DRAFT 20160503

RECONSIDERING THE LEARNING ENVIRONMENT

TRANSFORMING CITY TECH'S CLASSROOMS THROUGH THE LENS OF GENERAL EDUCATION

BUILDING AND GROUNDS COMMITTEE COLLEGE COUNCIL MAY 2016

Buildings & Grounds

Committee, College Council

Committee's Task:

Excerpt from Governance Plan (http://www.300jaystreet.com/college-council/about/governance_pla)

Article V Section D:

7) After the last council meeting of the academic year and before the organizational meeting for the upcoming year each committee shall submit a written summary of committee activities to the council secretary. These reports will be forwarded to the chair of the committee on committees who will give it to the chair of the committee for the following academic year.

12) Buildings and Grounds Committee

This committee shall be responsible for producing evaluations and making recommendations to the council concerning the condition, improvements and safety of the college proper and its environs. This committee shall be expected to provide liaison between the faculty and the office of the vice president for administration and finance. To further this goal, the buildings and grounds committee shall be represented on all college-wide committees dealing with the planning and use of the physical plant. Each academic year it shall produce an evaluative report on at least one important area of its purview and submit this written report to college council.

Buildings & Grounds

Committee Members 2015-2016

Professors	Departments
Sidi Berri Professor	Mechanical Engineering (chair)
MaryAnn Biehl Associate Professor	Communication Design (chair)
Jierong Cheng (secretary) Assistant Professor	Business
Tony Cioffi Professor	Construction Management + Civil Engineering Technology (chair)
Jason Ellis (non-voting) Assistant Professor	English
Monique Ferrell Professor	English + African Studies (interim chair)
Jean Hillstrom Assistant Professor	Social Sciences (chair)
Jason Montgomery (chair) Assistant Professor	Architectural Technology
Robert Polchinski Assistant Professor	Environmental Control & Facilities Management (chair)
Tess Tobin Associate Professor	Ursula C. Schwerin Library

acknowledgements

The Buildings and Grounds Committee would like to thank the following for their support and feedback as the Buildings and Ground Committee conducted this study and developed this report:

Miguel F. Cairol	Vice President for Administration and Finance
Julia Jordan	Director, Faculty Commons
Mariano Alemany	Campus Planning Officer
David Turkiew	Director of Technical Services and Higher Education
Karen Lundstrem	Director of Instructional Technology & The Technology Enhancement Centers
Members of the Technology Committee	College Council
Student Participants in Focus Groups	Various Departments

table of contents

Part I

Part II

Part I

questions

driving this project

questions

1. What implications do our goals for General Education at City Tech have for our learning environments?

2. What does scholarship tell us about the relationship between the built environment of classrooms and learning?

3. How can we facilitate active learning through classroom design?

4. What are institutions around the country doing?

literature review

reconsidering the learning environment

literature review

Introduction

City Tech has a firmly established policy of pragmatically filling General Education (GenEd) classrooms with tablet arm chairs for students to sit facing the front of the room where the professor's equipment is situated (desk, chair, podium, computer technology, and writing surface) for projecting information and learning experiences to the waiting minds of receding students. The need for this arrangement rests on the need of maximizing the seating for City Tech's growing student enrollment, but its continuance without reflection depends on an institutional and historical inertia for pedagogical models of the past and different generations of students than we now have. However, pedagogical research on improving student learning outcomes through reconfigurations of teaching spaces, utilization of innovative classroom furniture, and enhanced environmental conditions of learning spaces point the way forward for all higher education but more specifically for our college, which is itself reconfiguring itself as a leader within CUNY and the region. Simply put, the research on improving classroom spaces demonstrates an improvement in student learning outcomes without any changes to course content or pedagogical techniques. Essentially, improving the learning space will improve student success, which will in turn improve retention rates, graduation rates, and overall student development.

The literature review below discusses recent findings in the field of classroom design. It is organized in three sections: Philosophy, Furniture, and Environment.

Reconsidering Classroom Design Philosophy

As reported widely in contemporary pedagogical research, Wulsin argues that, "The traditional transference model of education in which a professor delivers information to students, is no longer effective at preparing engaged 21st-century citizens. This model is being replaced by constructivist educational pedagogy that emphasizes the role students play in making connections and developing ideas, solutions, and questions. Already, teachers are creating active learning environments that place students in small work groups to solve problems, create, and discover together" (Wulsin 2). The driving need for this change is, "To prepare students to be effective agents of change in a complex and interconnected world" (Wulsin 6). One of the most effect ways to accomplish this has to do with classroom design: "Well-designed space has the ability to elevate discourse, encourage creativity, and promote collaboration" (Wulsin 2). Considering the needs of City Tech GenEd classrooms, which need to accommodate the pedagogical approaches of many different teaching styles and subject matter, flexibility ensures these things: "Within the classroom walls, learning space should be as flexible as possible, not only because different teachers and classes require different configurations, but because in order to fully engage in constructivist learning, students need to transition between lecture, group study, presentation, discussion, and individual work time" (Wulsin 2). This flexibility for the classroom space mean that, "classrooms should be effective in multiple

configurations" (Wulsin 14). Some of the possible, "Classroom configurations include linear (lecture, presentation, video), horizontal (class discussion), cluster (small group discussion and activities), and network (decentralized instruction)" (Wulsin 14). The linear configuration represents the majority of City Tech classroom setups. City Tech classrooms can be reconfigured into other classroom arrangements, but they can only be done so by moving top-heavy tablet arm chairs noisily across the floor, which disturbs neighboring classrooms and offices above, below, and to the sides of the reconfigured classroom during each reconfiguration.

There are a number of university centers and higher education programs involved in planning, testing, and reporting on innovative classroom design for improved student outcomes. Some of these include SCALE-UP (Student-Centered Active Learning Environment for Undergraduate Programs), TEAL (Technology Enhanced Active Learning), The Link (flexible classrooms at Duke University), and ATLAS (Alliance for Technology, Learning, and Society at UC-Boulder). Another is the Center for the Enhancement of Teaching and Learning (CETL) at the Georgia Institute of Technology (Georgia Tech), which promotes best practices in all aspects of improving student learning outcomes, including those focused on classroom design and environment. Considering the need for better student learning outcomes, they argue for five philosophical principles of good classroom design: 1) "Classrooms should facilitate student engagement," 2) "Classrooms should facilitate student collaboration," 3) "Classrooms should facilitate connections between teachers & students," 4) "Classrooms should incorporate appropriate technology," and 5) "Classrooms should have flexible physical arrangement" (CETL 1). All of these apply equally to "Ramblin' Wrecks from Georgia Tech" as City Tech's students enrolled in GenEd classes.

CETL's philosophy for improved engagement, collaboration, and flexibility is supported by Baepler and Walker's work on active learning classrooms (ALCs), namely "educational alliances between students and instructors and among students, relationships that help to improve both the student learning experience and the learning outcomes that students achieve" (Baepler and Walker 27). In their study, Baepler and Walker's "focus on alliance is built on the general proposition that the social context in which teaching and learning takes place can affect, either positively or negatively, student academic and developmental outcomes" (Baepler and Walker 28). In addition to finding that the most effective learning involves active participation by students and instructors, they find that, "many aspects of the ALC design promote effective communication and feedback, in particular proximity, new lines of communication, the use of appropriate technology, and the promotion of higher quality communication" (Baepler and Walker 33). With the non-hierarchical structure of an ALC, communication flows in different directions between students and instructor, and among students, which supports more ways of sharing, discovering, and questioning. They describe how "the physical configuration of the ALCs, in particular the round tables, is designed to facilitate [student cooperation on projects and assignments]" (Baepler and Walker 35). While they focus on ALC classroom design centered around a node or round table-focused design, a classroom with furniture supporting reconfiguration and flexibility can be utilized by a City Tech professor wishing to

deploy ALC in her pedagogy.

Supporting the concept of space as a key component of student success, the National Learning Infrastructure Initiative (NLII), an Educause Program, argues that changing ideas about space (physical and virtual), and deepening understanding about how space affects how we learn has led to a fundamental shift in classroom design away from traditional classrooms to learning spaces. They state that, "As a result, the notion of a classroom has expanded and evolved; the space need no longer be defined by 'the class' but by 'learning.' Learning space design as an important consideration for colleges and universities" (NLII 1). They discuss how "designing space is an important institutional activity" that "[conveys] an image of the institution's philosophy about teaching and learning" (NLII 1). Due to the usefulness demanded of buildings (50-100 years), pedagogical trends (10 years), and technology (annual), they assert that, "the stakes are too high to risk settling for inadequate design" (NLII 1). More to the point, they argue that, "Learning, rather than heating systems, lighting controls, or computer projectors, should be at the center of learning space design" (NLII 1). They provide six components to learning space design. First, "the vision for a learning space derives from the underlying learning philosophy of the institution and its programs," and it should include, "A focus on learning," and "the interactive campus" (NLII 2). They identify analysis as the second step: "Before beginning the design of a learning space, several types of analysis and information gathering are recommended," and the areas of analysis include: "Disciplinary needs," "External benchmarking," "Learning modes," "Existing space use," "Gap analysis," and "Curricular reform" (NLII 3-4). The third component is assembling the appropriate team to create the learning space design, and it involves reaching out to all stakeholders and involving advocates who can put the design into practice (NLII 4). The fourth component is the design considerations, which includes, "A number of principles, considerations, and constraints [that] can impact learning space design. Maintaining a balance among these factors, while keeping learning as the primary objective, is a critical role for institutional leaders" (NLII 5). Design considerations include: "Design learning spaces around people," "Support multiple types of learning activities," "Enable connections, inside and outside," "Make space flexible," "Accommodate information technology," "Design for comfort, safety, and functionality," and "Reflect institutional values" (NLII 5-6). The fifth concern is policy considerations, such as the very important need for accessibility. Finally, the sixth component is assessment: "Ongoing assessment of learning spaces results in iterative design and continuous improvement" (NLII 6). The result of good learning space design has the potential to pay tremendous dividends for the institution as a whole: "Good learning space design can support each institution's mission of enabling student learning. In fact, the convergence of technology, pedagogy, and space can lead to exciting new models of campus interaction" (NLII 7). With City Tech's evolving mission as a senior college faced with goals of improving student retention and graduation rates, good learning space design seems like an easy way to meet those goals while adapting a design that also reflects City Tech's institutional values.

literature review

Reconsidering Classroom Furniture

Considering the already-existing configuration of City Tech's current GenEd classroom space, flexibility can be most easily acquired through new types of furniture that fulfill the current focus on tablet arm chairs while adding new affordances that transform the current transmission classroom designs into dynamic active learning environments.

Steelcase Education, a furniture manufacturer for educational environments, collaborated with academic researchers to test perceptual differences to learning between traditional/transmission pedagogy classrooms and new/active learning pedagogy classrooms through a self-reported assessment by students and faculty they called the Active Learning Post Occupancy Evaluation (AL-POE) tool (Scott-Webber et al. 1). They note that, "The success of any student is influenced by many variables. Academic studies have investigated several of them, from socioeconomic background to internal motivation to the influence of different teaching styles. Still often overlooked or underemphasized is the role of classroom design" (Scott-Webber et al. 1). They go on to say that, "More recently researchers have explored how a learning environment impacts students. The consensus is that learning spaces have physical, social, and psychological effects" (Scott-Webber et al. 2). Having students and instructors use a traditional classroom or one of Steelcase Education's scenarios (Verb, Node, media:scape, or LearnLab) without any "training from Steelcase on active learning practices. The settings were simply provided for their use as they saw fit" (Scott-Webber et al. 2), they found in the self-reported results that indicate "a highly positive and statistically significant impact of active learning classrooms on student engagement" (Scott-Webber et al. 3). Specifically, they report that the new classroom environments "improved active learning practices and had more positive impact on engagement compared to the old classrooms" (Scott-Webber et al. 3), "the majority of students rated the new classroom better than the old classroom on each of the 12 factors [collaboration, focus, active involvement, opportunity to engage, multiple means, in-class feedback, real-life scenarios, ways of learning best, physical movement, stimulation, comfortable to participate, and enriching experience]," "Overall, active learning practices and the impact of the physical space significantly improved in the new classrooms for both students and faculty," and finally, "The majority of students and faculty reported that the new classrooms contributed to higher engagement, the expectation of better grades, more motivation and more creativity" (Scott-Webber et al. 4). Based on their findings, they suggest, "As a result of the development of the evaluation instrument and this managed research program, decision makers at educational institutions, architects and designers can be assured that investments in solutions intentionally designed to support active learning can create more effective classrooms and higher student engagement" (Scott-Webber et al. 5). However, they also recommend training for faculty to maximize the learning possibilities for students using the new layouts and furnitures.

Bidwell discusses the classroom configurations tested by Steelcase Education and reported by Lennie Scott-Webber, Aileen Strickland, and Laura Ring Kapitula in the white paper annotated below, "How Classroom Design Affects Student

Engagement." In addition to illustrating the types of configurations and how they were used at Ball State University and University of Minnesota-Rochester. Gary Pavlechko of Ball State tells Bidwell that, "Never did I realize just how valuable a piece of furniture can be to how one perceives the learning opportunities" (qtd. in Bidwell par. 7). He goes on to say that faculty members in the redesigned classrooms, "[seem to be] getting lost within the learning space," and ""They have become so much a part of the learning experience, versus being just the teacher in the process. . . . Direct instruction has been around for a very long period of time, but when we talk about true learning, most experts will say that in order to understand how to teach effectively, you have to be yourself an effective learner" (qtd. in Bidwell par. 15-16). Bidwell reports that Ball State faculty have to go through a "six-semester professional learning process, which in part involves observing already-trained faculty" (Bidwell par. 17), because they only have a few classrooms currently configured with this new furniture and they want to ensure that those faculty assigned to those classrooms will use its affordances for the benefit of students.

Mirror the studies above, Henshaw and Reubens report in their case study how one simple change--adopting a new desk--achieves modest goals for active learning in a traditional classroom space. The reason behind their modest experiment is true for many institutions including City Tech: "Unfortunately, much of the time that students set aside for learning does and will continue to take place in classrooms that are not schedule for major renovation, and in buildings that were not designed with broader learning goals in mind. As a result, most institutions are left to consider more immediate options for making classroom space suitable for the evidence-based interactive instructional methods that a growing number of faculty members are adopting" (Henshaw and Reubens par. 1). Considering how best to use available dollars for the greatest active learning impact on a traditional classroom, they note, "Some of the most cost-effective solutions are updates on traditional designs" (Henshaw and Reubens par. 7). They settled on the tablet arm chair, which they explain, "is almost ubiquitous in campus classrooms throughout the world. The primary enhancements to the design include the use of casters, more flexible surface work space, and beneath-seat storage options for student book bags and other personal items. None of these represent revolutionary innovations, but together they begin to address a pressing need in the typical college classroom" (Henshaw and Reubens par. 7). For their experiment, they note the availability of The Node by Steelcase, but they partnered with Kreuger International (KI) and campus stakeholders to design a new adjustable, tablet arm chair on castors dubbed the KI Learn2. On using the KI Learn2 tablet arm chairs, students and faculty reported it taking less time to move desks, it generating less noise when moving desks, and it being more comfortable due to the tablet being adjustable and larger than typical tablet arm chairs. Faculty also appreciated being able to move around the room more easily (except when bookbags littered walk spaces as the KI Learn2 has no under-chair storage space), and being able to work more closely with individual or teams of students by simply pulling up a chair or having students bring their chairs to where the instructor is seated.

Cornell argues that new furniture and classroom arrangements enable the work of education and learning, which in turn,

produces graduates ready for a rapidly changing workplace. He argues, "Furniture is both tool and environment," which until recently supported, "[an] educational system suited [to] the industrial economy" (Cornell 33). He advocates for change, because, "The industrial economy has given way to the knowledge economy" (Cornell 33). This is even more true for our students at City Tech and their future careers. In the knowledge economy, he sees education and work as being closely aligned as a reciprocal cycle of learning and work, which necessitates changes to the tools that make learning and doing possible: "Successful leaders realize they need learning organizations. Successful educators realize they need to prepare a different breed of citizen. In a sense, work needs to become more like school, where learning is an expected part of the job. And conversely, school needs to become more like work, anticipating the kinds of skills and knowledge students will require for a happy and successful life. Work activity, or pedagogy in the case of education, has changed drastically. New methods require new tools and environments. Since furniture is a tool with a specific function, it too must change" (Cornell 34). He frames the need for change in classroom furniture around "user-centered design," with the users being: "instructors and learners" (Cornell 35). He suggests four, interdependent dimensions for designing the best user-centered furniture: 1) functionality, 2) comfort, safety, and health, 3) usability, and 4) psychological appeal (Cornell 35). Importantly, he notes that some cannot be favored over all, because "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" (Cornell 35). Furthermore, he reminds us to see the bigger picture: "The best solution is one in which furniture, architecture, and technology are designed to work seamlessly and harmoniously" (Cornell 35). While all dimensions are important, his discussion of functionality adds to the specifics of furniture adaptability: "Furniture should help the instructor and student achieve their goals using the methods and tools of their choice. Furniture should facilitate learning, not just be a place to sit" (Cornell 37). In one case of deploying new furniture selected for maximizing the four dimensions, he and his fellow researchers found, "First, all four aspects of user-centered design were assessed. Second, professors varied significantly in how they taught, supporting the need for flexibility. Third, what was taught had a strong bearing on how it was taught. . . . Fourth, different display media lend themselves to different uses. All serve a purpose. And finally, the environment had an unpredictable impact on behavior" (Cornell 39). Concluding, he provides these suggestions about how to accommodate the changing pedagogical and learning needs of the contemporary classroom: "To accommodate these changes the physical environment needs to be bigger, more flexible, provide ubiquitous access to technology, promote interaction and a sense of community, enable formal and informal learning, and convey a sense of energy. The environment should be a place people want to be, not a place they have to be. They should be motivated by fun and enjoyment as much as by a desire to learn" (Cornell 41). If these changes are put into place with measurable results, these classrooms become something much more significant in terms of claims about the teaching and learning at the institution: "If properly designed and placed, furniture is more than a place to sit; it can be a strategic asset" (Cornell 42). City Tech's adoption of innovative learning spaces

could become a "strategic asset" in multiple ways: a marketing tool for attracting new students and keeping existing students, a distinction for the institution within CUNY and the region as a pedagogical innovator, and a message to donors and partners that City Tech invests in all aspects of improving student success.

Reconsidering Classroom Environments

Van Note Chism argues that greater attention be paid to the classroom environment and its significant role in education. Unequivocally, she states that, "We know too much about how learning occurs to continue to ignore the ways in which learning spaces are planned, constructed, and maintained" (Van Note Chism 5). The hurdle to overcome is, especially considering the classroom design philosophy across much of City Tech's campus, "Were the rooms designed as general issue classrooms, however, the problems with flexibility might still remain, since often so-called all-purpose rooms have fixed seating, a clear front and back that favors teacher talk and projection rather than class participation, and space capacity limitations that prevent movement and reorientation" (Van Note Chism 7). She finds this way forward through changing how we think about classroom design: "In this new constructivist thinking, where teachers serve as facilitators for active student engagement, where learning occurs in many locations, and where power is distributed across actors, learning space needs are seen to be far more dynamic and situational than they were under the transmission model. The new way of thinking about facilitating learning implies the need for small-group meeting spaces, project spaces, spaces for whole-class dialogue where the students as well as the teacher can be seen and heard, spaces where technology can be accessed easily, spaces for display of ideas and working documents, and spaces that can accommodate movement and noise" (Van Note Chism 10). In particular, the concepts of "dynamic" and "situational" are key to utilizing existing space with new ways of teaching that are more integrative than the transmission model of education.

Dittoe describes several different examples of active learning classrooms and larger environments. He begins, "Designers of educational spaces have always instinctively known that the built environment has profound effect on its occupants" (Dittoe 81). What was once "gut feeling," is now supported by a growing body of theory, practice, and assessment (Dittoe 81). He laments that the classroom, "a place that must by its very essence support and encourage learning," is often, "unfortunately . . . inadequate for this important function" (Dittoe 81). He explores how innovation is taking place at several universities to transition from an instructional paradigm to a learning paradigm where they, "are responsive to the learning paradigm, with the nuances of function, flexibility, and aesthetics necessary to bring the built environment and the educational environment into a harmonious learning relationship" (Dittoe 81). He adds that, "This is a challenge, for this relationship involves not only size and shape and bricks and mortar but also light and color and the essential ambiance that stimulates emotional connections and allows the engagement and inquisitiveness necessary for deep learning" (Dittoe 81). To produce the synergy found in active learning classrooms, he asserts that "Enormous power and creativity can occur when architects are exposed to new ways of thinking about teaching and learning. . . . Similar enhancement occurs

when educators learn about the architectural viewpoint and about new developments in space design" (Dittoe 82). Of the spaces he describes, they exhibit differences due to having "different goals," but all of them, "allow creative and spontaneous learning," and "provide responsive built environments that encourage students to take charge, with proper guidance, of their own education" (Dittoe 82). These spaces are "student-centered and empowering," (Dittoe 82). Specifically, he focuses on how they "have affected the educational process in terms of space, furnishings, and equipment, the capacity to be functional and flexible, and provision of appropriate atmosphere and technology sufficient for the educational purpose" (Dittoe 82). Two of his examples stood out for consideration at City Tech in a GenEd course. First, The Prototype Laptop Classroom at Ohio Dominican College provided a challenge to architects to redesign a typically 600 sq. ft. classroom into an active learning classroom. They brought in stakeholders from all of the departments that would potentially use the classroom for input. Showing the datedness of the article, he describes how the classroom has a 2" false floor hiding electrical and ethernet for the classroom's laptops. The room contains "softly sculpted tables and large padded armchairs," "white boards lining two walls," and "audio visual equipment" in the rear (Dittoe 84-85). Better examples are the Innovative Classrooms at Rensselaer Polytechnic Institute, or what they call, "studio classrooms," used by many disciplines on campus (Dittoe 88). Describing these rooms in detail, he writes, "Studio classrooms at Rensselaer vary from room to room, with two predominant designs--the cluster configuration and the theater-in-the-round configuration. Cluster classrooms situate two to four students at tables around a single workstation. The clusters are arranged in rooms that have normal projection space along one wall but are otherwise flexible with respect to where the instructor is stationed. Often, there is display space all around the room so that students can work at white boards or chalkboards with their peers or the instructor. In these spaces, the instructor can circulate easily while students work, or can stand at one location easily seen and heard by students, who can swing their chairs around to obtain a good sight line" (Dittoe 88-89). Continuing his description, he writes, "In the theater-in-the-round configuration, students work two at a table supporting either one or two computers. The tables are arranged in concentric ovals, often in tiers, with the instructor station at one end and the student chairs on the inside of each oval. Students turn their chairs to the center for whole group discussion or lecture and away from the center for work on the computers. This arrangement prevents students from being distracted by the workstations while they are interacting or listening and affords the instructor a view of the screens from the center when the students are using the computers" (Dittoe 89). In both cases, "the basic design permits teachers to move fluidly from whole-group to small-group activity, from presentation to active engagement" (Dittoe 89). He remarks that, "These spaces reveal the subtle yet profound ways in which surroundings affect activity. It is disturbing to accept the bland classrooms of today as suitable for the most important of human endeavors--learning" (Dittoe 90). In addition to considerations of filling existing spaces with new equipment and furniture, Dittoe's observations point to the fundamental need for purpose-designed and built spaces for learning. Of course, these spaces should be dynamic and flexible, but they need to thought out, assessed, and learned from for improved learning space utilization in the future. One way to accomplish this at City Tech would be to design, build, and test

a small number of GenEd classroom spaces. Knowledge gained from these experiments could be expanded to other classrooms when the need and funding arise for classroom remodeling in City Tech's campus buildings.

Should experimentation with innovative classroom design be undertaken at City Tech, Barrett et al. provide insights for such research on these classroom spaces and a tested experimental model that attempts to understand "the complex problem" of "the holistic impact of built spaces on people 'in the wild'" (Barrett et al. 678). This model is "an Environment-Human-Performance (E-H-P) model that allowed the measurement, and so assessment, of built spaces and their human impacts" (Barrett et al. 679). This model was designed by considering "the hypothesis that the characteristics of the brain's functioning in synthesising sensory inputs highlights the importance of three broad design principles concerning our environment, namely: naturalness, indivdualisation and the appropriate level of stimulation. In this case, these relate, respectively, to: our basic animal demands, the needs of pupils in particular and the implications of the school-learning situation" (Barrett et al. 679-680). Of the classrooms studied, "It should be remembered that the spaces have been assessed in functional terms, focusing entirely on the impact of the differences between spaces on the academic performance of the pupils. In this context, it can be seen that parameters to do with the design principle of 'individualisation' are prominent" (Barrett et al. 688). Some of the most notable findings of environmental factors that support student learning that are addressable by reconfiguration of existing spaces include: natural light, "Classroom has high quality and quantity of electrical lightings," "The space adjacent to the window is clear without obstruction," "Classroom has a high-quality and purpose-designed Furniture Fixture & Equipment (FF&E)," "Interesting (shape and colour) and ergonomic tables and chairs," "More zones can allow varied learning activities at the same time," "The teacher can easily change the space configuration," "With regard to the display and decoration, classroom needs to be designed with a quiet visual environment, balanced with a certain level of complexity," "Colour of the wall, carpet, furniture and display can all contribute to the colour scheme of a classroom. However, it is the room colour (wall and floor) that plays the most important role" (Barrett et al. 688). Finally, they found that the six environmental factors of light, choice, flexibility, connection, complexity, and color "account for, in the order of, 25% of the learning progression of pupils" (Barrett et al. 688).

City Tech has a tremendous opportunity to be an innovator in learning spaces for the benefit of its students and to achieve its institutional goals. Considering the philosophy behind learning spaces, there are many different ways to deploy flexibility and adaptability into City Tech's GenEd classrooms. The most radical, with the greatest potential payoff, would be to remodel a small selection of GenEd classrooms, pair these rooms with instructors willing and able to use these new classroom's affordances in their GenEd classes, and assess how well they work by surveying instructors and students and measuring student learning outcomes against control classrooms (similar rooms in the same buildings that are not remodeled). The most cost effective, with a strong potential payoff, would be to outfit a standard GenEd classroom with new furniture, such as The Node or KI Learn2, pair these rooms with instructors willing and able to use these new classroom's affordances in their GenEd

classes, and assess how well they work by surveying instructors and students and measuring student learning outcomes against control classrooms (similar rooms in the same buildings that use a standard tablet arm chair). With this information, City Tech can strategize how best to use these techniques to make improvements that support our students and the goals of the institution. Additionally, publication of these efforts would highlight City Tech's investment in classroom design, which would elevate the institution's prestige and potentially attract investment from donors and partners.

WORKS CITED

Ambrose, Susan A. “How Learning Works: Seven Research-based Principles for Smart Teaching.” San Francisco, CA: Jossey-Bass, 2010. Print.

Baepler, Paul and J. D. Walker. “Active Learning Classrooms and Educational Alliances: Changing Relationships to Improve Learning.” New Directions for Teaching and Learning 137 (Spring 2014): 27-40. Wiley Online Library. 26 Sept. 2015.

Barrett, Peter, Yufan Zhang, Joanne Moffat, and Khairy Kobbacy. “A Holistic, Multi-Level Analysis Identifying the Impact of Classroom Design on Pupils’ Learning.” Building and Environment 59 (2013): 678-689. Elsevier. 26 Sept. 2015.

Bidwell, Allie. “A Swivel Chair: The Most Important Classroom Technology?” U.S. News & World Report 21 July 2014: n.p. Web. 26 Sept. 2015.

Center for the Enhancement of Teaching and Learning (CETL). “Teaching for Learning: A Philosophical Approach to Classroom Design - Five Basic Principles.” Center for the Enhancement of Teaching and Learning. Georgia Institute of Technology. Spring 2009. Web. 26 Sept. 2015.

Cornell, Paul. “The Impact of Changes in Teaching and Learning on Furniture and the Learning Environment.” New Directions for Teaching and Learning 92 (Winter 2002): 33-42. Wiley Online Library. 26 Sept. 2015.

Dittoe, William. “Innovative Models of Learning Environments.” New Directions for Teaching and Learning 92 (Winter 2002): 81-90. Wiley Online Library. 26 Sept. 2015.

Henshaw, Robert Griffith and Andrea Reubens. “Evaluating Design Enhancements to the Table Arm Chair in Language Instruction Classes at UNC Chapel Hill.” Journal of Learning Spaces 2.2 (2013): n.p. Web. 24 Sept. 2015.

National Learning Infrastructure Initiative. “Leading the Transition from Classroom to Learning Spaces: An NLII White Paper.” Educause.edu. Educause. Oct. 2004. Web. 26 Sept. 2015.

Scott-Webber, Lennie, Aileen Strickland, and Laura Ring Kapitula. “How Classroom Design Affects Student Engagement.” 360°: Exploring Workplace Research, Insights, and Trends. Steelcase Education. 2014. Web. 26 Sept. 2015.

Van Note Chism, Nancy. “A Tale of Two Classrooms.” New Directions for Teaching and Learning 92 (Winter 2002): 5-12. Wiley Online Library. 26 Sept. 2015.

Wulsin Jr., Lawson Reed. “Classroom Design - Literature Review.” The Special Committee on Classroom Design. Princeton University. Summer 2013. Web. 26 Sept. 2015.

national context

universities and colleges redefining classroom design

national context

Universities and colleges around the country are increasingly exploring the benefits of innovative classroom environments that move beyond a lecture focused model of education. Some have formed faculty institutional committees specifically around this topic. Pilot programs are becoming more common, with assessment of student learning providing evidence of impact. The findings are being integrated into planning documents and design guidelines for renovations and new construction of classrooms. The list below provides some examples of the types of studies, reports, and guidelines found in universities and colleges across the country.

Georgia Institute of Technology

In this document, Georgia Tech outlines the key principles for classroom design:

1. Classrooms should facilitate student engagement
2. Classrooms should facilitate student collaboration
3. Classrooms should facilitate connections between teachers & students
4. Classrooms should incorporate appropriate technology.
5. Classrooms should have flexible physical arrangements

Center For The Enhancement Of Teaching And Learning. “Teaching for Learning: A Philosophical Approach to Classroom Design - Five Basic Principles.” Center for the Enhancement of Teaching and Learning, Georgia Institute of Technology, spring 2009. Web. 25 Apr. 2016. http://www.cetl.gatech.edu/sites/default/files/Classroom%20Design%20-%20Principles%20and%20Information%20for%20Georgia%20Tech.pdf

Morgan State University

AIA supported study of the “extent the design of the physical learning space contributes to enhanced learning outcomes in an undergraduate, active learning class of ethnically diverse students”.

Determine, James, Mary Anne Akers, Isaac Williams, Christine Hohmann, and Catherine Martin-Dunlop. “Learning Space Design for the Ethnically Diverse Undergraduate Classroom.” SCUP Book. Society for College and University Planning, n.d. Web. 25 Apr. 2016. http://www.aia.org/aiaucmp/groups/aia/documents/pdf/aiab106445.pdf

national context

University of Minnesota

In their evaluation of a pilot program of active learning classrooms, responses to a questionnaire by faculty using the active classrooms noted improved and deeper relationship with students and more collaboration between students. Student responses to a questionnaire showed "very positive" reactions to active learning classrooms, including the positive impacts on teamwork and collaborative projects as well as the encouragement of discussion during classes. Students also felt more connected to their instructor and their classmates.

Alexander, Deb, Bradley Cohen, Steve Fitzgerald, Paul Honsey, Linda Jorn, John Knowles, Peter Oberg, Jeremy Todd, J.D. Walker, and Aimee Whiteside. *Active Learning Classrooms Pilot Evaluation: Fall 2007 Findings and Recommendations.* Rep. Minneapolis: U of Minnesota, 2008. Web. 2 May 2016. http://www.classroom.umn.edu/projects/alc_report_final.pdf

Arizona State University

ASU's classroom design guide includes space planning guidelines linked to teaching style:

Lecture Room:	17 square feet/student
Collaborative/Seminar:	22 square feet/student
Computer Instructional:	32 square feet/student.

ASU's guide also argues for alternative approaches to the tablet armchair lecture room, where rooms can "accommodate a variety of teaching methods, quick re-configuration, and technology." Programming exercises reveal faculty and student demand for flexible space and collaborative work spaces. Larger flat work surfaces are recommended in lieu of tablet armchairs to accommodate technology and books. Teamwork and collaborative work are promoted as more appropriate for current preparation for the workforce.

Classroom Design Guide. Rep. Arizona State University, May 2013. Web. 2 May 2016. <https://www.asu.edu/fm/documents/project_guidelines/Classroom-Design-Guidelines.pdf>.

national context

University of California, Berkeley

Faculty discuss the value of an active learning environment and the virtues of flexible arrangements that allow them to adjust the setting to enhance the goals for that day's class.

"Active Learning: Using Flexible Furniture." *You Tube.* University of California, Berkeley, 1 May 2015. Web. 3 May 2016. <https://youtu.be/epkrMKxRjss?list=PLNumXaqPunZleqgphXIR8WYnnQbOfaNRd>.

University of Indiana

Faculty discuss the value of an active learning environment.

"Collaborative Learning Studio at IU Bloomington." *YouTube.* University of Indiana, 1 Feb. 2014. Web. 03 May 2016. <https://youtu.be/V--U83Zz8Do?list=PLNumXaqPunZleqgphXIR8WYnnQbOfaNRd>.

University of Michigan

Michigan's classroom planning guide includes space planning guidelines linked to teaching style:

Lecture Room:	20 square feet/student
Collaborative/Seminar:	25 square feet/student
Active Learning Classroom:	30 square feet/student

Michigan's document on classroom planning emphasizes assessing the effectiveness of existing classrooms and seeking feedback from faculty, staff, and students to help determine "what types of room configurations, furniture, technology, and amenities work well for current and pedagogical needs." This feedback can be gained through formal surveys or focus groups. The planning document notes the unique role student feedback can play in planning classroom spaces: "students offer a completely different perspective from faculty or staff when planning classrooms. They are able to identify things that only those who spend several hours a week in the space can identify, such as the lack of a clock, obstructions in the view to the instructor, or acoustical or lighting issues." Michigan's recommended process for planning new classrooms or renovations of existing classrooms includes forming a dedicated Classroom Design Working Group to seek feedback and define the requirements.

Considerations for Planning New General Purpose Classrooms. Rep. University of Michigan, 18 May 2012. Web. 2 May 2016. <http://www.provost.umich.edu/space/instruct/ClassroomPlanningConsiderations.pdf>.

accreditation context

middle states commission on higher learning standards

accreditation context

Middle States standards for accreditation have implications for the learning environment. This section outlines the standards where the planning, design, and assessment of learning spaces on campus can play a role in meeting the criteria:

STANDARD III: Design and Delivery of the Student Learning Experience

An institution provides students with learning experiences that are characterized by rigor and coherence at all program, certificate, and degree levels, regardless of instructional modality. All learning experiences, regardless of modality, program pace/schedule, level, and setting are consistent with higher education expectations.

CRITERIA 2: student learning experiences that are designed, delivered, and assessed by faculty (full-time or part-time) and/or other appropriate professionals who are:

a. rigorous and effective in teaching, assessment of student learning, scholarly inquiry, and service, as appropriate to the institution's mission, goals, and policies;
b. qualified for the positions they hold and the work they do;
c. sufficient in number;
d. provided with and utilize sufficient opportunities, resources, and support for professional growth and innovation;
e. reviewed regularly and equitably based on written, disseminated, clear, and fair criteria, expectations, policies, and procedures;

STANDARD V: Educational Effectiveness Assessment

Assessment of student learning and achievement demonstrates that the institution's students have accomplished educational goals consistent with their program of study, degree level, the institution's mission, and appropriate expectations for institutions of higher education.

CRITERIA 3: consideration and use of assessment results for the improvement of educational effectiveness. Consistent with the institution's mission, such uses include some combination of the following:

a. assisting students in improving their learning;
b. improving pedagogy and curriculum;
h. implementing other processes and procedures designed to improve educational programs and services;

accreditation context

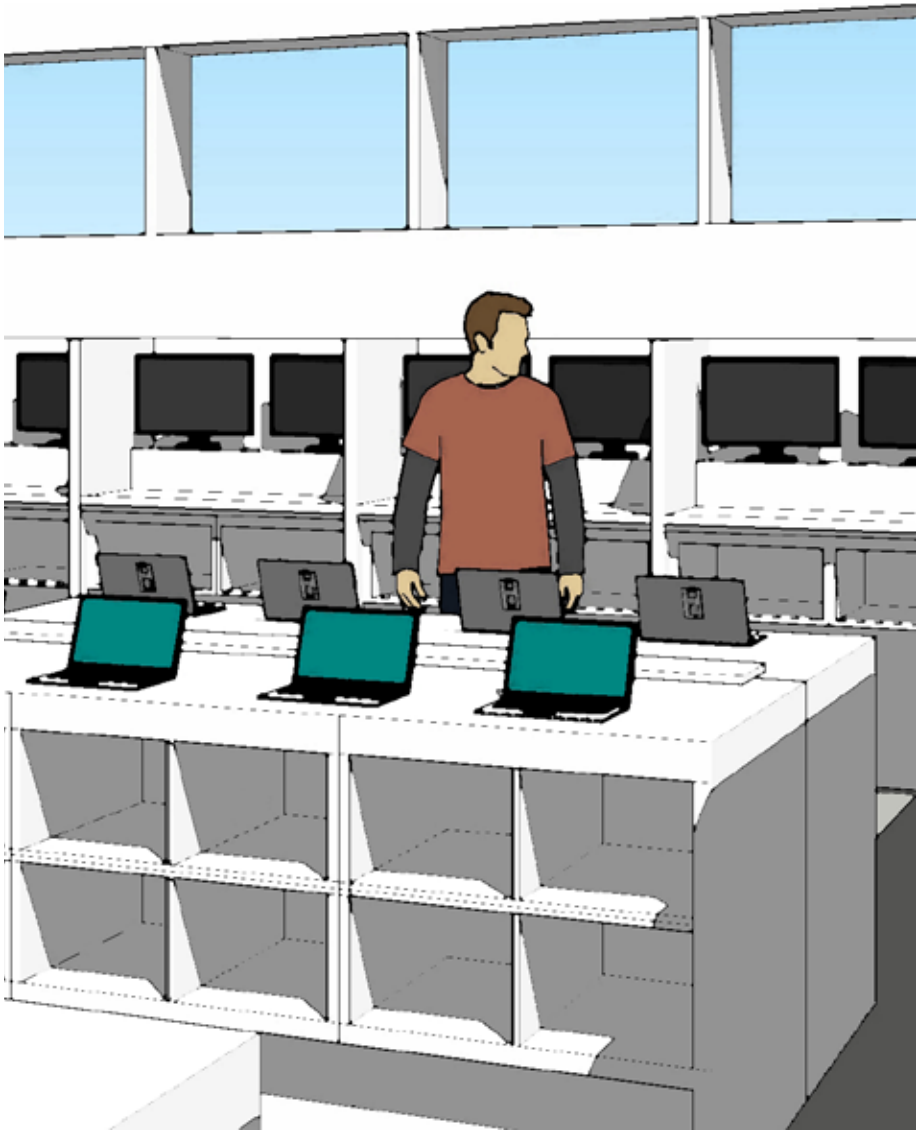
STANDARD VI: Planning, Resources, and Institutional Improvement

The institution's planning processes, resources, and structures are aligned with each other and are sufficient to fulfill its mission and goals, to continuously assess and improve its programs and services, and to respond effectively to opportunities and challenges.

CRITERIA 2: clearly documented and communicated planning and improvement processes that provide for constituent participation, and incorporate the use of assessment results;

CRITERIA 4: fiscal and human resources as well as the physical and technical infrastructure adequate to support its operations wherever and however programs are delivered;

CRITERIA 6: comprehensive planning for facilities, infrastructure, and technology that includes consideration of sustainability and deferred maintenance and is linked to the institution's strategic and financial planning processes;



college context

gen ed work on campus

college context

IMPORTANT GENERAL EDUCATION LEARNING GOALS—ADOPTED BY COLLEGE COUNCIL MARCH 2013:

New York City College of Technology aspires to be a living laboratory where General Education

- is represented by a mutually accepted core of knowledge, skills, and values that permeate all courses, not only in the liberal arts and sciences, but across the majors.
- makes rich use of the physical, historical, economic, and cultural aspects of our location in a diverse urban community
- stresses active learning and creative problem solving
- encourages engagement in personal, professional, and civic communities
- integrates theory/ knowledge and hands- on/ application
- maintains a global focus/ perspective
- is communications intensive

LIVING LAB GRANT

New York City College of Technology (City Tech) was awarded a $3.1 million grant from the U.S. Department of Education (DOE) under its Strengthening Hispanic-Serving Institutions (HSI) Title V Program with the goal of connecting City Tech students, faculty and curriculum to the dynamic "Living Laboratory" of the Brooklyn Waterfront in new and creative ways. The main mission of the grant titled, "A Living Laboratory: Revitalizing General Education for a 21st Century College of Technology," is to re-envision General Education as a Living Laboratory using City Tech's strengths: hands-on experiential models of learning and the vibrant Brooklyn Waterfront location. Among the four interrelated activities of the "Living Lab" grant, one is the General Education Seminar that brings together diverse groups of faculty fellows from across disciplines at City Tech to re-imagine and revitalize General Education.

BRIDGING THE GAP PROFESSIONAL DEVELOPMENT SEMINARS

This is a study group sponsored by Faculty Commons, bringing together like minded group of professors, from different departments, interested in cognitive research and instructional practice. The faculty meet in multiple groups, led by Faculty Commons facilitators. In the seminar faculty discuss the seven research-based principles for smart teaching and how to apply these principles in our teaching practice

(text: Ambrose, Susan A. "How Learning Works: Seven Research-based Principles for Smart Teaching." San Francisco, CA: Jossey-Bass, 2010. Print.

Part II

three learning spaces

testing strategies for active learning environments

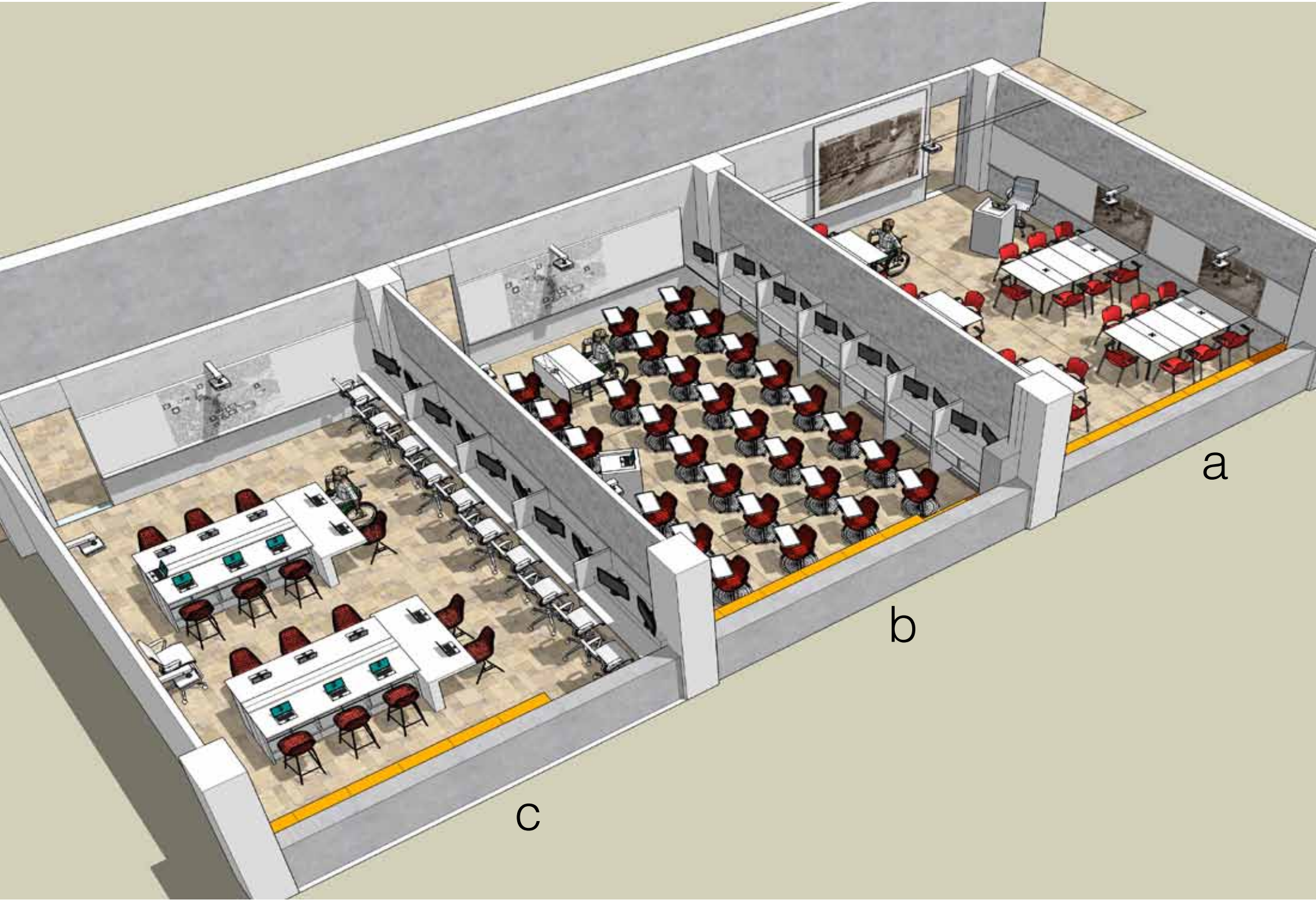
three learning spaces

overview

Based on the current research in the field of learning spaces and the pragmatic reality of established classroom construction in much of City Tech's existing building spaces, we explore several models of classroom design that meets the seating capacity requirement of Gen Ed classrooms while adopting new layouts that improve the pedagogical use of these spaces for a variety of different pedagogical styles ranging from tradition (lecture) to dynamic (active learning, collaboration, peer-to-peer learning, teamwork, and technology rich).

To simplify our design suggestions and to reconsider a constraint as an auspicious affordance, we focused on the typical Namm Building classroom and its approximate 21' x 29' dimensions (617 sq.ft) to re-imagine learning space possibilities at City Tech. Within this space, we propose three different furniture layouts that incorporate a student seating capacity of 35, 29, and 26 students respectively (depicted in the image above and explained in detail below). In each layout, there are different affordances, such as different types of seating, student work arrangements, and classroom technology, and different constraints, such as seating capacity and furniture movement.

All three designs share a common theme of dynamic reconfiguration for student learning experiences and different faculty pedagogies. Each also shares an incorporation of new forms of technology into the Gen Ed learning space (some more, some less). Despite new furniture and different types of computer and display technology, it should be noted that unclaimed wall space in the designs would be filled with whiteboards to accommodate the full gamut of teaching styles and learning opportunities.


a
b
c

three learning spaces

a: collaboration + group work

35 students @ 17.63 sq. ft. / student

b: multi-modal (lecture +)

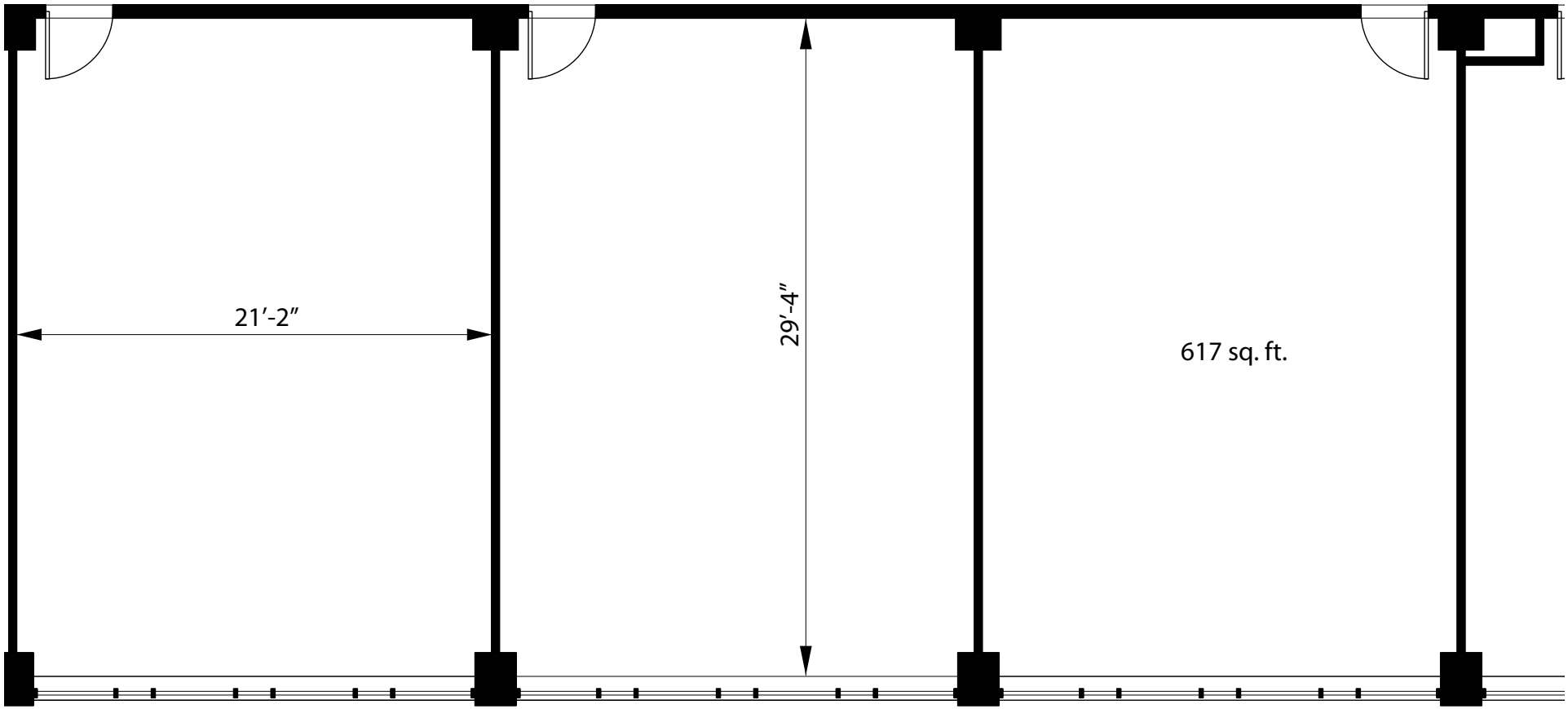
29 students @ 21.28 sq. ft. / student

c: active learning lab

26 students @ 23.73 sq. ft. / student

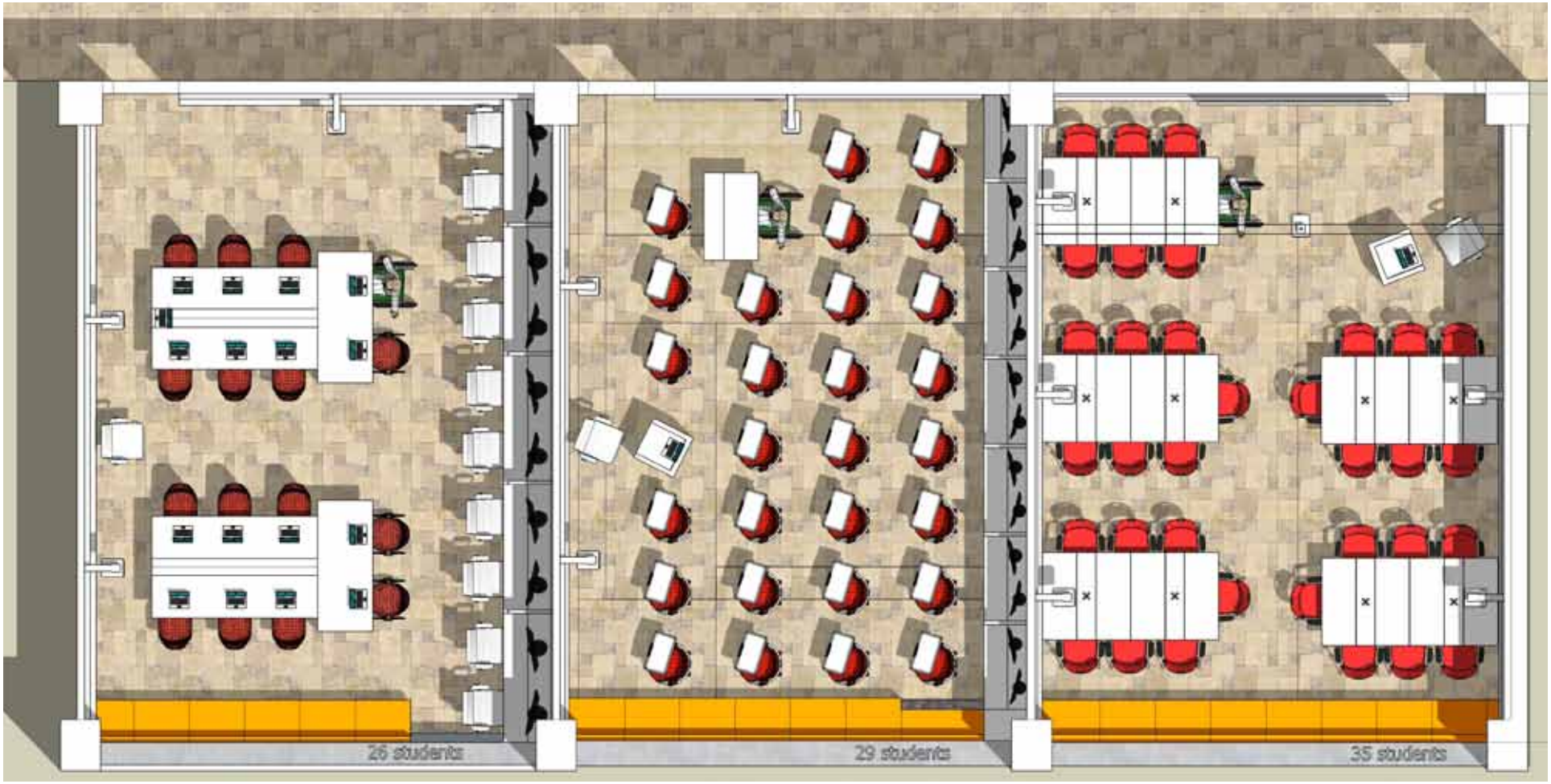
existing space

Namm Hall typical classroom



35 students: 17.63 sq. ft. / student
32 students : 19.28 sq. ft. / student
29 students: 21.28 sq. ft. / student
26 students: 23.73 sq. ft. / student

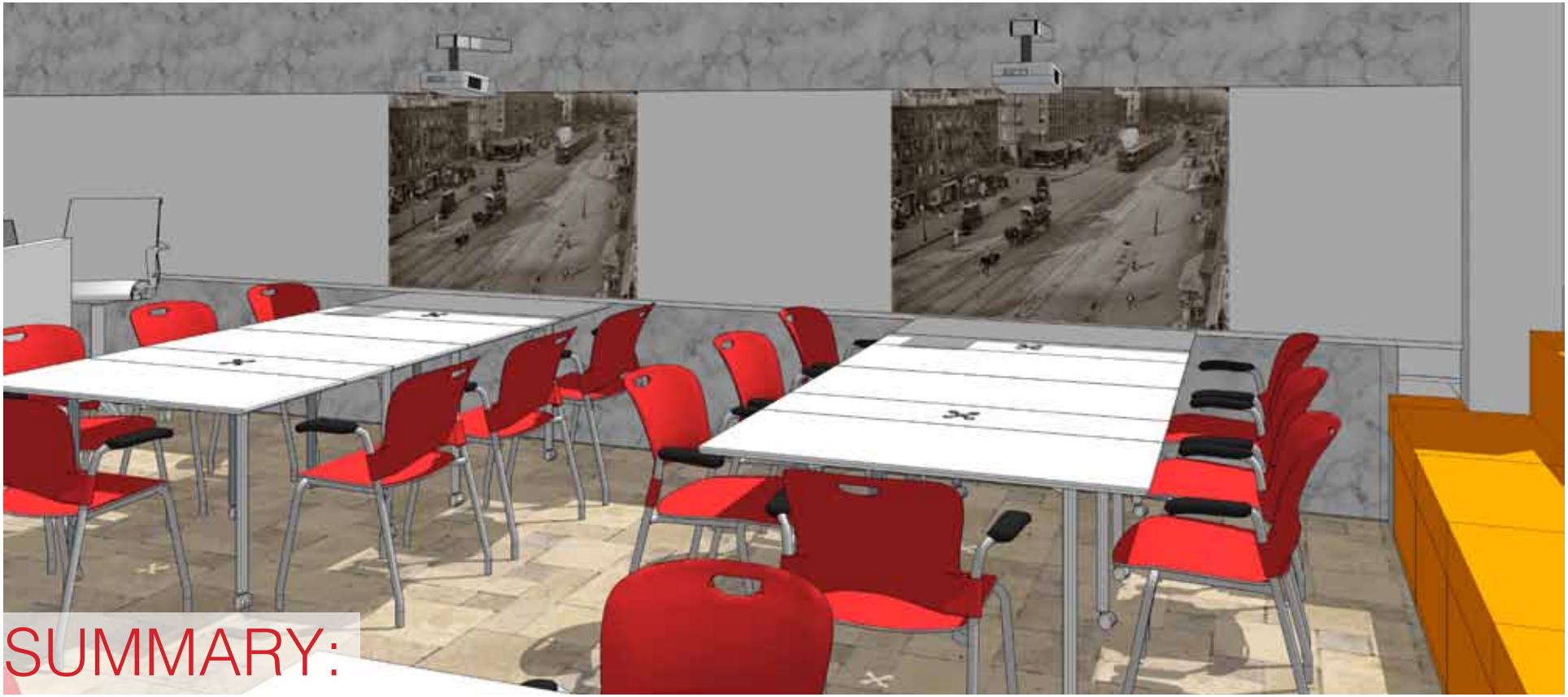
three possibilities



c b a

35
students

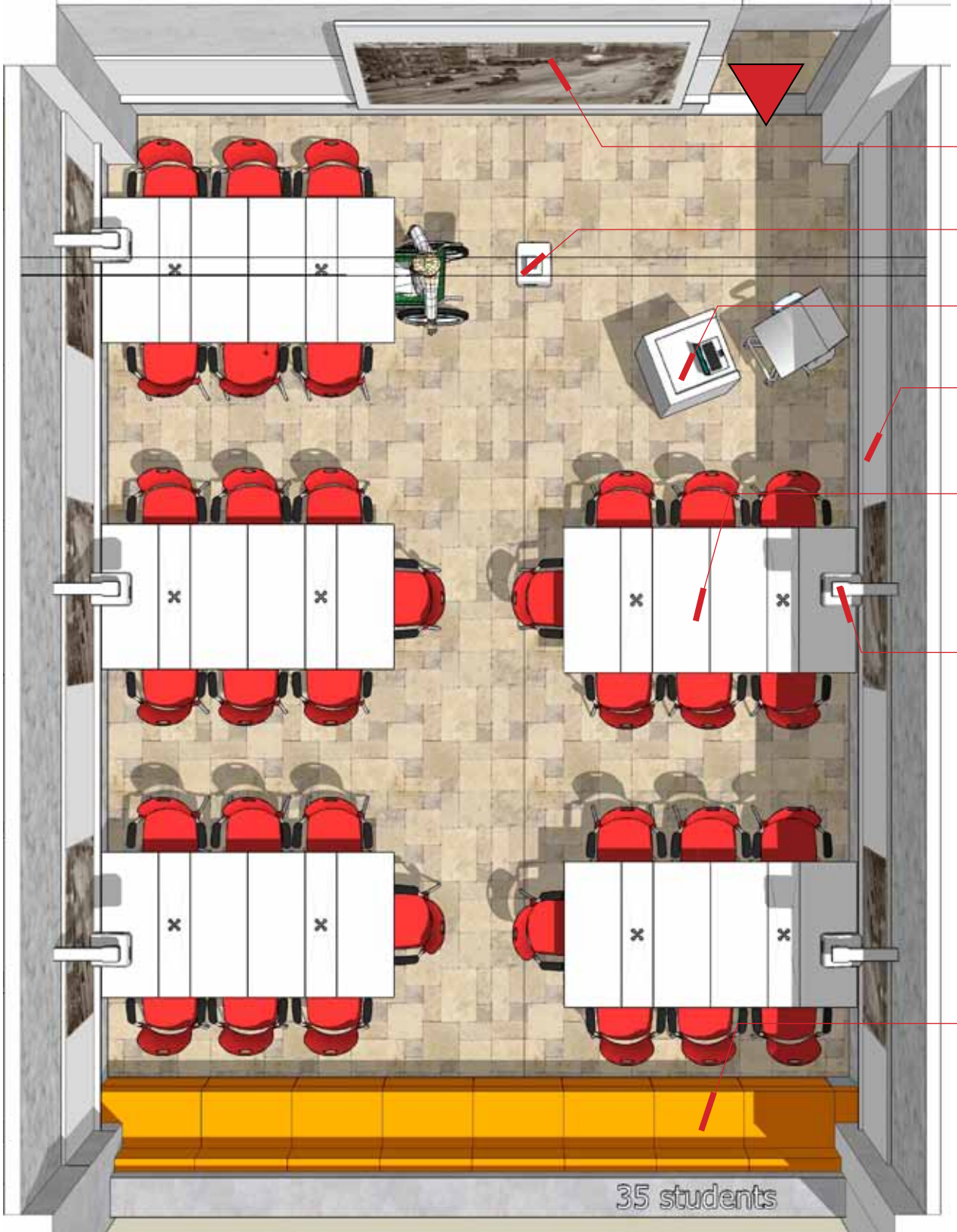
learning space a
collaboration + group work



SUMMARY:

This classroom is built around collaboration, discussion, and group work, fostering routine interaction between the students before and during class. Students can follow the instructor's presentation locally on the whiteboard adjacent to the table. Group project work or group discussion is enhanced by local projection capability from student laptops or college supplied devices as well as annotation and notes on the whiteboard surface.

This layout de-emphasizes a "front" or "back" of the classroom. Chairs are supplied with wheels to allow for easy rotation and movement. The tables fold and move out of the way for re-configuration of the room.



DROP-DOWN SCREEN FOR LARGE SCALE PROJECTION

CEILING PROJECTOR FOR LARGE SCALE PROJECTION

INSTRUCTOR'S PODIUM

WHITEBOARDS ON 3 WALLS

GROUP TABLE FOR 7 STUDENTS ADJACENT TO WALL OUTLETS FOR POWER + DATA

5 SHORT THROW PROJECTORS ABOVE EACH GROUP TABLE. CONTROLLABLE LOCALLY BY STUDENTS AT TABLE OR INSTRUCTOR'S PODIUM.

WINDOW BENCH (INFORMAL) SEATING FOR USE IN ALTERNATIVE ROOM CONFIGURATIONS

DESCRIPTION:

Instead of using tablet armchairs as is found in the traditional Namm classroom, this design utilizes moveable tables to create learning space centered on teams of seven students per table. With five tables in each classroom, this design accommodates 35 students with room for the instructor's podium and chair, and ample walking space between the center of the classroom and between the seating. An informal seating bench runs along the back wall beneath the window.

Each table gives its seven students adequate space for their notebook, a textbook, and BYOD technology. The tables are designed to fold into a small footprint for reorganization of the space for seated lecture, student presentations, technology demonstrations, or film viewing.

furntiure
possible selections

HERMAN MILLER

CAPER STACKING
CHAIR
W/ CASTERS

35 TOTAL

HERMAN MILLER

CAPER
MULTIPURPOSE
STOOL

1 TOTAL

HERMAN MILLER

INTERSECT FOLD-
AWAY TABLE
(SQUARE) 4'x4'

10 TOTAL

EPSON

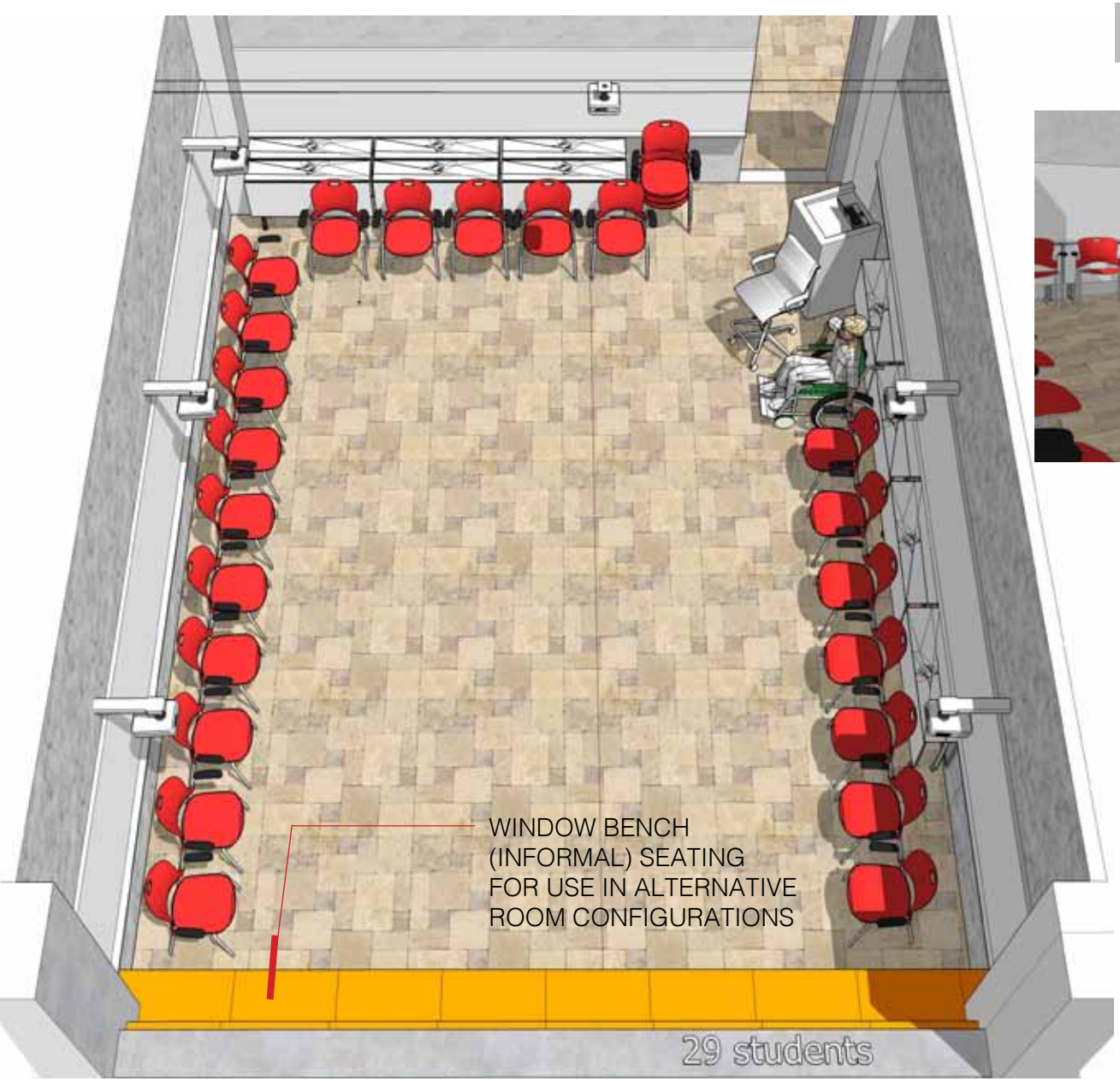
EB-595WI
PROJECTOR

or similar

6 TOTAL

reconfigured space

learning space a



The technology in this classroom includes a front mounted LCD display or projector connected to the instructor's podium computer. Along the two sidewalls, five LCD displays or projectors are mounted adjacent to each table and mirror the video content of the instructor's podium computer.

This classroom design maximizes student seating and student tabletop workspace for a variety of different Gen Ed classes. Using tables facilitates different kind of student work ranging from individual work, collaborative work, and peer review. In addition to using paper notebooks, students can use larger forms of paper, such as newsprint tablets, for writing and drawing according to the assignments given to them by their instructors.

learning space b

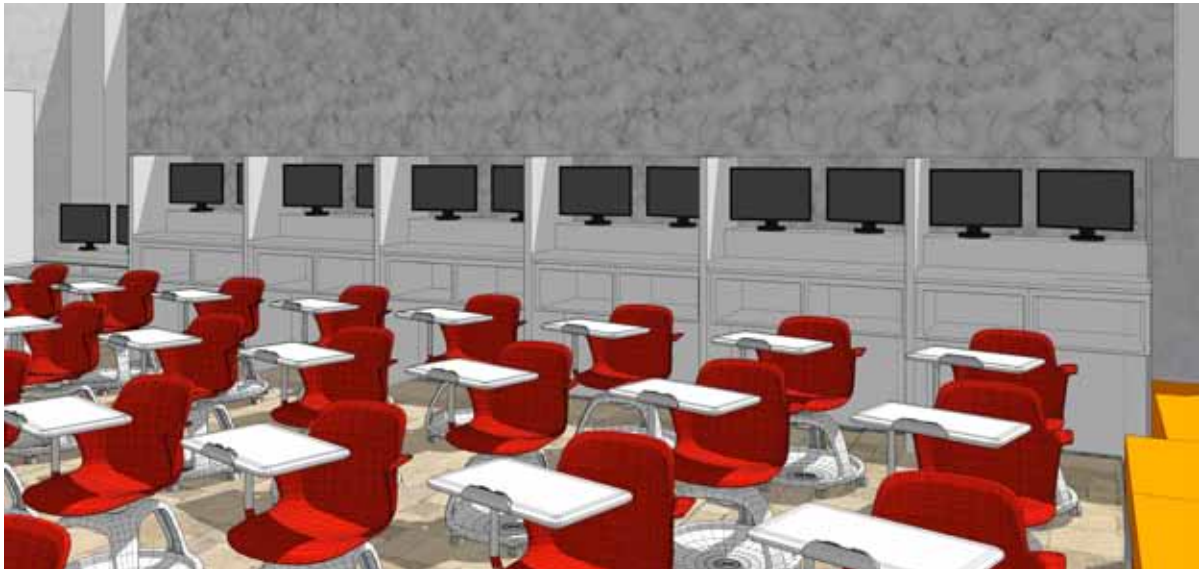
multi-modal (lecture +)

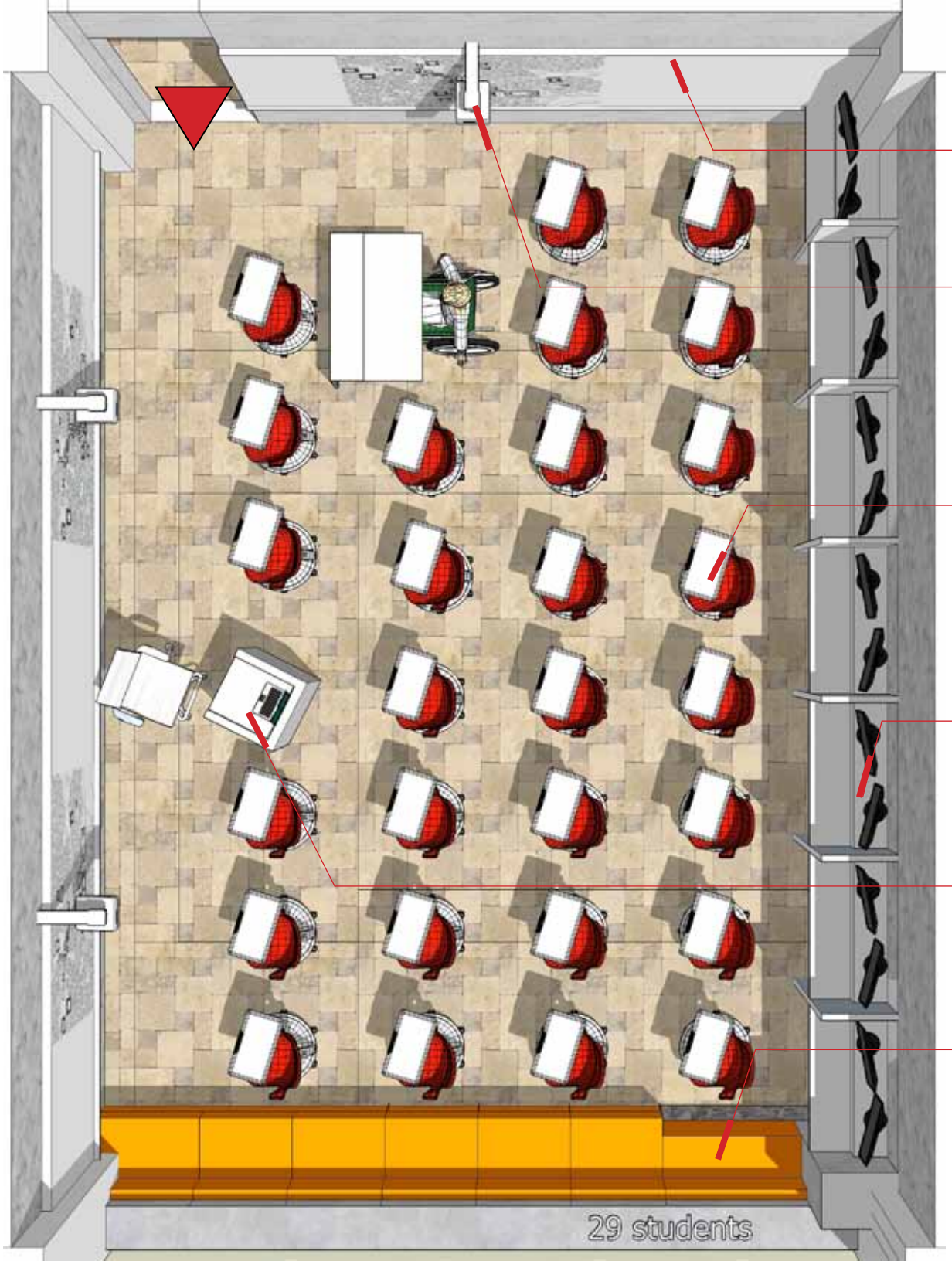
29
students

SUMMARY:

This classroom provides a traditional lecture setting with a primary projection wall and instructor podium. Three projectors facilitate increased visibility of presentations. Full length whiteboards on 2 walls allows for annotations and notes during instructor or student presentations. Two-person standing and ADA computing stations along one wall allow for in-class short duration collaborative digital work by a subset of the students.

The tablet armchairs on wheels allow for re-configuration of the room into smaller discussion groups or a seminar style circle. Informal seating is available by the windows.





WHITEBOARDS ON 2 WALLS

3 SHORT-THROW PROJECTORS
FOR HIGHER VISIBILITY AND ROOM
CONFIGURATION FLEXIBILITY

TABLET CHAIR ON WHEELS FOR EASY
RE-CONFIGURATION OF CLASSROOM
FROM LECTURE MODE TO BREAK-OUT/
DISCUSSION GROUP

COLLABORATIVE WORKSTATIONS
6 STANDING + 1 ADA

INSTRUCTOR'S PODIUM

WINDOW BENCH (INFORMAL) SEATING
FOR USE IN ALTERNATIVE ROOM
CONFIGURATIONS

DESCRIPTION:

Beginning with the Namm classroom space, this proposed design takes a different approach by using an innovative tablet armchair, such as the Steelcase Node, for a seating capacity of 29 students combined with seven, shared standing workstations along one sidewall, and an informal seating bench along the window wall.

The Steelcase Node tablet armchairs include a larger student workspace, caster wheels for easy and quiet rearrangement of seating, and storage space underneath the seat. They can be easily and effortlessly be moved about the classroom space for a variety of seating arrangements including lecture (rows facing the front of the classroom) and breakout groups (teamwork, peer review, collaboration).

furntiure
possible selections

STEELCASE

NODE MID-BACK CHAIR

TRIPOD BASE WORK SURFACE + CASTERS

29 TOTAL

BUILT-IN (4'w/2'd/5.5't)

2 PERSON STANDING WORKSTATION

POWER + DATA OUTLETS +CUBBIES

6 + 1 ADA TOTAL

HERMAN MILLER

CAPER MULTIPURPOSE STOOL

1 TOTAL

EPSON

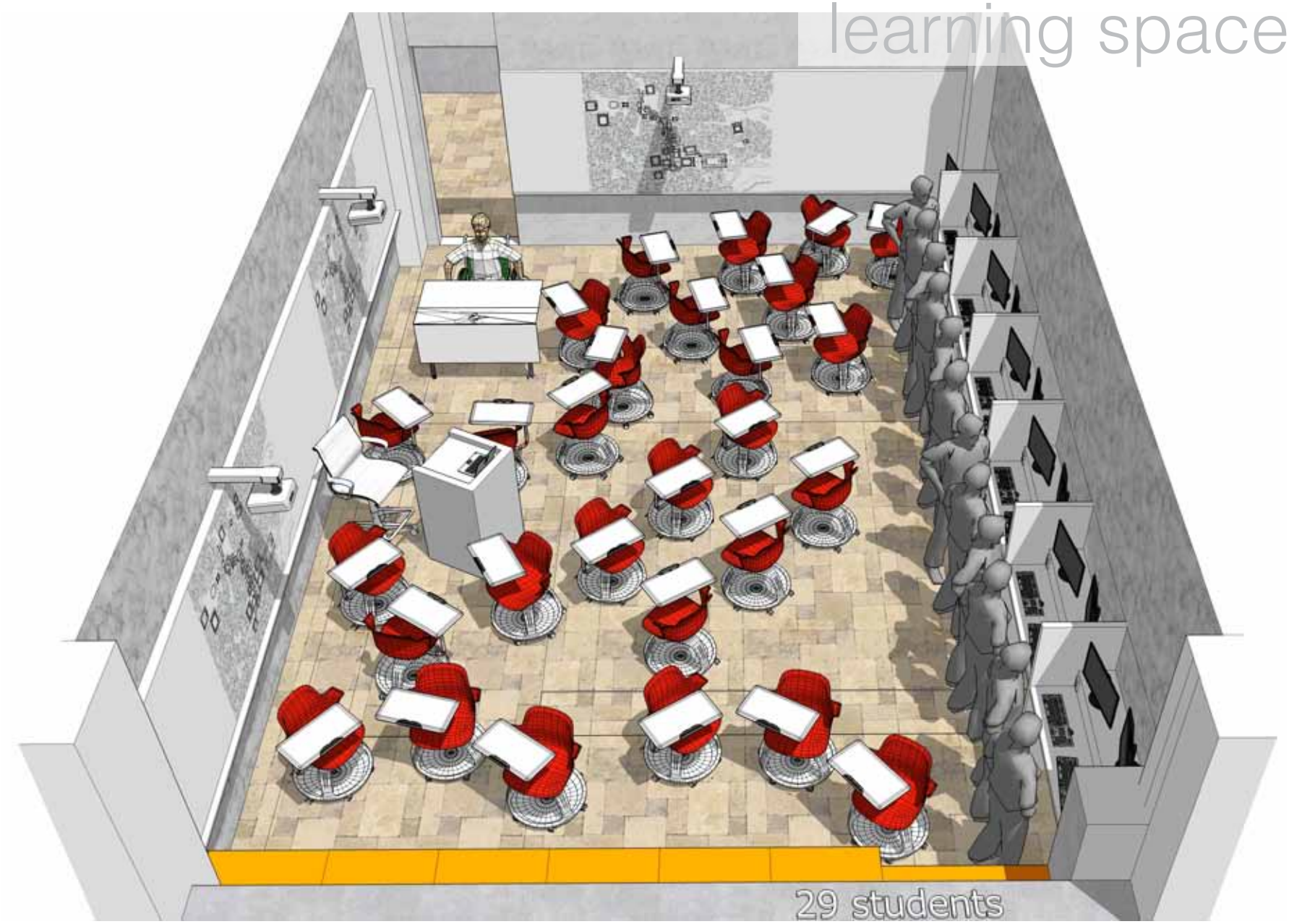
EB-595WI PROJECTOR

or similar

6 TOTAL

reconfigured space

learning space b



The seven shared, standing workstations along the sidewall enable students to work in small groups or pairs to use the computer for in-class assignments, such as writing, research, or illustration. The workstations are meant to enable other kinds of technology-driven class work without placing an undue burden on students to BYOD.

The sidewall opposite of the standing workstations serves as the instructor's focal point. It includes the instructor's podium and chair, and two LCD displays or projectors connected to the instructor's podium computer.

In addition to the perspectival and top-down views of the Node tablet chairs in rows shown above, the images below and opposite depict the classroom in breakout session arrangements, which include the chairs rearranged for teams and students standing up to use the workstations along the sidewall.

Using a combination of Steelcase Node tablet chairs and the standing workstations accommodates a variety of different Gen Ed courses and opens new possibilities for pedagogical experimentation and innovation by leveraging new furniture and technology to improve the learning environment of the fixed Namm classrooms. Furthermore, the Steelcase Node chairs facilitate an easy of classroom reorganization—of course, something that faculty do in the Namm classrooms now—in an easy and quiet way as to reduce classroom disruption in the faculty member's classroom doing the reorganization as well as reduce classroom disruption in the classrooms adjoining the reorganized classroom in all three dimensions (adjacent, across the hall, above, and below).

This design provides the greatest number of student seats for the number of possible seating configurations and classroom technology options.

learning space c

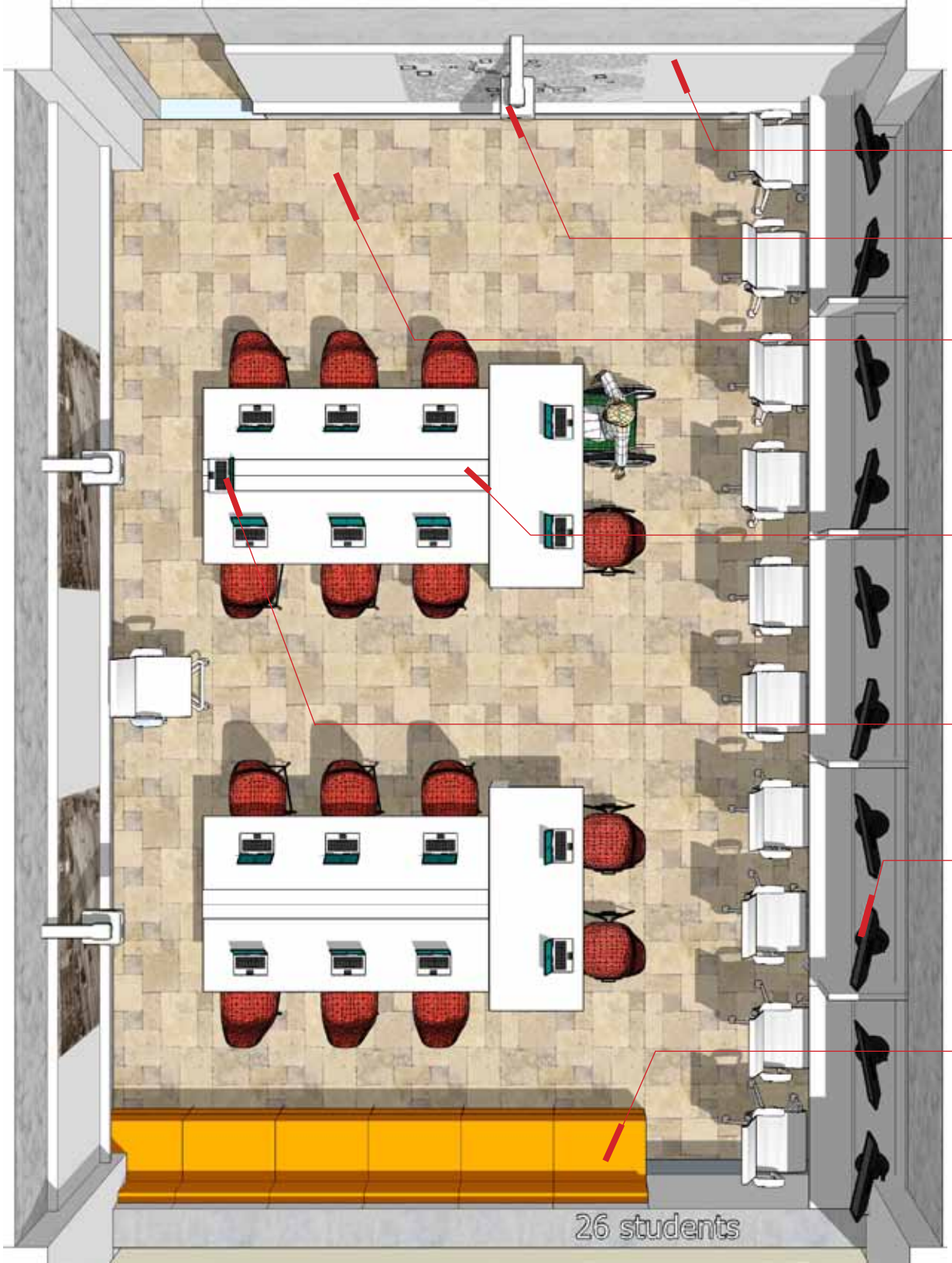
active learning lab

26
students

SUMMARY:

This classroom allows for all students to work digitally during class time, either on student or college supplied laptops or tablets, or on a bank of desktop computing stations along one wall of the room. All seating encourages teams of 2-3 students to work collaboratively on active in-class projects or assignments guided by the instructor.

College laptops and tablets are securely stored and recharged in the plan desks, which are fixed and have floor outlets for power and data. Pivoting chairs allow students along wall to quickly turn to face the instructor during presentations and discussions.



WHITEBOARDS ON 2 WALLS

3 SHORT-THROW PROJECTORS FOR SIMULTANEOUS MULTIPLE IMAGE PROJECTION

OPEN FLOOR SPACE ALLOWS GATHERING OF STANDING STUDENTS AROUND WHITEBOARD

FIXED PLAN DESK HARD WIRED W/ POWER + DATA ON TOP SURFACE. CUBBY STORAGE FOR STUDENTS + SECURE STORAGE FOR COLLEGE LAPTOPS.

INSTRUCTOR'S CONTROL POINT VIA LAPTOP (OPTIONAL WIRELESS OR WIRED CONNECTIVITY)

COLLABORATIVE WORKSTATIONS
5 SITTING STATIONS TOTAL

WINDOW BENCH (INFORMAL) SEATING ALLOWS ADDITIONAL SETTING FOR COLLABORATION OR DISCUSSION

DESCRIPTION:

In our most innovative proposed use of Namm classroom space, we combine table seating and workstation seating to enable a variety of different, yet overlapping learning experiences. This design includes two 8-seat plan desks with cubbies, laptop storage, and electrical/internet/AV outlets, and five shared seated computer workstations. Additionally, there is a window wall bench for informal seating. Not including the informal seating bench, this design accommodates 26 student seats.

In lieu of a podium, the instructor's workstation is at the opposite end of one student plan table, and it is connected to the two LCD displays or projector screens on the sidewall opposite the five shared seated computer workstations for student use.

furntiure
possible selections

HERMAN MILLER

EAMES PLASTIC
STOOLS (12)
CHAIRS (4)

16 TOTAL

BUILT-IN (6'w/2'd/5.5't)

2 PERSON SITTING
WORKSTATION

POWER + DATA
OUTLETS + CUBBIES

5 TOTAL

HERMAN MILLER

CAPER
MULTIPURPOSE
STOOL

1 TOTAL

EPSON

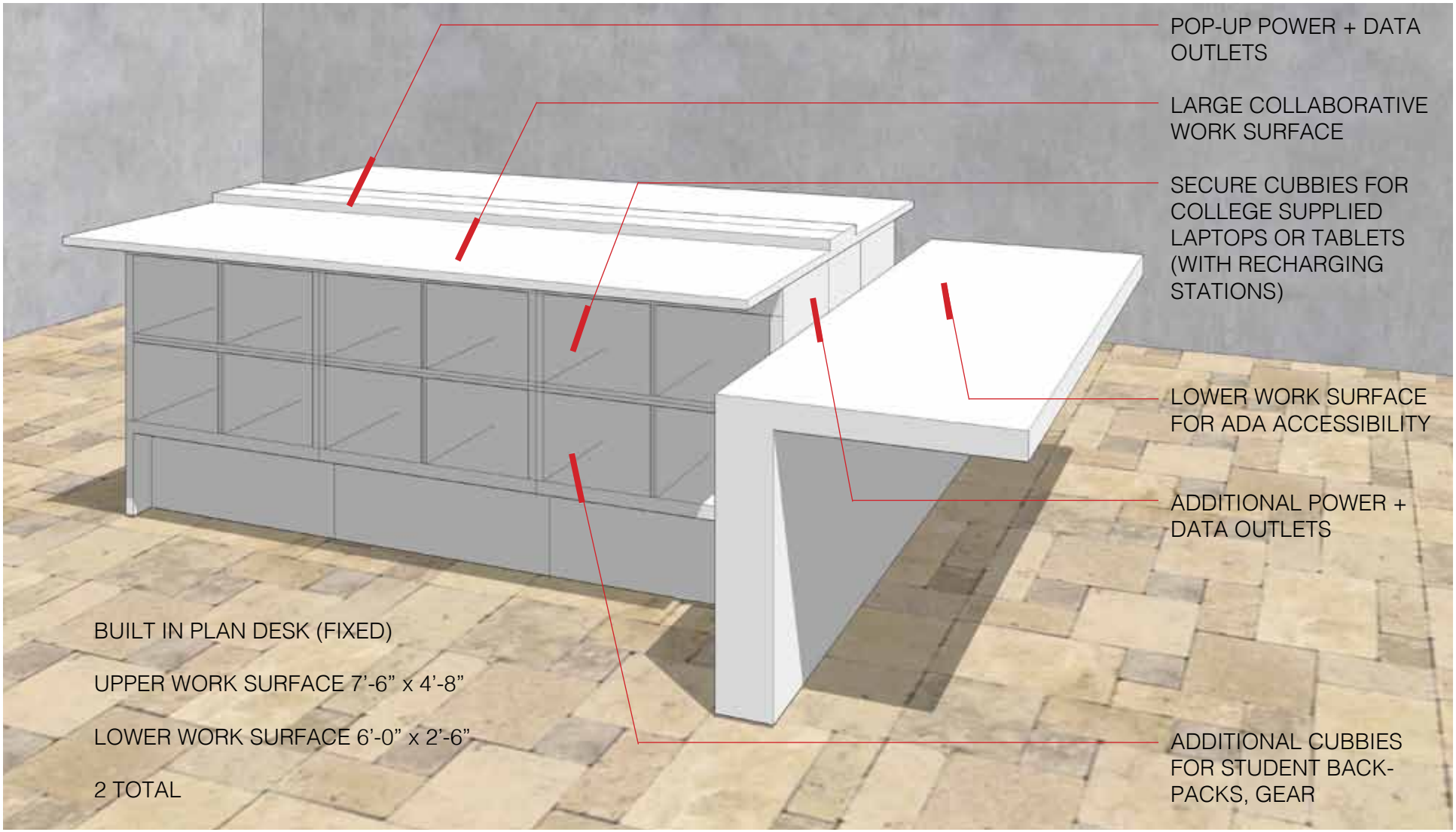
EB-595WI
PROJECTOR

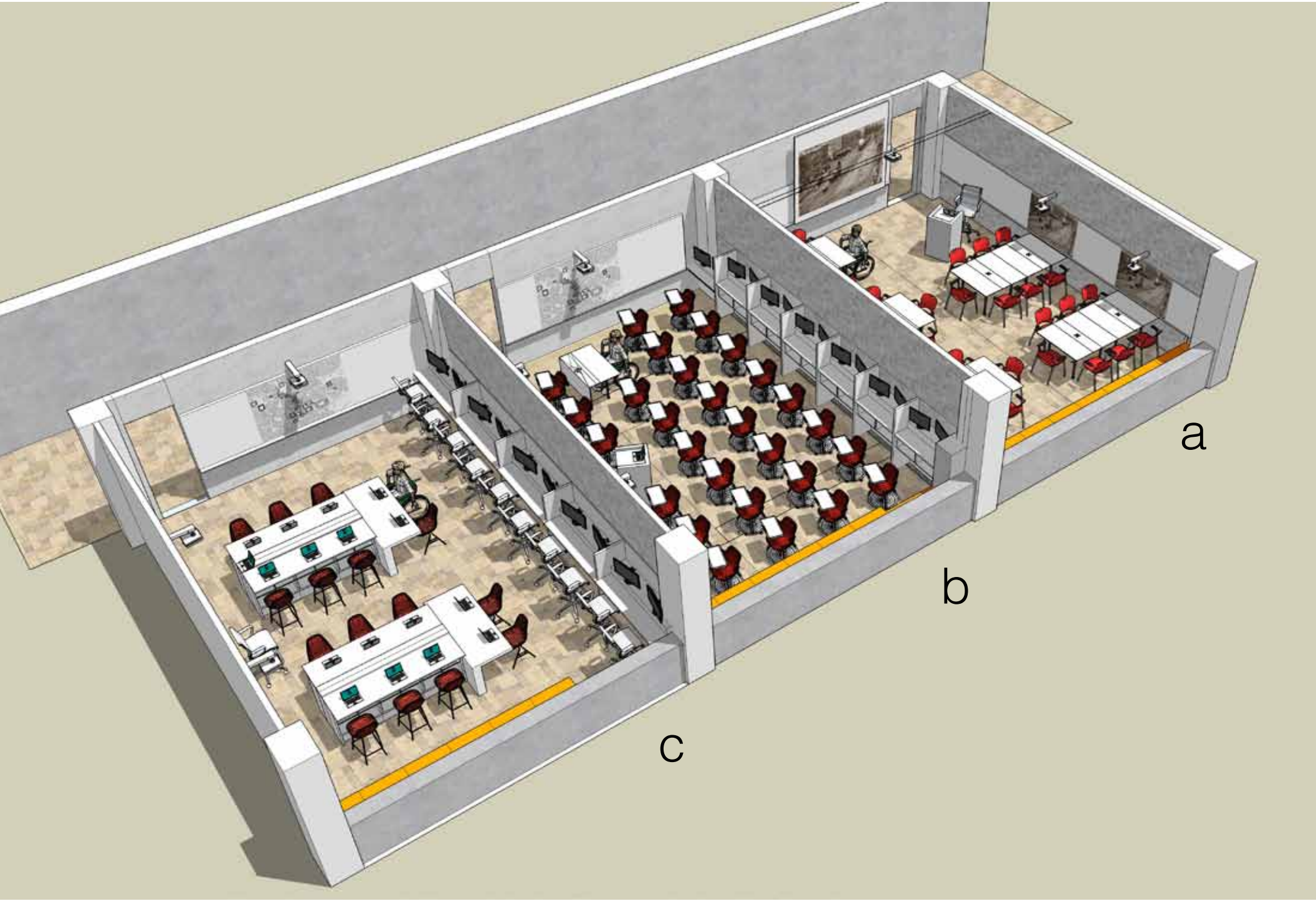
or similar

6 TOTAL

This classroom arrangement enables different kinds of student work. The plan tables support laptops for individual student use, and the five shared seated computer workstations support peer-to-peer learning and collaboration. Students can rotate from one space to the other within a class period or on a class-to-class basis. The plan tables' laptops can be secured with long-lead Kinsington locks and stowed away in the cubbyholes beneath the tabletop surface. This opens the table surface for traditional notebook paper and textbook exercises without the computers taking up table space. The additional electrical and Ethernet outlets would accommodate student BYOD technology in addition to the secured laptops and shared computer workstations.

While this arrangement has the lowest student seating of the proposed arrangements, it is the most experimental and most technology rich, which could make it an ideal candidate for learning space research and utilized only by faculty with expertise or training in teaching in such a classroom.




a
b
c