מכון ויצמן למדע
WEIZMANN INSTITUTE OF SCIENCE

Students' Attitudes and Motivation During Robotics Activities

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WiPSCE 2015

Introduction

Robotics activities…

It is important to

are new	• investigate students' expectations and beliefs towards the activities and its outcomes
involve problems and challenges	• examine students' abilities and determination in solving problems
involve collaboration	• examine students' beliefs regarding their ability to communicate and succeed
regarding STEM knowledge	• Check students' attitudes towards and motivation for learning STEM
are extracurricular	• investigate the influence of the environmental factors
as in school curriculum	• Contribute to the decision of integrating robotics activities as a curricular subject

Research Questions

- What are students' attitudes towards and motivation for learning about robots and how do the attitudes and motivation change after participating in the robotics activities?
- What are the students' attitudes towards and motivation for learning STEM and how do the attitudes and motivation change after participating in the robotics activities?
- How do other environmental factors impact students’ attitudes and motivation toward the robotics activities?

Background

Robotics Activities in Education

- Extracurricular activities
  - After school
  - Summer camps
  - Competitions
- School curriculum

Competitions

- Botball (Miller & Stein, 2000).
- TCFFHRC – Trinity College Fire-Fighting Home Robot Contest (Verner & Ahlgren, 2004)
- RoboFest – (Trudell & Chung, 2009)
- RoboCup
- FIRST – (Melchior et al., 2005)
- . . . . . .

Robots

Topobo

(Virnes, et al., 2008)

Scribbler

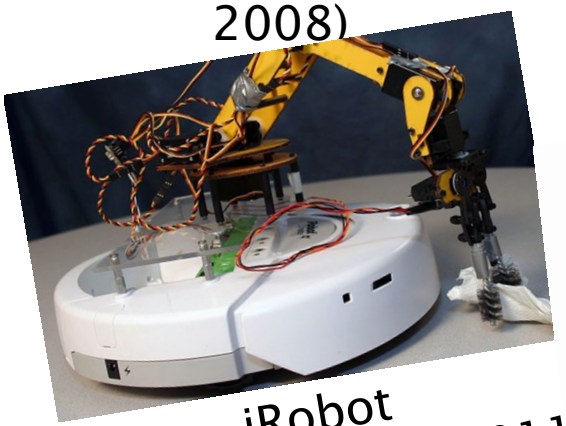
(Summet et al. 2009)

Dot and Dash

(Grant, 2013)

Thymio

(Riedo et al., 2013)

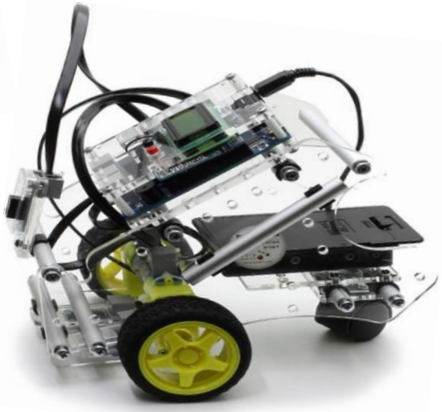


iRobot

(Anderson et al., 2011

LEGO Mindstorms

(Trobaugh, J., 2010)



Mama-Robot

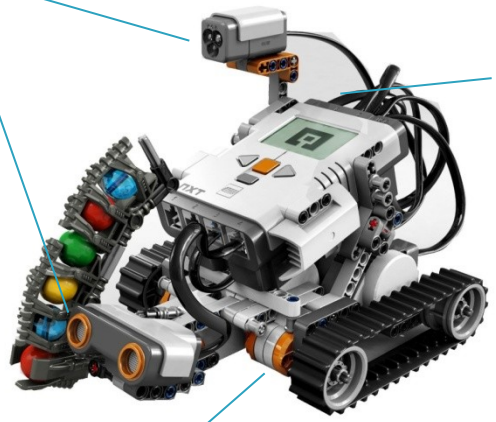
(Davide Cali, 2015)

Resources and tools

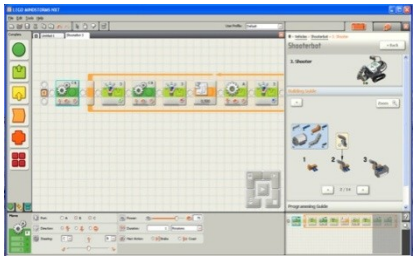
Software for programming

Sensors

Computer controller

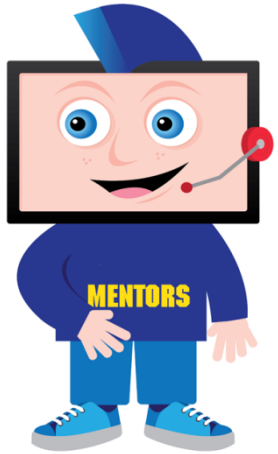


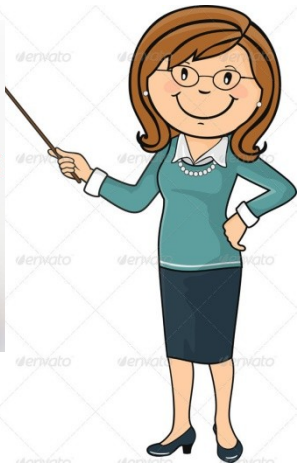
Motors



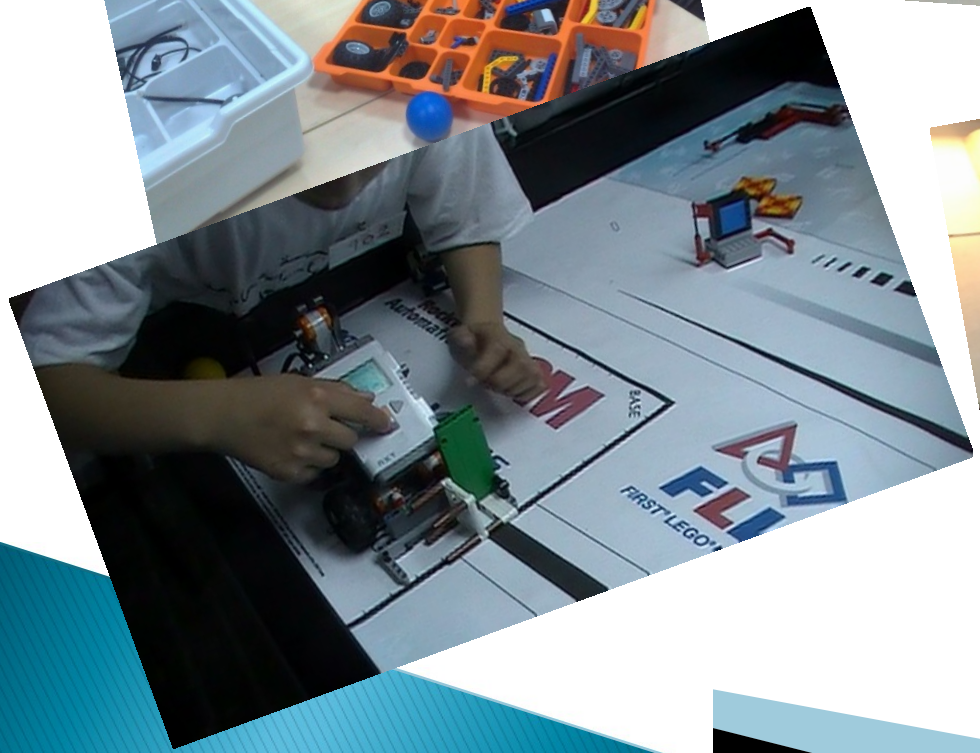
Visual programming environment

Ordinary programming languages





Robotics activities in schools



Attitudes and Motivation

- An *attitude* is a positive or negative stance, opinion and evaluation about something like objects, activities or ideas (Fortus, 2014).
- Motivation is the process that initiates, directs, and maintains goal-oriented behaviors (Social cognitive theory of Bandura (1982; 1997)

Attitudes and Motivation Categories

- **Intrinsic motivation**: involves the inherent satisfaction in learning science for its own sake
- **Extrinsic motivation**: involves learning science as a means to a tangible end, such as a career or a grade.
- **Self-determination**: the person who uses their own capacity for achieving optimal goals.
- **Self-efficacy**: an expectancy about one's capabilities to learn or to perform a given task, or avoid others

Environmental Factors

- Various environmental factors such as **gender, parents, peers, teachers, and schools** can influence the student's attitudes towards and motivation for science (Fortus, 2014; Osborne et al, 2003).

Literature Review

University Level

- Most of the literature that examined students' attitudes towards or motivation for robotics activities found positive impact on learning robotics and students showed interest in learning or specialized in science or engineering (Verner & Ahlgren, 2004; Lauwers, Nourbakhsh & Hamner, 2009; Apiola, Lattu & Pasanen, 2010). McWhorter and O'Connor (2009) found a decrease in the level of extrinsic goal orientation.

Literature Review

Middle and high school level

- The results showed an increase in the participants' interest in robotics, science and technology, a positive sense of belonging, increased self-confidence, and the acquisition of a variety of practical problem solving strategies. Also, self-efficacy was one of the predictors of students' satisfaction.

(Melchior et al., 2005; Miller & Stein, 2000; Avsec, Rihtarsic & Kocijancic, 2014).

Methodology

Research Instruments

- Pre- and post-questionnaires
- Observations during the entire period of the activities
- Semi-structured interviews with 2-3 students from each group

Perform a non-participant research: we were not involved in the activities themselves;

Population

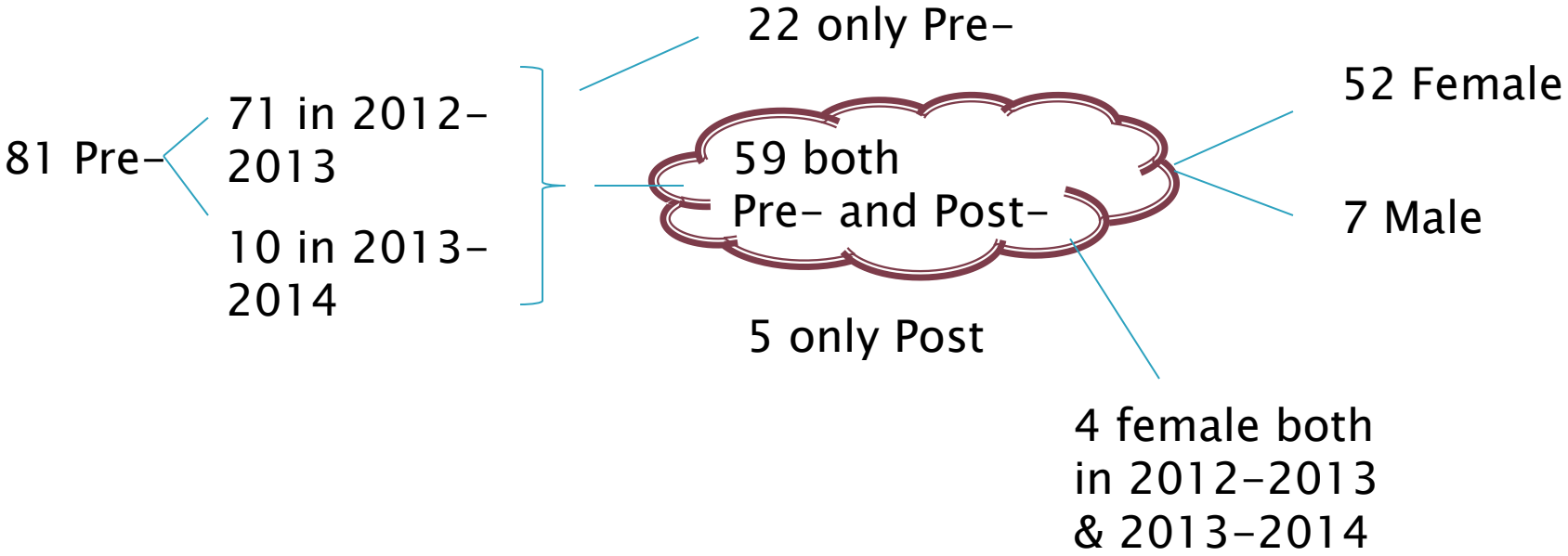
- Students aged 13-15 from 8 middle-schools working on the activities *throughout* the school year
- The activities started near the beginning of the school year and ended on the competition day
- The activities were extracurricular: participants in FIRST LEGO League robotics competition.
- Most of the teachers had no background in robotics
- The participants were self selected or selected

Population

UNRWA Private PS Gov IL Gov

2012 – 2013				2013 – 2014			
Group No	ST & Gender	ST with exp.	ST Interview	ST & Gender	ST with exp.	ST interview	Teachers
1	9 F	–	S1, S2, S3	7 F	3	–	Different
2	6 F	–	S8, S9	5 F, 2 M	2	–	Same*
3	8 F	4	S12, S13	Didn't participate in competition			
4	7 F	6	–	Not able to collect data*			
5	7 M	–	S4, S5	6 M	–	–	Same*
6	10 F	–	S5, S7	7 F	–	–	Same*
7	7 F	–	S10, S11	10 F	4	S16, S17	Different*
8	6 M, 2 F	–	S14, S15	Not able to collect data			
Total	62 (49F, 13M)	10 F	15 (11F, 4M)	37 (29F, 8M)	9 F	2 F	–

Distribution of Questionnaires



* Quantitative analysis: the questionnaires of 59 students
* Qualitative analysis: the observation of the 8 groups activities and the interviews with 17 students

Findings

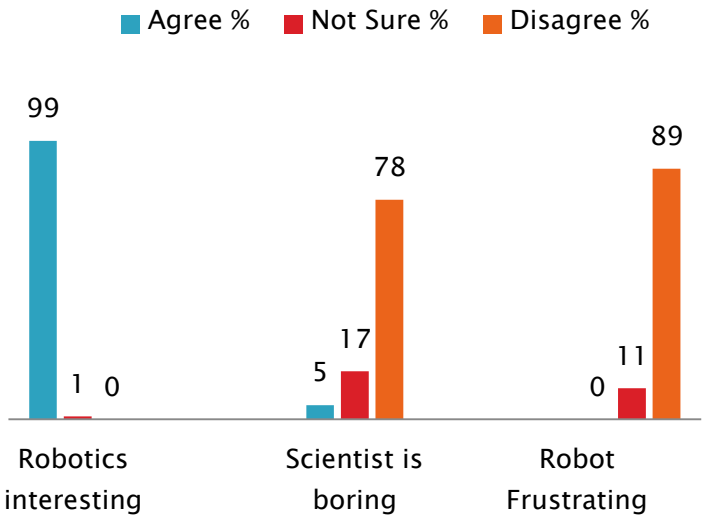
Quantitative

The results of the t-test on the difference between the pre- and the post-questionnaires showed no significant difference on all the categories

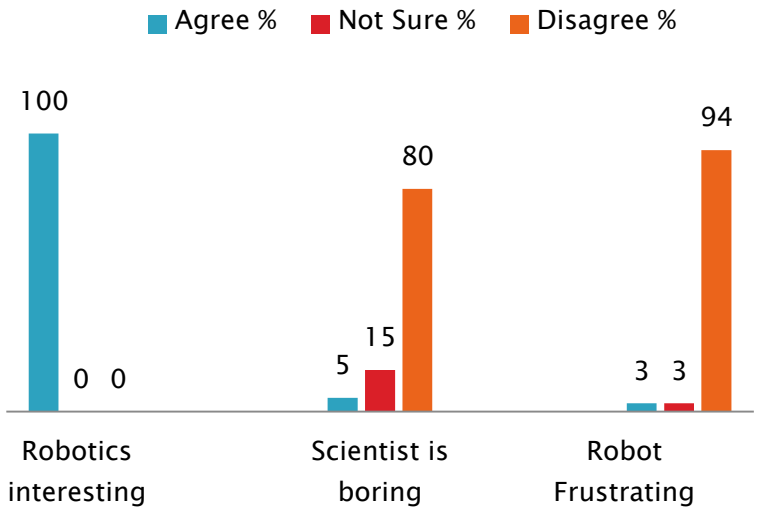
Categories	Cronbach's alpha	
	Pre-Questionnaires	**Post-Questionnaires**
Intrinsic motivation	0.74	0.73
Extrinsic motivation	0.64	0.53
Self-determination	Low	Low
Self-efficacy	0.66	0.57

Intrinsic Motivation

Pre-Questionnaire



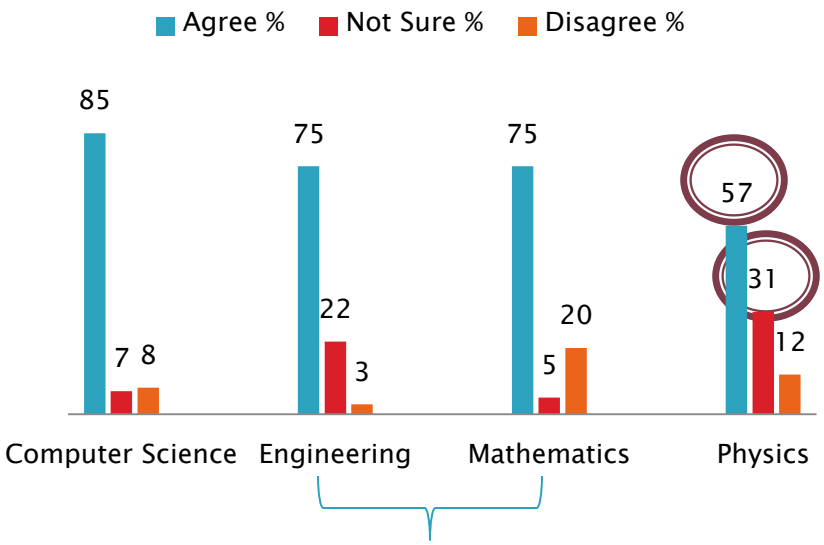
Post-Questionnaire



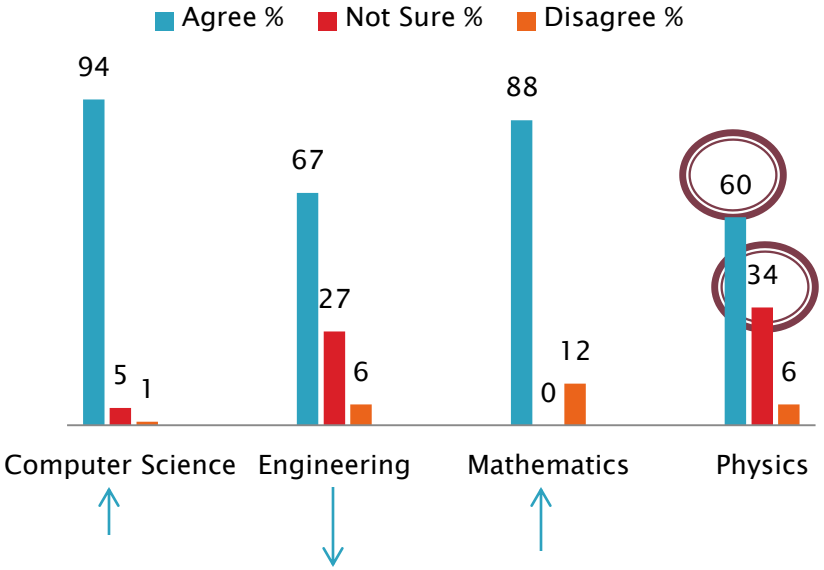
S6: We were happy and would like to participate next year if we have the chance. It was very nice because it was hands-on activities and not studying

Intrinsic Motivation

Pre-Questionnaire



Post-Questionnaire

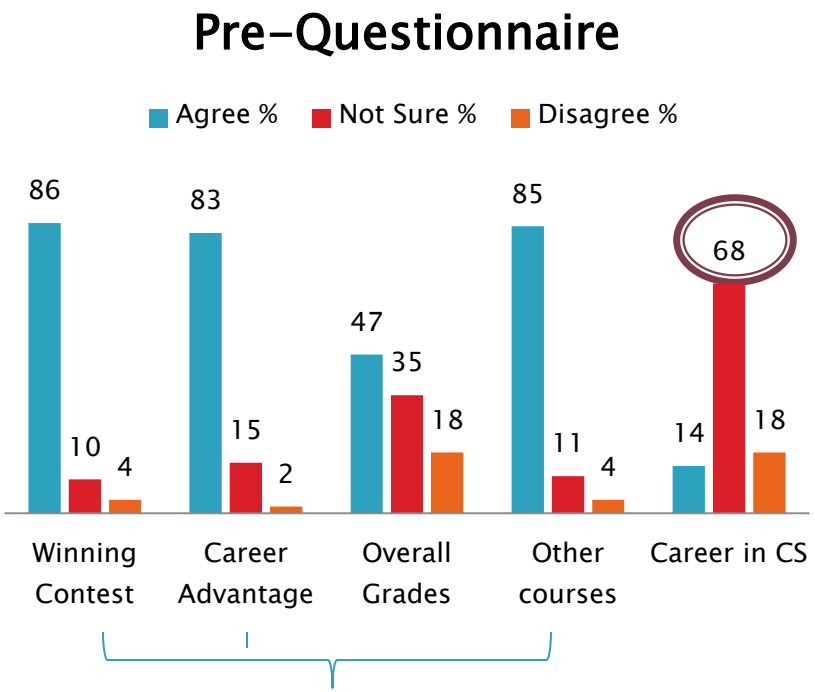


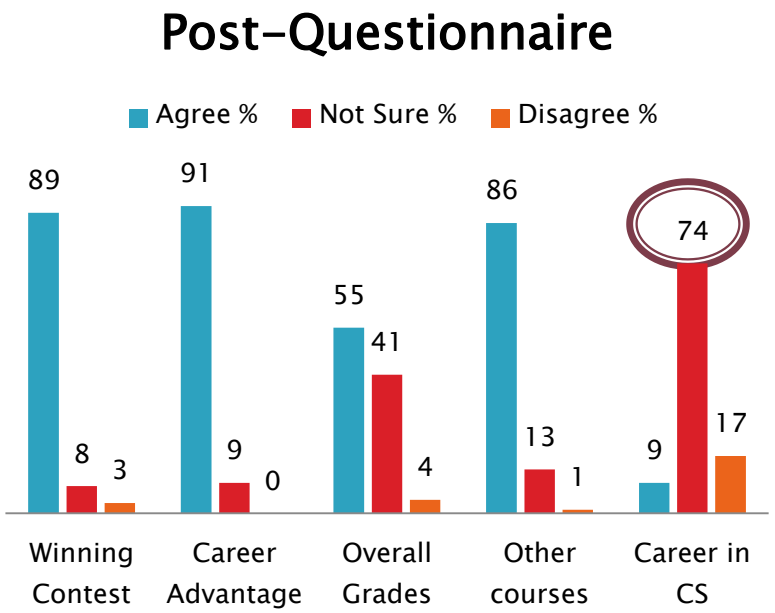
S1: I would like to get into the robotics 'science' because it involves physics and mathematics

was not mentioned during the observations or the interviews

S16: Reading other than school material helped me gain more information … mathematics and physics. A lot of physics concepts.

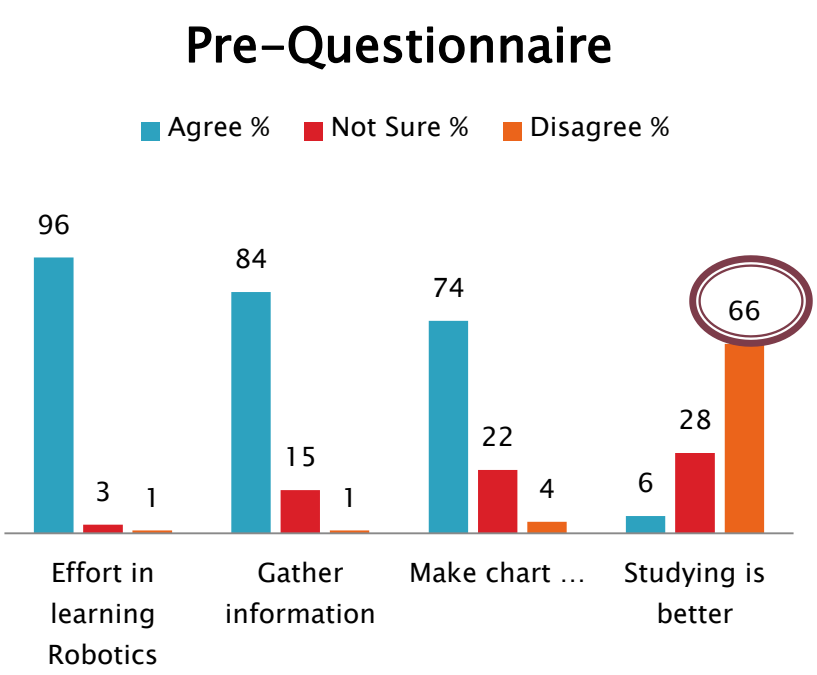
Extrinsic Motivation

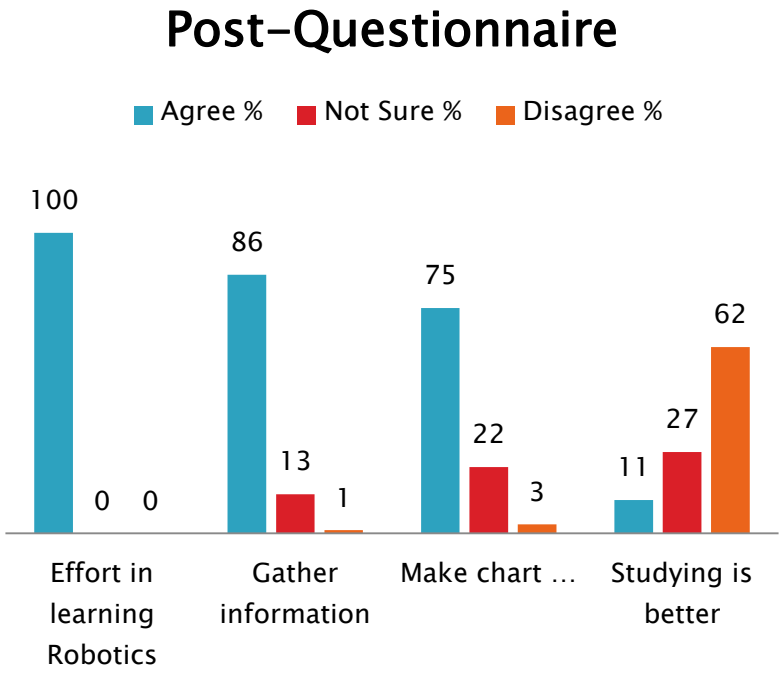




S16: We were under pressure to study for the other subjects .... I learned how to organize my time better … my accumulative grade raised.

Self-Determination

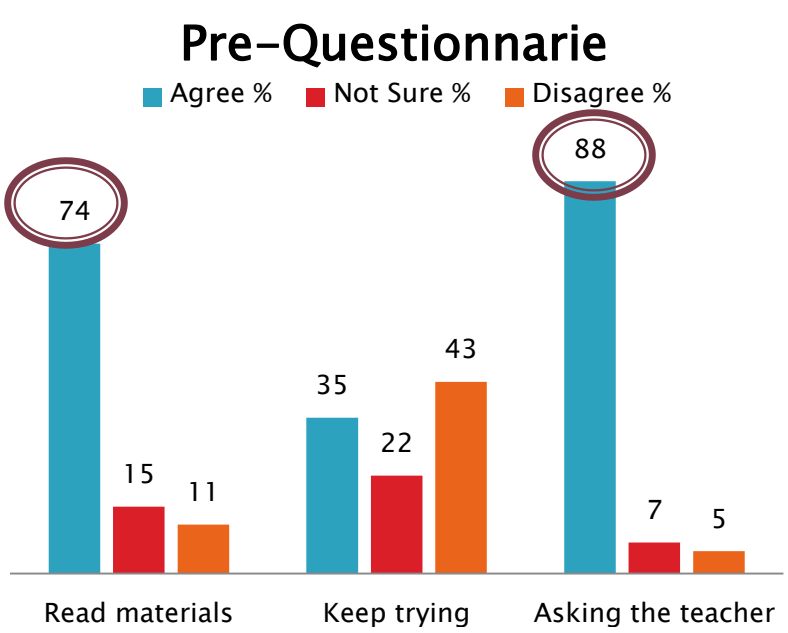


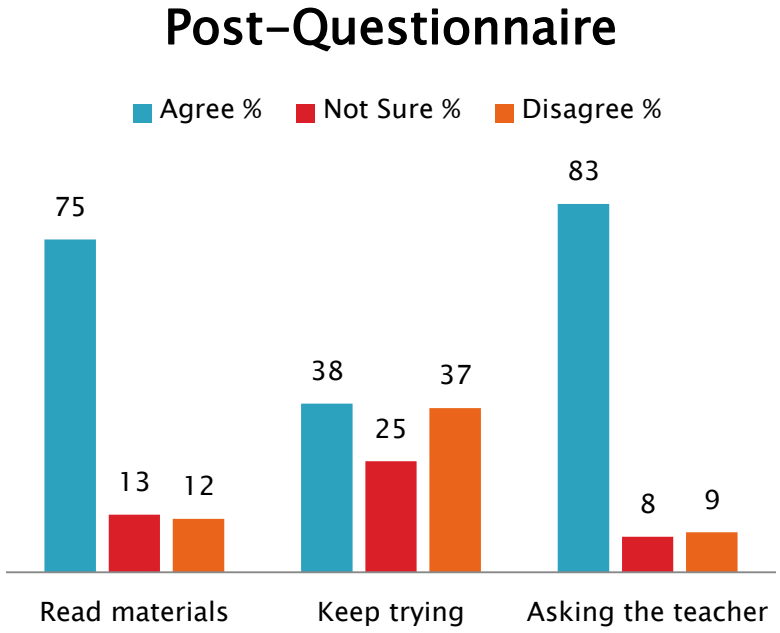


Some of the students worked hard on gathering information and solving problems without much help from the teacher or trainers

The observations showed students sneak out of the other subjects classes to work with the robots.

Self-Determination – if I have a problem,





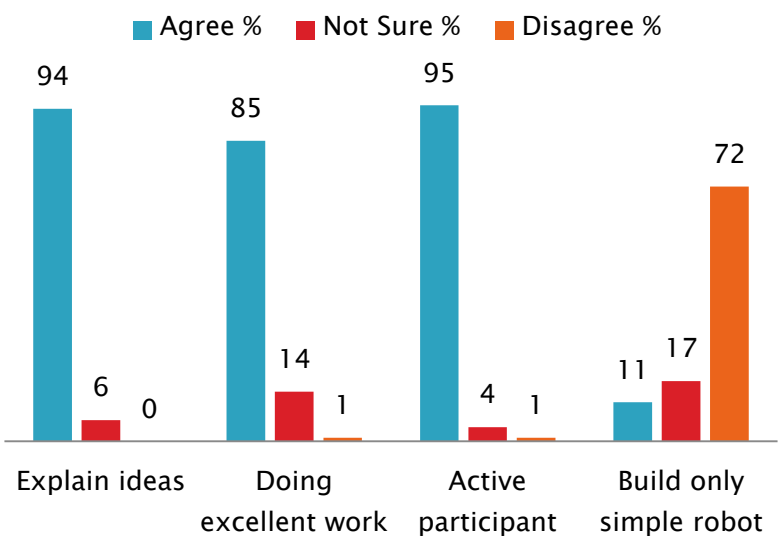
The observations showed most of the students were using trial-and-error

S4: The best thing … we were able to cause the robot to move on the black line without zigzagging by ourselves. We worked hard … searched for information about robotics.

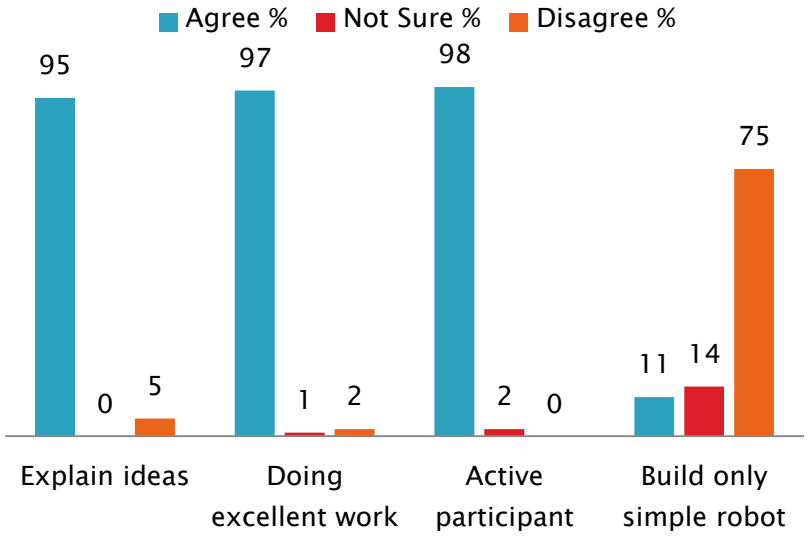
S7: Yes, there were some disappointments but we had to be persistent and work hard…

Self-Efficacy

Pre-Questionnaire

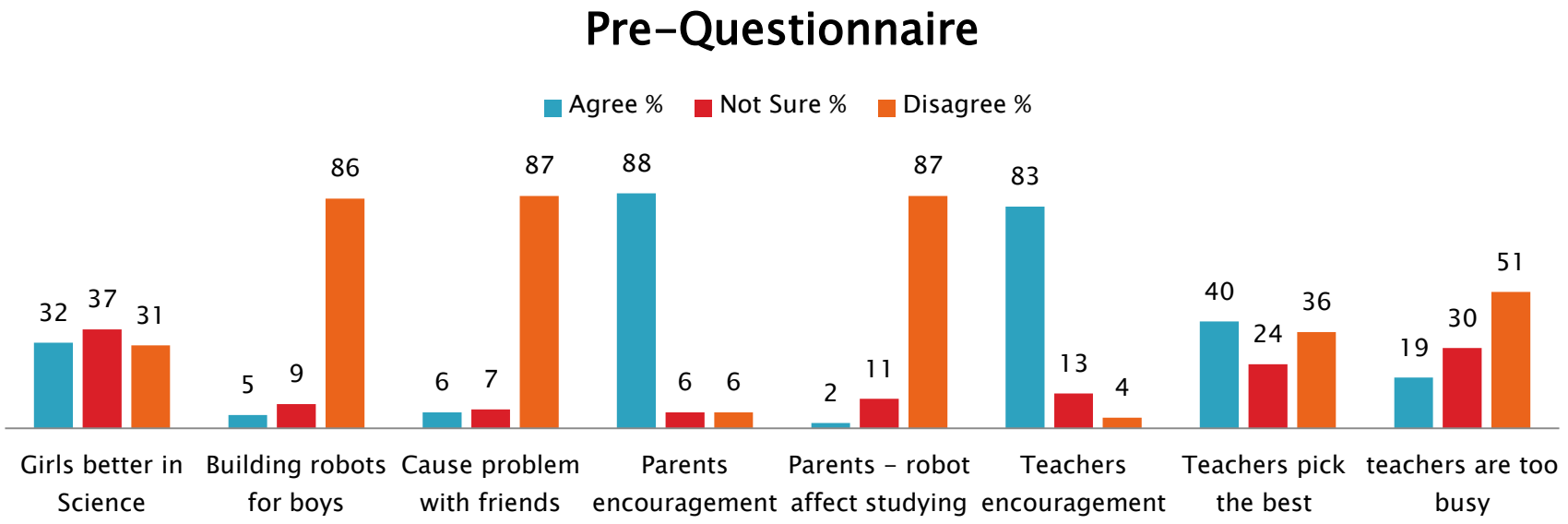


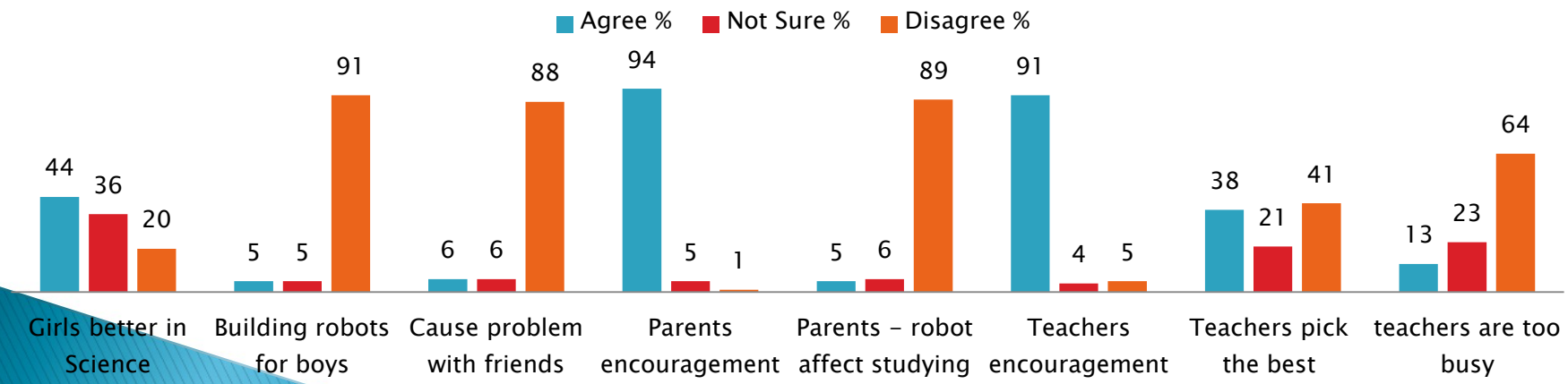
Post-Questionnaire



S12: We did not need to use gears. We can do several missions with this handle. So why should I use gears, it is hard to take them off. We need to figure out which one [gear] should be attached with the motor …

Environmental Factors





Discussion

Discussion

- Q1- Learning robotics: The students demonstrated high and positive attitudes and motivation when they started their activities and this remained high at the end of the activities.
- Q2 - Learning STEM: The results showed the students' preference for hands-on activities over studying for the curricular classes.
- Q3 - Environmental factors: The results showed a positive impact from parents, teachers and peer. Nevertheless, two groups referred to the dissatisfaction of the other teachers when the students missed their curricular classes.

  Gender was not a factor as much as an indicator that the robotics activities may help in boosting the females' attitudes toward and motivation for science and robotics subjects

Thank you