, are affected by its presence and success. Community members bring varying opinions and perspectives, which can contribute positively to school design. Their resources are also fundamental to school vitality, so securing long-term support is critical. This section summarizes the literature on community involvement in school design and how it impacts 21st century learning.

Community Members Bring Valuable Ideas and Perspectives

One of the core recommendations that emerged from the AAF Design for Learning Forum was that **districts should "involve citizen designers to reinvigorate the design process."** Many Forum attendees were of the opinion that school design processes are often prohibitively rigid and bureaucratic, which limits the opportunity for innovative design.[28] Not only is opening the design process up to community members important for equity and fairness, it may also bring fresh ideas to the fore. Moreover, involving multiple stakeholder groups helps to **corroborate and cross-check expert information and lends a greater sense of legitimacy to design proposals.**

Incorporating student feedback in particular is often cited as a school design best practice. A study conducted by the British nonprofit organization School Works that looked into student attitudes about their schools found that "**young people showed that they had a clear awareness of the links between their school environment and learning,** and they were on the whole extremely lucid in their arguments."[29] Students commented on various aspects their schools' physical space, including dining areas, classrooms, and meeting places. In general, their opinions resembled expert assertions about the physical factors that contribute to learning, particularly bright, clean, and comfortable environments.[30]

The Partnership for 21st Century Learning asserts that "students find that getting involved in building design provides them with a rich real-world learning experience."[31] More specifically, **participation may serve to develop certain 21st century skills.** Building design requires creative and critical thinking and draws upon artistic talents. Further, involvement in a collaborative process provides an opportunity to exercise leadership, judgment and teamwork skills. All of these are "21st century student outcomes" outlined in the Framework for 21st Century

[28] "School Design and Student Learning in the 21st Century." Op. cit., 37.
[29] Ibid., 38.
[30] Ibid., 38-39.
[31] "21st Century Learning Environments." Op. cit., 10.

Learning. The American Architectural Foundation's "Redesign Your School Contest" fosters these skills as students from around the country compete to design the most compelling architectural vision for their school. In developing their designs, individual students or groups of two were asked to consult community members and use available information to "create engaging and original ideas for the design of a school, classroom, or other learning environment."[32] Though intended for high school students, it is conceivable that a similar program could be developed for middle school students or turned into a classroom initiative.

Design for Community Benefit

A recurring theme throughout the literature is the need for schools to be designed for community benefit, not just student benefit. Now more than ever, **the support of community members and key decision-makers** – essential to financial stability of schools – **rests on the ability of schools to serve multiple purposes and stakeholders.** If districts want to push forward with plans to build cutting-edge, innovative schools, they must be designed to include features that appeal to members of the broader community. This reality was alluded to in the first section of this report, and stems from changing community and demographical dynamics as well as a growing push for accountability in public spending.

Speaking at the National Summit on School Design, Akron, Ohio Mayor Donald Plusquellic claimed that the public supported the city's passing of a multimillion-dollar bond deal to fund the construction of new schools because the schools were to feature recreational, cultural, and other facilities made available to all residents. Since the schools offer resources and services for all community members, all members have a stake in their upkeep.[33]

These community services no doubt directly benefit students as well. Not only are students able to take advantage of them during after-school hours, the school's role as a community center allows them the opportunity to interact with people from outside their immediate school community. **After-school events can thus serve to develop social and cross-cultural skills, which are important 21st century competencies.**

Leveraging Community Resources

School districts are constantly faced with the challenge of balancing the need to provide the resources necessary for developing 21st century skills with their fiscal realities. According to the AAF, schools are becoming smaller and more specialized. As this phenomenon develops, the AAF claims schools will shed typical public

[32] "About the Contest." American Architectural Foundation. http://www.archfoundation.org/aaf/redesignyourschool/About.htm
[33] "Report from the National Summit on School Design: A Resource for Educators and Designers." Op. cit., 35.

school staples like gymnasiums and libraries in favor of focusing on classroom space.[34] **To continue to provide these services to students, districts are beginning to think innovatively, partnering with community organizations like public libraries and the YMCA.** This naturally affects school design at the initial planning-level. Robust partnerships between districts and other public and nonprofit entities can shape how scarce school space is utilized. If, for example, a partnership is established between a school district and a local recreation center to provide room for physical education classes, designers of a new or refurbished school can devote more space to multipurpose rooms, computer labs, or common areas than they otherwise would have been able to if design plans had to include a gymnasium.

Naturally, **a large part of the feasibility of such partnerships will rest on proximity to community resources.** For this reason, schools located in urban areas are typically much better situated to take advantage of already existing community resources than schools in suburban or rural settings. However, the AAF claims **municipalities are increasingly adopting this model of clustering community services**, which may influence the design of schools and other public institutions in areas where both are needed.[35]

The **Minneapolis Interdistrict Downtown School** is an example of a school that has leveraged community partnerships to ensure its students have all the resources they need to succeed. The school uses the gym facilities of a nearby YMCA and the library facilities of a local public library, which has generated cost savings to the district and has also engendered "unexpected collaboration and new approaches to learning."[36]

In a more expansive project, partnering organizations developed Hartford, Connecticut's "learning corridor" – a 16-acre campus containing four schools, a Boys and Girls Club, a family center, and a Girl Scouts council. The schools on-site include a Montessori magnet, a middle school magnet, and two Greater Hartford Academies that teach advanced math, science, and arts curricula.[37] Students benefit from learning and interacting in a highly diverse environment as well as the wealth of resources available to them.

Facilitating Community Involvement

Participants in the National Summit on School Design and the AAF provide some general guidelines for incorporating community input into the school design process. They suggest that **the process begin early** to provide sufficient time for community members to offer input before decisions are tabled. The use of a **professional**

[34] "School Design and Student Learning in the 21st Century." Op. cit., 34.
[35] Ibid., 34.
[36] "Report from the National Summit on School Design: A Resource for Educators and Designers." Op. cit., 36.
[37] Ibid., 37.

facilitator is also recommended to help participants achieve a consensus. The process itself should begin with a **visioning process**, where key stakeholders share their views on the role of the school in educating youth and serving the broader community.[38]

In its report covering the National Summit on School Design, the AAF provides illustrative examples of exemplary community input procedures. One such example is from a school district in Cincinnati, Ohio, which engaged the public through a visioning process that led to the development of several multipurpose schools, or "community learning centers" as they are referred to in the report. Stakeholders were engaged long before designs were drawn up and "the community's aspirations, values, and hopes [were] incorporated into the design decisions."[39]

Case Study

Pine Jog Elementary School and the Florida Atlantic University Pine Jog Environmental Education Center[40]

Pine Jog Elementary School, a preK-5 school with spaces for community use, holds 960 students. The school has engaged in a partnership with Florida Atlantic University's Environmental Education Center to "provide ongoing environmental stewardship of the nature preserve." Visitors to the Environmental Education Center can tour the school grounds and participate in various environmental education activities. This and other initiatives work to involve the community and the school in shared resource efforts. At the same time, the school and university partnership provides "a unique opportunity to introduce pedagogical changes to the current County elementary school curriculum. The buildings and site are designed to help teachers teach and students learn, while reducing long-term operational costs."[41]

Learning spaces for the elementary school students include butterfly gardens, storm water collection and water re-use demonstration areas, solar energy learning centers, and biological life cycle study areas that include native wildlife. Additionally, the school includes break-out program rooms, storytelling areas, and multiple outdoor and wet areas that are available for use by multiple classrooms.

Both the school and the educational center include LEED features such as preferred alternative-fuel and carpool vehicles, water-efficient plumbing and waterless urinals, student recycling stations, recycled construction materials, efficient mechanical

[38] Ibid., 39.
[39] Ibid., 40.
[40] Pine Jog Elementary School and the Florida Atlantic University Pine Job Environmental Education Center, DesignShare. http://www.designshare.com/index.php/projects/pine-jog-elementary-school-and-the-florida-atlantic-university-environmental-education-center/narratives
[41] Ibid.

equipment, and polished concrete floors in high-use areas. Students, staff, and the greater community can view the building performance through "green-screen" energy monitoring.

The total cost was $30,250,000, $28,000,000 of which were building costs. DesignShare notes that the cost was "relatively high because of environmental mitigation."[42]

The pictures below show a learning corridor at Pine Job Elementary and an aerial view of the school

Source: DesignShare

Source: DesignShare

[42] Ibid.

Small Schools

The research on small schools (in terms of enrollment) is vast and growing. Small schools have been credited with reducing school violence, raising student achievement, and a host of other educational and social benefits. This section, however, focuses narrowly on research linking small schools to 21st century learning outcomes.

There is a **significant body of research that supports the notion that smaller schools lead to greater student achievement and foster deeper and more personal student interactions.** Summarizing the research on small schools, David Goldberg, the communications director of Smart Growth America, claims small schools have lower dropout rates, higher standardized test scores, and higher rates of participation in extracurricular activities than larger schools.[43] A now dated report discussed research on the relationship between school size and social interactions. The author claims smaller schools, absent the rigid bureaucratic structures of larger institutions, are better able to develop a community environment. In one case, an investigator found that an embedded sense of community "increased student investment and led to an emergence of civic thinking and civic commitment that moved beyond the learning community and beyond the walls of the school."[44]

The AAF and participants in the Summit on School Design identify small schools as an important design consideration for furthering 21st Century Learning. Summit participants discussed the benefits associated with creating a "'small school' culture that fosters personal relationships and attachments."[45] They also warned that the **movement away from small neighborhood schools** toward larger consolidated schools **could isolate schools from their supporting communities.**[46] This concern was also raised by Goldberg, who found that in order to save costs, large consolidated schools are being built on vast swaths of cheap land outside of residential areas and are often only accessible by automobile.[47]

The AAF acknowledges that in many districts, the push to create larger schools has been influenced in part by resource constraints and growing enrollments. Goldberg concedes that in general, costs per student are generally lower in large schools than they are in small schools.[48] However, resource limitations are but one consideration districts need to make when considering school size. Participants in the National

[43] Goldberg, D. "Schools & Small Schools." *On Common Ground*, Winter 2005, p. 10. http://www.realtor.org/smart_growth.nsf/docfiles/winter05sprawl.pdf/$FILE/winter05sprawl.pdf
[44] Raywid, M. A. "Taking Stock: The Movement to Create Mini-Schools, Schools-Within-Schools, and Separate Small Schools." ERIC Clearinghouse on Urban Education, Institute for Urban and Minority Education, April 1996, p. 27. http://www.dcbsimpson.com/Raywid%201996%20-%20small%20schools.pdf
[45] "Report from the National Summit on School Design." Op. cit., 27.
[46] Ibid., 27.
[47] Goldberg. Op. cit., 7-9.
[48] Ibid., 10.

Summit agreed that **"school size needs to be determined within the framework of a community's needs and vision, academic goals, and economics."**[49]

While there is ample literature on the benefits of reducing the size of high schools, there is considerably less research focusing specifically on the effects of smaller schools on elementary school student achievement. However, evidence from one large-scale study suggests that students in K-8 schools also benefit from small overall enrollments. Valerie Lee and Susanna Loeb's study of K-8 schools in Chicago is one of the most robust studies available on the effect of K-8 school size on student achievement. The study found that **sixth- and eighth-grade math scores were moderately higher among students in small schools compared to their peers in middle and large schools**, although only the effect size comparing small and middle-sized schools was statistically significant. This effect can be partially explained by **teachers' sense of collective responsibility for student learning**, which in this experiment, was found to be associated with higher math scores and **was greater in smaller schools.**[50]

[49] "Report from the National Summit on School Design." Op. cit., 27.
[50] Lee, V. E. and S. Loeb. "School Size in Chicago Elementary Schools: Effects on Teachers' Attitudes and Students' Achievement." *American Educational Research Journal*, 37:1, Spring 2000, p. 22. http://www.stanford.edu/~sloeb/papers/School%20Size.pdf

Appendix: National Center for the Twenty-first Century Schoolhouse Planning Model

The National Center for the Twenty-first Century Schoolhouse's Planning Model for designing 21st century school facilities is comprised of two parts. Content in both parts is inspired by what the Center calls the "learner-centered" approach to school design. Some sections of Part I offer suggestions for designing schools according to the learner-centered approach, while others establish the need and context for forward-thinking building design. Key points from each section are listed in this appendix.

Part II contains links to Internet resources that guide educators and school designers in planning, designing, implementing, maintaining, and assessing learner-centered, 21st century school facilities. The resources can be found by accessing the URL provided in the footnote to this sentence and clicking on the square icons comprising the perimeter of the displayed diagram.[51]

Part I: Key Points

Meeting Demands[52]

- This section provides an overview of current and future facilities-related challenges facing American schools.
- Older schools may be less able to accommodate innovations in curriculum development, instruction strategies, and content development than more modern schools.
    - 21 percent of schools in the United States are more than 50 years old, and an additional 50 percent are at least 30 years old.
- In 2000, the Office of Education Research and Improvement estimated it would cost $127 billion to modernize the nation's schools. The National Education Association's estimate was much higher - $322 billion.
- School districts continue to struggle to convince taxpayers and policy-makers of the need to invest in modernizing schools, despite mounting evidence of detrimental effects of poor quality facilities.
- Clean air, good lighting, and comfortable learning environments are needed to ensure optimal educational outcomes. Providing these environments for all

[51] "Planning and Designing Learner-Centered School Facilities." National Center for the Twenty-first Century Schoolhouse. http://edweb.sdsu.edu/schoolhouse/plan/2_main.htm
[52] "Meeting Demands." National Center for the Twenty-first Century Schoolhouse. http://edweb.sdsu.edu/schoolhouse/plan/1_demand.htm

learners requires adequate funding, competent design, construction, and maintenance.

Implementing a Learner-Centered Philosophy[53]

- Schools should be designed to accommodate human dimensions, meaning design must center around human sizes, motions, and characteristics.
- School facilities are an important contributor to the learning experience. Thus, educators, planners, and designers should consider the learner's environment when making design decisions: How will the built environment facilitate learning?
- School facilities should appeal to diverse learning styles, "providing an environment responsive to the educational, developmental, psychological, and social needs of all learners, applying best practices in curriculum and instruction."

Engaging the Community[54]

- Teachers and administrators must join together with community members to address some overarching questions of school design:
  - What makes a school significant?
  - How do we know when a school's physical structure reinforces the established goals of teaching and learning?
  - Do we understand why certain spaces work and others do not?
- Community engagement should occur early in the design process to exchange information and develop community ownership over the project. Engagement should occur through public forums and planning workshops.
- Initial tasks for collaborative design teams include documenting existing conditions of a problem, defining the problem's context, and collecting relevant data.
- School occupants – administrators, teachers, and students – must be the ones to identify outcomes and determine the methods of achieving them.

[53] "Implementing a Learner-Centered Philosophy." National Center for the Twenty-first Century Schoolhouse. http://edweb.sdsu.edu/schoolhouse/plan/1_learner.htm
[54] "Engaging the Community." National Center for the Twenty-first Century Schoolhouse. http://edweb.sdsu.edu/schoolhouse/plan/1_engage.htm

Designing and Environment for Learning[55]

- The school environment is central in students' cognitive, social, and emotional development.
- School spaces should reinforce each other both physically and aesthetically.
- When school design decisions are made "based on the overall quality of a facility rather than [mere] adherence to myriad individual standards," the resulting structures "begin to provoke thought and encourage learning just as powerfully as they protect occupants from the elements."

The Impact of the School Environment on Learning and Teaching[56]

- Research supports the notion that specific building features and conditions affect learning, such as: building age, level of modernity, temperature, indoor air quality, lighting, overall impression, and design classifications such as "flexible classroom arrangements, clearly defined pathways, positive outdoor spaces, large-group meeting rooms, instructional neighborhoods, and ample egress."
- Teacher attitudes and behaviors are influenced by building features and conditions.
- Parental and community engagement with schools has been found to be related to the quality of school facilities.

[55] "Designing An Environment for Learning." National Center for the Twenty-first Century Schoolhouse. http://edweb.sdsu.edu/schoolhouse/plan/1_design.htm
[56] "The Impact of the School Environment on Learning and Teaching." National Center for the Twenty-first Century Schoolhouse. http://edweb.sdsu.edu/schoolhouse/plan/1_impact.htm

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