

# Understanding the Impact of School Design on Academic Performance

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*Results of a Post-Occupancy Evaluation for Butler Elementary School*



**Keywords:**

School Design  
K-12 Education  
Teacher Satisfaction  
Student Perceptions  
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**Prepared by:**

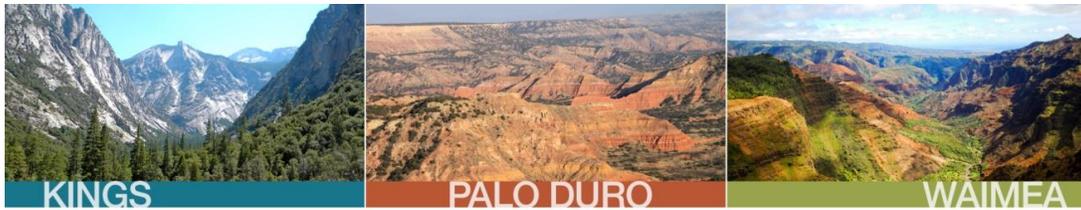
Brandon Ro, *Research Leader*  
VCBO Architecture  
524 South 600 East  
Salt Lake City, UT 84102  
vcbo.com

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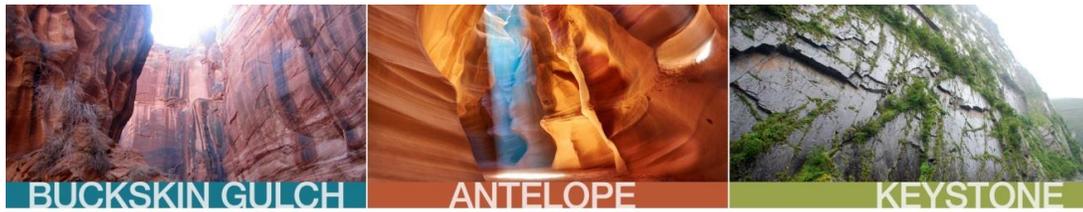
**MAIN LEVEL FLOOR PLAN**

## 1 Executive Summary

Understanding the impact of school design on academic performance is critical for educators and designers. How one goes about evaluating the quality of a learning environment is a fundamental aspect for studies seeking to understand the value of architectural design and its functional performance on educational outcomes. Surveys are one means to address this challenge. The following study investigates the impacts of elementary school design on educational outcomes through a post-occupancy evaluation (POE) survey.

In order to assess how the learning environment was performing from the building users' perspective at Butler Elementary School in Cottonwood Heights, Utah, a POE survey was conducted from May to June 2017. The short one-month survey gathered a total of 160 responses that were comprised of students, teachers, administrators, and parents. The survey was designed to capture several different aspects of environmental quality. The present study focuses on four main areas of the survey and includes:

- 1) Student perspectives of the learning experience
- 2) Teacher perspectives of the instructional experience
- 3) Student and teacher perspectives of the classroom environment
- 4) Parental perspectives of their child's academic performance



**UPPER LEVEL FLOOR PLAN**

Major findings from the survey suggest that a flexible classroom environment has a positive and direct impact on the perceptions of students, teachers, and parents.

- The survey revealed that the overall student learning experience was enhanced. Students felt the layout of the school and classrooms fostered collaboration and made it easy to work in groups. Students largely believed the open and flexible layout improved student-teacher interactions. The school design also helped students to pay more attention in class.
- Teachers had similar responses. They felt student attention span increased and student-teacher interactions were improved. The design also enhanced their instructional experience and facilitated different teaching techniques. A large majority of teachers were not only satisfied with the design of the building, but they felt it provided quality learning experiences for their students.
- Parents equally had positive responses. A majority of parents felt the school was preparing their child for the next academic year, and many had witnessed improvements in their child's academic performance. Parents also reported that the design of the school was enhancing their child's ability to learn. A majority of

parents felt that the classroom design in particular was a key factor affecting their child's learning experience and academic performance.

In the end, this study illustrates some of the impacts the classroom environment has on human perceptions to learn or teach. The results of the survey are relevant for designers, architects, educators, administrators, and policy makers who are concerned with improving academic performance through better educational design. Better school design leads to better learning environments.



## 2 Introduction

### 2.1 Purpose of the Study

It is critical for educators and designers to understand the impact of school design on academic performance. On the other hand, evaluating the quality of a learning environment is a key component for understanding the value of architectural design and its functional performance. Designers, architects, educators, administrators, and policy makers are all concerned with improving academic performance through better educational design strategies and surveys are one means to investigate this problem. VCBO Architecture in conjunction with the Canyons School District set out to conduct a building evaluation study of Butler Elementary School in 2017 to identify how successful the building was in meeting its design goals. Finished in time for the 2016-2017 school year, a post-occupancy evaluation survey was developed to not only evaluate end-user satisfaction but also to assess general building and workspace conditions. In particular, there was an emphasis on evaluating how well the learning environment was performing to facilitate student learning and group collaboration as part of the larger project-based curriculum at the new school.

## 2.2 About the School

Butler Elementary School is a two story masonry building at 89,000 gross square feet that was designed as a new school to replace the old school building. The design was tied closely to the local context by playing off of the theme of the canyons and mountains, as the city Cottonwood Heights - where the school is located - has been deemed "The City between the Canyons." The exterior was divided into distinct vertical elements to evoke a sense of looking at a canyon while still maintaining a strong horizontal stratification to tie the overall mass together.

The school also features two exterior courtyards which serve as educational elements. The North courtyard is titled "Big Cottonwood Canyon" and the South is referred to as "Little Cottonwood Canyon."

The interior of the school continues with the theming from the exterior. The dining and multipurpose area is branded as "Basecamp." Twenty-seven classrooms are organized by grade level in different wings of the building. Each individual teaching wing of the school is given a color designation and named after a famous canyon found in the United States. Lastly, the Media Center on the second level is branded "The Summit."

## 2.3 Background Literature

Architects, designers, building owners, facility and operations managers, environmental psychologists, and researchers often conduct post-occupancy evaluations (POE) to assess "building performance from the building users' point of view."<sup>1</sup> *The Architect's Handbook of Professional Practice* defines post-occupancy evaluation services as a means to "address how well a facility contributes to the productivity, satisfaction, and well-being of the occupants and the goals of the organization."<sup>2</sup> After an initial literature review was conducted to clarify the purpose, methods, and procedures of conducting post-occupancy evaluations,<sup>3</sup> it was concluded that a survey instrument would best serve the purposes of the present study in evaluating the environmental quality of the building.

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<sup>1</sup> Wolfgang F.E. Preiser and Jack L. Nasar, "Assessing Building Performance: Its Evolution from Post-Occupancy Evaluation." *Archnet-IJAR*, v.2, no.1 (March 2008), p.85.

<sup>2</sup> Larry Lord and Margaret Serrato, "Postoccupancy Evaluation." In *The Architect's Handbook of Professional Practice*, 13<sup>th</sup> ed. (New York: John Wiley & Sons, 2001), 688.

<sup>3</sup> See, for instance, Alastair Blyth, Anthony Gilby, and Mel Barlex. *Guide to Post Occupancy Evaluation*. Higher Education Funding Council for England (HEFCE), 2006; "Occupant Indoor Environmental Quality (IEQ) Survey," *Center for the Built Environment: Research*. The Regents of the University of California, n.d. web; Larry Hartman, "Boxes on the Light Shelf: An Introduction to Post Occupancy Evaluation." *American Institute of Architects*, <http://www.aia.org/akr/Resources/Documents/AIAB092700>; Larry Lord and Margaret Serrato, "Postoccupancy Evaluation." In *The Architect's Handbook of Professional Practice*, 13<sup>th</sup> edition (New York: John Wiley & Sons, 2000), pp. 688-692; "Post-Occupancy Evaluation: Holding the Mirror up to Architecture." Special edition of *Research & Design*. AIA Research Corporation. 1, no. 3 (July 1978); Wolfgang F. E. Preiser and Jack L. Nasar, "Assessing Building Performance: Its Evolution from Post-Occupancy Evaluation." *Archnet-IJAR*, 2, no.1, pp.84-99 (March 2008). Mardelle M. Shepley, et. al. "Pre- and Post Occupancy Evaluation of the Arlington Free Clinic." *American Institute of Architects*, <http://www.aia.org/practicing/groups/kc/AIAB086526>; Richard E. Wener, *Post Occupancy Evaluation Procedure: Instruments & Instructions for Use [Correctional Facilities]*. National Institute of Correction Jail Center (1994).

Regarding the important role of educational spaces and their impact on academic performance, several studies concluded that children's perceptions of their classroom environment had an impact on learning outcomes.<sup>4</sup> One study, in particular, found that the classroom environment had a 25% impact on student performance.<sup>5</sup>

## 2.4 Hypothesis

In order to assess the impact of design decisions on academic performance, the hypothesis for this study predicted that a classroom layout with varying types of non-traditional features and furnishings (such as soft seating, moveable chairs, stools, and tables) would have a positive impact on the learning experience of elementary children and that a flexible classroom configuration would provide an improved instructional experience for teachers.

## 3 Methodology

### 3.1 Survey Design

The post-occupancy evaluation survey for Butler Elementary School was designed based on several precedents of educational surveys.<sup>6</sup> There were a total of 69 questions in the full survey ranging in question type from multiple-choice, ranking scale, and open-ended. The questions were organized into 9 main sections under the following

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<sup>4</sup> Gwen C. Marchand, et al., "The impact of the classroom built environment on student perceptions and learning," *Journal of Environmental Psychology* 40 (2014): 187-197; Zheng Yang, Burcin Becerik-Gerber, Laura Mino, "A Study on Student Perceptions of Higher Education Classrooms: Impact of Classroom Attributes on Student Satisfaction and Performance," *Building and Environment* 70 (2013): 171-188; Peter Barrett, et al., "A holistic, multi-level analysis identifying the impact of classroom design on pupils' learning," *Building and Environment* 59 (2013): 678-689; Laura L. Brock, et al., "Children's perceptions of the classroom environment and social and academic performance: A longitudinal analysis of the contribution of the Responsive Classroom approach," *Journal of School Psychology* 46 (2008): 129-149; Lamine Mahdjoubi and Richard Akplotsyi, "The impact of sensory learning modalities on children's sensitivity to sensory cues in the perception of their school environment," *Journal of Environmental Psychology* 32 (2012): 208-215; John Poelker, "Students of Today and Tomorrow: Discovering How and Where they Learn Best," *Perkins+Will Research Journal* 2, no.2 (2010): 56-71.; Tinka Rogic, "Game Changers: Shaping Learning," *Perkins+Will Research Journal* 6, no.1 (2014): 54-66.

<sup>5</sup> Peter Barrett, et al., "A holistic, multi-level analysis identifying the impact of classroom design on pupils' learning," *Building and Environment* 59 (2013): 678-689.

<sup>6</sup> See Jeffery A. Lackney, "Assessing the Impact of the Physical Environment on the Educational Process: Integrating Theoretical Issues with Practical Concerns." Paper presented at the UEF21 New Jersey Institute of Technology Conference (Newark, NJ, September 17, 1999); *International Pilot Study on the Evaluation of Quality in Educational Spaces* (Paris: CELE-OECD Centre for Effective Learning Environments, 2009); Henry Sanoff, Celen Pasalar, and Mine Hashas, *School Building Assessment Methods* (n.p.: National Clearinghouse for Educational Facilities, 2001); "Occupant Indoor Environmental Quality (IEQ) Survey," *Center for the Built Environment: Research*. The Regents of the University of California, n.d. web; Alastair Blyth, Anthony Gilby, and Mel Barlex. *Guide to Post Occupancy Evaluation*. Higher Education Funding Council for England (HEFCE), 2006; "Daylighting in Schools: An Investigation into the Relationship Between Daylighting and Human Performance," Condensed Report prepared by the Heschong Mahone Group, Pacific Gas and Electric Company, August 1999; Beth Schueler, "A New Tool for Understanding Family-School Relationships: The Harvard Graduate School of Education PreK-12 Parent Survey," *FINE Newsletter* 5, no.1 (February 2013), <http://www.hfrp.org/publications-resources/browse-our-publications/a-new-tool-for-understanding-family-school-relationships-the-harvard-graduate-school-of-education-prek-12-parent-survey>; Brandon Ro, "Evaluating Quality Learning Environments," VCBO Architecture: Salt Lake City, 2015), [https://www.academia.edu/19696710/Evaluating\\_Quality\\_Learning\\_Environments\\_Results\\_of\\_a\\_Post-Occupancy\\_Evaluation\\_for\\_Odyssey\\_Elementary\\_School](https://www.academia.edu/19696710/Evaluating_Quality_Learning_Environments_Results_of_a_Post-Occupancy_Evaluation_for_Odyssey_Elementary_School)

titles: 1) the respondent's role at school, 2) parents' perceptions of their child's academic performance, 3) the student learning experience, 4) the teacher instructional experience, 5) the classroom environment, 6) personalization and ownership, 7) building design and safety, 8) school appearance and aesthetics, and 9) the respondent's background. Based on responses to the first question regarding the respondent's role at the school, each individual was taken to a series of sections and questions best suited to their involvement with the school. The particular survey sections assigned to different demographic groups is summarized in Table 1. Only the following sections are examined in the present study: parental perspective of their child's academic performance; students' learning experience; teacher instructional experience; and the classroom environment.

	Student	Faculty/ Teacher	Administrator/ General office/ Maintenance personnel	Parent/ Patron
1. Role at School	X	X	X	X
2. Child's Academic Performance				X
3. Learning Experience	X			
4. Instructional Experience		X		
5. Classroom Environment	X	X		
6. Personalization & Ownership	X	X	X	
7. Building Design & Safety	X	X	X	X
8. School Appearance & Aesthetics	X	X	X	X
9. Background	X	X	X	X

Table 1. Distribution of survey sections based on role at school

### 3.2 Survey Demographics

The post-occupancy evaluation survey for Butler Elementary School was conducted online through *SurveyMonkey* from May 15, 2017 to June 13, 2017 and resulted in a total of 160 survey participants. The sampling method resulted in a non-scientific (non-probability) sample of survey respondents ranging from students, teachers, administrative personnel, and parents. The purpose of the post-occupancy evaluation survey was not designed to capture a scientific (probability) sample "that is truly representative of the larger population" and, therefore, cannot be used for making generalizations (inferential statistics).<sup>7</sup> Rather the survey was meant to serve as an assessment of a particular building environment, namely Butler Elementary School, to assess the occupant satisfaction of the learning environment by capturing perceptions, beliefs, opinions, and attitudes. The nature of the sampling method used in this survey resulted in a non-scientific (non-probability) group of respondents and can be

<sup>7</sup> Linda N. Groat and David Wang, *Architectural Research Methods* (New York: J. Wiley, 2002), 218-19.

characterized as both a convenience and voluntary sample. Below is a summary of the demographic breakdown by user group.

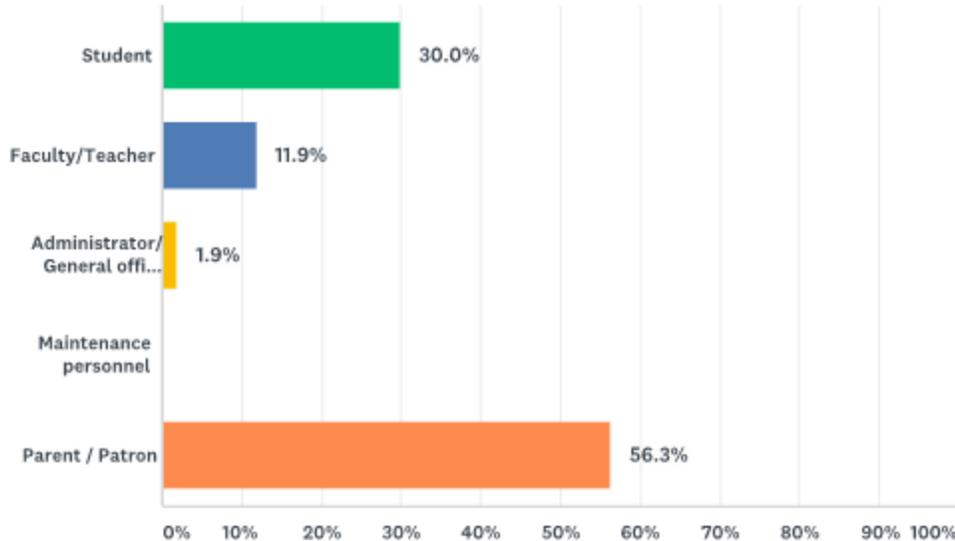


Figure 3.2. Distribution of survey demographics

### Students

The student demographic comprised of 48 respondents representing the second largest group from the overall survey at 30%. The largest groups of students who participated in the survey were third (57.8%) and fourth graders (35.6%). Student respondents were distributed throughout two of the six areas of the school; 36.4% were located in the Antelope-Orange house and 56.8% in the Keystone-Green house. The respondents were slightly more female (51.2%) with the average student age being 9.

### Faculty / Teachers

A total of 19 teachers participated in the survey which made up 11.9% of the respondent population. The largest group of teachers taught First grade (30.8%) with the rest of the grades fairly evenly distributed – Kindergarten (15.4%), Second (15.4%), Third (15.4%), Fourth (15.4%), and Fifth (7.7%). Consequently, teachers were fairly evenly distributed throughout the school: 18.8% Waimea-green house, 25% Palo Duro-orange house, 12.5% Kings-blue house, 12.5% Keystone-green house, 25% Antelope-orange house, 6.3% Buckskin Gulch-blue house. Teachers were predominately female (94.1%) with the median age group falling between 40-49.

### Administrators / General Office / Maintenance Personnel

The next group of survey respondents was composed of administrators, and general office staff. This group of 3 respondents represented only 1.9% of the survey population. The majority of respondents were female (66.7%) with an average age between 40-49.

### Parents / Patrons

Parents and patrons of the school were the largest group at 90 participants making up 56.3% of the population. Parents had children distributed amongst all grade levels with the highest percentage in the First grade (27.2%). The majority of parents were both female (75.6%) and mothers (75.6%) that fell between the age of 30-49 (95.1%).

## 4 Results

The results of the post-occupancy survey related directly to the learning environment layout are organized into four main sections: 1) student learning experience, 2) teacher instructional experience, 3) classroom environment, and 4) parent perceptions of their child's academic performance.

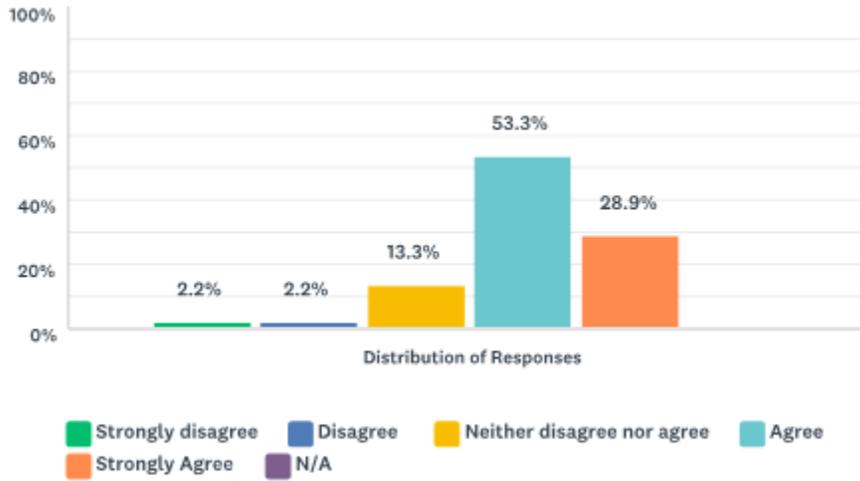
### 4.1 Student Learning Experience



The first section of the survey focused on the student learning experience. This portion of the survey was only administered to students to gauge the perception of the educational environment of the school. Topics dealt with social interaction, group work, student-teacher interactions, attention span, and the students' perceived ability to learn based on environmental factors.

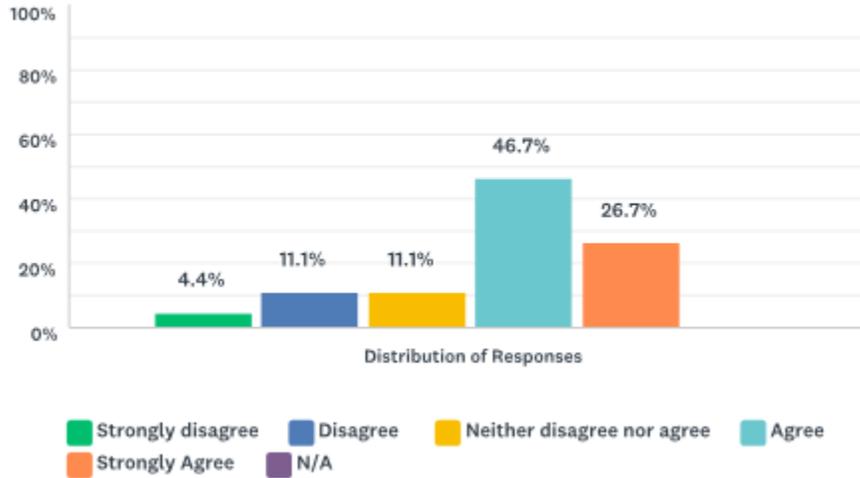
*Does the layout of the school and classrooms make it easy to work in groups?*

**Findings:** N = 45; Mean = 4.0; SD = 0.84; 82.2% ≥ agree



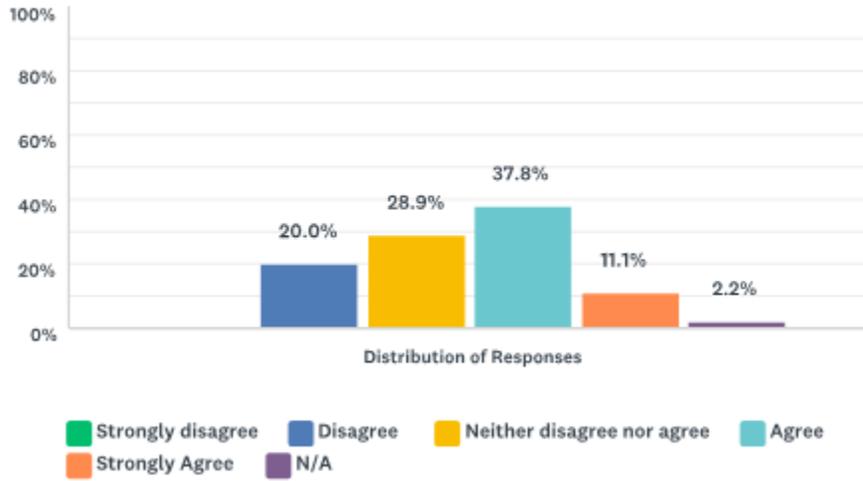
*Does the layout of your school and classroom help make learning more fun?*

**Findings:** N = 45; Mean = 3.8; SD = 1.09; 73.4% ≥ agree



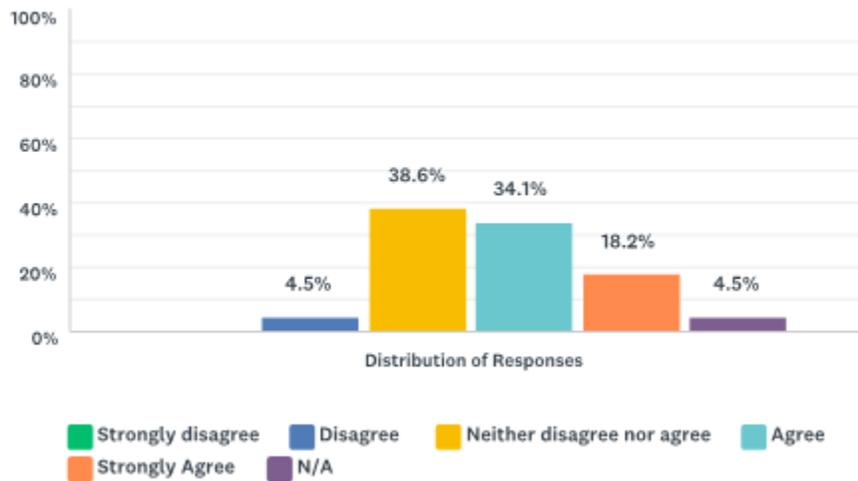
*Does the layout of your school and classroom help you pay attention more?*

**Findings:** N = 45; Mean = 3.4; SD = 0.94; 48.9% ≥ agree



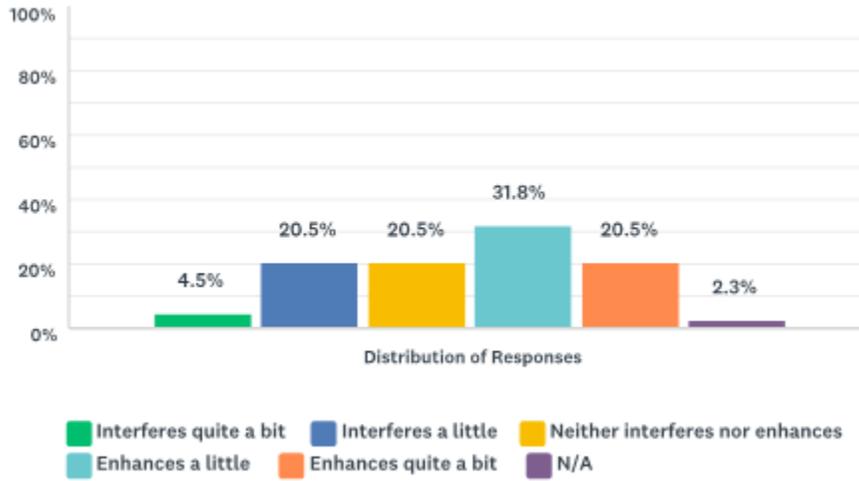
*Does the layout of your school and classroom encourage student-teacher interaction?*

**Findings:** N = 44; Mean = 3.7; SD = 0.83; 52.3% ≥ agree



*Overall, does the layout of the classroom enhance or interfere with your ability to learn?*

**Findings:**  $N = 44$ ;  $Mean = 3.4$ ;  $SD = 1.17$ ;  $52.3\% \geq$  enhances



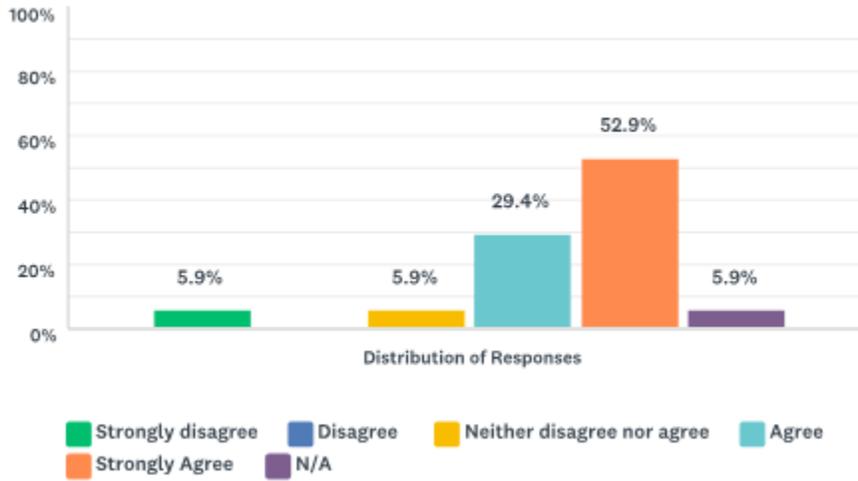
## 4.2 Teacher Instructional Experience



The teacher instructional experience section of the survey was only administered to faculty members. Similar to the student learning experience, topics dealt with how the environment might affect social interaction, group work, intra-class collaboration, student-teacher interactions, student attention span, the teacher's perceived ability of his/her students to learn, instructional techniques, and quality educational opportunities.

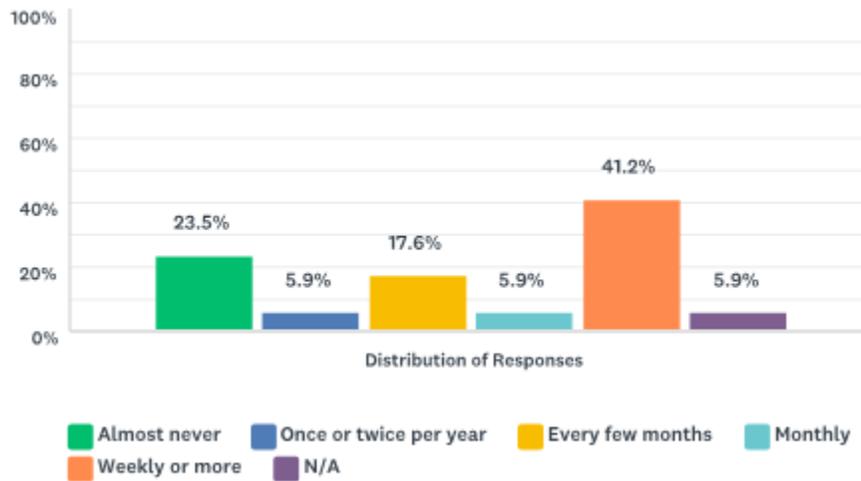
*Does the layout of the school and classrooms make it easy to work in groups?*

**Findings:**  $N = 17$ ;  $Mean = 4.3$ ;  $SD = 1.04$ ;  $82.3\% \geq \text{agree}$



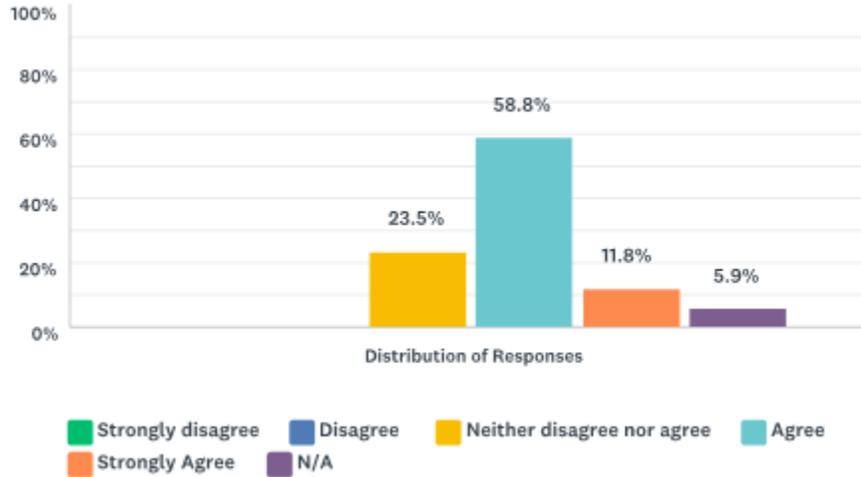
*How often does your class work collaboratively with other classes?*

**Findings:**  $N = 17$ ;  $Mean = 3.4$ ;  $SD = 1.65$ ;  $47.1\%$  monthly or more



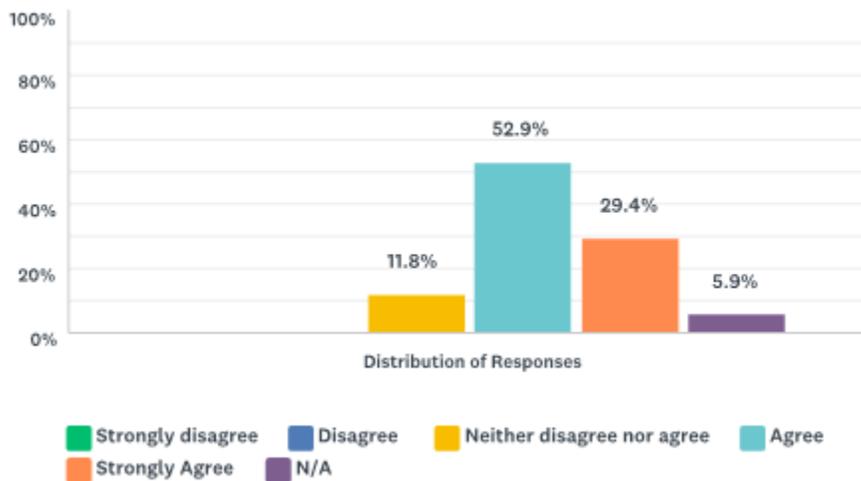
*Does the layout of the school and classroom help your students pay attention?*

**Findings:** N = 17; Mean = 3.9; SD = 0.60; 70.6% ≥ agree



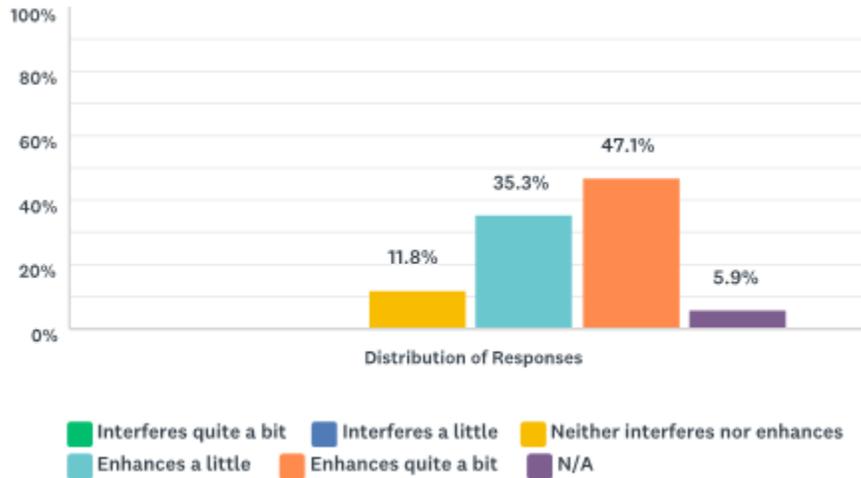
*Does the layout of your school and classroom encourage student-teacher interaction?*

**Findings:** N = 17; Mean = 4.2; SD = 0.63; 82.3% ≥ agree



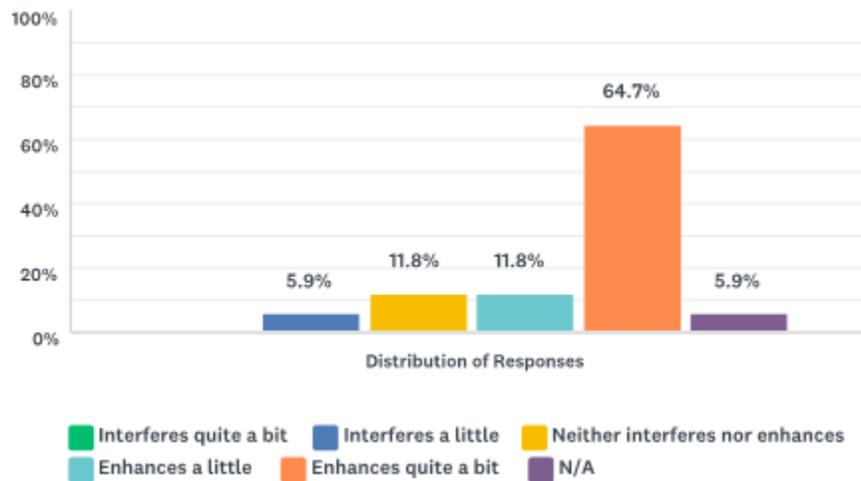
*Overall, does the layout of the classroom enhance or interfere with your students' abilities to learn?*

**Findings:**  $N = 17$ ;  $Mean = 4.4$ ;  $SD = 0.70$ ;  $82.4\% \geq$  enhances



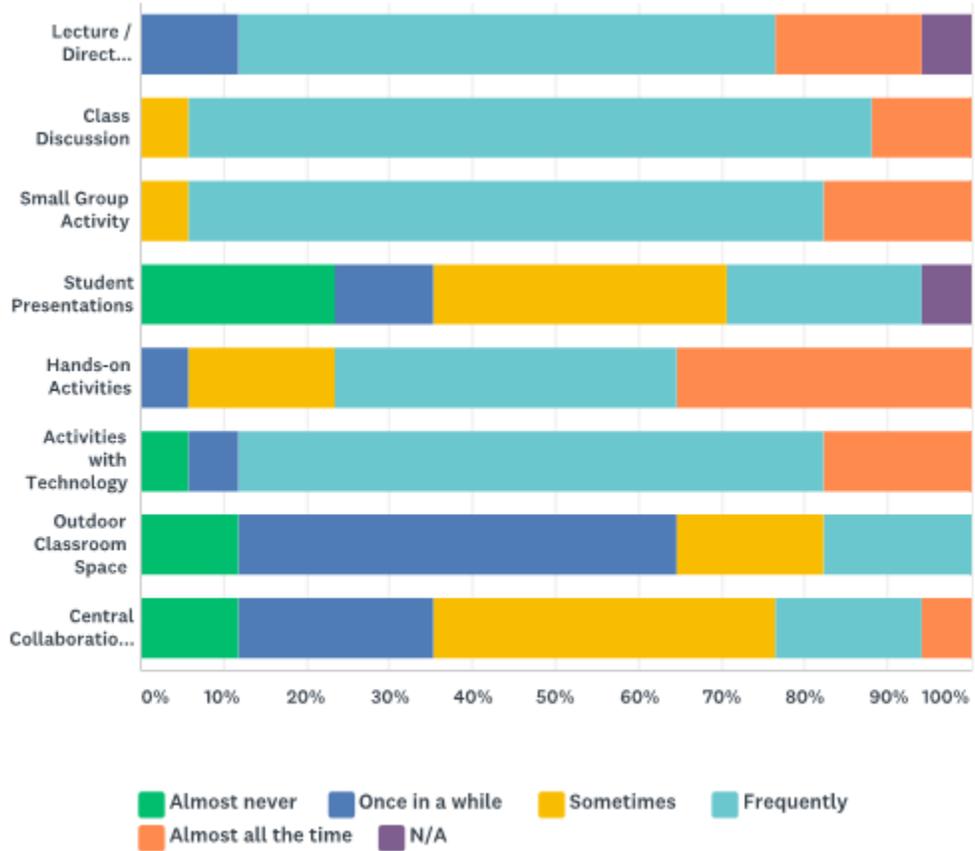
*Overall, does the layout of the classroom enhance or interfere with your ability to teach?*

**Findings:**  $N = 17$ ;  $Mean = 4.4$ ;  $SD = 0.93$ ;  $76.5\% \geq$  enhances



*How often do you use each of the following instructional techniques?*

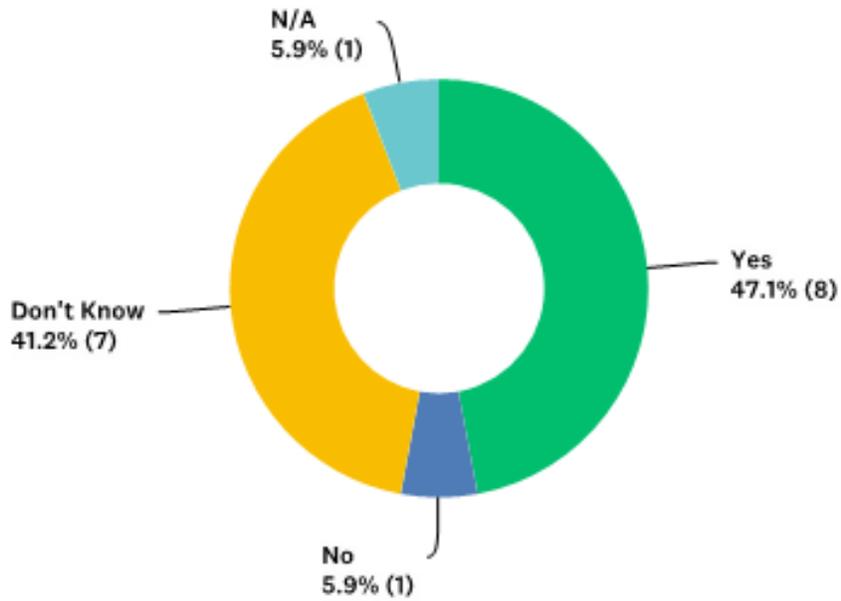
**Findings:** N = 17; Ranking = 1<sup>st</sup> Class Discussion (94.2% ≥ frequently), 2<sup>nd</sup> Small Group Activity (94.1% ≥ frequently), 3<sup>rd</sup> Activities with Technology (88.2% ≥ frequently), 4<sup>th</sup> Lecture (82.6% ≥ frequently)



	ALMOST NEVER (1)	ONCE IN A WHILE (2)	SOMETIMES (3)	FREQUENTLY (4)	ALMOST ALL THE TIME (5)	N/A	TOTAL	WEIGHTED AVERAGE
Lecture / Direct Instruction	0.0% 0	11.8% 2	0.0% 0	64.7% 11	17.6% 3	5.9% 1	17	3.94
Class Discussion	0.0% 0	0.0% 0	5.9% 1	82.4% 14	11.8% 2	0.0% 0	17	4.06
Small Group Activity	0.0% 0	0.0% 0	5.9% 1	76.5% 13	17.6% 3	0.0% 0	17	4.12
Student Presentations	23.5% 4	11.8% 2	35.3% 6	23.5% 4	0.0% 0	5.9% 1	17	2.63
Hands-on Activities	0.0% 0	5.9% 1	17.6% 3	41.2% 7	35.3% 6	0.0% 0	17	4.06
Activities with Technology	5.9% 1	5.9% 1	0.0% 0	70.6% 12	17.6% 3	0.0% 0	17	3.88
Outdoor Classroom Space	11.8% 2	52.9% 9	17.6% 3	17.6% 3	0.0% 0	0.0% 0	17	2.41
Central Collaboration Space	11.8% 2	23.5% 4	41.2% 7	17.6% 3	5.9% 1	0.0% 0	17	2.82

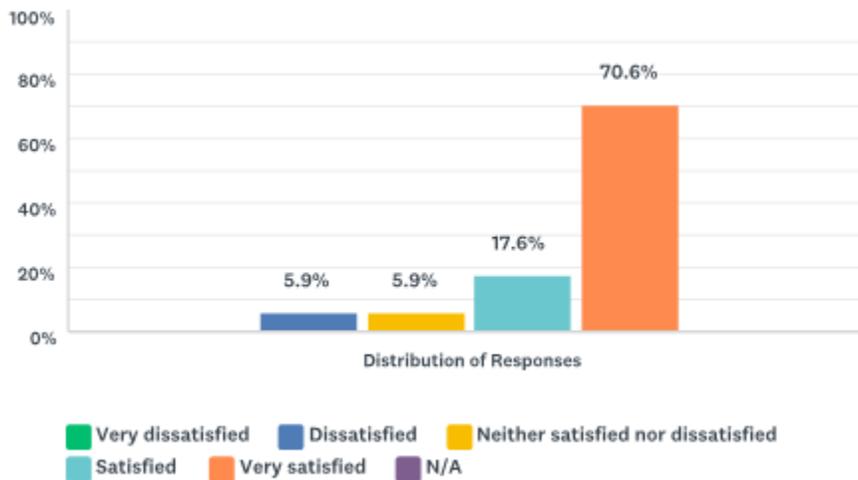
*Have you noticed any change in your teaching techniques as a result of the classroom environment?*

**Findings:** N = 17; 47.1% changed



*Overall, how satisfied are you with the design of the building in helping you to provide quality learning experiences for your students?*

**Findings:** N = 24; Mean = 4.0; SD = 1.06; 79.1% ≥ satisfied



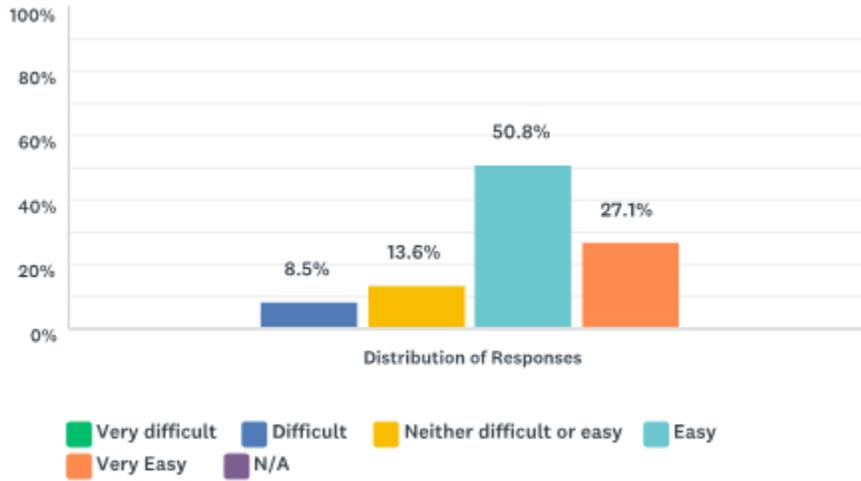
### 4.3 Classroom Environment



In the classroom environment section of the survey, both teachers and students were asked a series of questions regarding classroom flexibility, adaptability, collaboration, and connectedness. Other environmental factors included questions probing the quality of lighting, acoustics, thermal comfort, and air quality.

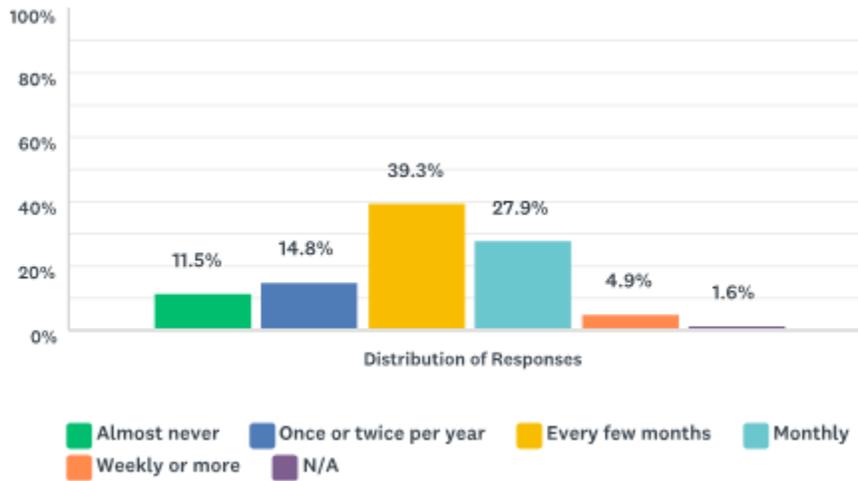
*How easy is it to move the classroom furniture?*

**Findings:**  $N = 59$ ;  $Mean = 4.0$ ;  $SD = 0.86$ ;  $77.9\% \geq \text{easy}$



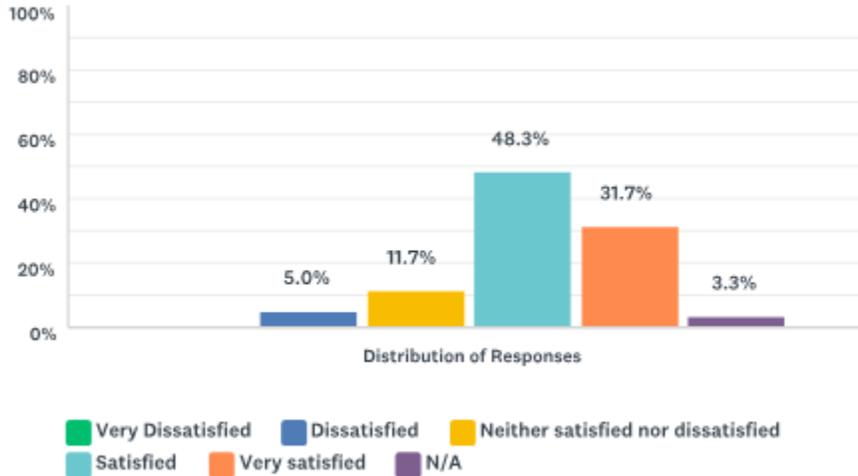
*How often does the classroom layout and furniture change locations?*

**Findings:**  $N = 61$ ;  $Mean = 3.0$ ;  $SD = 1.05$ ;  $32.8\% \geq \text{monthly}$



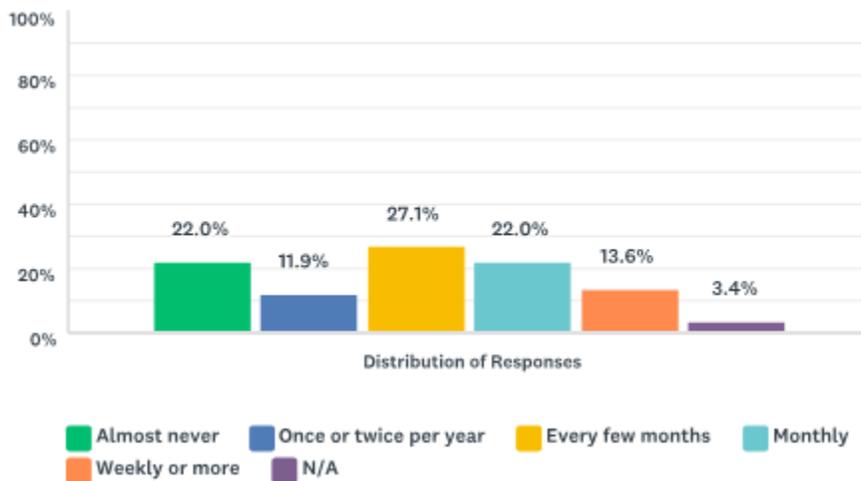
*How satisfied are you with the ability to move around the classroom and work with others during class?*

**Findings:**  $N = 60$ ;  $Mean = 4.1$ ;  $SD = 0.80$ ;  $80\% \geq$  satisfied



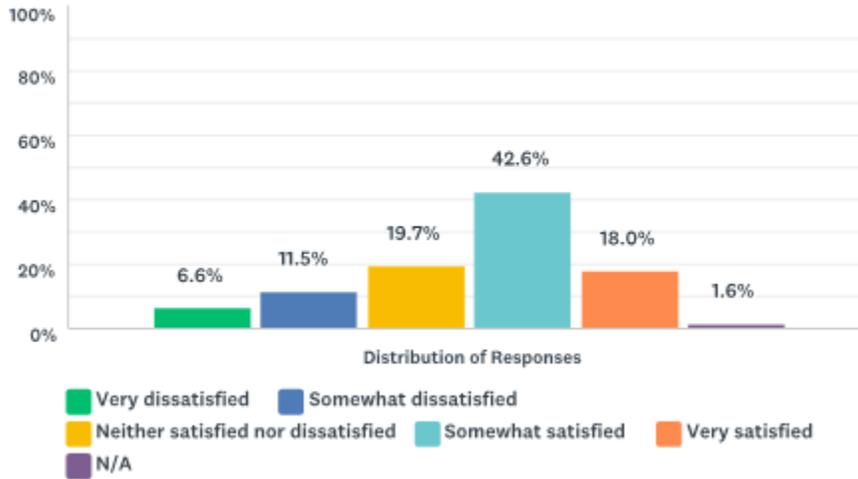
*How often does your class have activities in the central collaboration area?*

**Findings:**  $N = 59$ ;  $Mean = 2.9$ ;  $SD = 1.35$ ;  $35.6\% \geq$  monthly



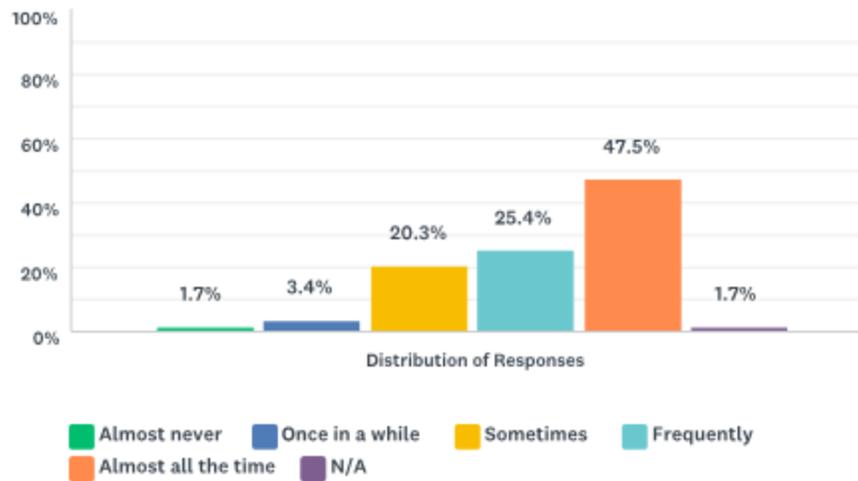
*How satisfied are you with the noise level in your classroom? (i.e., there is not too much noise coming from outside the room to disrupt my work)*

**Findings:**  $N = 61$ ;  $Mean = 3.6$ ;  $SD = 1.12$ ; 60.6%  $\geq$  satisfied



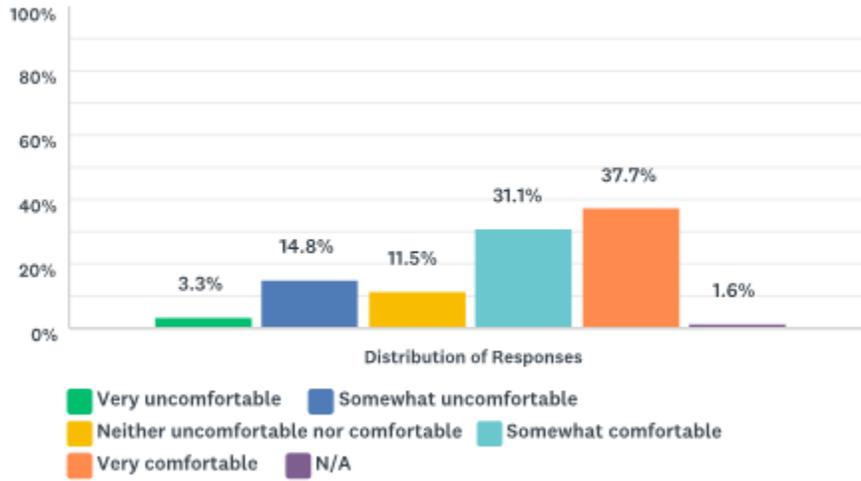
*Are teachers and students able to hear each other clearly in the classrooms?*

**Findings:**  $N = 59$ ;  $Mean = 4.2$ ;  $SD = 0.98$ ; 72.9%  $\geq$  frequently



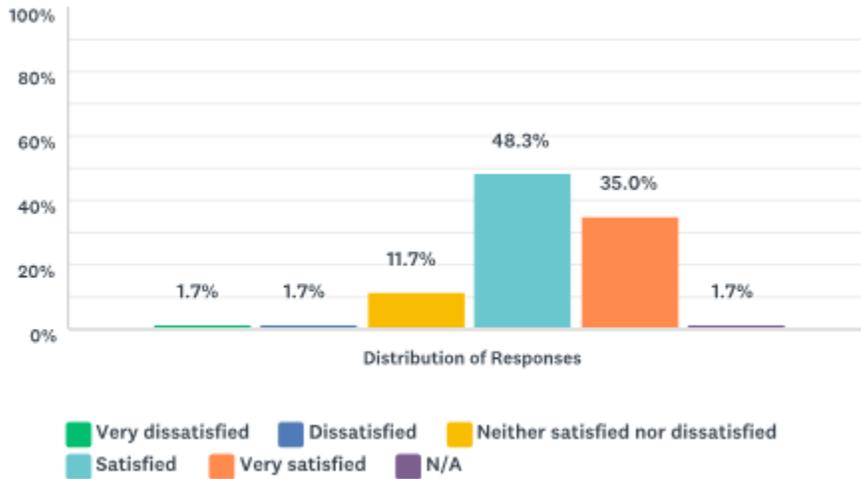
*How comfortable is the temperature in your classroom? (i.e., it is not too hot or too cold)*

**Findings:**  $N = 61$ ;  $Mean = 3.9$ ;  $SD = 1.18$ ;  $68.8\% \geq$  somewhat comfortable



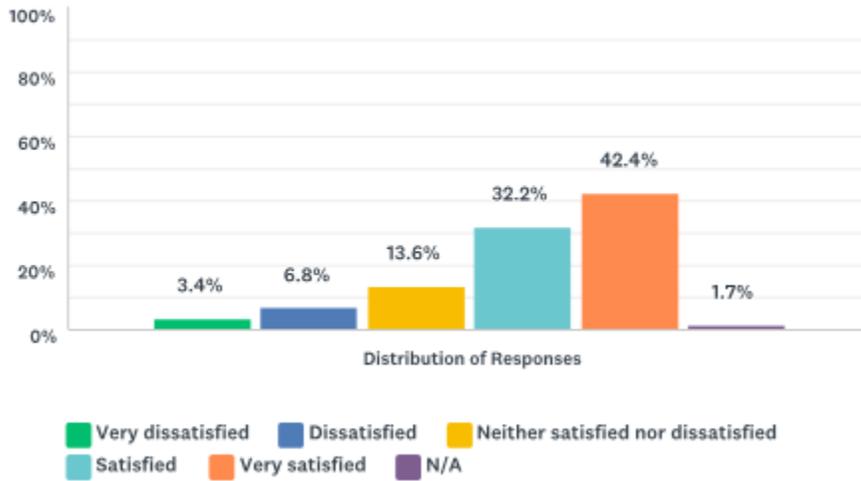
*How satisfied are you with the amount of electric light in your classroom?*

**Findings:**  $N = 60$ ;  $Mean = 4.2$ ;  $SD = 0.82$ ;  $83.3\% \geq$  satisfied



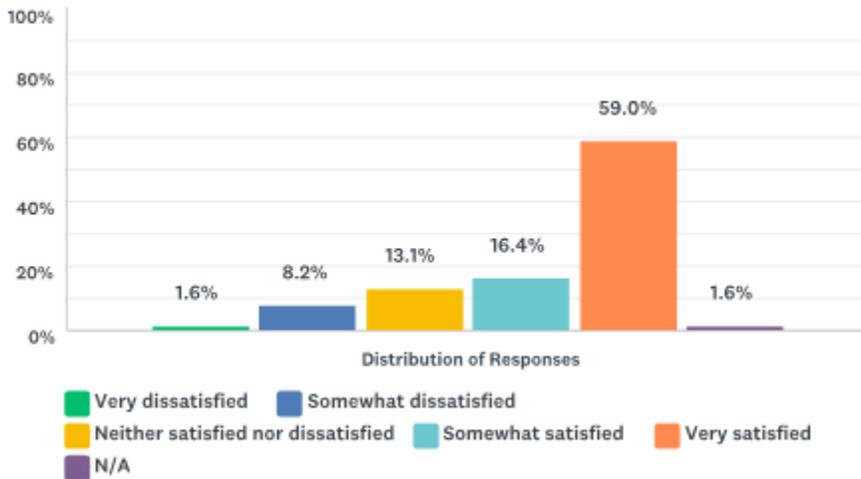
*How satisfied are you with the amount of natural daylight in your classroom?*

**Findings:** N = 59; Mean = 4.1; SD = 1.07; 74.6% ≥ satisfied



*How satisfied are you with the air quality in your classroom? (i.e., I can breathe easily, it is not stuffy or too breezy)*

**Findings:** N = 61; Mean = 4.3; SD = 1.07; 75.4% ≥ satisfied



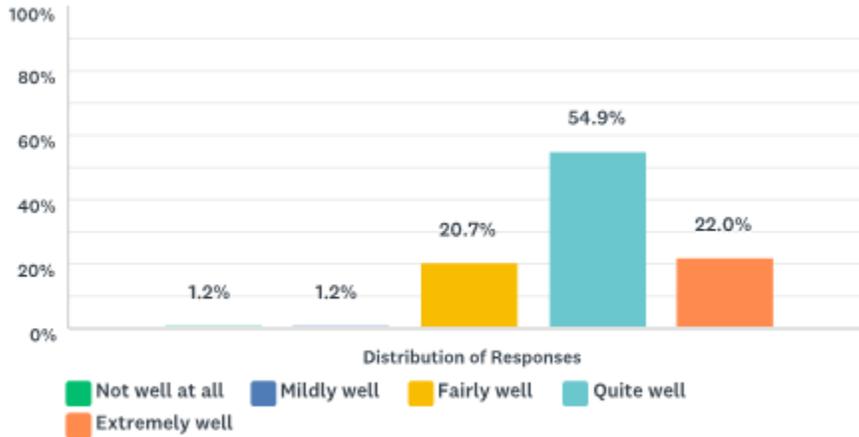
#### 4.4 Parent Perceptions of their Child's Academic Performance



In the section of the survey for parents, the primary goal was to learn about their perceptions of her or her child's academic performance. Topics ranged from parental involvement, student sense of belonging, social development, motivation to learn, academic performance, and how the building affects their child's learning ability. For this study, only the later two topics are discussed.

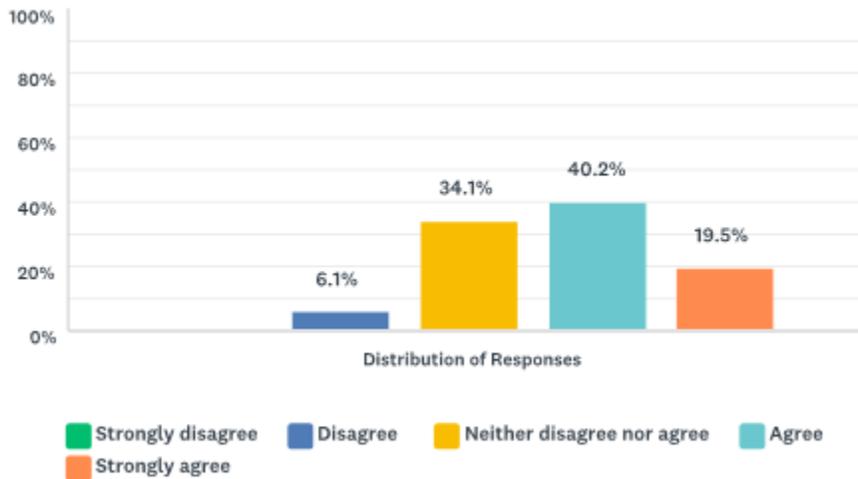
*How well do you feel your child's school is preparing him or her for his or her next academic year?*

**Findings:**  $N = 82$ ;  $Mean = 4.0$ ;  $SD = 0.76$ ;  $76.9\% \geq$  quite well



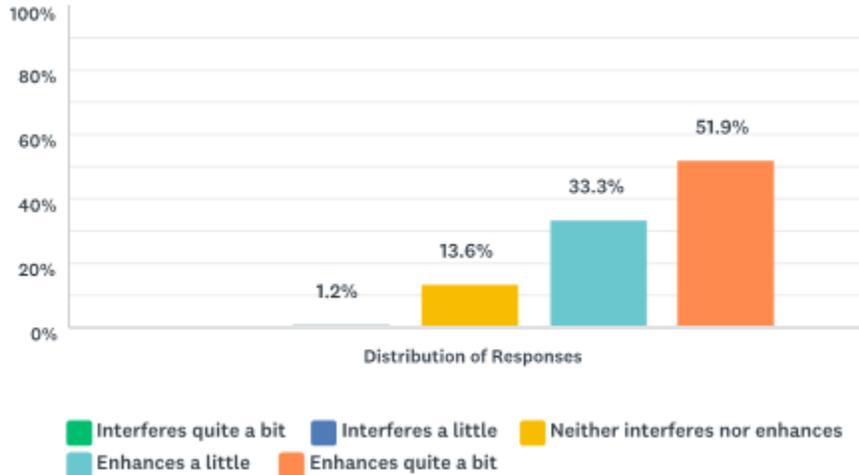
*Over the past year, have you noticed any improvements in your child's academic performance?*

**Findings:**  $N = 82$ ;  $Mean = 3.7$ ;  $SD = 0.84$ ;  $59.7\% \geq$  agree



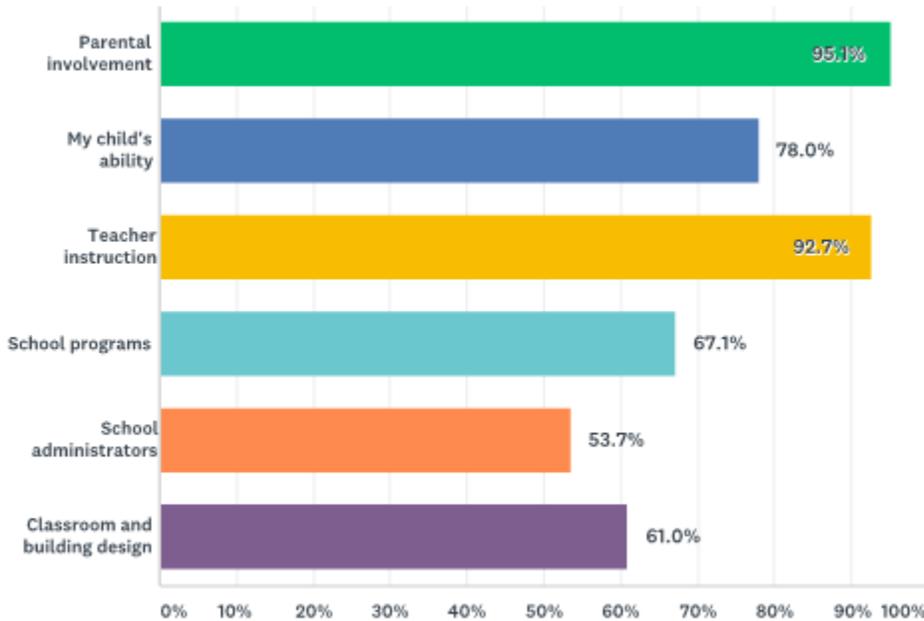
*In your opinion, does the layout of the classroom and school enhance or interfere with your child's ability to learn?*

**Findings:** N = 46; Mean = 3.8; SD = 1.17; 85.2% ≥ enhances; 51.9% enhances quite a bit



*In your opinion, what factors are primarily responsible for the success of your child's academic performance and learning? (Please select all that apply)*

**Findings:** N = 82; Mean = 3.2; SD = 1.69; 95.1% parental involvement, 92.7% teacher instruction, 78% child's ability, 67.1% school programs, 61% classroom and building design.



## 5 Discussion



Over the course of the first year since being finished, Butler Elementary School's distinct architecture and interior design is having a positive effect on the learning experience of students. Of the 48 students that took the survey, 82 percent agreed the layout of the school and classrooms fostered collaboration and made it easy to work in groups. Somewhat related, over half of students (52%) also agreed that the school design encouraged student-teacher interactions. Not only did the layout of the school and classrooms help make learning more fun (73%), but nearly half of students (49%) reported the design helped them pay more attention in class. Overall, 52 percent of students specifically reported that the layout of the classroom enhanced their ability to learn as compared to the 25 percent who noted that it interfered with learning.

The teacher instructional experience at Butler Elementary School was assessed by 19 faculty members and had similar positive findings. Closely aligned with student perceptions about group collaboration, 82 percent of teachers felt the layout made it easy to work in groups. A large majority of teachers (82%) also felt the spaces encouraged student-teacher interactions. Almost half of teachers (47%) reported that they worked collaboratively with other classes on at least a monthly basis. Nearly three-fourths of teachers (71%) also felt the school design helped their students pay attention. Overall, a clear majority of teachers (82%) reported that the layout of the classroom enhanced their students' abilities to learn.

Similarly, the layout of the classroom appeared to enhance at least three out of four (77%) faculty members' ability to teach. Almost half of teachers (47%) noticed some change in their teaching techniques as a result of the classroom environment with the most frequently used instructional techniques being class discussion (94.2%), small group activities (94.1%), activities with technology (88.2%), and lecture (82.6%). In the end, 79% of faculty members were satisfied with the design of the building and felt it provided quality learning experiences for their students.

Both teachers and students (n=67) evaluated the classroom environment at Butler Elementary School based on its classroom adaptability. Contributing to a flexible classroom, 78 percent of users reported that it was either easy or very easy to move classroom furniture. While 39 percent reported that the classroom and furniture layout changed every few months, another third of participants (33%) indicated that it changed at least on a monthly basis. In a question regarding the crowdedness and spaciousness of the classroom, 80 percent of respondents were satisfied with their ability to move around the classroom and work with others during class time. A third of classes (36%) also held activities in the central collaboration area at least monthly.

Beyond classroom adaptability, teachers and students evaluated the classroom based on other environmental factors. In regards to acoustic quality, for instance, nearly three-fourths (73%) of teachers and students reported they were able to hear each other clearly in the classroom. Consequently, 61 percent of respondents were satisfied with the noise level in the classroom. Moving on to illumination levels, a large majority of respondents were satisfied with both the amount of electric light (83%) and natural daylight (75%) in the classroom. Regarding thermal comfort, two-thirds (69%) of participants were comfortable with the temperature in their classroom. Lastly, three-fourths of students and teachers (75%) were satisfied with the air quality in their classroom.

Parental perceptions of their child's academic performance are an important factor in assessing the success of the learning environment. Of the 90 parents and guardians participating in the survey a large majority (77%) felt the school was preparing their child for their next academic year. Nearly two-thirds (60%) agreed there had been significant improvements with their child's academic performance. Four out of every five parents (85%) also felt the layout of the classroom and school enhanced their child's ability to learn. When asked what factors were primarily responsible for the success of their child's academic performance and learning, parents felt the top three contributors were parental involvement (95%), teacher instruction (93%), and their child's own ability (78%). Nearly two-thirds of parents (61%), however, also felt classroom and building design was an important factor contributing to the success of their child's academic performance.

## 6 Conclusion

The impact of school design on perceived academic performance becomes apparent from a reading of the descriptive statistics of the survey. It also appears that the hypothesis of this study is supported by the results of the survey. A flexible classroom environment that is used by teachers to implement different instructional techniques has a positive and direct impact on the perceptions of students, teachers, and parents. Both the student learning experience and teacher instructional experience were enhanced through the flexible classroom layout employed at Butler Elementary School. Students, for instance, felt the layout of the school and classrooms fostered collaboration and made it easy to work in groups. The design also helped them pay more attention in class and fostered student-teacher interactions. Teachers had similar responses regarding student attention span and student-teacher interactions. A large majority of teachers were not only satisfied with the design of the building, but they felt it provided quality learning experiences for their students. Parents also perceived the design of the school was enhancing their child's ability to learn and that the classroom design was an important factor affecting their child's learning experience.

Some of these perceptions may be attributed to the newness of the learning environment, the honey-moon phase, since the survey was conducted within a year of the school's completion. While the findings from this study are insightful and useful, further investigation is needed to validate the reliability of the research. For instance, a follow-up survey should be conducted after the school has been open for 5 years to verify whether the classrooms are still as effective for both students and teachers alike. The study could also be improved through a cross-sectional analysis of several elementary schools using the same classroom layout and school design as well as comparing them to more traditional classroom designs. Future research should include longitudinal studies looking more directly at how educational outcomes (i.e., measurable academic performance such as grades, social development, instructional performance, absenteeism, and turnover rates) are affected by the physical conditions of the classroom.

Overall, this study illuminates how a quality learning environment affects end-users and their perceptions of their abilities to learn and teach. The post-occupancy evaluation survey of Butler Elementary School reveals how the building design is successfully facilitating student learning, promoting group collaboration, and nurturing project-based curriculum. The results of the survey are relevant for designers, architects, educators, administrators, and policy makers who are each concerned with improving academic performance through better educational design strategies. A better understanding of the impacts of school design on the educational experience leads to better schools, students, and teachers.