Using Robots & Wearables to Teach Programming

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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].

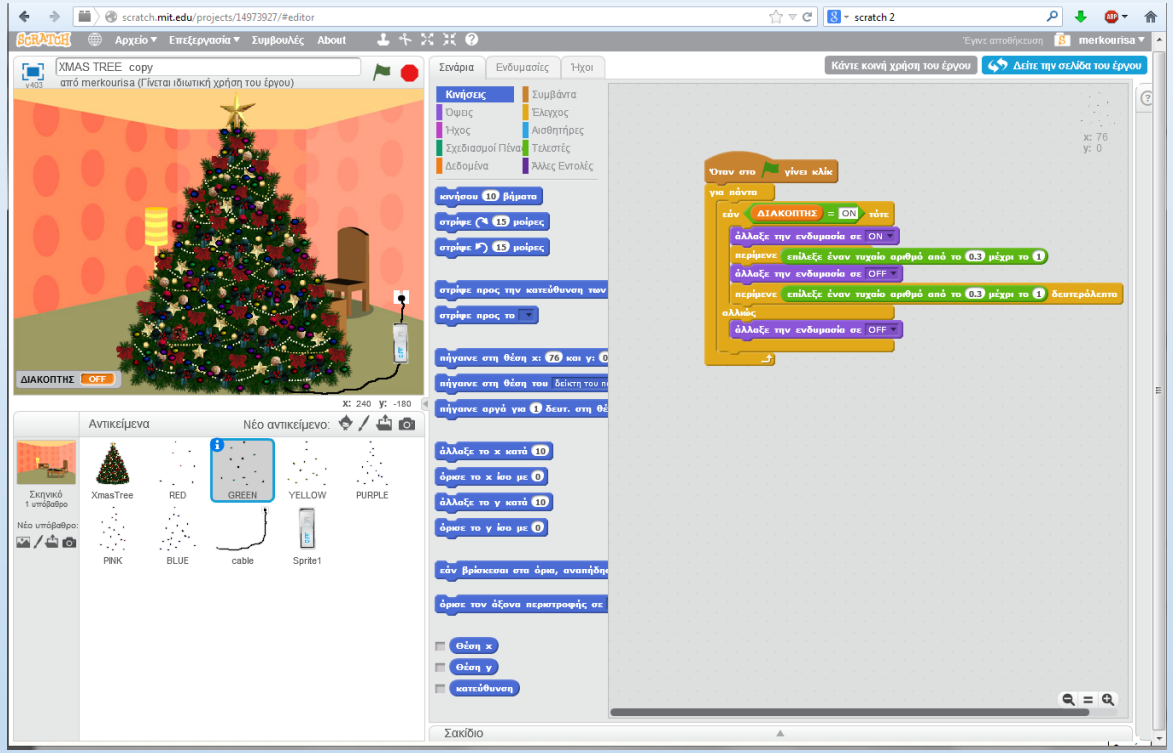
Research Questions

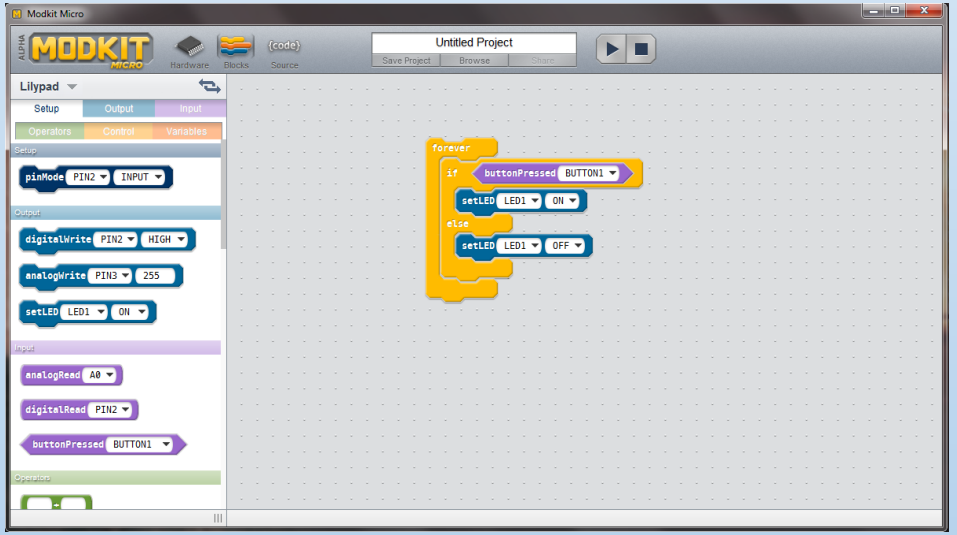
1. Is tangible computing more engaging than desktop computing in learning computer programming?
2. Are there differences between boys and girls with regard to the preference of a tangible platform?
3. Through which target platform, students can develop their programming skills more effectively?

Methodology – Materials

Tangibility	Target platform	Development software
Disembodied	Desktop computer	Scratch 2.0
Robotic	Lego Mindstorms NXT	Enchanting
Wearable	Arduino LilyPad	Modkit [7]

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

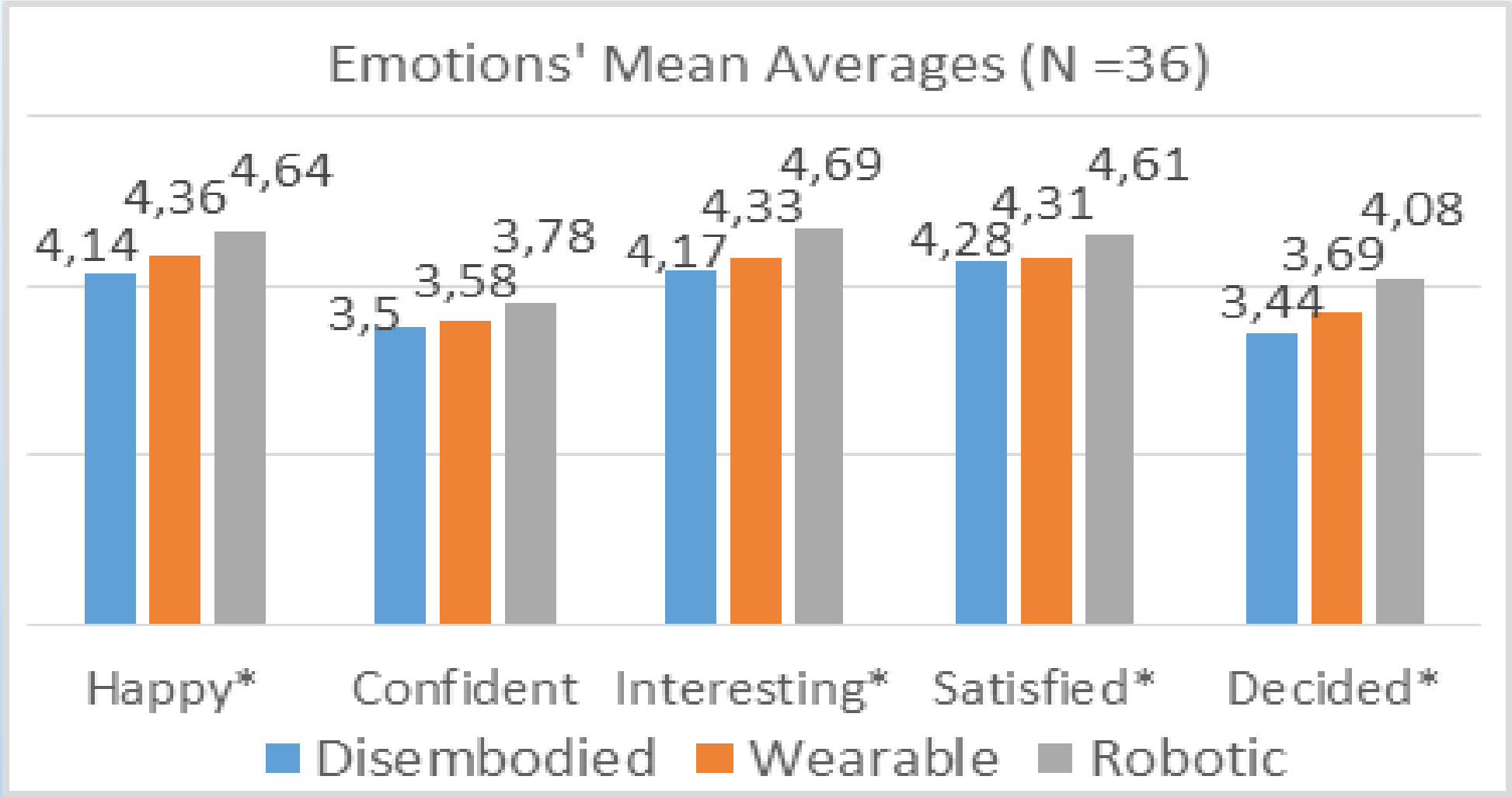
- Randomized within groups study (Scratch – First, Lego – First and LilyPad – First).
- 36 students from the first grade class (18 boys και 18 girls).
- No student had previously received teaching in computer programming.
- Study was conducted during the regular school time.
- Limitations in selecting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

Methodology – Measuring Instruments and Data Analysis

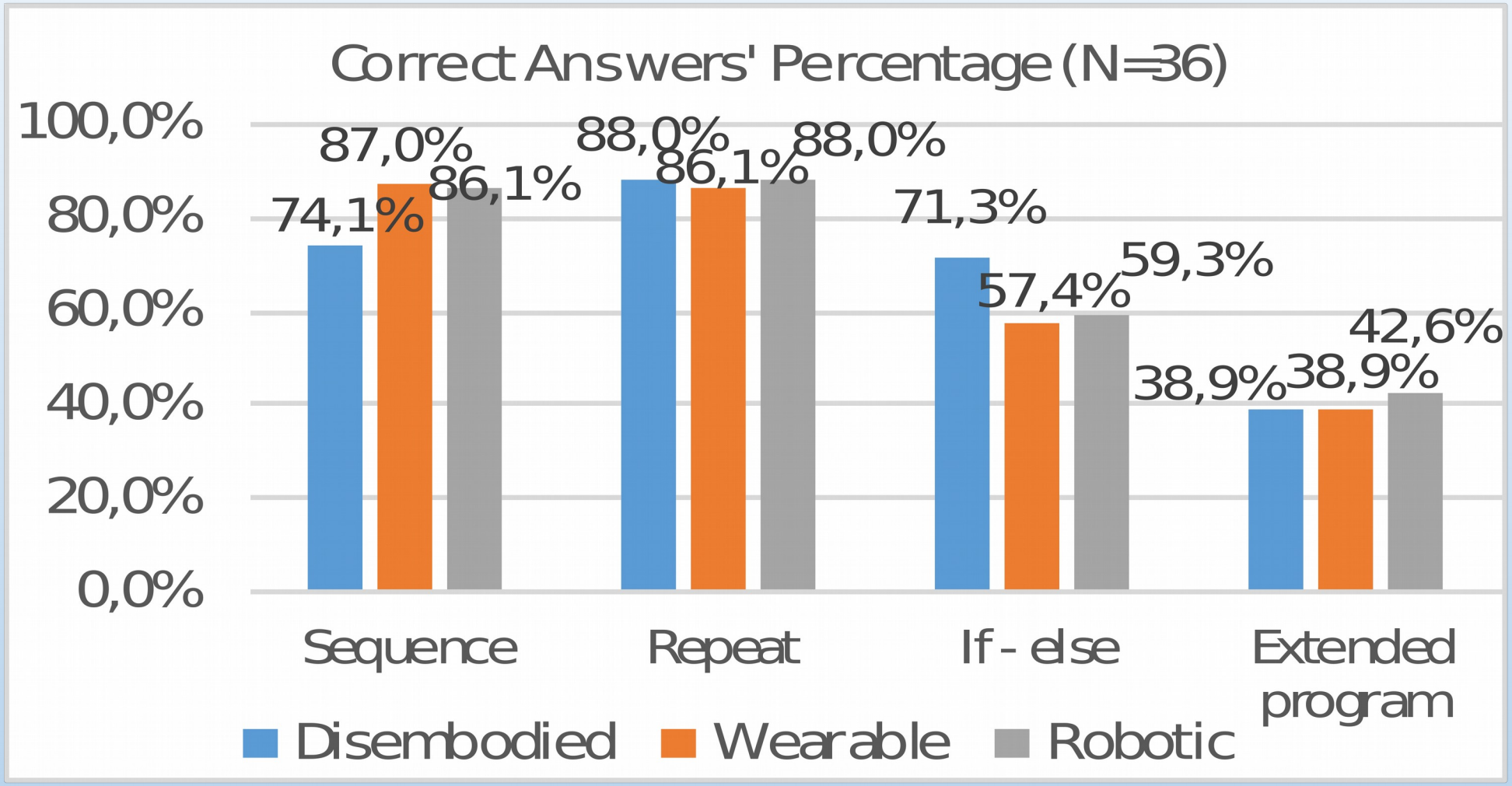
- **Pre – Test** : 4-level Likert questionnaire
  - ✓experience and attitude towards computers
  - ✓Experience towards coding
  - ✓Experience towards robotics
  - ✓Experience towards electronics
- **Emotions – Test** : 5-level Likert questionnaire
  - ✓Happy-Sad
  - ✓Confused-Confident
  - ✓Boring-Interesting
  - ✓Disappointed-Satisfied
  - ✓Undetermined-Determined
- **Computational Thinking Examination**: 12 assessment questions [6]
  - ✓Sequence
  - ✓Repeat
  - ✓If – else
  - ✓Extended Program

❑ Data Analysis with SPSS

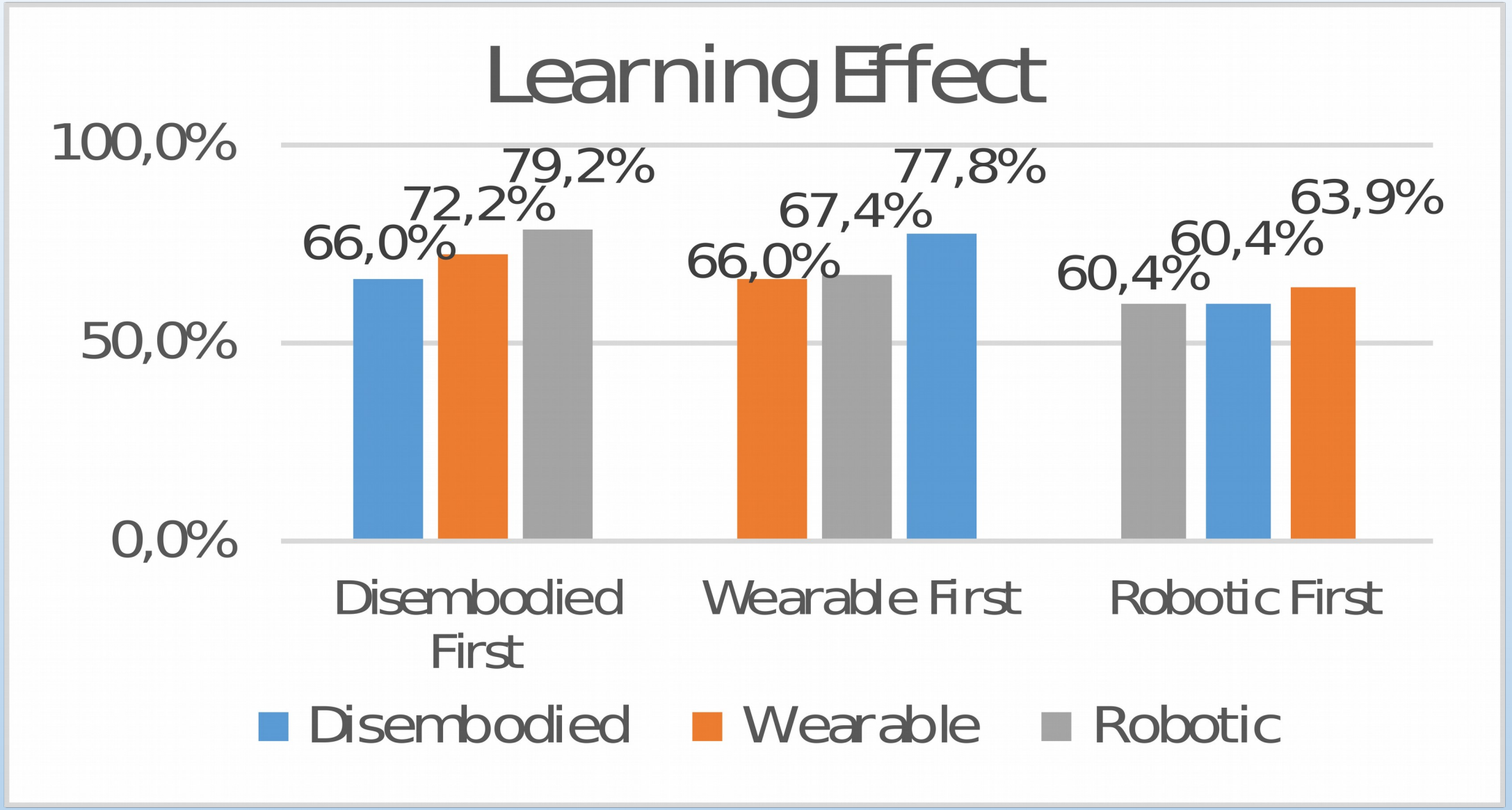
Results – Emotions



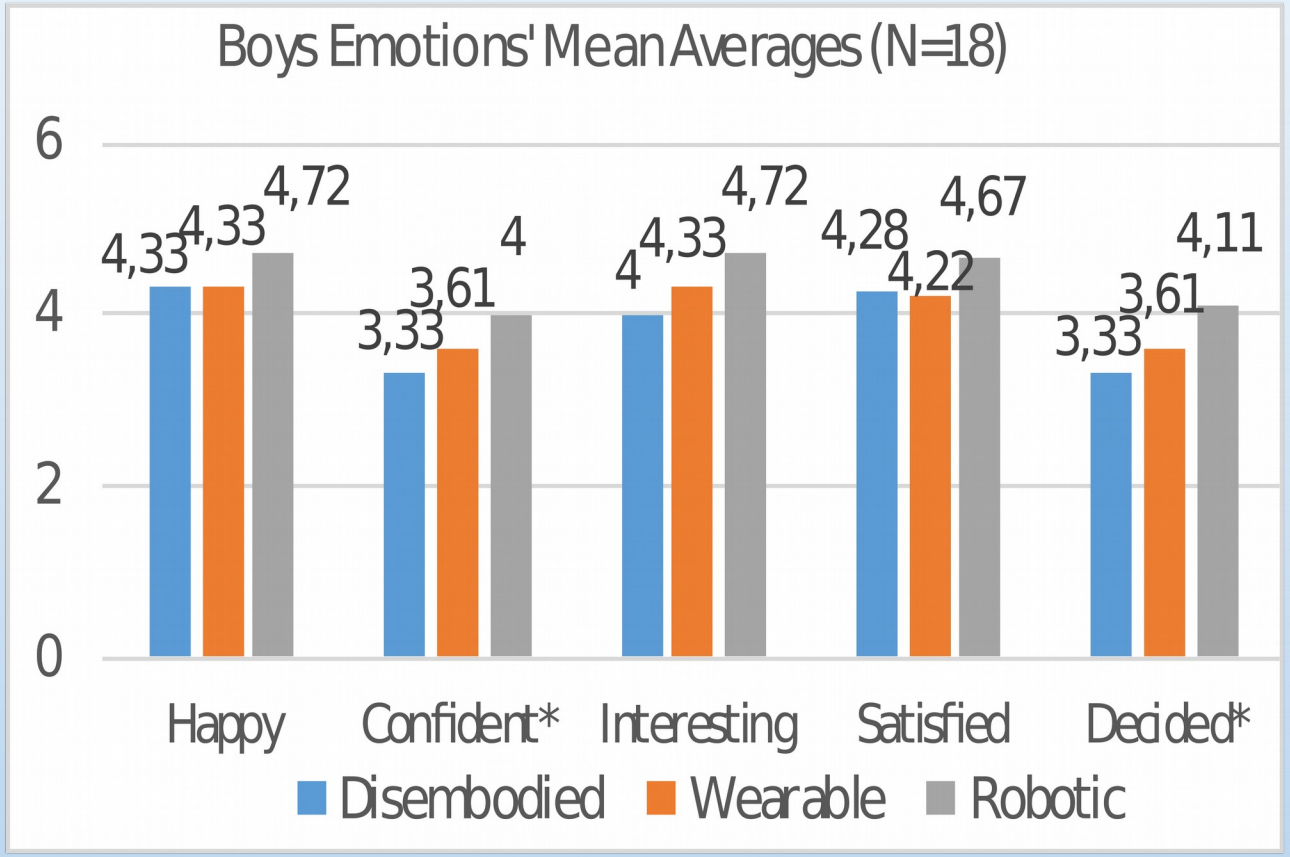
Results – Performance

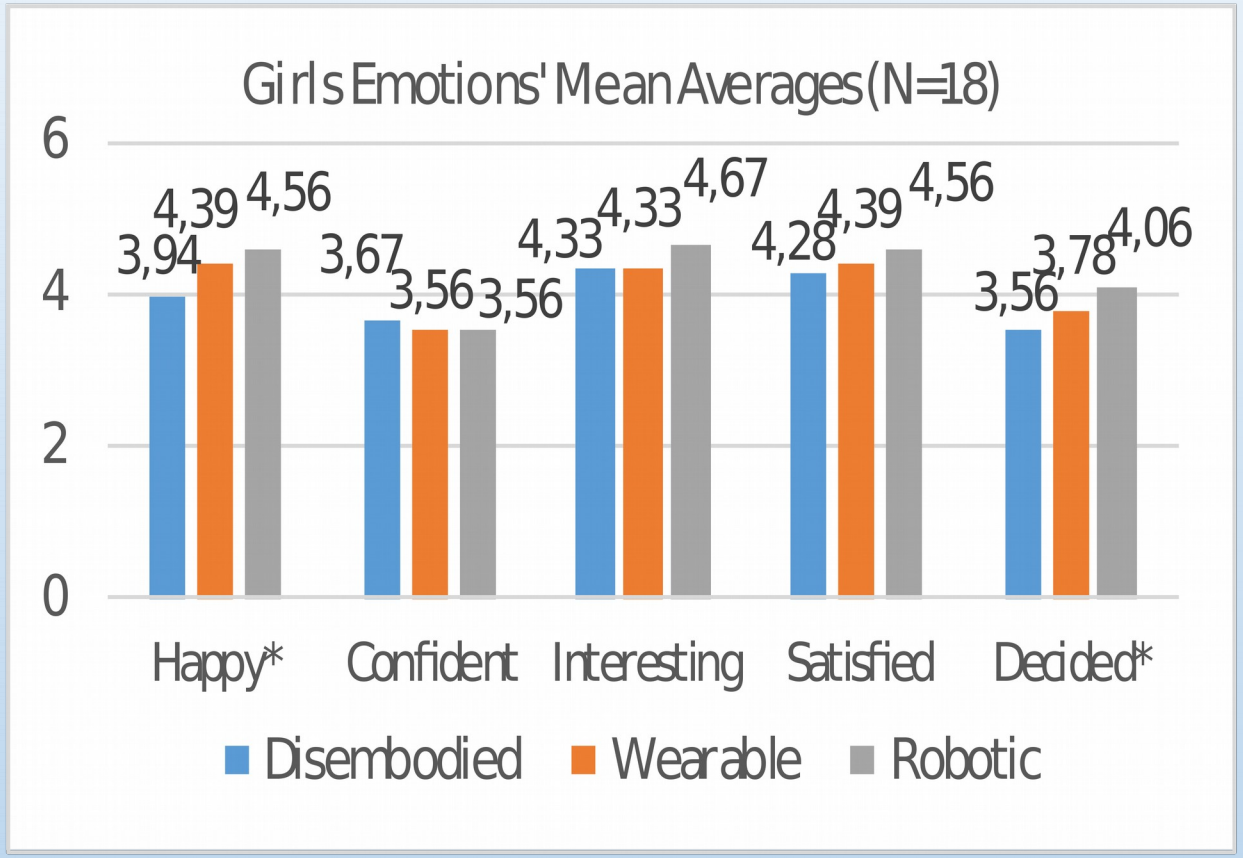


Results – Learning Effect

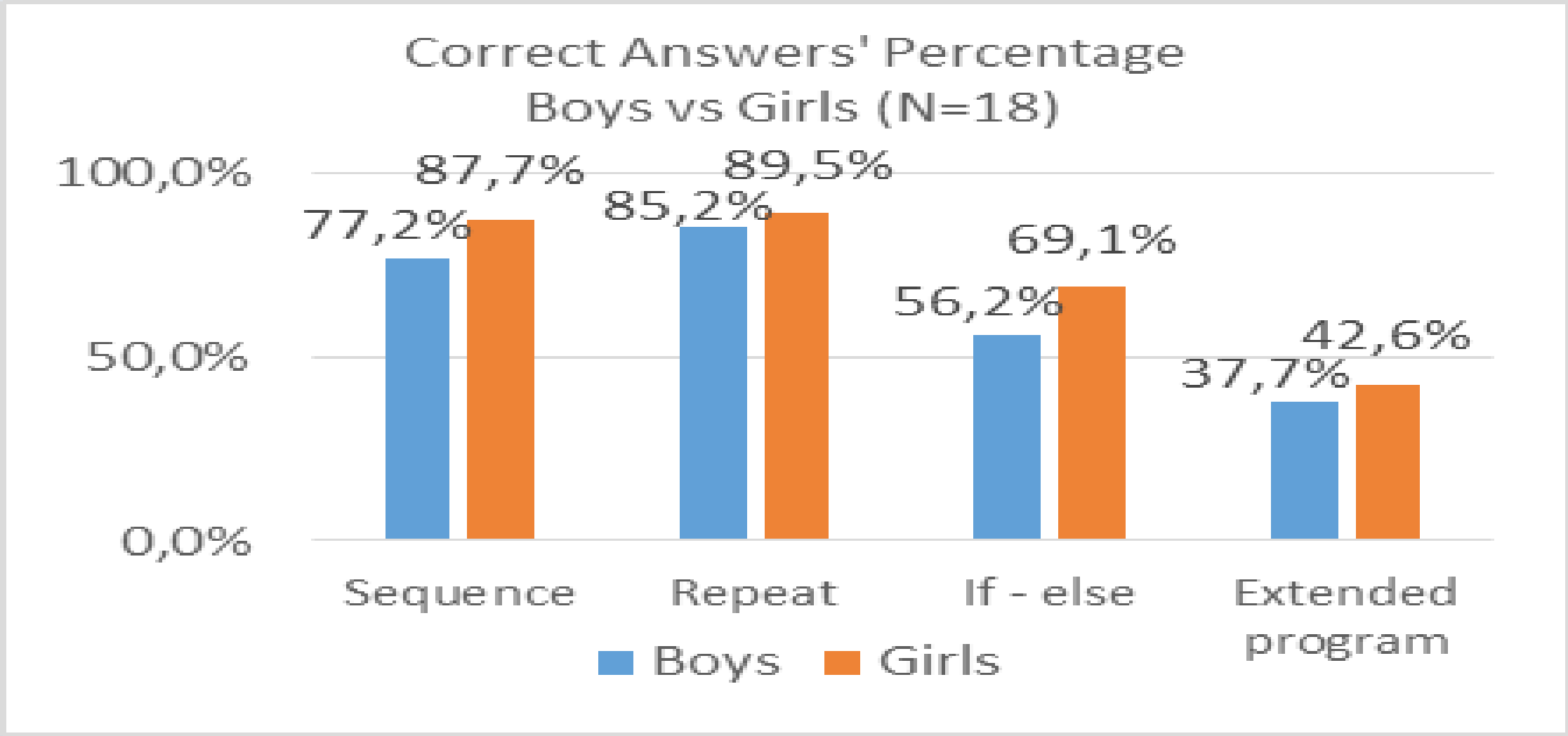


Results – Gender and Emotions





Results – Gender and Performance



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 App Inventor with Mindstorms Robots
- Study using Kinect as input to Scratch [4].
- Study comparing tangible programming environments (tangible) with desktop programming environments [3].

Publications

- Alexandros Merkouris and Konstantinos Chorianopoulos. 2015. Introducing Computer Programming to Children through Robotic and Wearable Devices. In *Proceedings of the Workshop in Primary and Secondary Computing Education* (WiPSCE '15). ACM, New York, NY, USA, 69-72. DOI: http://dx.doi.org/10.1145/2818314.2818342
- Alexandros Merkouris, Konstantinos Chorianopoulos and Achilles Kameas. Teaching programming in secondary education through embodied computing platforms robotics and wearables. *ACM Transaction On Computing Education. Accepted*

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[10] Kanjun Qiu, Leah Buechley, Edward Baafi, and Wendy Dubow. 2013. A curriculum for teaching computer science through computational textiles. In *Proceedings of the 12th International Conference on Interaction Design and Children* (IDC '13). ACM, New York, NY, USA, 20-27