Introducing Computer Programming to Children through Robotic and Wearable Devices

Alexandros Merkouris
Ionian University
Department of Informatics
Corfu, Greece
c14merk@ionio.gr

Konstantinos Chorianopoulos
Norwegian University of Science and Technology
Trondheim, Norway
choko@acm.org

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].

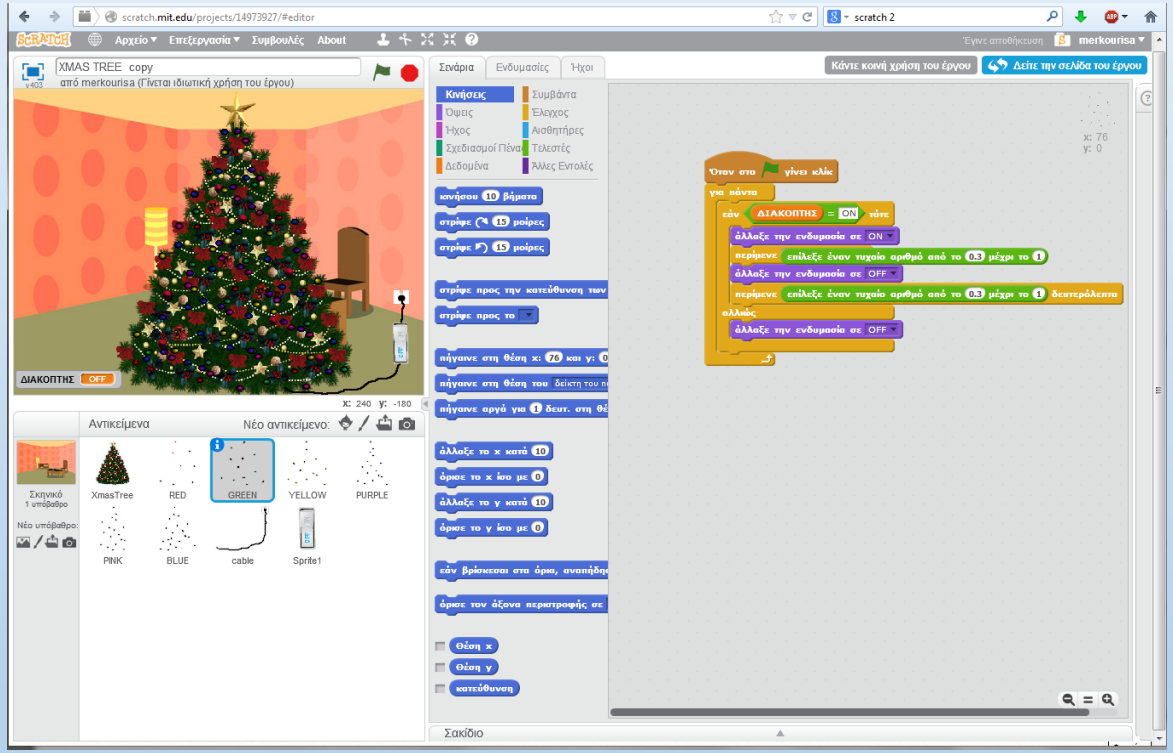
Research Questions

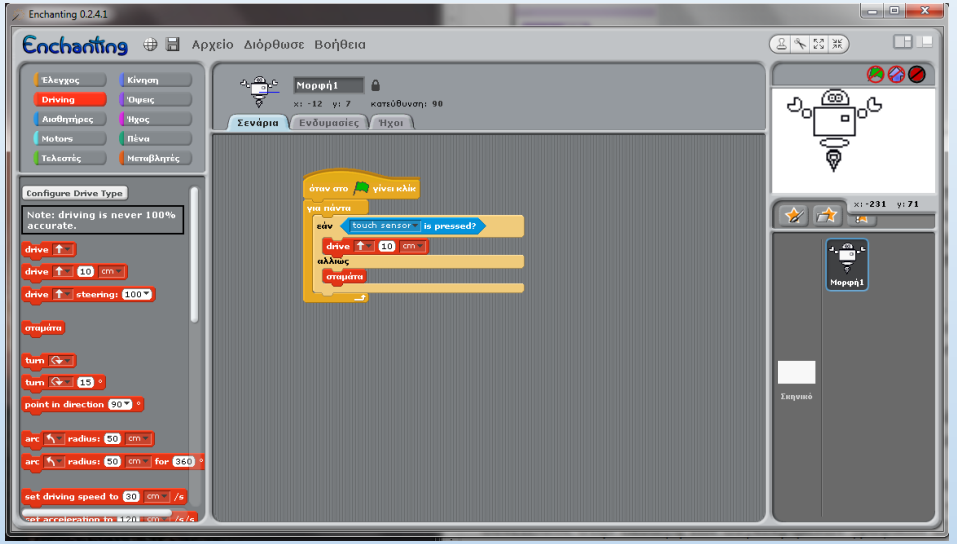
1. Is tangible computing more engaging than desktop computing in learning computer programming?
2. Are there differences between boys and girls with regard to the preference of a tangible platform?
3. Through which target platform, students can develop their programming skills more effectively?

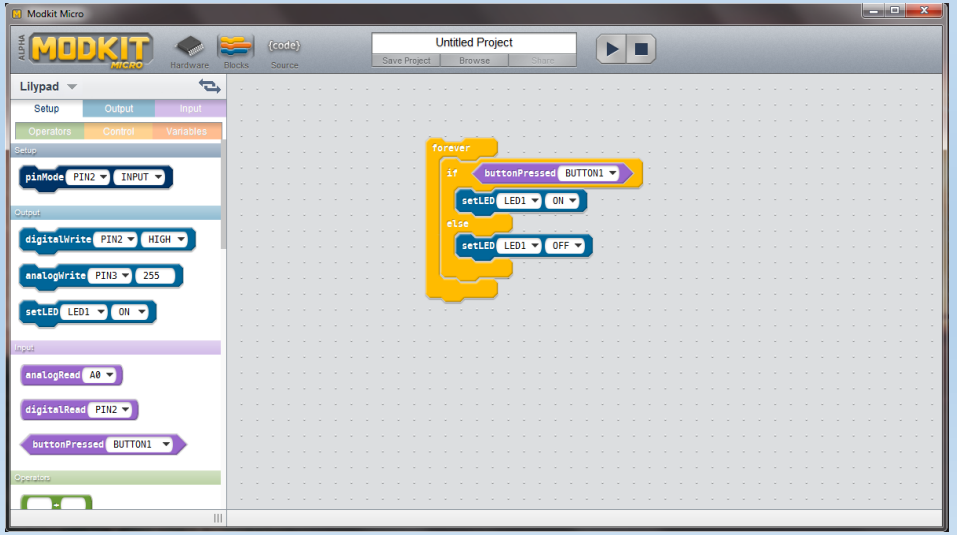
Methodology – Materials

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

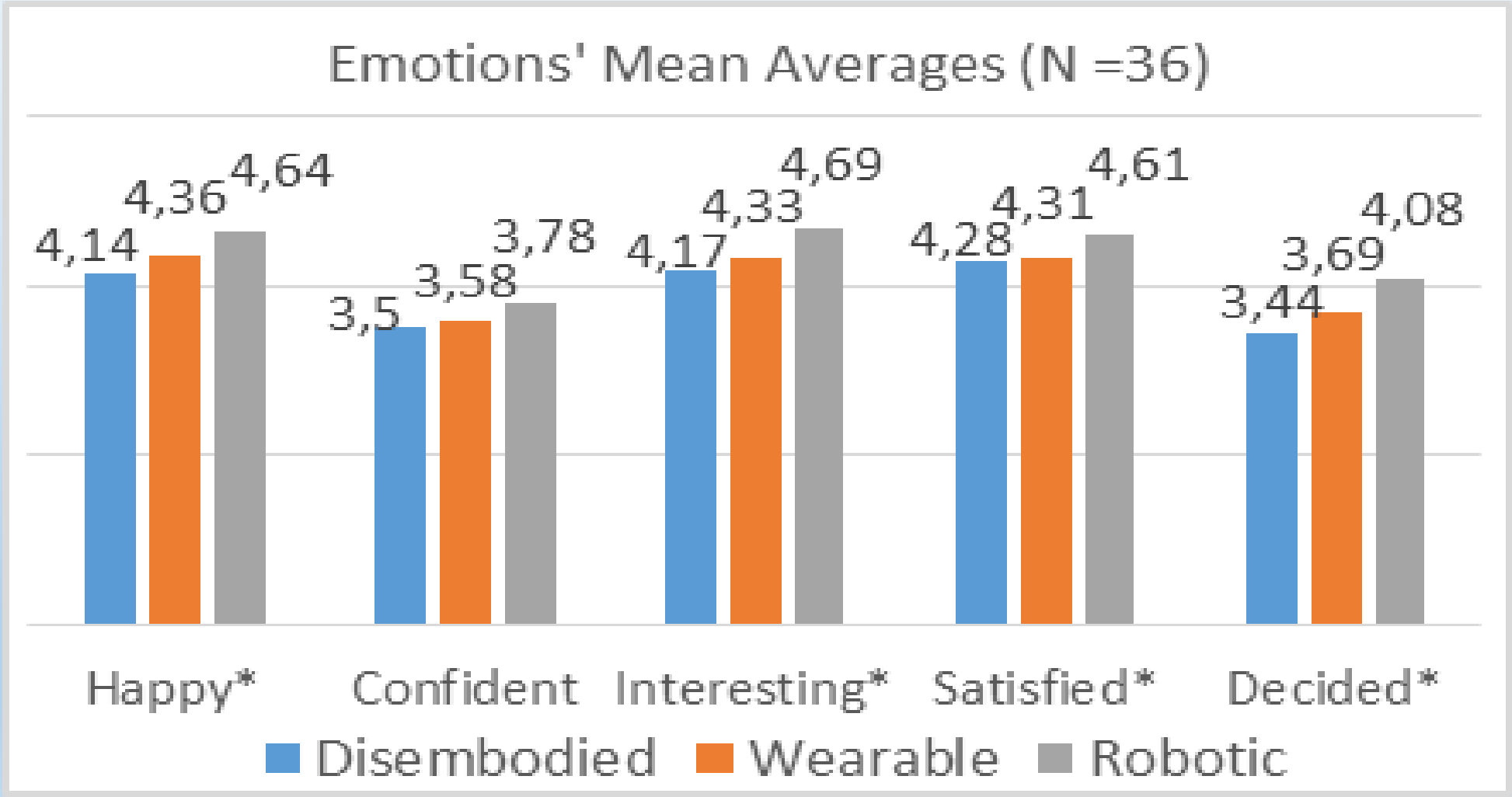
- Randomized within groups study (Scratch – First, Lego – First and LilyPad – First).
- 36 students from the first grade class (18 boys και 18 girls).
- No student had previously received teaching in computer programming.
- Study was conducted during the regular school time.
- Limitations in selecting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

Methodology – Measuring Instruments and Data Analysis

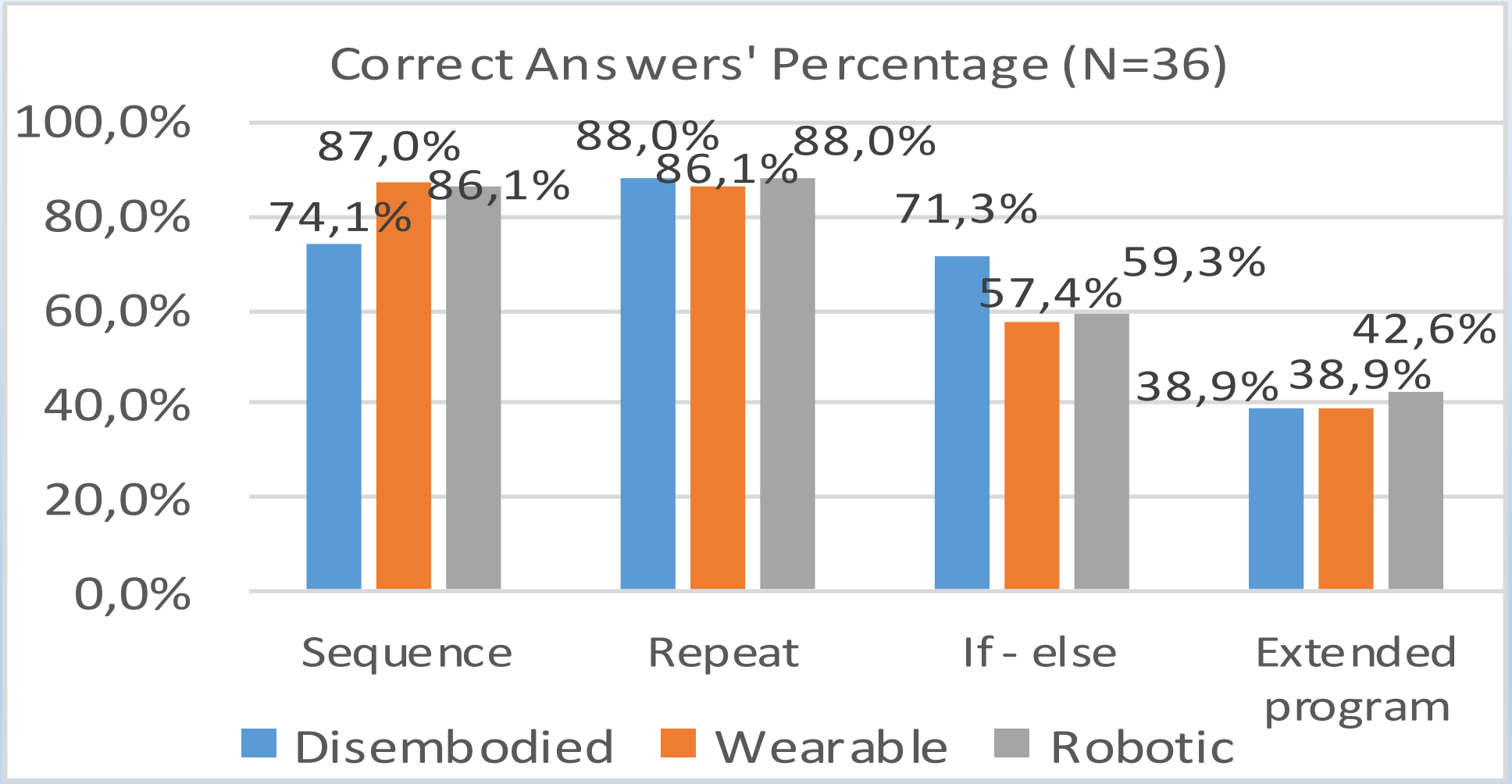
- **Pre – Test** : 4-level Likert questionnaire
  - ✓ experience and attitude towards computers
  - ✓ Experience towards coding
  - ✓ Experience towards robotics
  - ✓ Experience towards electronics
- **Emotions – Test** : 5-level Likert questionnaire
  - ✓ Happy-Sad
  - ✓ Confused-Confident
  - ✓ Boring-Interesting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

❑ Data Analysis with SPSS

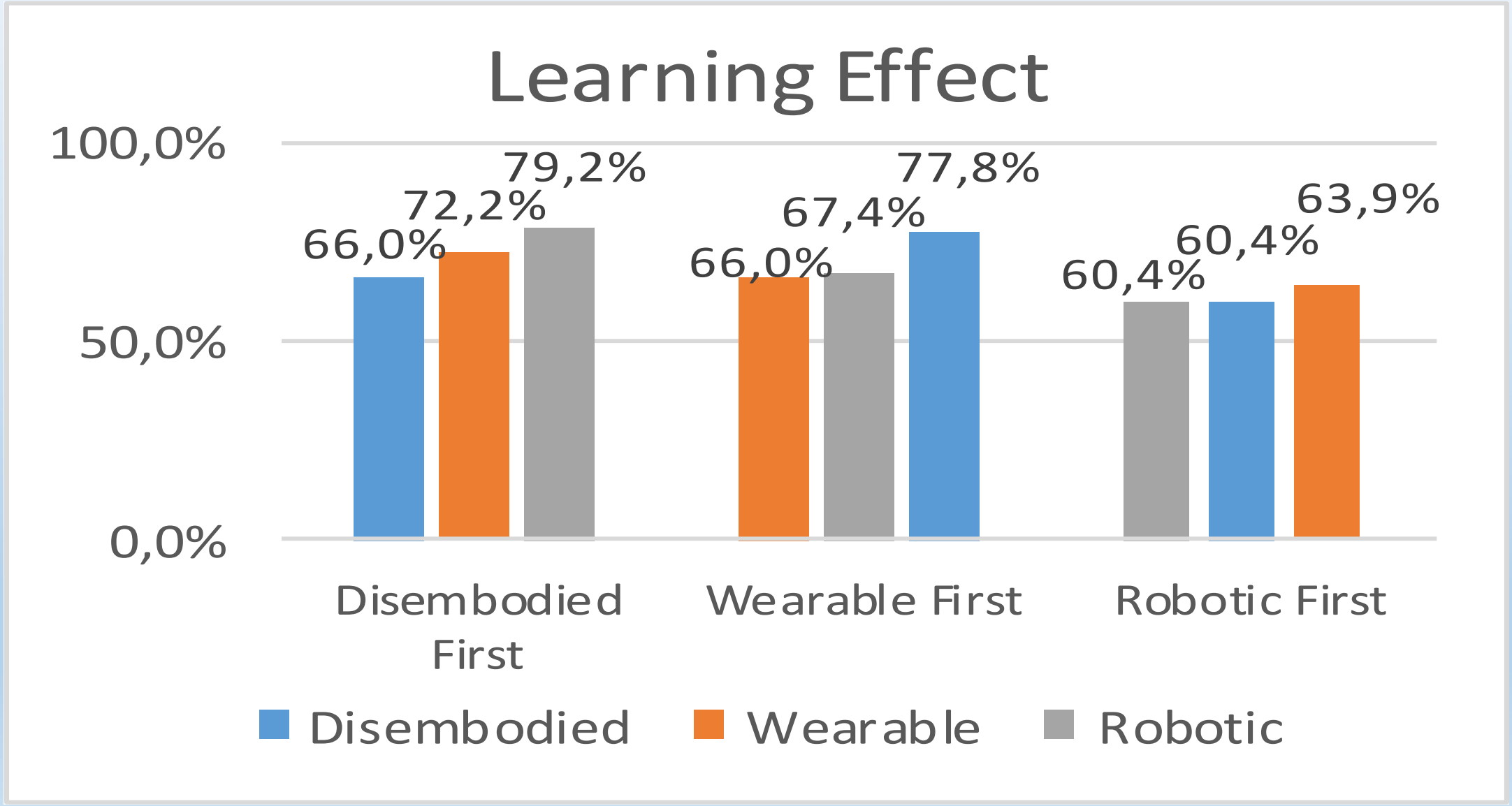
Results – Emotions



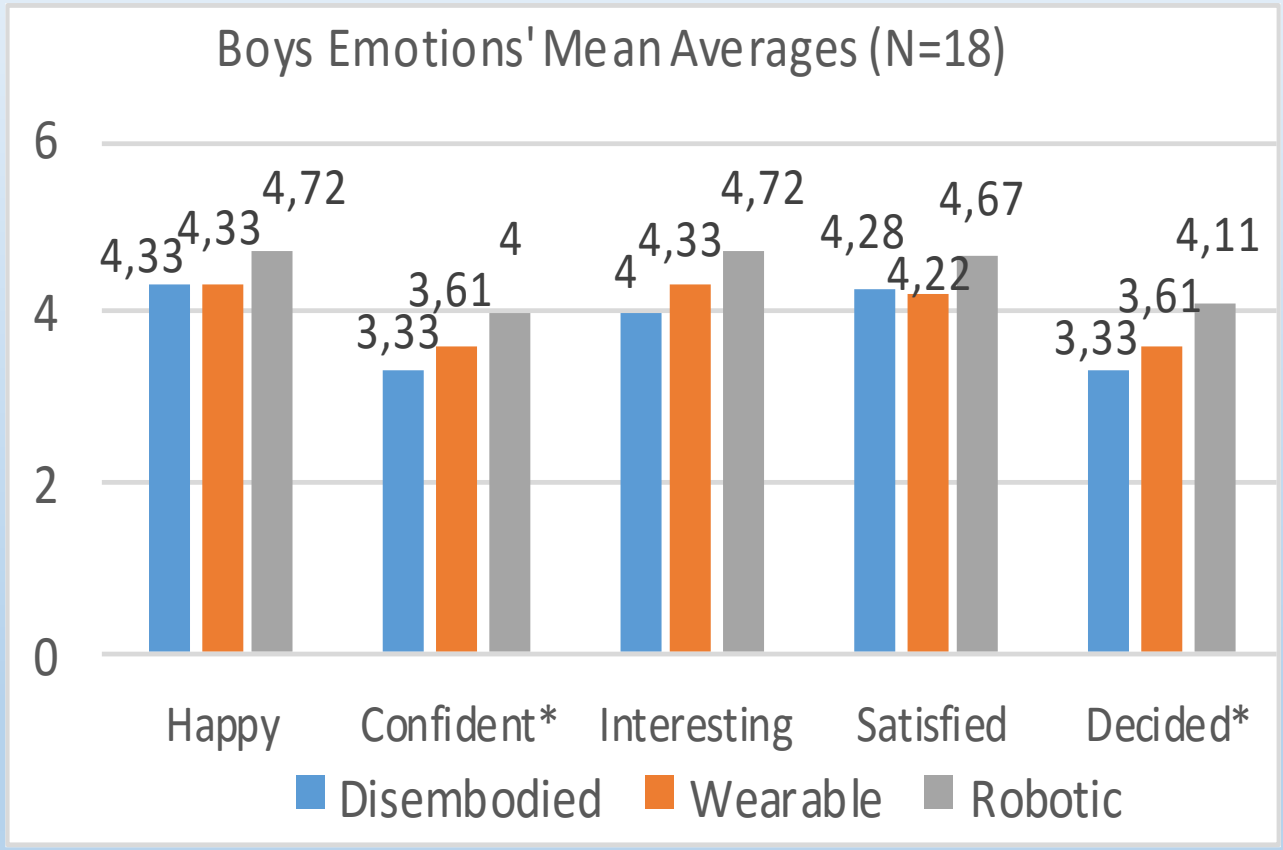
Results – Performance

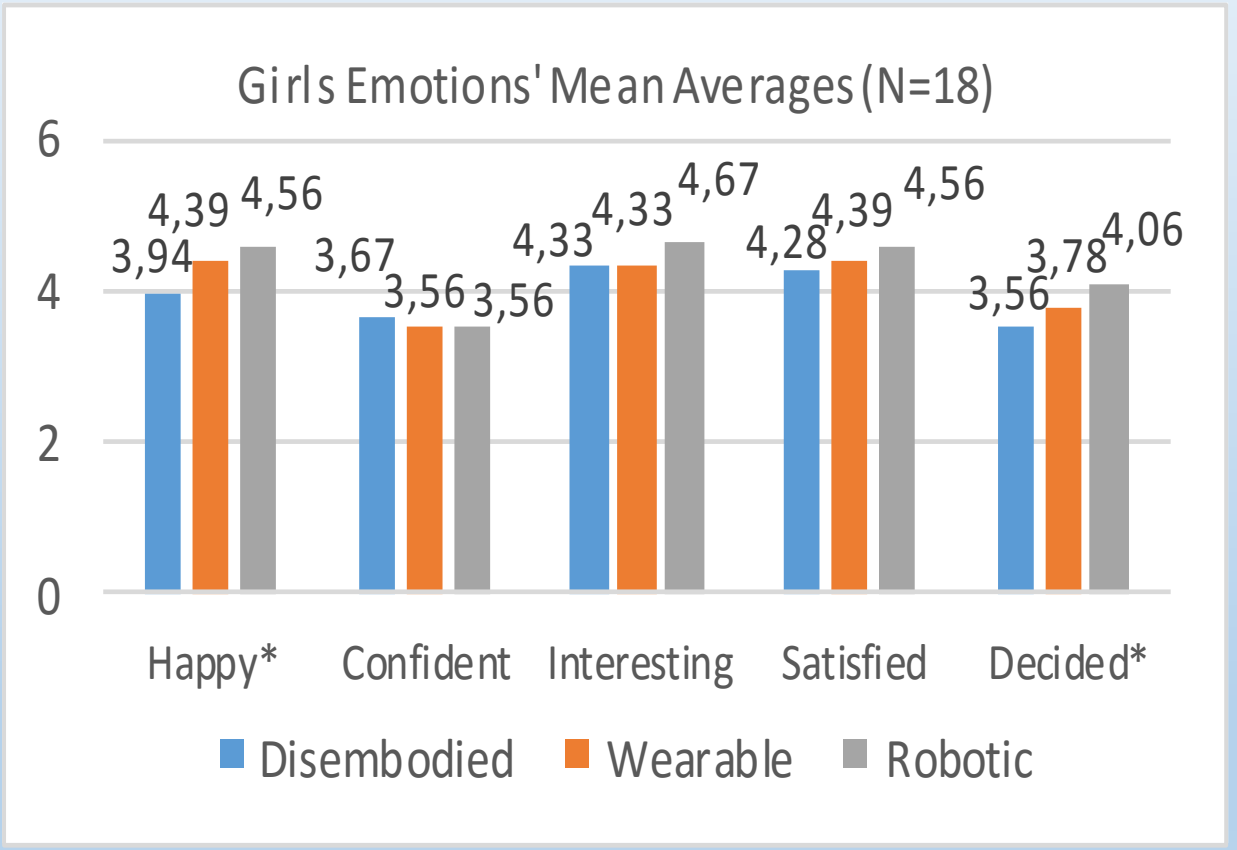


Results – Learning Effect

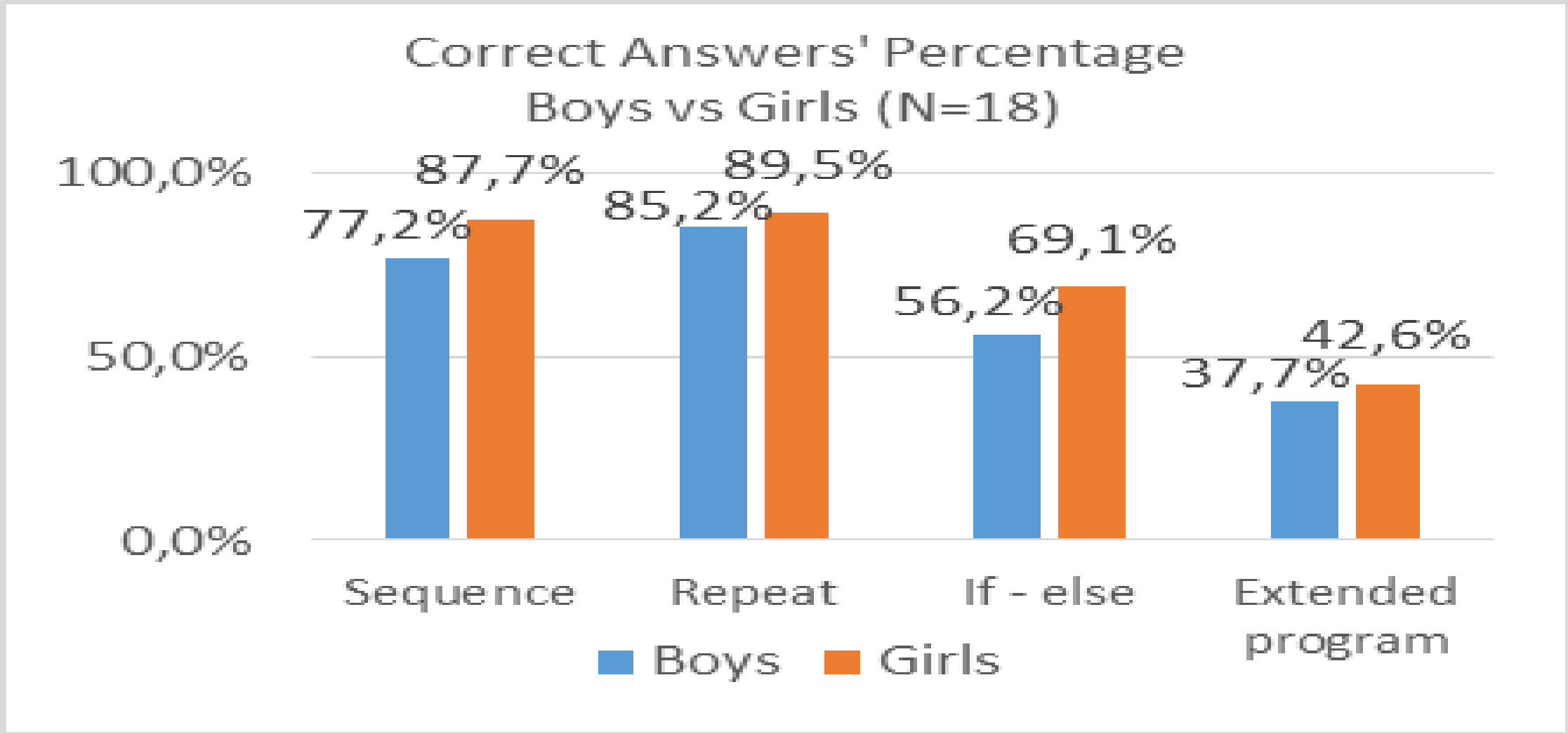


Results – Gender and Emotions





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

References

[1] Fabiane Barreto Vavassori Benitti. 2012. Exploring the educational potential of robotics in schools. *Comput. Educ.* 58, 3 (April 2012), 978-988.

[2] Leah Buechley, Mike Eisenberg, Jaime Catchen, and Ali Crockett. 2008. The LilyPad Arduino: using computational textiles to investigate engagement, aesthetics, and diversity in computer science education. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (CHI '08). ACM, New York, NY, USA, 423-432.

[3] Michael S. Horn and Robert J. K. Jacob. 2007. Tangible programming in the classroom with tern. In *CHI '07 Extended Abstracts on Human Factors in Computing Systems* (CHI EA '07). ACM, New York, NY, USA, 1965-1970.

[4] Howell, S. (2012). Kinect2Scratch (Version 2.5) [Computer Software]. http://scratch.saorog.com

[5] Yasmin B. Kafai, Eunkyoung Lee, Kristin Searle, Deborah Fields, Eliot Kaplan, and Debora Lui. 2014. A Crafts-Oriented Approach to Computing in High School: Introducing Computational Concepts, Practices, and Perspectives with Electronic Textiles. *Trans. Comput. Educ.* 14, 1, Article 1 (March 2014), 20 pages.

[6] Colleen M. Lewis. 2010. How programming environment shapes perception, learning and goals: logo vs. scratch. In *Proceedings of the 41st ACM technical symposium on Computer science education* (SIGCSE '10). ACM, New York, NY, USA, 346-350.

[7] Amon Millner and Edward Baafi. 2011. Modkit: blending and extending approachable platforms for creating computer programs and interactive objects. In *Proceedings of the 10th International Conference on Interaction Design and Children* (IDC '11). ACM, New York, NY, USA, 250-253.

[8] Omar Mubin, Catherine J Stevens, Suleman Shahid, Abdullah Al Mahmud,and Jian-Jie Dong. A review of the applicability of robots in education. *Journal of Technology in Education and Learning*, 1, 2013

[9] Papert, S. *Mindstorms: children, computers, and powerful ideas*. New York, NY: Basic Books, 1980.

[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