Introducing Computer Programming to Children through Robotic and Wearable Devices

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Related Work

• **Programming tangible objects**: ubiquitous computing platforms, such as robotics [1, 8] and wearables [2, 5, 10], have advantage over desktop programming [9].

• **Girls and Programming**: wearable computing may inspire more girls to pursue computer science [2, 5].
Research Questions

1. Is tangible computing more engaging than desktop computing in learning computer programming?

2. Are there differences between boys and girls with regard to the preference of a tangible platform?

3. Through which target platform, students can develop their programming skills more effectively?
## Methodology – Materials

<table>
<thead>
<tr>
<th>Tangibility</th>
<th>Target platform</th>
<th>Development software</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disembodied</td>
<td>Desktop computer</td>
<td>Scratch 2.0</td>
</tr>
<tr>
<td>Robotic</td>
<td>Lego Mindstorms NXT</td>
<td>Enchanting</td>
</tr>
<tr>
<td>Wearable</td>
<td>Arduino LilyPad</td>
<td>Modkit [7]</td>
</tr>
</tbody>
</table>
Methodology – Materials
Methodology – Activities

• Three equivalent activities, one for each treatment.
• 45’ duration each activity.
• First Part: Preparing the Virtual and Physical Objects.
• Second Part: Programming.
  • Sequence
  • Repeat
  • If – else
Methodology – Subjects

• Randomized within groups study (Scratch – First, Lego – First and LilyPad – First).
• 36 students from the first grade class (18 boys και 18 girls).
• No student had previously received teaching in computer programming.
• Study was conducted during the regular school time.
• Limitations in selecting larger sample.
Methodology – Measuring Instruments and Data Analysis

• **Pre – Test**: 4-level Likert questionnaire
  - experience and attitude towards computers
  - Experience towards coding
  - Experience towards robotics
  - Experience towards electronics

• **Emotions – Test**: 5-level Likert questionnaire
  - Happy-Sad
  - Confused-Confident
  - Boring-Interesting
  - Disappointed-Satisfied
  - Undetermined-Determined

• **Computational Thinking Examination**: 12 assessment questions [6]
  - Sequence
  - Repeat
  - If – else
  - Extended Program

Data Analysis with SPSS
Results – Emotions
Results – Performance

Correct Answers' Percentage (N=36)

- Sequence: Disembodied 74.1%, Wearable 88.0%, Robotic 71.3%
- Repeat: Disembodied 86.1%, Wearable 86.1%, Robotic 88.0%
- If-else: Disembodied 71.3%, Wearable 57.4%, Robotic 59.3%
- Extended program: Disembodied 42.6%, Wearable 38.9%, Robotic 38.9%
Results – Learning Effect

![Learning Effect Graph]

- Disembodied First: 66.0%
- Wearable First: 66.0%
- Robotic First: 60.4%
- Disembodied: 72.2%
- Wearable: 67.4%
- Robotic: 60.4%
- Disembodied: 79.2%
- Wearable: 77.8%
- Robotic: 63.9%
Results – Gender and Emotions

Boys Emotions' Mean Averages (N=18)

Girls Emotions' Mean Averages (N=18)
Results – Gender and Performance

Correct Answers' Percentage
Boys vs Girls (N=18)

<table>
<thead>
<tr>
<th>Task</th>
<th>Boys</th>
<th>Girls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sequence</td>
<td>77.2%</td>
<td>87.7%</td>
</tr>
<tr>
<td>Repeat</td>
<td>85.2%</td>
<td>89.5%</td>
</tr>
<tr>
<td>If - else</td>
<td>56.2%</td>
<td>69.1%</td>
</tr>
<tr>
<td>Extended program</td>
<td>37.7%</td>
<td>42.6%</td>
</tr>
</tbody>
</table>
Programming with ubiquitous platforms

• Students expressed more positive feelings towards robotics.

• Wearable computing has been preferable to the desktop. Not as favorable as the robotic one.

• Tangible computing platforms did not affect dramatically the student’s performance in programming.

• Using robots as the introducing target platform had a neutral learning effect.
Gender and Programming

• No gender difference in the interest toward the type of the ubiquitous computing platform. Girls are as much emotionally engaged in robots as boys.

• Girls performed better in all programming concept categories.
Future Work

• Repeat the experiment with other groups of students and additional activities following the student initiative.
• Study using Kinect as input to Scratch [4].
• Study comparing tangible programming environments (tangible) with desktop programming environments [3].
References


