Evaluation of the After-school STEM Program

at

Jefferson, Simmons, and Waldo Middle Schools

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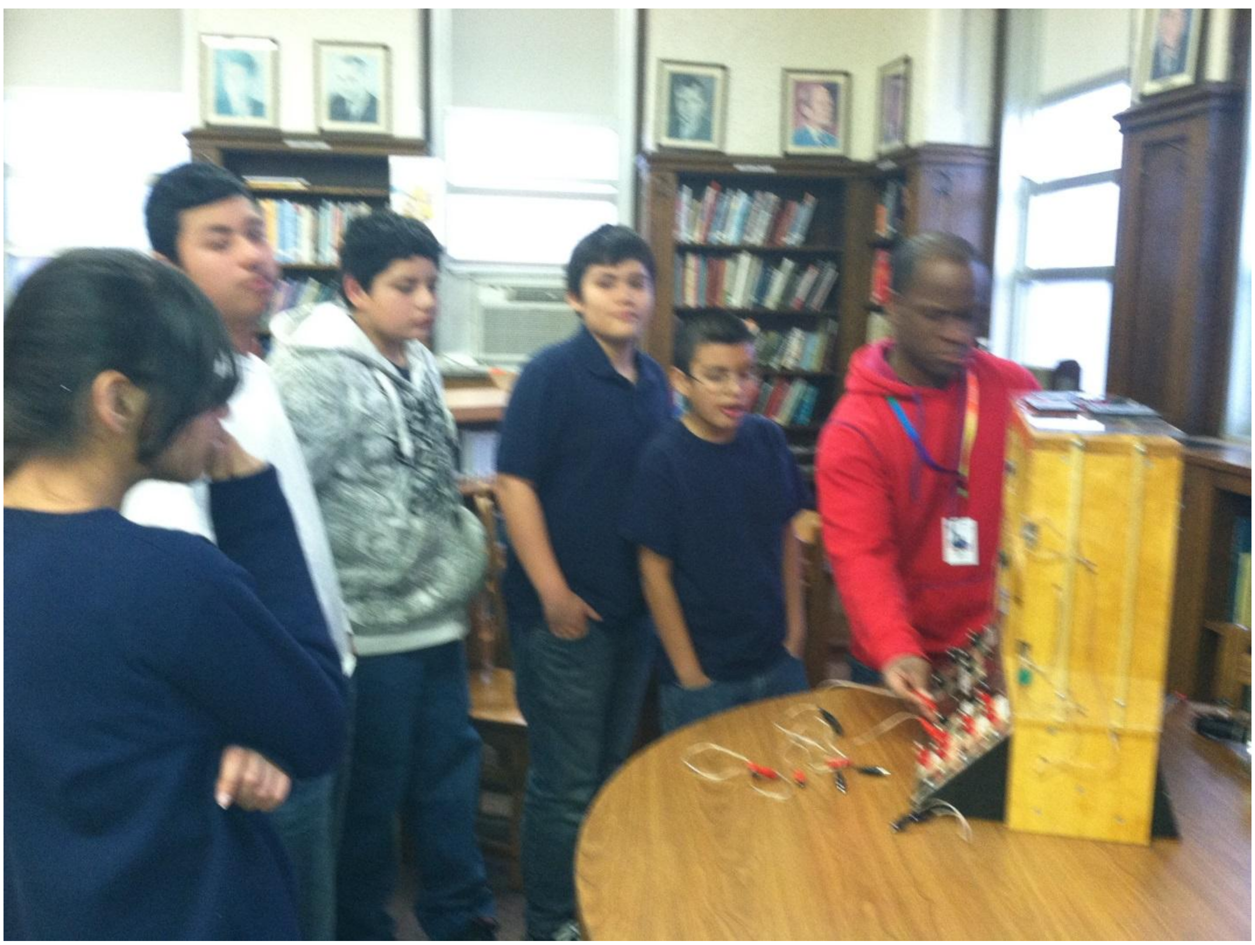

In the 2013-2014 school year, Aurora University's Institute for Collaboration developed and implemented two after-school program study units in Science, Technology, Engineering, and Mathematics. The units covered were "Motion and Flight" and "The Environment." These programs were delivered at Jefferson, Simmons, and Waldo Middle Schools in Aurora East School District 131. The program was run one day a week, one hour per day for a total of 13 to 22 visits per school. Any student in the after-school program in these, three schools was welcome to participate in the program.

CURRICULUM DEVELOPMENT

Each unit was prepared by Aurora University faculty and one classroom teacher. These units will become part of the curriculum for the John C. Dunham STEM Partnership School at Aurora University, which serves students in grades 3 – 8. These collaboratively developed units are aligned to the Next Generation Science Standards, the Common Core Standards in Mathematics, and best practices in inquiry-based learning.

PARTICIPANTS

A total of 18 youth at Jefferson Middle School, 25 youth at Simmons Middle School, and 20 youth at Waldo Middle School took part in the project (total 63). However, not every youth attended the program every day. Specifically, for the Motion and Flight Unit, 55 youth took the pre-test, and 36 youth took the post-test. A total of 28 youth were present on both test days. For the Environment unit, 34 youth took the pre-test, 35 youth took the post-test, and 24 youth were present on both test days.

EVALUATION PLAN

The youth were asked to complete criterion-referenced pre-tests and post-tests of content knowledge as well as tests of attitude. The test for Motion and Flight contained 10 questions, and the test for The Environment contained 21 questions. In addition, students were given pre-test and post-test surveys about their attitudes toward mathematics and science. These surveys were based on the Modified Attitude Toward Science Inventory mATSI. This instrument is an adaptation of the Attitudes Toward Science Inventory for minority, urban youth. The Cronbach's alpha reliability index for the mATSI is .70, which is adequate. Paired samples t-tests were conducted to determine significance of growth, and Cohen's d statistics were calculated to estimate effect size. In one school, the mATSI was given to students who did not participate in the STEM program as well as to students who did (at post-test only). In this case, the post-test scores of students who did participate in the program were compared to those of students who did not participate using an independent samples t-test. Finally, qualitative interviews were conducted with Aurora University faculty about their experiences in implementing the program.

RESULTS

The results will be presented in sections: Motion and Flight; The Environment; and Modified Attitude Toward Science.

Motion and Flight

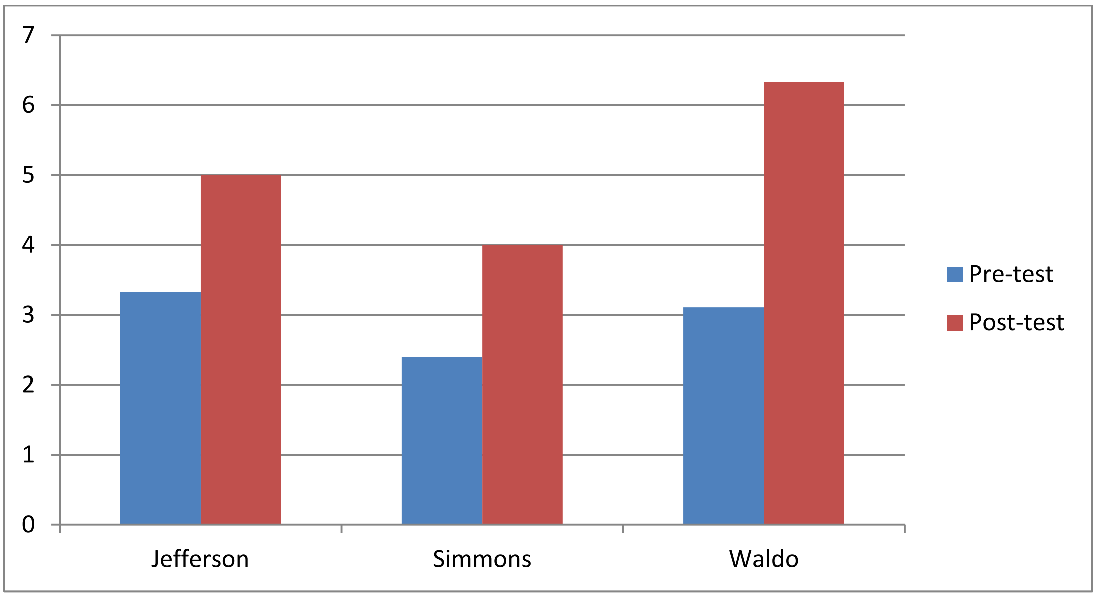

Figure 1. Changes in knowledge of Motion and Flight from pre-test to post-test by location.

Figure 1 indicates that youth in each location made gains in their concrete knowledge of Motion and Flight principles. Each of these gains was statistically significant (Jefferson: t (8) = -2.774, p = .024; Simmons: t (9) = -3.539, p = .006; Waldo: t (8) = -2.956, p = .018). The findings suggest that, even though attendance was not consistent, youth who took part in the program on both the day of the pre-test and the day of the post-test demonstrated significant increases in knowledge.

The Environment

Figure 2 demonstrates that, as was the case with Motion and Flight, students who participated in The Environment in all three schools made gains in knowledge. The gains made specifically by students at Jefferson Middle School did not prove to be statistically significant for two reasons. First, the students in that school had some knowledge of environmental principles prior to taking the pre-test, and second, only a total of four students took both tests at that school. The gains made in both Simmons and Waldo Middle Schools were statistically significant (Simmons: *t* (7) = -4.141, *p* = .004; Waldo: *t* (11) = -4.111, *p* = .002).

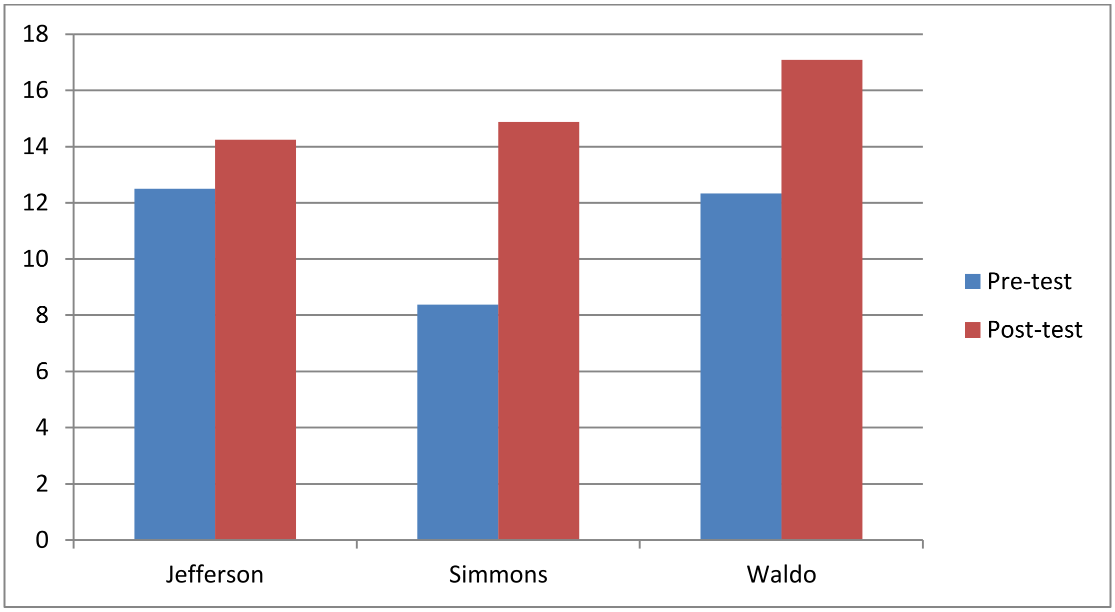

Figure 2. Changes in knowledge of The Environment from pre-test to post-test by location.

The findings suggest that youth made meaningful gains in concrete knowledge of The Environment during their participation in the program but that existing knowledge may vary location and that extent of participation may vary by location as well.

Attitude Toward Science

Because many youth completed the pre-test but not the post-test, or vice versa (59 youth took the pre-test and 48 youth took the post-test, but only 19 youth took both), results in this section are reported in aggregate rather than by school. Figure 3 demonstrates that the scores on the Modified Attitude Toward Science Inventory score increased for youth who took both the pre-test and the post-test. This score was nearly but not quite significant (*t* (18) = -1.870, *p* = .078). The difference between post-test scores for those who were involved in the program and those who were not involved in the program was statistically significant (*t* (35) = -3.584, *p* = .001). However, the fact that the post-test score of non-involved students was lower than the pre-test score of the involved students suggests that a substantial degree of self-selection into this program is occurring. The scores suggest that students who are more interested in and knowledgeable about science are the ones expressing willingness to take part in the program. Thus, the scores of non-involved students are lower than those of involved students at the end of the program not only because scores of involved students increased but also because scores of involved students were higher to begin with. Additional exploration of this possibility could be accomplished by adding pre-tests for non-involved students.

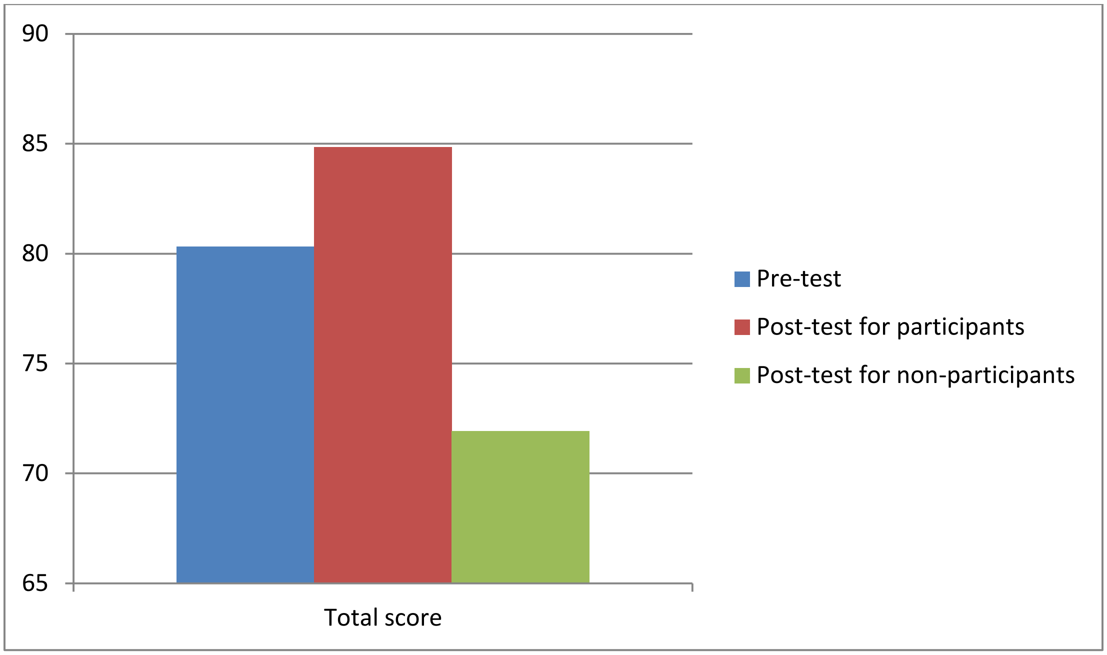

Figure 3: Changes in attitude from pre-test to post-test for participants, post-test scores for non-participants

Perceptions of Aurora University Faculty

Interviews were conducted with available faculty members regarding their experiences in the implementation of the program. All the faculty members who participated indicated that the experience was a positive one and also indicated that several aspects of the experience could be addressed in order to improve the experience.

- Benefit to students – faculty members indicated that, on the whole, kids "loved it" and "learned a lot." Some faculty members felt that the field trips were particularly valuable. Part of the reason for this was that some of the participating students had not had the opportunity to engage in activities such as the visit to Red Oak Nature Center in the past (although, some students consequently were not used to "being outdoors in nature" and had some complaints about this). Students also appreciated the visits from SciTech and the museum. Moreover, the students found the curriculum engaging, enjoyed connecting with the college students working in the program, and built relationships among themselves.
- Student engagement - the results presented in Figure 3 demonstrate that the students who took part in the program rated their attitudes toward science as becoming more positive during the course of the project. Interestingly, the students who participated in

the project appeared to have had, on average, a more positive attitude toward science from the outset than those who did not. However, some of the students who participated did not demonstrate significant interest in the topic matter, and in some cases, these students distracted those students with greater interest. Given that most youth in the after-school program struggle academically, and some of them struggle behaviorally, engagement of this group of students is indeed challenging. Finding ways to draw students who have neutral or negative attitudes toward science into the program by personalizing the content and its delivery to the extent possible (e.g. give them problem-solving responsibilities, demonstrate how the content relates to their personal lives) might improve the experience for all students. In addition, given the implication that the program is more likely to recruit students with at least a marginally greater interest in science from the outset, considering how motivate students who are disinterested in science to participate in the program would be beneficial with regard to overall program goals of increasing engagement of all students in STEM topics.

- After-school program support for attendance – the attendance of students who were thought to be participating in the program was sporadic. This may be in part due to the fact that attendance at the after-school program is sporadic. However, part of the inconsistency arises from the fact that other, sometimes more desirable, program activities (such as a pizza party) would take place at the same time, and students would sometimes choose to attend those instead. Encouraging program leaders to schedule program activities such that competing activities might be offered at different times might improve attendance. In addition, ensuring that program leaders have a positive attitude toward the program and are encouraging of attendance might support more consistent attendance. In the coming year, attendance of each student will be tracked, and the extent to which more consistent attendance contributes to greater learning and attitude change will be assessed.
- After-school program support for STEM program delivery – the extent of involvement in the delivery of the STEM program by after-school program Site Coordinators and teachers varied by location. In some locations, little involvement of after-school program staff members was evident, and this resulted in greater challenges in helping students participating to remain on-task. In addition, in some cases, the supervision of college students working in the program was left to the STEM program staff members, and this created some additional challenges for program delivery.

CONCLUSIONS

The after-school STEM program was associated with increases in knowledge (statistically significant increases, in all but one instance) of Motion and Flight and The Environment. This is noteworthy given that attendance at the program was irregular. Thus, despite the fact that not all youth attended each session, these increases in knowledge were still able to be made. In addition, the program was associated with nearly-significant improvements in attitudes about science. Both administrators and youth enjoyed the program. Several adaptations are planned for the coming year. Those adaptations that are planned include a specific tracking of attendance of each youth and working with programs to promote more regular attendance. Finally, administrators will work with local educators and Aurora University students to strategize concerning best practices for engaging hard-to-engage youth.