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White Paper:
Efficacy Study of *The Foos* Game

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Headline

New Learn-to-Code game *The Foos* lays strong foundation for computer science thinking skills and increases confidence in problem-solving skills in young children.

Executive Summary

An independent study was conducted to measure the effectiveness of the game *The Foos* in increasing computational thinking tasks[1], confidence in problem solving, and sparking an interest in pursuing computer science activities in children ages 5-8. Twenty-seven (27) children at two study sites participated in a pre- and post-test separated by three play sessions with *The Foos* on iPads and touch-screen PCs. The primary findings were that following just three 30-minute play sessions, participants demonstrated a significant increase in computational thinking skills, confidence in problem solving, and interest in pursuing computer-science and coding activities.

Methodology
Participants

Twenty-seven children from diverse socioeconomic and ethnic backgrounds in the San Francisco Bay Area participated in the study. Subjects were drawn from those attending summer session at Khan Academy Lab School in Mountain View, CA and YMCA San Francisco

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[1] "Computational thinking" is a way of solving problems, designing systems, and understanding human behavior that draws on concepts fundamental to computer science. See Center for Computational Thinking, Carnegie Mellon.

Summer Session in San Francisco, CA. By drawing on subjects from diverse environments the study was able to generate data based on users with varying levels of computer and/or coding experience. The participants ranged from ages 5 – 8 years of age, and were roughly balanced by gender (48% male/ 52% female). Twenty-one percent of the sample had some prior experience with coding or programming.

Procedure

- Participants were evaluated before and after playing "The Foos" with a pair of sequencing tasks followed by several measures of confidence in the areas of computer programming.
- Participants were given a pre- and post- test 2-3 weeks apart via iPad or web-based assessment. The tests were constructed and delivered using Qualtrics assessment software. A moderator assisted pre-readers with completion of the assessment.
- The pre- and post-tests each contained 3 image-based sequencing questions that employed visual images asking the student to correctly sequence tasks in order to achieve a desired goal – assembling a sandwich and moving a character through seven obstacles and objectives on a screen. Two of these items employed a stack-ranked answer choice system that allowed the subject to drag and drop the correct movement of the character into sequence. The remaining question was a multiple choice question type. These sequencing tasks were of low, moderate and high difficulty for the age group. The low difficulty questions asked for only a single sequencing command. The high difficulty question required that students correctly rank seven separate commands, mentally envisioning and tracking their moves.
- Pre- and post-tests contained a broad diversity of questions measuring the confidence of students in problem solving and computer use. These questions focused on how good students consider themselves at computer and problem solving activities in comparison with other activities.
- Participants played *The Foos* in three separate 30-minute sessions in their classrooms during a period of 2-3 weeks.

Results

After 1.5 hours of play, there was a significant increase in performance on the computational thinking task of sequencing.

- On the sequencing task of low to moderate difficulty (moving a character across obstacles to collect treasure) the test group showed an 18% improvement in accuracy.

- On the sequencing task of moderate difficulty (following steps to assemble a peanut butter and jelly sandwich), the test group increased their accuracy rate 22%.

- On the sequencing task of high difficulty (moving a character across obstacles to collect treasure), the test group showed a total increased accuracy of rate 3%, with gains of up to 14% on individual steps of the task.

After 1.5 hours of play, there was a significant increase in self-reported interest in computer-related activities.

- Of 27 respondents, 14 reported an increased interest in programming computers as a job they would want to have when they grow up.
  - On the above question, the mean response rank was 2.55 pre-test and 1.88 post-test with a $t(27) = 2.28$ $p < .05$.

- Of 27 respondents, 10 reported an increased interest in programming iPad or computer games when they grow up.

After 1.5 hours of play, there was a significant increase in confidence toward difficult tasks and problem solving abilities.

- Subjects showed an increased confidence in their ability to code. Mean response rank in coding ability was 3.25 pre-test and 2.14 post-test with a $t(27) = 3.46$ $p < .05$.

- Subjects showed an increased confidence in their ability to "think like a programmer." Mean response rank in "thinking like a programmer" was 2.92 pre-test and 1.92 post-test with a $t(27) = 3.03$ $p < .05$.

- Of 27 respondents, 7 showed increased perception of persistence in the face of difficult tasks.

- Of 27 respondents, 7 showed increased perception of their own diligence.

- Of 27 respondents, 7 showed increased confidence in puzzle- and problem-solving tasks.
  - On the above question, the mean response rank was 3.44 pre-test and 2.74 post-test with $t(27) = 2.76$ $p < .05$.

- Of 27 respondents, 15 showed increased confidence in problem solving abilities.
  - On the above question, the mean response rank was 1.81 pre-test and 1.48 post-test with $t(27) = 2.54$ $p < .05$.

Usability and Appeal

The Foos had a wide appeal and participants were very enthusiastic about it.

- 25 of 27 respondents reported that *The Foos* was either fun or "the best game ever!"
- 26 of 27 respondents reported that they would recommend *The Foos* to a friend.
- 12 of the 27 respondents reported that *The Foos* too easy, 6 reported it was a too hard, and 8 reported it was just right.
- The most frequent response to how to improve *The Foos* was to add more levels/worlds, and complexity.
- The teachers reported *The Foos* fits well within the STEM curriculum for Kindergarten through third grade.

Conclusion

This study demonstrates effectiveness of *The Foos* for strengthening computational thinking skills and sequencing abilities and increasing self-confidence in computer science-related skills in young children. Specifically, just 90 minutes of gameplay with *The Foos* significantly 1) Increased interest in computer science careers, 2) Increased confidence in ability to code, 3) Increased confidence for ability to think like a computer programmer, 4) Increased confidence in puzzle- and problem-solving abilities, and 5) Increased problem-solving in children ages 5-8. The game is shown to be enjoyable for children participating in the study, and provides valuable learning experience in the context of play.