



The Smart Classroom – an Industry-Academia Collaborative Attempt to Design the Future Teaching and Learning Environment

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Abstract

The emersion of technological singularity in our daily life can no longer be ignored. Companies around the world are busy connecting their products and services with the Internet of things. With that in mind, initially funded by the National Research Council Canada, an Ontario based Furniture Company named Borgo partnered with an academic research partner, the Niagara College based Productivity and Innovation Lab, to ideate the future classroom design. The associated study explored how the world of connectivity can be integrated with the design of the future classroom to foster a better teaching and learning environment. The researchers explored how common classroom variables such as sound, temperature, shape, light, color, flooring, plants and so on can be leveraged to foster a better teaching and learning environment. In addition, the study also investigated how the new generation furniture can support modern pedagogical teaching and learning practices to maximize knowledge dissemination and retention. The study focused on the classroom design for higher education (both at the graduate and undergraduate levels), collected data from Ontario students and faculty members, and also made recommendations for subsequent steps.

Technology is changing fast, maybe too fast. It is even getting hard to keep up with it, and while that may not be the case for a compulsive user, it is almost certainly true for developers. I noticed the trend of technological singularity when I was at the consumer electronic show in Las Vegas, earlier in January. Whenever I see a technological trend emerging, I always consider: what does that mean for education? How it going to affect the future classroom? Today everything is data, our conversation, sleep, physical activities, and so on. But why not classroom activities, why we do we not pay attention to our activities in the classroom or the furniture we use in the classroom. Why do we still teach the same way we have been for hundreds of years, is the future generation going to excited to go to today's classrooms? Does the classroom need to be "so blah", why can't it look nice? Why can't we have nice furniture in the classroom? Why can't we have plants, why the classroom can't look appealing? And in addition to being visually improved, how can we add technology to make classrooms smart and connected? How can we collect data about our classroom activities and use the data for our health benefits? With all these questions in mind, I partnered with an Ontario based furniture manufacturer to explore the idea of the smart classroom. The project was initially funded by the National Research Council Canada, and all I knew was that we needed to think outside the box; that was the only direction I provided to my research associates. During the pilot phase of this project, the research team conducted two different activities concurrently: i) conduct a survey of current college students and likely future higher education students who are currently enrolled in the high school system. ii) conduct research on environmental factors in the actual classroom.

A survey instrument was used to collect feedback from students about their perception of certain changes in classroom furniture, as well as what could or could not, and should or should not be included in the proposed changes. The survey instrument included questions associated with age, learning style, classroom distraction, color stimulation, furniture placement, effect of furniture placement on learning experience, allergies, effects of different lighting sources on learning experience, and personal response on whether comfortable furniture in the classroom is a good or bad idea. The results of the survey returned 100 responses and suggested the need for a change. A large majority (73%) of the survey participants were aged between 15-24 years of age, 17% were aged between 25-29 years of age and 10% were aged 30+; 41% of participants prefer Kinesthetic learning (physical interaction), 36% prefer visual learning, 5% and aural leaning, and the rest prefer a combination of visual, aural, tactile and kinaesthetic; in regard to classroom distraction, 68% of the survey participants are easily distracted and what distracts them most are: sounds, people talking, technology, noise, cell phones, and hunger; In

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regards to the use of color in the classroom, 26% of participants indicated that *yellow, orange and red* colours stimulate their attention, focus and motivate them, 15% find *blue, green, and brown* stimulating, 9% of the people surveyed responded that *white, grey and black* are stimulators and 32% selected all of the above colours for stimulating and motivating them; In reference to furniture placement in the classroom, 80% of people surveyed stated that Facing forward toward the teacher was the most effective way they have been taught, 4% while on a computer, 11% facing other students, 3% facing different directions and 2% indicated facing the source of information whatever it is (teacher, computer, or other students) or Interaction with the whole class; 43% of people surveyed stated that furniture arrangement has affected their learning experience, while 57% responded that it has not; In regards to the use of plants in the classroom, 7% of people surveyed stated that they have allergies to a plant or plants and 92% responded that they have no allergy; In regards to the use of distracting and disruptive sounds, 35% of people are distracted by music, 64% by talking, 20% by computer screens, 24% by white noise, 18% selected all of the above sounds and 6% selected 'Other.'; 32% of people surveyed stated that certain lights do affect their learning opportunities, while 68% responded that they do not; The majority of students surveyed appear to be open to the idea of comfortable furniture as an option, or the replacement of the current furniture provided at current classrooms. Based on the responses, comfort is important to the participants and it could play pivotal role in their success. Factors associated with classroom lighting, sound and colors in the classrooms are also important. Classroom distraction is also a critical factor; they need to be addressed to foster a better teaching and learning environment.

The research team also investigated environmental factors such as sound, temperature, shape, light, color, flooring and plants and their effects on the classroom. The literature review indicated that all of the above variables except plants result in an improvement of learners' performance. Excessive ambient noise negatively affects the ability of students to learn when noise decibels are higher than signal decibels. Temperature and ventilation correlates to increases in student performance. The ideal temperature found was 20°C and a ventilation rate of 7.1 litres per second per student. Shape of the classroom affected the amount of interaction between students. Having rounded tables, rather than rows of tables lined up better with the current evolving pedagogy of teachers according to the research. Natural and brighter light positively affected student's ability to learn and be attentive. Light hues of cold colours such as blue and violet improve attention. Writing in contrast colors increases retention rates. Flooring is another important aspect, with the focus on being able to move furniture while remaining quiet and clean. Overall the research suggests that with ideal conditions, student learning, attentiveness and performance can be measurably improved.

Sound plays a key role in the classroom environment. It is important to be able to hear the professor clearly, which in turn leads to the improvement of listening skills and learning retention. Factors associated with background noise, reverberation and signal-to-noise ratio (SNR) need to be addressed to foster a better learning environment. A recent study indicated that noise level and speech level need to be almost equal (SNR=0) in order for adults to be able make sense of even the most familiar words [1]. Reverberation of noise occurs from the sound reflection of different surfaces in the room and which can worsen the classroom noise. Therefore it is important that future classroom design uses materials that avoid such prolongation of sound.

As educators, we all know how important is the first day of class is. Last fall, in one of my classes, we were experiencing noise from the air conditioning system. It was so loud that class couldn't hear anything, although I was very loud. Anyway, to make a long story short, maintenance had to turn off the air conditioning system and then it was too hot for the class to pay attention to what I was saying. So, I decided to cancel the class and first day of bad experience in the class impacted the class attendance throughout the entire semester. The temperature of the classroom actually plays a big role in teaching and learning. Niemeyer suggested that an ambient temperature that reflects a usual room temperature based on the season is best [3]. A recent study conducted in a relatively colder environment in Sweden found that having a lower ambient temperature improves the speed at which tasks are completed in a school setting, the researcher studied temperature between 20°C and 25°C; At the 20°C point, students reported a reduction in headaches, and a neutral feeling to temperature, rather than too warm or too cold [3].

The widely used row-by-row seating in our classrooms has existed since the medieval ages, which initially served the traditional behaviourist methodology and lecture-based curriculum. A recent study indicated that the traditional classroom has inconsistencies and disadvantages in the way that students learn: certain seats within the classroom provide a better learning experience, while other seats provide a more

negative learning experience; a few central rows tend to provide a better experience, while the sides are more neutral and the seats farther back actually yield a negative experience [4]. Educators around the globe adopted pedagogical styles such as group discussion, case based learning, and interactive learning. They have also made use of modern educational technologies and integrated them into the curriculum. However, most institutions are failing to offer a classroom to their learning community that serves a variety of teaching styles. But what if we design a classroom with easily adjustable furniture and other flexible elements so that the same space can be used to create different settings or layouts for diverse classroom activities such as lecture, group work, design work, computer programming, and so on? In regards to the use of natural light, Heschong argued that newer buildings designed with lower ceilings over the last 50 years are not optimized for daylight, and that has caused a reduction in the amount of daylight in modern classrooms [5]. Heschong studied several school districts in California with a wide range of classroom daylight conditions and found that “students in classrooms with the most window area or daylight were found to have 7% to 18% higher scores on the standardized tests than those with the least window area or daylighting” [5]. Daylight is undoubtedly more beneficial than electric sources, and also a source of vitamin D that has other benefits such as mental health. But in much colder climates or monsoon season, when there is not much sun to help, can the high power light bulbs serve as an alternative source of daylight and also offer mental health benefits to the learning community? Further study needs to be conducted.

The color used in classroom walls, floors, and furniture can also play a critical role. Color preferences can also be associated with cultural background, geographic location, and climate. A recent study compared the differences in preferred colors between highly industrialized Polish people and unindustrialized Yali residents from Papua (Indonesia). The Indonesian people preferred yellow and red warm colors, whereas most Polish people preferred blue colors [6]. Further study need to be conducted if some colors are better for certain leaning activities or certain types of learners, and whether what is positive for some students could have a negative effect on other types of learners (for example an international student from another culture or opposite climate condition). The flooring is also important, furniture needs to be easily movable, the surface should bring background noise to levels studies have found to be optimal, and if carpets are used they shouldn't have a high rate of dirt and pollutants.

It is important to note that the survey study was conducted in the Niagara region, and the weather in Niagara is relatively cooler than many other parts of the world. The industry-academia collaboration between the furniture manufacturer Borgo and academics from Niagara college helps to create better products and services for future classrooms, where Borgo learns from academics about actual classrooms issues and educators learn from Borgo about its rationale behind its current design practices.

References

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