Developing Instruments: Student Academic Engagement Levels and Satisfaction with School Design

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Abstract

This paper explores the relationship between student academic engagement and student satisfaction with the school building, both with the classroom and the building overall in the effort to build two new measurement instruments. This work was the third in a series investigating this same topic, each survey being a refinement of its predecessor. Consistent with the previous two trials, we showed that academic engagement and satisfaction with the school building's design tends to go hand-in-hand, as measured by our surveys,. Of particular interest is the fact the effect of school design on engagement was consistent across schools, gender, and grade level. We also achieved very good results for survey reliability, and we are confident that the surveys are valid.

Keywords: Active learning, survey development, student outcomes, education design, student engagement

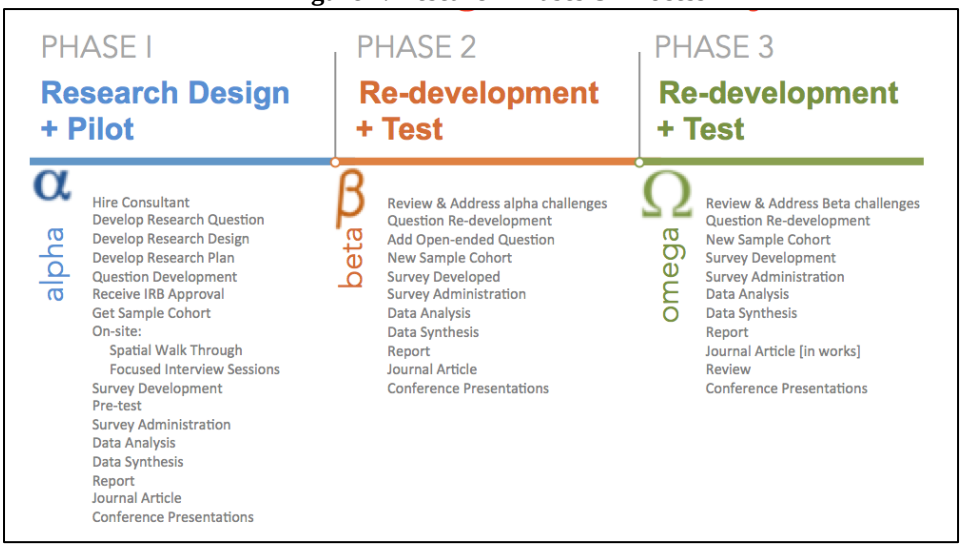
INTRODUCTION

This researcher team has worked to establish two new statistically reliable and valid instruments. When finalized, the instruments are destined to be used post building occupancy for schools housing students and educators for grades nine to twelve. Two indexes were created – Student Engagement Index© and a Teacher Engagement Index©. Our research question was, *"Can we demonstrate that the design of the built environment for grades 9-12 impacts student academic engagement levels?"* Why post occupancy? "Although many definitions of post-occupancy evaluation

(POE) have been proposed, a useful working definition is that POE is the examination of the effectiveness for human users of occupied designed environments (see Bechtel & Srivastava, 1978; Gutman & Westergaard, 1974; Ostrander & Connell, 1975; Zeisel & Griffin, 1975 in Zimring & Reizenstein, 1980, p. 429). 'Effectiveness' includes the many ways that physical and organizational factors enhance achievement of personal and intuitional goals" (Zimring & Reizenstein, 1980, p. 429).

The purpose of this work was to build reliable and valid instruments to be used post-occupancy at scale. Its development has gone through three phases (see Figure 1) all using grades 9-12 in schools across the USA, designed by DLR Group's K12 Education Studio as convenience samples (Scott-Webber, Konyndyk, French, Lembke, & Kinney, 2017; Scott-Webber, Konyndyk, French & French, 2018).

Figure 1. Research Phases & Process



This type of social science research was not an experimental design, limiting one's ability to draw definitive conclusions. It was recognized that multiple factors influenced respondents' answers. Knowing these limitations, we worked to address issues of impact from the design of built environment at both the micro (or classroom) and macro (or overall building) levels, teaching practices, connection to school as 'community,' etc., acknowledged and then tried to determine perceptions of influence of the built place on these. The ultimate goal was to develop instruments that when completed will act as 'tools' for architectural firms in education practice to continually test and improve design solutions – always looking to support student academic successes. This article articulates the research methodology, analysis techniques, findings, along with limitations and conclusions allowing the reader an understanding of both the level of complexity and the

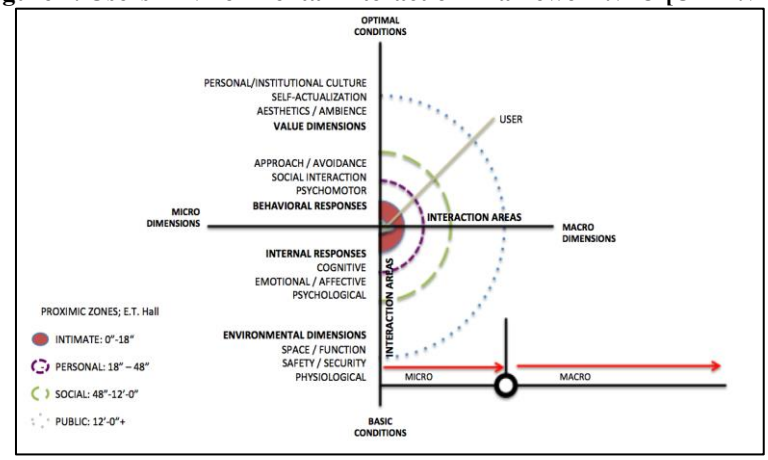
work it took to build these instruments. To date the survey results consistently affirm the importance of physical surroundings for students, by demonstrating a connection between satisfaction with physical surroundings and student academic engagement.

BACKGROUND

This research was trying to 'prove' that the design of space makes a difference in how individuals engage with each other, their teachers and with their academic content. This work also tried to understand and measure what was impacting interactions, or engagements. We believed it was important to not just answer the research question, but try and provide a tool, or index and measurable awareness levels to use as gauges of engagement and environmental fit. This current work builds on a career effort and the questions used are framed from multiple researchers in multiple arenas put together in a more holistic approach and called the Users Environmental Interaction Framework.v2© (UEIF.v2©) (Scott-Webber, 1999; French, Scott-Webber, Ferking, & Fulton, 2015). The engagement index and awareness levels by user groups in this grades 9-12 study were derived from this early, and ongoing research. A review of the framework is next.

The graphic in Figure 2 showed the complexity of interaction / engagement understandings with multiple facets including three specific segments: (1) layers of the design of the built spaces - the micro level, or classroom, and macro level, or overall, (2) two Dimensions of Value and Environment, and (3) two Responses of Internal and Behavioral. This framework has built on the research of many others, particularly classical Environment Behavior theorists, in an effort to more fully examine space and its relationship to its users (Hall, 1966; Sommer, 1959; Scott-Webber, 2000 & 2004; Scott-Webber, Abraham, & Marini, 2000; Maslow, 1943; Bloom, Krathwohol & Harrow, 1956; Elliot & Covington, 2001) (see Figure 2). The following sections of this article include: the methodology, and discussion regarding the reliability and the validity of the survey instruments. Analysis was next. The impact of the physical environment followed and was documented through the discussion of the analysis: which question groups had a strong correlation with engagement, the perceived impact of the building on the respondents, and a look at "movement" questions. Cluster analyses of both the students and the teachers provided another way to see the results and provided insight into the different "cultures" of the surveyed schools. Finally, we share the limitations along with conclusions.

Figure 2. Users Environmental Interaction Framework.v2© [UEIF.v2©]



METHODOLOGY

Sample

This survey development, the third in a series, was the largest to date (student's n= 3004; teacher's n=245) (refer back to Figure 1). It involved six schools across the USA, most residing in the mid-western region, and was considered a convenience sampling.

Technique

Each succeeding survey in this testing series was a modification of its predecessor, done with the intention of improving response rates, eliminating unneeded questions, and improving the usefulness of the data. The results of the changes we made were: (a) fewer people dropping out part way through the survey, (b) better reliability numbers, and (c) more usable data (see Table 1). To evaluate reliability, we used Cronbach's Alpha (Tavakol & Dennick, 2011) as the criterion ability. The next step was a Principal Component Analysis (Lever, Krzywinski & Altman, 2017) of each question group to determine whether the mean of the items in the question group was a good proxy for each question group. Next, Composite Variables (Song, Lin & Ward, 2013) were developed, including engagement indexes for both students and teachers. We followed these steps with a Cluster Analysis (Abonyi & Feil, 2007) done for each survey, based on the composite variables. We used a t-test and a Correlation Analysis (Trochim, 2006) to look at the perceived impact of the building on engagement. Our look at validity included both Convergent & Discriminant Validity (Trochim, 2006), or whether items are positively correlated that should be, and whether the expected items are uncorrelated or negatively correlated.

Details

On the student survey, over half of the respondents answered all the questions, and another 858 skipped only one or two question items, and 219 skipped three items. Thus 2,622 students, 87% of the total, skipped at most three question items in the survey. The ranking question was the mostly frequently skipped question by far; about one-fifth of the students did not answer it. Perhaps doing the ranking required a little more thinking than the other questions? Over 93% of the students who started the survey stayed with it all the way to the end.

Results for the teachers were similar; about 90% stayed with the survey all the way to the end. The problem of "survey fatigue" which we had encountered in the first survey test had largely been eliminated. After looking at response rates, the next stage in the analysis was to assess reliability, that is, to ask whether people gave similar answers to similar questions. An objective criterion of reliability was Cronbach's Alpha, which varies between 0 and 1, with higher values indicating greater reliability. Results for the student survey were excellent. For the applicable question groups (1 – 8), all values were greater than .84. Results for the teacher survey were also very good, with all values greater than .72.

Table 1. Overall Response Rates / Students & Teachers

School	Total Students	Respondents	% Responding		Total Educators	Respondents	% Responding
A	1,213	817	67.4%		87	59	67.8%
B	1,648	337	20.4%		197	45	22.8%
C	80	60	75.0%		5	5	100.0%
D	2,100	825	39.3%		130	86	66.2%
E	500	401	80.2%		17	14	82.4%
F	1,190	564	47.4%		76	36	47.4%
Total	**6,731**	**3,004**	**44.6%**		**512**	**245**	**47.9%**

The next step was a principal components analysis of each of the question groups. This procedure was done to determine whether the mean of the items in the question group was a good proxy for the group, or whether the group needed to be subdivided. One question, about the values of the school, showed a possible need to be broken up, with the "Testing" value looking somewhat different from the others. However, separating it out in the analysis gave almost identical results to including it, and so it was included with the others as part of the composite variable.

After this, composite variables were created; one variable to represent each question group. The mean of the answers in each group was used as the composite. If one item in the group was left unanswered, the mean of the

remaining items was used; if more than one item was left empty, the composite variable was set to missing. The composite variable for the question, "At the end of a school day, how often do you feel that you…" was used to create the engagement index for both the student and the teacher surveys.

To see which question groups were most closely allied with engagement, the engagement index was regressed on each individual question group, providing insight into the relationship between engagement and the built environment. Demographic variables were also considered. For students, grade level was never important, while gender sometimes played a minor role. Some schools seemed to show higher overall engagement levels than others. However, the slope of the regression line was always the same across genders and across schools; that is, the association of each question group with engagement was the same, regardless of gender or school, for both teachers and students. Following this analysis, a cluster analysis was done for each survey, based on the composite variables.

Using a t-test and a correlation analysis, we also looked at the perceived impact of the building (question 3 for students and teachers, and also question 7 for the teachers). Questions about movement were compared with student engagement. Finally, some differences in the "cultures" of the schools were noted.

Validity

While the reliability of a survey instrument was concerned with whether respondents gave similar answers to similar questions, asking whether a survey was valid was to ask whether it measures what it seeks to measure, a more difficult question. We looked for convergent validity, that is, whether items were positively correlated that should be, and discriminant validity, that was, whether the expected items were uncorrelated or negatively correlated. We considered each survey separately.

Student Survey

On the student survey, the composite variables were correlated with each other in ways that made sense, a strong argument for the overall validity of the survey. For example, the strongest correlation among the composite variables was that of the composite building and classroom ratings from question 4 with each other: 0.90. The "ratings" questions (2 and 4) were correlated strongly with each other, and the "impact" of questions (3 and 7) correlated well with each other, as were the "design" questions (2 and 8), strong evidence of overall validity.

One would expect that whether one views various items as important in the abstract (Q1) would be less correlated with the other questions, and indeed its correlations with the other composite variables were all .53 or lower, providing evidence of discriminant validity.

Additional strong evidence of overall validity was seen by comparing the results of this survey to those of the second trial, the "Beta" survey. In looking at the regressions of the student engagement index on the other composite variables, one sees even stronger values of R^2 in this survey than in the Beta, when comparing corresponding questions. The relative values of R^2 in the regressions in the two surveys are similar. (R^2 was a measure of the goodness of fit of the regression.) Given the variety and number of schools in the two surveys (four schools in the Beta and six in this Omega survey), the consistency of results across schools and surveys was another indication of the overall validity of the surveys.

Teachers

In the teacher survey, the larger correlations of the composite variables occur where one would expect, evidence of convergent validity. As with the student survey, the strongest correlation was between the composite classroom ratings and the composite overall building ratings, both from question 4, the correlation having a value of .86. The questions about building impact (questions 3 and 7) were well correlated, and questions about how well the building and classroom function (second part of question 1, questions 2, both parts of 4, question 8, and question 10) tended to be well correlated, giving good evidence of convergent validity. The first part of question 1, a more abstract theoretical question about the importance of various activities, had no correlations above .36 with the other composite variables, which were all concerned with what was happening in practice. These lower correlations thus provided evidence of discriminant validity.

As in the Beta survey, the Teacher Engagement Index had lower correlations with the other composite variables than did the Student Engagement Index. We confirmed the findings in the Beta that student engagement was more closely correlated with satisfaction with the building than teacher engagement was. In fact, regressions of the Teacher Engagement Index on the various composite variables yielded values of R^2 quite similar to those of the Beta survey.

This satisfying consistency between the current survey and the Beta was another indication of the overall validity of the surveys. Thus, we had confidence these surveys were reliable and valid.

What Makes Up The Engagement Index?

For both students and teachers, the engagement indexes were based on specific questions (eight for the students, seven for the teachers) (see Table 2). For reliability, the values of Cronbach's Alpha for this group of questions were .915 for the students and .773 for the teachers. For students, a principal components analysis of the question items showed the first component accounting for 63% of the variation, with the loadings from the individual items all between .72 and .84, indicating that the mean was an excellent summary for the group of questions. For teachers, the first principal component accounts for 45% of the total variability, with loadings varying from .55 to .81, again indicating that the mean provided a good summary of the question group. The mean of the respective question groups were used to provide the engagement indexes for both students and teachers.

Table 2. Engagement Index Questions

A	1	ITEM	DESCRIPTION: Index Contributor: "At the end of the day, did the design of the built environment contribute to…" [1 = low; 5 = high]	1	2	3	4	5
	STUDENT	a	My recognition that I contributed very well on my team's projects					
		b	My taking care of my studies appropriately					
		c	Feeling appreciated by my peers					
		d	My making good use of my time					
		e	Getting the teacher's help I needed					
		f	My doing my best effort					
		g	My challenging myself academically					
		h	Being stimulated by what I am learning					

The questions that the engagement indices were based on were on a 1- (Never) to-5 (Always) scale, and the indices were also on the same 1- to 5-scale, since the indices were simply the means of the underlying questions. The overall mean engagement was higher for the teachers than for students (3.95 vs. 3.59), while the student engagement index had greater variability. The engagement index was critical to this paper, as it was the dependent variable in the regressions shared in the next section.

ANALYSIS

Regression

Student Survey

The student survey showed that satisfaction with the building and academic engagement was connected. Comparing student engagement with question 2 (How well the classroom design provides for your needs?), a good regression model also accounted for the effect of the school. We had a strong R^2 of .32, with $p < .0001$ (see Figure 3).

There was a similarly strong relationship between student engagement and student ratings of the classroom in question 4 (noise level, lighting, temperature, etc.). Including the school in the model gave $R^2 = .31$, with $p < .0001$ (see Figure 4).

Figure 3. Q5. The Student Engagement Index Regressed on Q2 and School

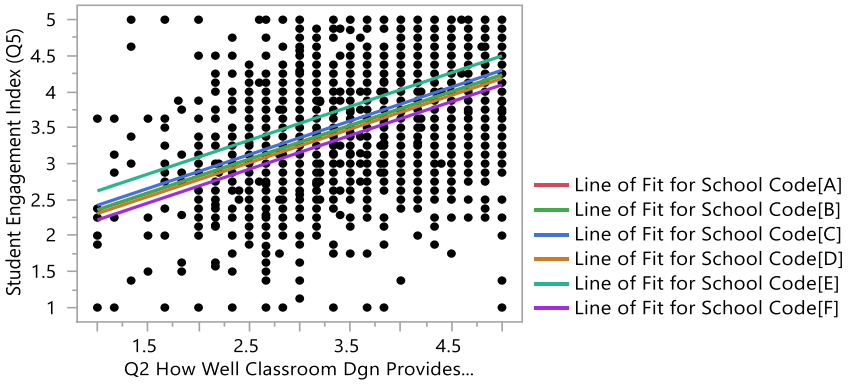
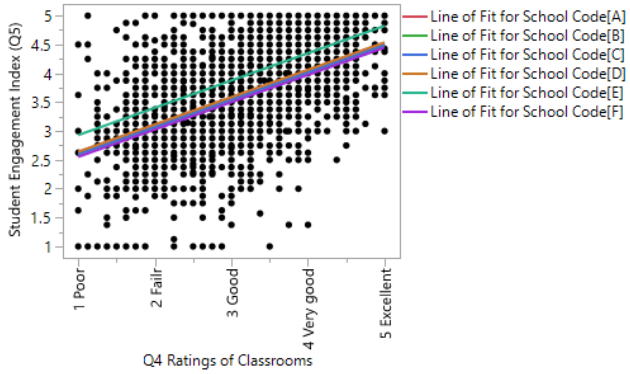


Figure 4. Q5. SEI Regressed on Q4 / Ratings of the Classroom



The strongest correlation with student engagement was with the ratings of the perceived values of the school. The more the students perceived that the school valued creativity, critical thinking, collaboration, or the 21st century learning skills, the higher their academic engagement was likely to be. A simple linear regression model had $R^2 = .445$, with $p < .0001$ (see Figure 5).

Interestingly, the more students believed that the building's design affected them (question 7), the higher their engagement was likely to be (see Figure 6). This model, using question 7 and the school, gave an $R^2 = .30$.

Figure 5. Q5. SEI Regressed on Q6 / Values of the School

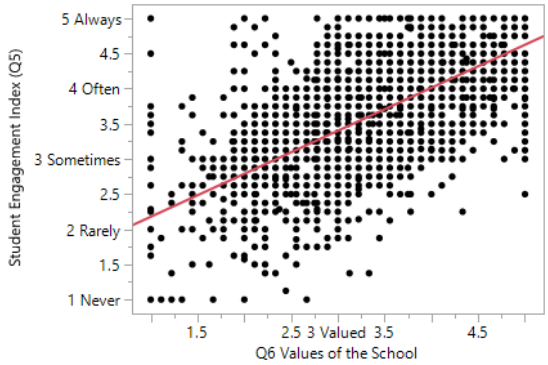


Figure 6. Q5. SEI Regressed on Q7 (Level of Impact on You of the Building)

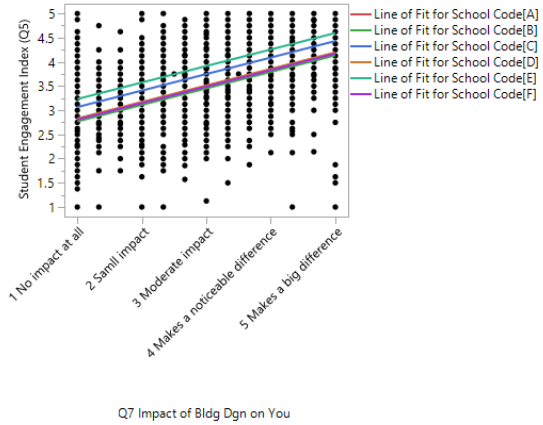
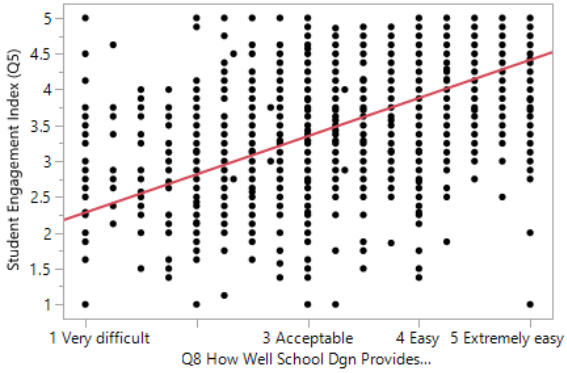


Figure 7. Q5. SEI Regressed on Q8 (How Well the School Design Provides…) / Students



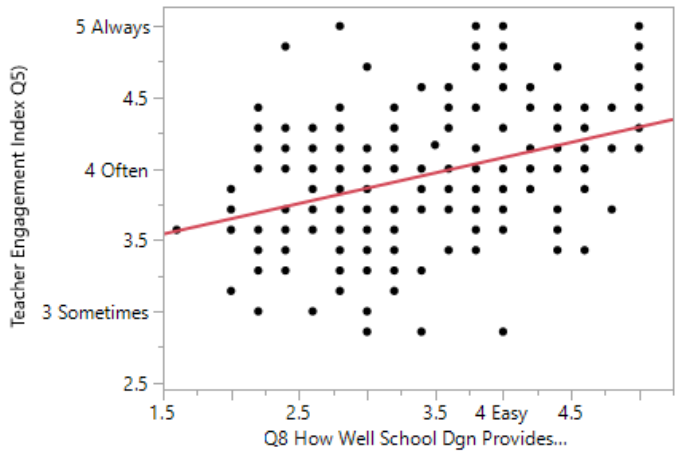
Another very strong relationship was between the SEI and question 8 (How well the design of the school provides for certain needs, such as access to peers and teachers, ability to move around, and access to teaching technologies?). School and gender were not important here, and the

regression of the engagement index on question had an R^2 = .39 (see above Figure 7).

Teacher Survey

The relationship between satisfaction with the physical surroundings and engagement was much weaker with the teachers than for the students, similar to the findings from the Beta survey. For many of the questions, knowing which school the teacher was in gave more information about the probable teacher engagement level than knowing the teacher's answers to the questions. There were some real differences between the schools; it seems that the "situational culture" (Scott-Webber, 2018) of the school was more important for teacher engagement than several of the topics explored in their survey. The educational level of the teacher was never a factor, and gender was not very important, either. Teachers who gave higher ratings to the questions had only a slight tendency to have higher values of the TEI. The highest value of R^2 came from the question group asking how well the design of the school provided important abilities (see Figure 8) but that regression only had R^2 = .14, much lower than the values found in the student survey.

Figure 8. Q5. SEI Regressed on Q8 ("How Well the School Design Provides…") / Teachers



In regressing the TEI (Teacher Engagement Index) on the composite variables, the values of R^2 on this survey were quite comparable to those of the Beta. Four of the R^2 values were higher in the Beta survey for the teachers, and three were higher in the current survey (i.e., 'Omega'), but none differed by a large amount. In both surveys, the school was a greater influencer of the TEI than some of the composite variables. In short, we have largely confirmed and replicated the results of the Beta: the design of the building makes a statistically significant difference in teacher engagement, but other factors proved even more important in predicting

teacher engagement. This finding suggested that the school culture was at least as important from the teachers' perspective as the building's design.

Comparing the Regressions of the Students and Teachers

In comparing the composite variables to the respective engagement indices for the students and the teachers, we saw that each of the composite variables was much more strongly correlated to the engagement index for the students than for the teachers. This result was very similar to that of the previous ("Beta") survey. For both groups, the highest correlations with the respective engagement indexes were with questions 6 (values) and 8 (how well the design of the school provides various things) (see Table 3).

Table 3. Comparing Regressions / Students & Teachers

Composite Variable for Question Group	Correlation Coefficient with Engagement Index		Value of Rsquare from Regression on Composite Variable	
	Students	Teachers	Students	Teachers
Q1 Importance of various items	.486	.182	.238	.034
Q1 Design Supports	-	.273	-	.075
Q2 How well classroom provides…	.548	.245	.304	.063
Q3 Impact of classroom design	.412	.207	.172	.046
Q4 Classroom Ratings	.536	.263	.288	.071
Q4 Building Ratings	.524	.295	.277	.090
Q6 Values – all items included	.665	.339	.445	.118
Q7 Level of impact of the building	.515	.229	.267	.053
Q8 How well design of school provides…	.623	.372	.391	.139

Cluster Analysis / Students

Several judgment calls were made while doing this cluster analysis: which variables to include, the clustering method to use, and so on. Here, Ward's (Murtagh & Legendre, 2011) method was employed and seven clusters used (see Table 4). The average level of student engagement sorted the clusters here. Seven clusters may be more than one normally wishes to deal with, but look at cluster 7, a group of 37 apparently disgruntled students. This group was something of an outlier. They consistently gave the lowest rating to almost every question item. The questions became: (a) Did they not take the survey seriously, or (b) are they really that unhappy, and/or (c) something else? Of the 37, 20 were from school A, which had low ratings for several of the questions, and 11 more were from school D, which also

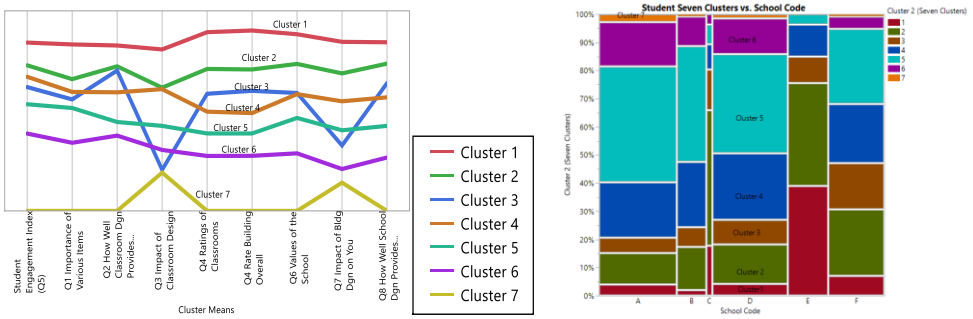
Table 4. Cluster Means / Student [Dgn = design]

Cluster	Count	SEI (Q5)	Q1 Import of Various Items	Q2 How Well Classroom Dgn Provides...	Q3 Impact of Classroom Dng	Q4 Ratings of Classroom	Q5 Rate Building Overall	Q6 Values of the School	Q7 Impact Blgg Dgn On You	Q8 How Well School Dgn Provides...
1	266	4.539	4.414	4.687	4.449	4.285	4.481	4.586	4.600	4.690
2	522	4.067	3.722	4.252	3.500	3.639	3.752	3.985	3.911	4.239
3	257	3.615	3.317	4.165	1.461	3.202	3.353	3.396	2.335	3.828
4	545	3.828	3.467	3.710	3.463	2.887	2.936	3.373	3.301	3.529
5	841	3.259	3.145	3.090	2.552	2.504	2.556	2.891	2.667	2.928
6	262	2.650	2.451	2.806	1.955	2.108	2.137	2.174	1.821	2.260
7	37	1.044	1.092	1.234	1.392	1.142	1.108	1.009	1.523	1.135

tended to have low ratings. None of the 37 respondents were from schools C or E, which always seemed to have high ratings.

Figure 9 showed the cluster means in the above table (refer back to Table 4) (see Figure 9). Clusters 1 (red) and 2 (green) had the highest SEI and the highest ratings of all the other question groups. This pattern was throughout, except for cluster 3, the blue line, which showed some differentiated ups and downs. This later group of 257 students was somewhat engaged but saw little impact from the classroom design (Q3), and not much impact from the overall design on the building. School E had the highest percentages of students in the "best" clusters, followed by school C, suggesting some real differences by school; reference the right side of the figure 'Model by School.'

Figure 9. Cluster Means / Students Overall & Model by School



Cluster Analysis / Teachers

A five-cluster model proved the most useful for the teachers (see Table 5 & Figure 10).

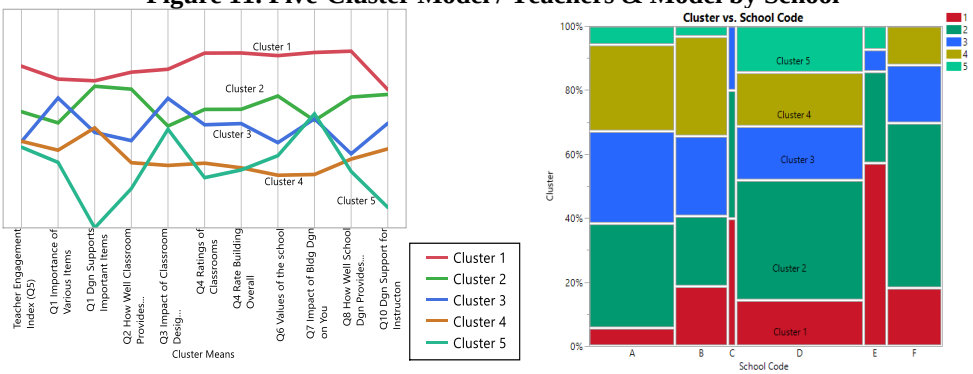
Note that the clusters were ordered by the average values of the Teacher Engagement Index (TEI), with cluster 1 being the "best." Clusters 3, 4, and 5 had very similar levels of the average TEI, but rather different values for the other questions.

Table 5. Cluster Analysis / Teachers [Dng = design]

Cluster	Count	TEI (Q5)	Q1 Import of Various Items	Q2 How Well Classroom Dgn Provides	Q3 Impact of Classroom Design	Q4 Ratings of Classroom	Q5 Rate Building Overall	Q6 Values of the School	Q7 Impact of Bldg Dgn on You	Q8 How Well School Dgn Provides	Q10 Dgn Support for Teaching
1	36	4.381	4.269	1.978	4.056	4.007	4.097	4.398	4.512	4.378	1.978
2	76	4.006	3.707	1.949	3.032	3.252	3.336	3.834	3.289	3.709	1.961
3	44	3.760	4.027	1.709	3.532	3.045	3.142	3.182	3.321	2.882	1.858
4	41	3.763	3.356	1.733	2.322	2.530	2.544	2.726	2.321	2.805	1.767
5	16	3.714	3.200	1.213	2.975	2.336	2.516	3.000	3.411	2.625	1.559

Cluster 5 was particularly interesting, in that the teachers in cluster 5 did not believe the building or classroom designs supported them very well (see questions 1, 2, 4, 8, and 10), but they saw that the building's design had a moderate impact on them. They were much less pleased with their physical surroundings than the other four groups. Cluster 1's teachers had the highest average level of engagement, and they gave the highest ratings to all the other questions used for the clustering. Cluster 2, the green line, with the second-highest level of engagement, also gave relatively high ratings to all of the other questions. Note that clusters 3, 4, and 5 all have about the same level of teacher engagement, as measured by the index, but they gave divergent ratings to the other questions. Cluster 4 saw the least impact from the building on them in Q3 and Q7, though they were not as negative about design support for instruction (Q1 and Q10) as cluster 5. The right side of this figure showed the percentages in each cluster by school. Schools C and E, which had the fewest respondents, had the highest percentages of the most-engaged teachers (clusters 1 and 2), followed by school F, which also had a relatively small number of respondents. This data suggested that there were some real differences in "situational culture" from school to school. Note that the teachers' clusters lined up similarly to the student clusters by school.

Figure 11. Five-Cluster Model / Teachers & Model by School



Impact of the Physical Surroundings

Question 4, "Please rate the Classroom and the Overall building's design in terms of these factors…" looked at the overall and classroom relative to environmental qualities. The following told the story shared earlier particularly relative to temperature comfort for both user groups. The furniture seating choices that were not making student particularly happy were consistent with earlier findings. Students also seemed to find the spatial designs more inviting than did the educators.

The question, "Do students and teachers see an impact from the building…" question 7b, was the only item on which students saw more than just a moderate impact (a value of 3). For students especially, this might have been a difficult question to answer accurately, as most of them probably had not experienced several different physical learning environments, and therefore would be less aware of how the physical environment may affect them. This data from the students' perspective was shared in Table 6 (see Table 6).

Table 6. Student Averages

Question Item	Mean (Students)	T-test for H_0: mean <= 2.5
Q3a Motivation to attend classes	2.80	P < .0001; (N = 2973)
Q3b Ability to do your best work	3.02	P < .0001; (N = 2971)
Q3c Willingness to work hard	2.93	P < .0001; (N = 2961)
Q3d Motivation to achieve better grades / learning outcomes	2.95	P < .0001; (N = 2967)
Q7a Perception that learning is valued	3.02	P < .0001
Q7b Ability to move around to be deeply engaged in your learning	3.20	P < .0001
Q7c Perception that you can stay connected to the school community	3.06	P < .0001

Teachers generally saw about the same or a little more impact than the students. This data result was also the case in the Beta survey. The finding was not surprising, as teachers have had the experience and years of seeing how their students succeeded, or where they struggled. Thus, it would stand to reason that due to their experiences they 'know better' what to expect in terms of students' outcomes than individual students might see of themselves (see Table 7).

Table 7. Teacher Averages

Question Item	Mean (Teachers)	T-test for H0: mean <= 3.0	T-test for H0: mean <= 2.5
How much impact does the design of the classroom have on your students'…			
Q3a Motivation to attend classes	2.97	Not significant	P < .0001
Q3b Ability to do their best work	3.35	P < .0001	P < .0001
Q3c Ability to participate in classroom discussions/activities	3.72	P < .0001	P < .0001
Q3c Willingness to work hard	2.89	Not significant	P < .0001
Q3e Motivation for them to achieve better	2.94	Not	P < .0001

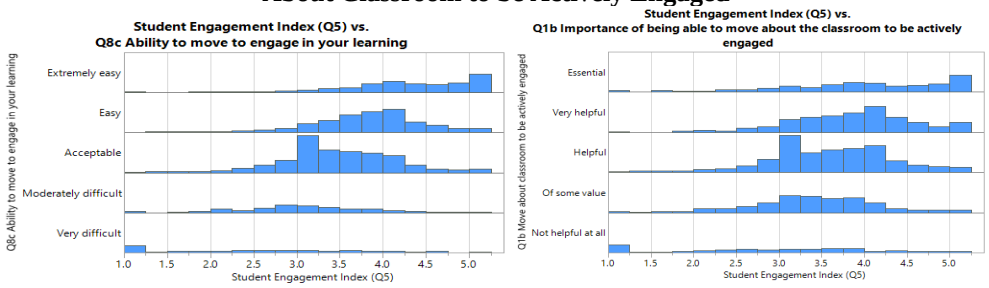
grades/learning outcomes		significant	
Q7 Impact of the design of the building's physical spaces on your…			
Q7a Motivation to teach your classes	3.08	Not significant	P < .0001
Q7b Ability to do your best work	3.27	P = .0008	P < .0001
Q7c Perception that teaching is valued	3.35	P < .0001	P < .0001
Q7d Ability for you to move around to get your students deeply engaged in their learning	3.79	P < .0001	P < .0001
Q7e Perception that you can stay connected to the school community	3.08	P = .0012	P < .0001
Q7f Willingness to work hard for higher learning outcomes for your students	3.13	P = .059	P < .0001
Q7g Perception that learning is valued	3.47	P < .0001	P < .0001

"Movement" Questions

Students who believed that movement was important and / or believed that their schools facilitated movement tended to have higher values of the SEI (see Figure 12). The graphs in this section all showed the engagement index on the horizontal axis, with a histogram of its values for each possible answer to the question on the vertical axis.

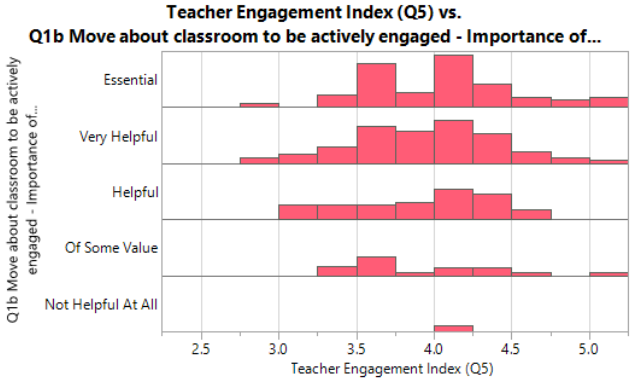
A one-way ANOVA showed that the apparent differences in student engagement at each level of Q8c were very real, and the overall ANOVA had a significance p < .0001. Students who believed that they needed to be able to move about the classrooms tended to be more engaged. The correlation of this variable (Q1b) with the SEI was not quite as strong as shown in the preceding graphs, but was still very real (p < .001) and very strong, as shown in the graph below (refer back to Figure 12).

Figure 12. Q5 vs Q8c Ability to Move to Engage in Your Learning & Q5 vs Q1b Move About Classroom to be Actively Engaged



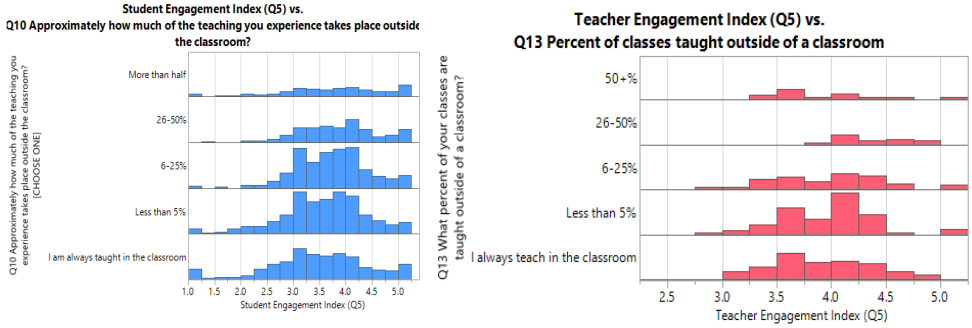
For teachers, the story was different. None of the "movement" questions were closely related to teacher engagement (see Figure 13). For example, the mean TEI was between 3.87 and 4.07 for each of the responses to the questions about moving about the classroom.

Figure 13. Q5 vs Q1b Move About Classroom to be Actively Engaged



Engagement rose slightly for students when classes were taught outside the formal classroom (see Figure 14). The mean engagement value rose from 3.41 to 3.81 as the percentage went from zero to over 25%. This information was statistically significant, with $p < .001$. However, the percentage of teaching done outside of the classroom seemed to have little to do with teacher engagement (see Figure 14).

Figure 14. Q5 vs Q13 What Percent of Your Classes Are Taught Outside of a Classroom

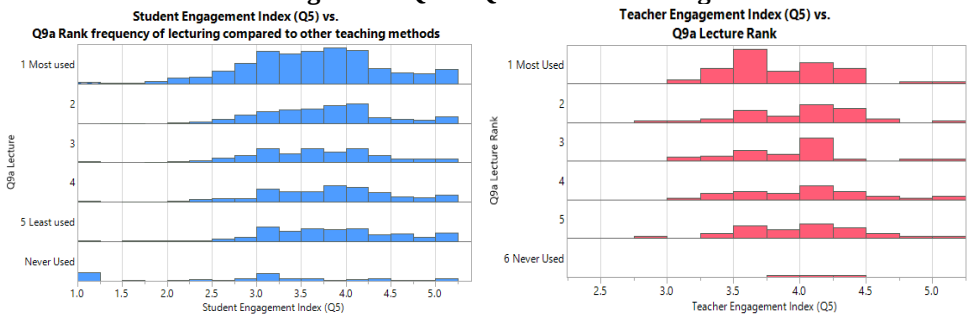


Lecturing

Another question we asked concerned the association of the amount of lecturing done and engagement. In the student survey, we ranked the relative frequencies of five teaching strategies used by teachers – lecture, small group work, team projects, hands-on projects, and one-to-one instruction. A look at the SEI against the students' rankings of the teaching strategies used showed only a very minimal relationship. Students whose teachers never lectured seemed to have a slightly lower engagement than the others (see Figure 15). The "Never used" group had a mean SEI of 2.86, while the other groups had mean values ranging from 3.55 to 3.73. The pattern was similar for all the other teaching methods ranked in question 9. Figures for ranking of small group work, team projects, etc. would look very

similar to the figure above for lecturing. Could it be that students need a mix of different teaching methods? Or, does this age cohort not really understand the word 'lecture', thus maybe more language to understand our question would be required. Teachers who said that lecturing was their most used teaching strategy seemed to be a little less engaged than the others, but the relationship was not strong (see Figure 15).

Figure 15. Q5 vs Q9 Lecture Ranking



Individual Questions "Of Interest"

Results to some individual questions that were "of a particular interest": (a) feeling safe, (b) temperature comfort, and (c) moving to learn. The following figures shared comparisons using percentages between the questions about the Overall built environment's design and the Classrooms.' For example, 29% of the students reported that they did not feel very safe, even in the classroom, and for the overall building, a third of the students gave answers of "Fair" or "Poor" to this question. The following graphic shared the comparisons between questions 4e1 and 4e2, the building Overall and the Classroom using percentages relative to "feeling safe" (see Figure16). The percentages for teachers regarding "feeling safe" were similar.

Teachers saw movement as being more important than students did. Perhaps the teachers' responses were due to their expertise in understanding how important it is for learners to 'move to learn' (Kilborne, Scott-Webber, & Kapitula, 2017). Teachers also saw more impact from the building's affordances on movement than did the students (see Figure 17). A later section deals with the impact of the building on this subject in more detail.

Figure 16. Student Ratings on Environmental Qualities at Both the Classroom & Overall Levels

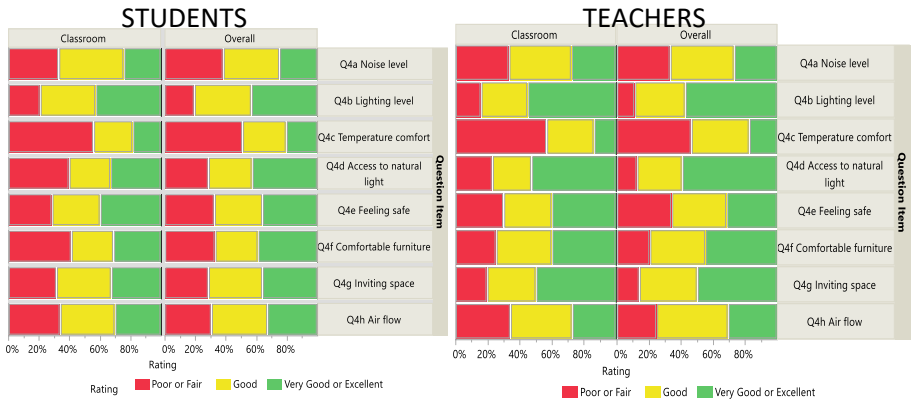
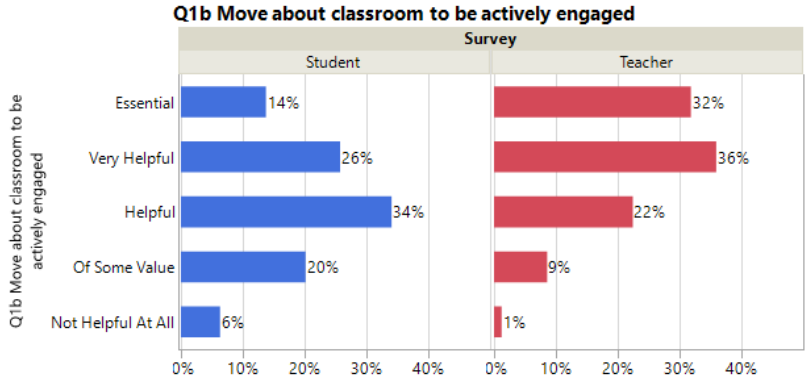
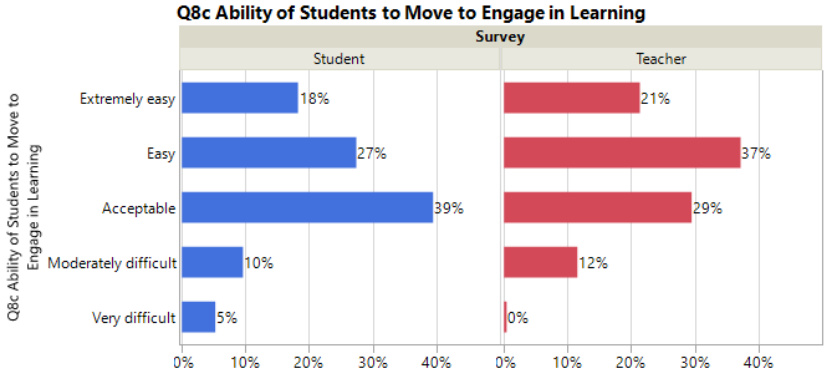


Figure 17. Q1b. Importance of Being Able to Move About the Classroom to be Actively Engaged in Learning



Concerning the ability of students to move, teachers believe that it is easier than the students do (see Figure 18).

Figure 18. Q8c. Ability of Students to Move to Engage in Learning



We pushed these movement questions further and asked if students and teachers felt the overall building's design impacted an ability to become deeply engaged in the students' learning processes (see Figures 19 & 20).

Figure 19. Impact of Building's Physical Spaces on Your Ability to Move Around to be Deeply Engaged in Your Learning / Students

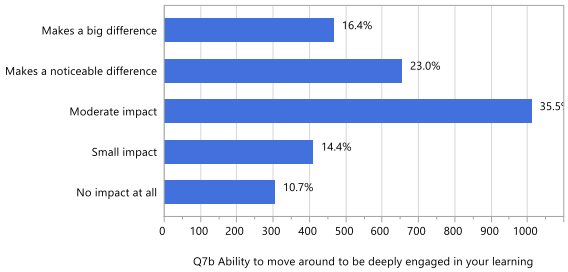
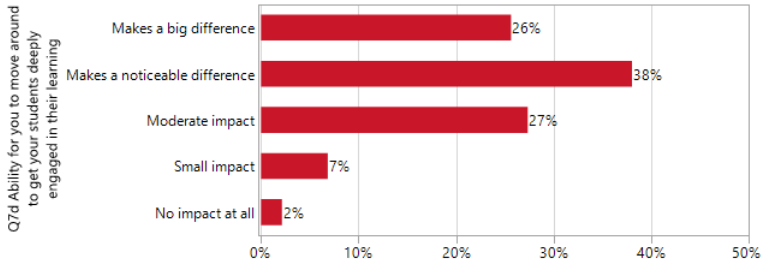
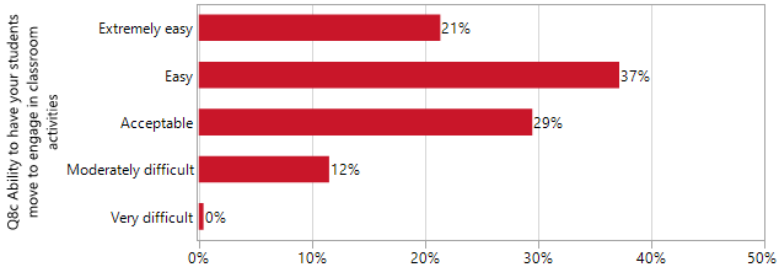


Figure 20. Impact of Building's Physical Spaces on Your Ability Move Around to Get Your Students Deeply Engaged in Their Learning / Teachers



And then we asked teachers specifically about how well the design of the classroom(s) they were teaching in provided them with an ability to configure and then reconfigure the space to support their pedagogical strategies (see Figure 21). All of the analysis helped us build the actual indexes.

Figure 21. How Well Does the Building's Physical Design Provide You with the Ability to Have Your Students Move to Engage in Classroom Activities? / Teachers



LIMITATIONS

In surveys such as these, multiple factors contributed to user responses, and one cannot control for all possible variables. These surveys

worked to include some control in determining the types of teaching strategies used versus the level of student activity permitted, and how the design of the learning place afforded those activities. While the surveys showed very nice correlations between satisfaction with the physical surroundings and student engagement, it must be noted that correlation was not the same as causation. Someone might argue, for example, that an overall positive attitude could be behind both being more engaged and being more satisfied with the building and classrooms. Finally, one must be cautious in generalizing from our non-random sample of six schools to all schools in the country.

CONCLUSION

With 3,004 students responding from six schools having different schedules, located in different places, and having different sizes, we nonetheless have consistent results. For all of the statistical modeling done, it was never necessary to include interaction terms for gender, school, or grade level to achieve a reasonable statistical model. In other words, the correlations shown here are consistent across gender, school, and grade level, even though the survey indicated some different "cultures" at the different schools. Thus, we have generated two reliable and valid survey instruments that demonstrate the importance of the built environment for increasing student academic engagement levels for these schools.

Next Steps

We have reliable and valid surveys for grades 9-12 [i.e., Student Engagement Index(c) and Teacher Engagement Index(c)], which architects and education decision makers may use post-occupancy and see where 'they' are compared to the indexes indicators. Grade 6-8 levels will be the next surveys to be developed. The Teacher Engagement Index was also solid as is, but we believe it might be important to 'unpack' the culture issue that has remained a dominant finding across all survey studies. This Post-Occupancy Evaluation working to evaluate student success as measured by levels of engagement research is ongoing.

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