SCIENCE, TECHNOLOGY, ENGINEERING AND MATHEMATICS (STEM) EDUCATION: METHODS TO IMPROVE PSAT SCORES USING A STEM FOCUS

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ABSTRACT

Research has shown that learning experiences in informal educational settings such as camps provide significant benefits for secondary students. In order to expand the amount of students entering into Science, Technology, Engineering and Mathematics (STEM) university majors and ultimately careers in STEM fields, the Aggie STEM Center conducted a two-week summer camp for secondary students (n=35). This study demonstrated the learning successes based on informal PSAT scores that can be achieved through inquiry-based experiences of a STEM summer camp at a major Texas university with inner city high-school students. Results on the PSAT pre/post tests by mathematic, writing, and reading using the 95% confidence intervals indicated that there were statistically significant gains for both reading and writing and less for mathematics.

Keywords: STEM, high school, summer camp, PSAT scores

1 INTRODUCTION/BACKGROUND

In Texas, Science, Technology, Engineering and Mathematics (T-STEM) initiatives offer a fundamental approach to inspiring students, and advancing the studies in these four fields. A key element within the T-STEM initiative are the seven T-STEM centers which are tasked with creating new STEM instructional materials and providing research based, high quality, STEM, professional development opportunities to Texas teachers and students. The Aggie STEM Center is located at a large land-grant university, Texas A&M University, and has research as a central part of the mission. The Aggie STEM Center has extended its mission to work with students as well as educators. In an effort to increase the number of and preparation of students entering into STEM postsecondary studies and careers and to assist in the long-term educational and economic development and alignment of these fields, the Aggie STEM Center hosts an annual summer camp for secondary high-school students.

Originally the PSAT was an acronym for Preliminary Stanford Assessment Test, then Preliminary Scholastic Assessment Test but now it is known just as the PSAT. It is a standardized test administered by the College Board and National Merit Scholarship Corporation in the United States. Approximately 3.5 million students take the PSAT each year in October at their high
schools. High-school sophomores and juniors generally take the test but it can be taken as early as seventh grade. The scores from the PSAT are used (with the permission of the student) to determine eligibility and qualification for the National Merit Scholarship Program. The PSAT covers critical reading skills, math problem-solving skills, and writing skills [1].

2 THEORY/LITERATURE

Having informal education (IE) experiences is important. [2] Research shows that IE settings such as camps, clubs, museums, zoos, aquariums and environmental centers provide visitors with active learning experiences that engage individuals in inquiry-based exploration. [3] Based on the work of others [4]-[5], this study provides valuable opportunities for student learning, motivation, and engagement, in learning in a nonthreatening context [6] while fostering positive learning outcomes. The Aggie STEM summer camp design at Texas A&M University shows great promise for fostering inclusive learning across settings. [7]

Research has shown that learning experiences in IE settings provide significant benefits for 12-15 year old children [3]-[5] in two general areas: cognitive and affective domains. [3] In this regard, IEs can yield significant cognitive benefits for children by enhancing their rate of learning and their breadth of conceptual knowledge while also improving their attitudes toward STEM learning. [8]-[9] In particular, females may benefit more from STEM IE because they are given opportunities to take on challenging subject matter without male competition. [9]

STEM interest can be portrayed as a positive inclination toward STEM content areas. When students developed an interest in one of the STEM subjects, this in turn encouraged them to pursue a STEM-related career. [10] Researchers [11] claimed that student’s engagement in real-world informal educational activities enhanced students’ early interest in STEM. Studies situated in the real world incorporating activities from students’ daily lives increased their interest in STEM. [12] Offering additional programs along with schooling experiences helped students consider STEM college majors. [13]

3 METHODOLOGY

During the summer of 2010, The Aggie STEM Center provided a two week-long STEM overnight summer camp for underrepresented secondary students from one urban inner city academy in Texas. These students (n = 35) participated in an intensive STEM focused curriculum for 13 days. Sessions included real world science and math applications through project-based learning (PBL) activities, robotics, university engineering and science lab tours, radio and television communication, museum tours, and PSAT preparation. PSAT preparation sessions were held daily focusing on mathematics, writing, and reading, and for a minimum of one hour. Emphasis was placed on these three content areas plus general test taking strategies. This study demonstrates the learning successes based on informal PSAT scores that can be achieved through inquiry-based experiences of a STEM summer camp at a major Texas university with inner city high-school students. Students were pretested during the first day of camp and posttested during the last day of camp using an Educational Testing Service (ETS) designed assessment instrument.
4 RESULTS

Three regression models were developed (see Table 1), one for each posttest mathematics, writing, and reading, and using the pretest scores as predictor variables. The structure coefficients were computed for each model. The mathematics model was statistically significant (p<.001) with the pretests for writing and mathematics variables being statistically significant predictors. However, the structure coefficients indicated that the pretest score for reading was just as important as the writing pretest for mathematics achievement. The writing model was statistically significant (p=.012). The pretest for writing was the most statistically significant predictor, and the structure coefficients indicated it was the single best predictor. In the final model, reading was statistically significant (p=.03) with pretests for reading and writing being statistically significant predictors. The structure coefficients indicated that prereading was the best predictor followed by prewriting and distantly by premath. Therefore, we can infer from the following that for success on PSAT mathematics both reading and writing are important components. So focusing on mathematics alone without considering both reading and writing will not have as large a gain as a more integrated approach. Success with PSAT writing was not related to either mathematics or reading. However, PSAT reading was dependent on performance in writing, and to a smaller degree on mathematics.

### TABLE 1. Regression models predicting outcomes for post test scores in mathematics, writing, and reading

<table>
<thead>
<tr>
<th>Model</th>
<th>Independent Variables</th>
<th>$r^*$</th>
<th>B</th>
<th>Std. Error</th>
<th>Beta</th>
<th>$F$</th>
<th>$P$</th>
<th>$R^2$</th>
<th>Adjusted $R^2$</th>
<th>Model significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model 1 (Mathematics)</td>
<td>Constant</td>
<td>.97</td>
<td>10.29</td>
<td>0.25</td>
<td>-0.05</td>
<td>0.72</td>
<td></td>
<td>.47</td>
<td>.41</td>
<td>p &lt; .001</td>
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<tr>
<td></td>
<td>Prereading</td>
<td>.125</td>
<td>0.05</td>
<td>0.14</td>
<td>-0.05</td>
<td>0.72</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Preswriting</td>
<td>.078</td>
<td>0.30</td>
<td>0.17</td>
<td>0.24</td>
<td>1.74</td>
<td>.09</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Premath</td>
<td>.931</td>
<td>0.78</td>
<td>0.17</td>
<td>0.68</td>
<td>4.62</td>
<td>&lt; .001</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Model 2 (Writing)</td>
<td>Constant</td>
<td>2.33</td>
<td>7.50</td>
<td>3.11</td>
<td>.004</td>
<td></td>
<td></td>
<td>.30</td>
<td>.23</td>
<td>p = .012</td>
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<tr>
<td></td>
<td>Prereading</td>
<td>.464</td>
<td>0.62</td>
<td>0.10</td>
<td>-0.03</td>
<td>0.15</td>
<td>.88</td>
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<tr>
<td></td>
<td>Preswriting</td>
<td>.984</td>
<td>0.09</td>
<td>0.12</td>
<td>0.11</td>
<td>0.62</td>
<td>.54</td>
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<td></td>
<td>Premath</td>
<td>.270</td>
<td>0.43</td>
<td>0.13</td>
<td>0.54</td>
<td>3.47</td>
<td>.002</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model 3 (Reading)</td>
<td>Constant</td>
<td>2.10</td>
<td>9.84</td>
<td>2.15</td>
<td>.04</td>
<td></td>
<td></td>
<td>.26</td>
<td>.19</td>
<td>p = .03</td>
</tr>
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<td></td>
<td>Prereading</td>
<td>.717</td>
<td>0.39</td>
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<td>0.51</td>
<td>2.85</td>
<td>.01</td>
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<td></td>
<td>Preswriting</td>
<td>.198</td>
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<td>Premath</td>
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<td>0.16</td>
<td>0.34</td>
<td>2.16</td>
<td>.04</td>
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</tbody>
</table>

Notes: Independent variables for each model is PSAT post math for Model 1, PSAT post writing for Model 2, and PSAT post reading for Model 3.

* $r^*$ = structural coefficients.

When considering pre/post performance by subject, mathematics, writing, and reading, the 95% confidence intervals indicated that there were significant gains for both reading and writing and less for mathematics (see Figure 1).
FIGURE 1. Confidence intervals for PSAT pre-posttests.

5 DISCUSSION

The results presented above indicate that a two-week long STEM summer camp can result in significant gains in student performance. In addition, even though the camp had a focus in science, technology, engineering, and mathematics, significant gains were made in both writing and reading posttest performance. Increases in scores from pretest to post test were across the board. The most significant posttest gains occurred in writing (the subject with the lowest pretest scores). Reading had the next lowest pretest scores, and also showed significant posttest gains. The highest pretest scores occurred in math, perhaps accounting for the more modest posttest gains. It is possible that a STEM summer camp attracts students with more interest and more skill in math (as evidenced by higher pretest scores).

Based on the experience and data presented above, the Aggie STEM Center is expanding the two-week-long STEM summer camp to students from other T-STEM academies. Future camps will include an overnight residential option as well as a day student option for local students (perhaps including middle school students).

6 ACKNOWLEDGEMENTS

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REFERENCES