Impact of Teachers’ Technology Use on Students’ Mathematics Achievement in Elementary Classrooms: Comparisons between Taiwan and U.S.

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The reform of mathematics education in 1999 has encouraged technology integration in K–12 mathematics teaching and learning.

National Council of Teachers of Mathematics (NCTM) has expressed the importance of technology integration in mathematics education.
Importance of Technology

- In the Principles and Standards for School Mathematics administered by NCTM, technology is one of the six principles in school mathematics.

- “Technology is essential in teaching and learning mathematics; it influences the mathematics that is taught and enhances students’ learning” (NCTM, 2000, p.11)
TIMSS Review

- The Trends in International Mathematics and Science Study (TIMSS) is the most comprehensive international assessment of educational contexts and student achievement in K–12 mathematics and science teaching and learning.

- It surveys stakeholders from four levels in a public school education system—teachers, students, school principals, and national curriculum coordinators.
House has done a series of studies on the computer use in science and mathematics class using TIMSS data.

Results of his studies showed that students, in particular, male students who reported frequent use of computers had lower grades in tests than those who used computers less in science class.
Literature Review

- In House other studies in TIMSS Asian classes, students who used computers more frequently had lower algebra test scores.

- Finding from his studies was endorsed by Papanastasiou and Ferdig’s study (2006) using data from Program for International Student Assessment (PISA).

- In their study, students’ higher frequency of computer use was correlated with their lower level of mathematics literacy acquisition.
Literature Review

- However, these results are not consistent with previous studies that showed positive impact of technology use.
- Swain and Pearson (2003) explained the negative impact in their study and mentioned that teachers used computers primarily for lower-level thinking activities.
- Therefore, the types of activities should also be associated when discussing technology use in mathematics teaching and learning.
Based on the aforementioned rationale, the purpose of this study was to explore the impact of teachers’ technology (calculator and computer) use for different teaching activities on elementary students’ mathematics performance across various topics and cognitive skills in Taiwan and U.S.
Specific Research Questions

Four specific research questions:

- Does technology use for different teaching activities have impact on students’ overall mathematics performance?
- Does technology use for different teaching activities have impact on students’ mathematics performance in terms of various topics?
- Does technology use for different teaching activities have impact on students’ mathematics performance in terms of various cognitive skills?
- Are there a differences in terms technology use and its impact on students’ mathematics performance between Taiwan and U.S.?
Participants

- There were 4131 grade 4 students nested within 343 schools in Taiwan sample, including 48.1% girls and 51.9% boys
- There were 7896 grade 4th students nested within 904 schools in US sample, including 51% girls and 49% boys
- A total of 343 teachers in Taiwan and 904 teachers in U.S.
TIMSS–2007 has a 41–item questionnaire for fourth grade teachers

With this questionnaire, the information about teachers’ academic and professional background, instructional practices, and attitudes toward teaching mathematics and science was provided

Items 16, 17, 18, and 19 about the use of technology in class were used
At grade 4 level, the TIMSS–2007 mathematics tests included three content domains and three cognitive domains:

- Three content domains: Number (50%), geometric shapes and measures (35%), and data display (15%)
- Three cognitive domains: knowing (40%), applying (40%), and reasoning (20%)
Chi-square tests were conducted to examine if there was a difference of technology use between Taiwan and U.S.

Several multiple regression analyses were performed to examine if technology use for different teaching activities had impact on students’ mathematics performance.

SPSS 17.0 was used
Used Variables

- For the multiple regression analysis, dependent variables for calculator and computer use included: *the first plausible values* for overall performance, three content domains, and three cognitive domains.

- Independent variables for calculator use included SES (how many books at home), and Item17 a) check answers, b) do routine computations, c) solve complex problems, and d) explore number concepts.

- Independent variables for computer use included SES (how many books at home), Item19 a) Discover mathematics principles and concepts, b) Practice skills and procedures, and c) Look up ideas and information.
Results: Technology use

- Chi-Square results indicated that there were differences in terms of calculator and computer use, but not Internet use, between Taiwan and U.S.
- There were larger proportion of teachers in U.S. who permitted students to use calculators during mathematics lessons
- There were larger proportion of U.S. classrooms that had computer(s) available to use during mathematics lessons
- Once the classrooms had computers, there was no difference of having access to the Internet between Taiwan and U.S.
## Results

### Calculator Use

<table>
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<th>Calculator use (YES)</th>
<th>Calculator use (NO)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>TAIWAN</td>
<td>79 (49.7%)</td>
<td>80 (50.3%)</td>
<td>159</td>
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<tr>
<td>USA</td>
<td>357 (70.3%)</td>
<td>151 (29.7%)</td>
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<td>Total</td>
<td>436</td>
<td>231</td>
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### Computer Use

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<td>70 (41.7%)</td>
<td>98 (58.3%)</td>
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<td>USA</td>
<td>356 (66.8%)</td>
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<td>Total</td>
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### Internet Access

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<th>Total</th>
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<tbody>
<tr>
<td>TAIWAN</td>
<td>52 (94.5%)</td>
<td>3 (5.5%)</td>
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<tr>
<td>USA</td>
<td>327 (97.3%)</td>
<td>9 (2.7%)</td>
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<tr>
<td>Total</td>
<td>379</td>
<td>12</td>
<td>391</td>
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</table>
Results: Calculator use in Taiwan

- Multiple regression analyses showed that teachers’ calculator use for “check answers”, “do routine computations”, “solve complex problems”, and “explore number concepts” had no significant impact on overall mathematics performance as well as performance on three content domains (Number, geometric shapes and measures, and data display domains) and performance on three cognitive domains (knowing, applying, and reasoning), controlling for SES, for Taiwanese students.
Results: Calculator use in U.S.

- Multiple regression analyses showed that teachers’ calculator use for “check answers”, “do routine computations”, “solve complex problems”, and “explore number concepts” had no significant impact on overall mathematics performance as well as on three content domains and performance on three cognitive domains, controlling for SES, for American students.
Results: Computer Use in Taiwan

- Multiple regression analyses showed that teachers’ computer use for “discover mathematics principles and concepts”, “practice skills and procedures”, and ”look up ideas and information” had no significant impact on overall mathematics performance as well as performance on three content domains and on three cognitive domains, controlling for SES, for Taiwanese students
Results: Computer Use in U.S.

- Multiple regression analyses showed that teachers’ computer use for “discover mathematics principles and concepts” and ”look up ideas and information” had no significant impact on overall mathematics performance as well as performance on three content domains and on three cognitive domains, controlling for SES, for American students.

- However, teachers’ computer use for “practice skills and procedures” had significant impact on overall mathematics performance as well as performance on three content domains and on three cognitive domains, controlling for SES, for American students.
Discussion

- Generally speaking, American teachers use technology more frequently to enhance students’ learning than Taiwanese teachers.

- Teachers’ technology use in Taiwan and U.S. seems not to have an significant impact on students’ performance on various mathematics topics and skills.

- In U.S., teachers’ computer use for practicing skills and procedures makes positive contributions to improve students’ performance on mathematics learning.
Suggestions

- The way that teachers use technology to enhance students’ learning can be further considered.
- Because of classrooms as analytical units, small sample size causes low power.
- Multi-level analyses can be applied in the future study.