Effects of Instruction in Advanced Planning on Computational Problem Solving in a Group Environment

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Introduction

- Computer science (CS) is a rapidly growing field
- By 2020, there will be a surplus of 1,000,000 jobs (Colby, 2015)
- Expected growth in jobs of 12% from 2014 to 2024 (Bureau of Labor Statistics, 2016)
- Computational thinking improves conceptualization across many domains (Wing, 2006)

EFFECTS OF TEACHING PLANNING ON PROBLEM SOLVING

Introduction

- CS is difficult for students to learn
- Requires high order skills (Barak, 2013)
  - Applying
  - Analyzing
  - Creating
- Requires clear goals and plans
  - Difficult for many students (Searle, 2013)

From Causes and Cures in the Classroom: Getting to the Root of Academic and Behavior Problems (p. 22), by M. Searle, 2013. Alexandria, VA: ASCD. Copyright 2013 by ASCD. Reprinted with permission
Inquiry Question

HOW (IF AT ALL) DOES EXPLICIT INSTRUCTION IN ADVANCED PLANNING AFFECT COMPUTATIONAL PROBLEM SOLVING IN A GROUP?
Methodology

- We created the “Scratch That: Computational Thinking with Scratch” educational outreach program
- Added a lesson on the advanced planning strategies

Methodology

- Children whose schools or scouting troops visited for field trips \((N = 54)\) completed surveys about their typical education environment and their experience with a group problem solving activity during the lesson.
  - We taught certain students \((n = 27)\) the experimental lesson.
  - Others \((n = 27)\) were taught the standard curriculum.
- Students’ responses analyzed using \(t\) tests and Correlation-Regression Analyses.
Human and Animal Subjects Review Status

- Pursuant to federal law, proposal submitted to the IMSA Human and Animal Subjects Review Committee
  - Declared as exempt from oversight
- All students treated ethically
  - Data anonymized
  - Informed assent
  - Right to withdrawal

Results

- Mean perception of the outcomes of the problem solving process were higher in the control group (Figure 1)
  - Mean perception of validity of solution not significantly higher in control group, $t(52) = 1.05, p = .917$
  - Mean perceptions of participation and understanding significantly higher in control group, $t(41) = 2.186, p = .035; t(43) = 2.042, p = .047$
  - Mean number of students utilizing the advanced planning strategies (goal setting, action planning, and division of labor) was not different between groups, $t(52) = -1.119, p = .268; t(52) = -0.536, p = .594; t(50) = 1.358, p = .180$

Figure 1. Mean response on Likert scale for perceived characteristics of the problem solving process in both the control and experimental groups. Error bars depict ±1 SE.
Results

- Positive correlations exist between use of goal setting or division of labor and the perceived validity of a solution (Table 1)
- All other correlations not statistically significant

Table 1: Correlations between Usage of Advanced Planning Strategies and Perceptions of Problem Solving Outcomes

<table>
<thead>
<tr>
<th>Advanced Planning Strategy</th>
<th>Validity of Solution</th>
<th>Active Participation</th>
<th>Student Understanding of Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goal Setting</td>
<td>$r(52) = .301^*$</td>
<td>$r(52) = .134$</td>
<td>$r(52) = .127$</td>
</tr>
<tr>
<td>Action Planning</td>
<td>$r(52) = .233$</td>
<td>$r(52) = .052$</td>
<td>$r(52) = .156$</td>
</tr>
<tr>
<td>Division of Labor</td>
<td>$r(50) = .286^*$</td>
<td>$r(50) = .181$</td>
<td>$r(50) = .251$</td>
</tr>
</tbody>
</table>

Note: $^*p < .05$
Conclusions

- Student should set goals and divide labor while working on computation problems in groups
- Explicitly teaching the advanced planning strategies does not affect their usage
- Teaching advanced planning strategies decreased student’s perceived achievement
Discussion/Future Studies

- Advanced planning strategies should not be taught
  - Student perception of performance strongly correlated with teacher analysis (Chang, Tseng, & Lou, 2012)
  - National Education Commission on Time and Learning (2005) found limited school time affects learning when teachers try to cover too much

- We still need to learn more about CS education
  - Some schools are teaching CS without even touching a computer (Paul, 2015)
    - Is this effective?
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References


