

Can Science Museums Partner with School Districts and Impact Learning?

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Summary

Exploration Place, a science center in Wichita, Kansas, has been partnering with school districts to teach science in the classroom in a sustained meaningful way. Through ongoing evaluation over five years the results demonstrate that the teaching methodology of a science center yields: tremendous student engagement, the key to learning; enhanced confidence by teacher to instruct STEM lessons and increased the frequency they do it; and stronger interest in STEM subjects for students and an increased interest in considering a STEM career.

Background

Exploration Place: The Sedgwick County Science and Discovery Center, a hybrid children's museum and science center, opened April 1, 2000 in Wichita, Kansas. The iconic landmark building was designed by internationally renowned architect Moshe Safdie and is situated on 20 acres along the banks of the Arkansas River. It features 11 thematic exhibit galleries, a 60-foot digital dome theater and planetarium, family friendly maker space, 140 seat theater for live science shows, five classrooms, a multipurpose room, science store, outdoor terrace, playground and picnic grove.

Since opening, Exploration Place has served nearly 4 million people. Metrics for the most recently completed fiscal year that ended June 30, 2017 compared with the prior year include: 297,172 served, a 15.8% increase; 88,000 students served in educational programs both on site and through outreach, a 27% increase; and 4500 membership households, a 14.5% increase.

Opportunity

A turning point came in 2013 with two changes regarding state education policy in Kansas. First, was the adoption of the Next Generation Science Standards (NGSS). In the same year, the Kansas College and Career Readiness Standards were adopted. Standardized science testing would shift to fifth grade and launch with the 2016/17 academic year. Schools were accustomed to math and reading standardized testing which does impact a school's 'grade'. There was discussion to incorporate the new science testing into the school's 'grade'. In general, to teach elementary school in Kansas, college students are required to take one science methods class and one science subject class. That is not sufficient preparation to teach and engage students in science learning in a participatory manner. It is little wonder that many elementary teachers focus on reading science text books and emphasize vocabulary. Not surprising, this policy shift was causing concerns for school administrators.

At about the same time, two independent funding opportunities became available for Exploration Place. A local philanthropist wanted to support the museum and help expand its educational programs. The idea was to conduct programs at the public school on a regular basis where her granddaughter would be entering kindergarten. The hope was that the anticipated positive results would demonstrate to the local school district, the largest in the state, that the science center could make an impact. South of Wichita, in rural Sumner County, a new casino opened. There were requirements that it provide \$1.5 million annually, through an affiliated nonprofit, to enhance public school education in the county. Most was earmarked for teachers for supplies, graduating seniors, and project grants for teachers, but a portion was available for other organizations. There was discussion regarding a collaborative grant by Wichita museums for school field trips. But Exploration Place was hoping that rather than a stimulating one-time school group visit, there could be regular in-depth classroom lessons by the science center. The Casino supported this idea. Both potential funders were keen to understand how the science center would measure success. The goal for both research projects would be to shift attitudes toward STEM rather than measure the acquisition of knowledge and information.

Research Projects

The philanthropist funded science education program was for Hyde Elementary School, an urban school in Wichita, in a district with about 50,000 students. This school has a relatively consistent student population. The program began with kindergarten in the 2013/14 academic year. The longitudinal study would follow the cohort of students for six years, through fifth grade during the 2018/19 academic year. The principal wisely insisted that the program be provided for both classes of each grade. This would ensure that all students in the grade receive the program for six years since student composition in the classes change as they advance to the next grade. Over the six years, the funding source for the second class varied from the school's parent association, to the district and to the philanthropist. Weekly science lessons, framed around a monthly theme are conducted for the two classes per grade. A monthly parent newsletter is also provided with activities that can be done at home with common materials and supplies and provide a vehicle to help parents become involved with their child's learning.

The Sumner County science education program is funded by the Kansas Star Casino's, Kansas All-Star Scholars Fund. The program began during the 2013/14 academic year as a pilot program serving third and fourth grade students in two districts. By the second academic year, all eight districts and 11 schools in the rural county were participating. Exploration Place educators conduct science lessons in 23 third and 23 fourth grade classes about three times a month.

For these two programs, there are front-end discussions held every August prior to the start of school. For Hyde, Exploration Place meets with the Principal and the two classroom teachers. For Sumner County, a large meeting is held with all teachers and any administrators who choose to attend. These meetings facilitate dialogue to understand science center style of teaching, provide assurances that lessons are aligned with NGSS, and ensure the museum takes

into consideration classroom plans and different school district pacing guides. During the academic year there are 28 science lessons conducted for each class. Each lesson is about 40 minutes long. During the academic year 1,344 STEM lessons are delivered using about 100 different lesson plans. Exploration Place provides all the supplies and a team of extremely dynamic educators.

Teaching Methodology

Science center methodology is different than typical elementary classroom science instruction. The qualities are hands-on activities often done in stations around a classroom, inquiry-based, project or theme based, requires working in teams, and self-directed rather than following step by step instructions from a teacher. It does not include books, lectures and vocabulary. What this looks like is markedly different than standard classroom learning. It is messy, noisy, excited squealing students, organized chaos with student teams at different activity stations, and not everyone in the class doing the same thing at the same time. Each lesson is guided by a list of components such as skill building, using science tools, questioning, wacky familiar materials, experiments, kinetic activities, science and engineering processes, charting, recording and data sampling and then sharing results. Some teachers find the atmosphere and messiness quite stressful. It sometimes requires conversations to help assuage the concerns, and in a few instances has required principal intervention with the teacher. But anecdotally teachers share that the students who are inclined to misbehave are very well behaved during these programs.





Teacher Training

Teacher training is at the core of both projects, but not traditional expert lecture teacher training. Rather, this project was shaped to be embedded professional development. Teachers were not allowed to consider this free time and were required to assist science center educators in their classroom. The term ‘teacher training’ was never used. The principals and superintendents were aware of the intent and were very supportive but the intent was not shared with the teachers. It was determined by administrators during the shaping of the research project that teachers might be more open and receptive if it was not stated directly as a teacher training endeavor.

Evaluation

The overarching goal and research question for both projects was to understand if a science center learning partnership with formal education, a school, can change student attitudes toward STEM and increase teacher confidence to teach STEM. It was essential that an objective outside evaluator conduct the assessment. Exploration Place engaged the services of Kim McDowell, PhD from Wichita State University who is an experienced evaluator for school-based programs, is networked nationally and came recommended from the Wichita school district. The museum worked with Dr. McDowell to develop the evaluation methodology which included surveys and observation.

Each year surveys were done in August – January – May with students and teachers at the program schools as well as control schools with comparable demographics for each of the two research projects. For students, the assessment was evaluating their attitude toward STEM and their interest in considering a STEM career in the future. For teachers, the assessment was evaluating their confidence to teach STEM in the classroom and their frequency to instruct STEM in the classroom.

Student surveys were adapted by Dr. McDowell from the STEM Semantics Survey by Tyler-Wood, Knezek and Christensen (2010). The survey instrument was created for middle school students and adapted for use with these projects. The number of questions was reduced, some phrasing was modified and explanations were added, where needed, since this was for elementary students. For the Hyde research project for grades K-1, the teachers read the survey for the students and they responded to the questions by choosing an emoji face that best reflected how they felt about the statement. By second grade, the Hyde students were using the same form as the fourth and fifth grade students in the Sumner County research project. At the teachers’ discretion, they could read the survey to their class to help ensure students understand the words and meaning. In year one for both research projects, all questions were segregated for each subject within STEM – science, technology, engineering and mathematics. Beginning in year two, Dr. McDowell combined the questions to be STEM. Despite the modifications to the original survey form to shorten it, use of emojis for two years at Hyde, and the shift from segregated to combined STEM, professional evaluator Dr. McDowell is able to analyze the multi-year data.

The teacher surveys were adapted from “Teacher Efficacy and Attitudes toward STEM Survey” by Arden, Wiebe, Regan and Picart (2012). It was created to measure K-12 teacher confidence to teach STEM and their attitude toward STEM. Dr. McDowell shortened the survey to be sensitive to teacher workload and to ensure greater participation.

Evaluation Results

Each question on the survey form yields a numerical score. To simplify the presentation of the evaluation results, the charts below show the difference between the numerical score in August at the beginning, and May at the conclusion of the academic year. One point is considered statistically significant. Below are the charts for the evaluation results for both research projects at the conclusion of the 2017/18 academic year, the fifth year of the studies.

**Evaluation Results – Hyde Elementary
2017/18**

Teachers	Control School	Hyde
Confidence Teaching STEM	+ 1.9	+ 9.1
Frequency STEM Instruction	+ 1.1	+ 9.1
Students	Control School	Hyde
Attitudes Toward STEM	+ 0.8	+ 8.1
Interest in STEM Careers	+ 1.0	+10.4

**Evaluation Results – Sumner County
2017/18**

Teachers	Control School	Sumner County	
		All	2-3 years in program
Confidence Teaching STEM	+ 1.1	+ 10	+ 2.9
Frequency STEM Instruction	+ 1.0	+ 8.4	+ 1.9
Students	Control School	Sumner County	
Attitudes Toward STEM	+ 0.9	+ 9.1	
Interest in STEM Careers	+ 1.7	+ 1.9	

A few things to note:

- The control schools did show some gain from the beginning of the academic year for both students and teachers.
- The gains for students and teachers who participated in the programs at Hyde and Sumner County were statistically significant.
- For Hyde, each year there are two new teachers in the program.
- For Sumner County, the program is consistently for third and fourth grades and has teachers that have been in the program multiple years. Those teachers continue to show gains compared with teachers in the program for the first year.

During academic year 2014/15 Dr. McDowell suggested another evaluation tool be implemented to measure student engagement for the Sumner County project since engagement is the key ingredient to learning. Evaluators observed students in the class during science/STEM lessons both in the control schools and 13 classrooms with Exploration Place educators. There were five overt behavior categories observed; with two to six specific characteristics for each category numerically noted on a 5-point scale.

**Engagement Observations – Sumner County
2014/15**

Overt Behavior	% Very High or High		% Medium or Low	
	Intervention	Control	Intervention	Control
Positive Body Language	84.4%	75.2%	15.6%	24.8%
Consistent Focus	91.8%	84.8%	8.2%	15.2%
Verbal Participation	94.5%	80.2%	5.5%	19.8%
Student Confidence	95.1%	83.5%	4.9%	16.5%
Fun & Excitement	97.3%	80.5%	2.7%	19.5%

The difference in student engagement between the control schools and those with Exploration Place educators is dramatic. As noted by Dr. McDowell: “I can take your money and do this again next year – but it is not necessary. Your methodology has the children engaged.” We followed her advice and did not continue this process in future years.

The results of these projects have garnered some great recognition locally. USD259, the school district that includes Hyde Elementary, has incorporated Exploration Place into several federal grants to introduce this program to other schools in the district. In Sumner County, five of the eight school districts have engaged Exploration Place to expand this program to additional grades. For academic year 2018/19 Exploration Place educators are providing 28 lessons to 64 classrooms.

Evaluation Next Steps

With five years of very solid data, Dr. McDowell is conducting a deep assessment of both research projects. For students in both projects she will be comparing results by gender, by years in the program, and by gender and years in the program. For Hyde, she plans to study comparisons of the fifth-grade standardized science test scores: Hyde with the rest of the district; Hyde with STEM schools in the district; and fifth graders this year with prior years at Hyde. For Sumner County, she plans to compare students in middle school science classes who were in the program with their peers who were not.

Conclusion

The research question at the outset of both of these studies was whether partnering with a science center can impact the learning for students in classrooms. The results are clear that Exploration Place is making a real difference for both students and teachers. Science center methodology is the key.

The larger implication for these results still needs to be understood. Is this type of program scalable to impact even more schools? Should science center methodology be considered for training future teachers in colleges and universities? Can policy makers not only appreciate the role of informal science with formal education but also effect changes for resources to teach science such as extensive training by science centers or having a science center educator in a school? Exploration Place plans to continue exploring the larger questions that have emerged from these research projects.