Mathematics as a Language

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Mathematics as a Language
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Research Question
How does the implementation of academic language affect student learning?

Literature Review
- Gottlieb and Ernst-Slavit (2013) define academic language as a way to communicate ideas, concepts, and higher thinking processes, but it is used so that students may acquire a greater insight into the materials.
- Marino (2005) emphasizes that pre-planning, open ended questioning, grouping and time all affect the implementation of academic language in the classroom.
- Fry and Villagomez (2013) and Glanfield, Oviatt, and Bazcuk (2006) found positive qualitative results in implementing academic language in relation to student learning.

Methodology
- Twenty-one eighth grade students and two seventh grade students in a high school were the participants of the study.
- Formative and summative assessments, student responses and lesson plans were collected during student teaching and content analyzed.
- Used class discussions/activities to determine the increased and correct use of academic language.

Common Mistakes with Language

Figure 1: Student sample work that shows a proof in the opposite direction.

<table>
<thead>
<tr>
<th>Statements</th>
<th>Reasons</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.) $\overrightarrow{AD} \parallel \overrightarrow{BC}$</td>
<td>1.) Given</td>
</tr>
<tr>
<td>$\angle 2 \cong \angle 3$</td>
<td>2.) Def’n of $\cong$’s</td>
</tr>
<tr>
<td>$\angle 2 = \angle 3$</td>
<td>3.) same side int. angles are sup.</td>
</tr>
<tr>
<td>3.) $\angle 5$ and $\angle 2$ are supp.</td>
<td>4.) Def’n of supp. angles.</td>
</tr>
<tr>
<td>$\angle 3$ and $\angle 6$ are supp.</td>
<td>5.) Subst.</td>
</tr>
<tr>
<td>4.) $\angle 5 + \angle 2 = 180^\circ$</td>
<td>6.) Subst.</td>
</tr>
<tr>
<td>$\angle 3 + \angle 6 = 180^\circ$</td>
<td>7.) Same side interior angles are supp. in parallel lines.</td>
</tr>
<tr>
<td>5.) $\angle 5 + \angle 2 = \angle 3 + \angle 6$</td>
<td></td>
</tr>
<tr>
<td>6.) $\angle 5 + \angle 3 = \angle 2 + \angle 6$</td>
<td></td>
</tr>
<tr>
<td>7.) $\overrightarrow{AB} \parallel \overrightarrow{CD}$</td>
<td></td>
</tr>
</tbody>
</table>

Figure 2: Student sample work includes the confusion between transitive and substitution property.

<table>
<thead>
<tr>
<th>Statements</th>
<th>Reasons</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.) $\angle 5$ is supp. $\angle 3$</td>
<td>2.) Consecutive angles</td>
</tr>
<tr>
<td>3.) $\angle 2$ is supp. $\angle 6$</td>
<td>3.) Consecutive angles</td>
</tr>
<tr>
<td>4.) $\angle 2$ is supp. $\angle 5$</td>
<td>4.) Substitution</td>
</tr>
<tr>
<td>5.) $\angle 3$ is supp. $\angle 6$</td>
<td>5.) Substitution</td>
</tr>
<tr>
<td>6.) $\angle 5 \equiv \angle 6$</td>
<td>6.) Substitution</td>
</tr>
</tbody>
</table>

Figure 3: Student sample works that demonstrates the students mathematical reasoning skills on the topic.

Find $x$ to make $a$ and $b$ parallel. Justify why the lines would be parallel.

a.) $m\angle 7 = x; m\angle 9 = 4x + 20$

\[
x + 4x + 20 = 180
\]
\[
5x + 20 = 180
\]
\[
x = 32
\]

b.) $m\angle 8 = 3x - 12; m\angle 7 = 2x + 10$

\[
3x - 12 = 2x + 10
\]
\[
x = 22
\]

Results and Data Analysis
• There was significant confusion on the direction of the proof (Figure 1) and the difference between transitive property of congruence and the substitution property of equality (Figure 2).
• Students who were not able to justify their work, had difficulty discovering correct solutions (Figure 3).
• Student responses corroborate with student work findings where students shared about having more issues with word problems (mathematical skills and reasoning) than procedural problems.

Conclusion
• There are several clear misconceptions caused by a lack of academic language use in the classroom, however, students also had a better understanding of the material when they were able to use academic language effectively.
• I recommend teachers pay precise attention to the language used in the classroom to benefit student learning.
• There is room for future research on how the implementation of academic language affects the students as they progress through mathematics courses.