

# The Mindstorm Effect: A Gender Analysis on the Influence of LEGO Mindstorms in Computer Science Education<sup>\*</sup>

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## ABSTRACT

In the UK, as elsewhere, the number of students choosing to study computer science is declining. This is especially true with female students. This paper explores the effectiveness of LEGO Mindstorms in a pedagogic context in education and its ability to attract female students to computer science. A mixed methods approach was used in this study, in which we looked at the FIRST LEGO League competition and how female students participate in these.

The results demonstrate that, while young people enjoy using Mindstorms, they do little to influence young people to consider computer science education. They can, however, be used effectively as an opportunity to engage young people in further computing skills and computational thinking. The lessons we learn from this research indicate that we need to use these tools as a foundation rather than as a solution to the problem for attracting more women into computing.

## 1. INTRODUCTION

Computer Science is an ever-growing field, however there is a noticeable lack of women choosing to study Computer Science or to enter the IT industry. There are many reasons that have been suggested for this. For instance it may be perceived to be too geeky or just for men. There have been various initiatives and tools proposed to help change the way that computing is perceived. One approach is through the use of LEGO Mindstorms. This has been used in several instances to change people's perception of computer science and ICT in attempts to show people that these fields can be fun and exciting. Mindstorms can help teach children and young adults the importance of teamwork and problem solv-

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ing and can encourage users to be creative and innovative in their design.

## 2. LITERATURE REVIEW

### 2.1 Women in Computing in the UK

There are many reasons why women choose not to study or work in the technology sector. This has been reported as a weakening in the country's economic position. The decline is apparent already at GCSE level (age 14-16), where there are ever fewer girls who choose to do a full course in ICT. The decline then continues right through to industry. Although there have been major national efforts to encourage females to study computing, the numbers remain low.

### 2.2 Status of CSE in the UK

Part of the above problem lies in the ICT national curriculum, and to this end in January 2012 it was announced that the ICT curriculum was to be dropped in September of the same year, and instead Computer Science would eventually be taught [2]. This has been supported by several industry experts and it is hoped that the new curriculum will give schools the freedom to create their own ICT and Computer Science curricula. Companies such as Google and Microsoft are currently working together and with technology education organisations, such as the British Computer Society (BCS), to produce free educational material for schools. In order to encourage young people to study computing, tools such as Mindstorms are being used in various initiatives to enthuse young people about technology and creativity.

### 2.3 The use of LEGO Mindstorms in schools

Mindstorms kits are used in schools to provide an exciting way for children and young adults to learn about technology. They teach students various skills including teamwork and programming and can potentially change the way ICT is viewed. The teaching of ICT is often given as a reason for females being disinterested in pursuing ICT or computing in further education [3] because many females find it boring [6]. FIRST LEGO League (FLL) is a worldwide competition in which teams of 11-16 year olds design and program autonomous robots to complete tasks. With over 19,000 teams in over 55 countries, FLL is constantly expanding. This type of initiative gives something like Mindstorms a purpose: pupils have something to aim for.

In this study we looked at Mindstorms and whether it can attract females to the field of computing. From previous related studies, it is known that girls are willing to

engage in robotic activities [4]; one can no longer assume that robots are only for males. However, existing studies of the effectiveness of Mindstorms in education (eg, [1, 5]) tend to concentrate on university students.

### 3. METHODOLOGY

A questionnaire was given to students who were taking part in a local version of the FLL; 93 questionnaires were returned. The questionnaire had four categories: Demographics, LEGO Mindstorms, Career Choices and Educational Choices. These were devised in order to gather data about: how long the students had been using Mindstorms; if the students felt they had learnt any new skills by using them; and if this usage had influenced their education and career choices. These questions were asked in order to understand if and how Mindstorms can change a young person's perception of Computer Science and technology. Qualitative and quantitative data methods were used to collect data and there were a range of both open and closed questions. The data sample consisted of 32 females and 61 males and the students were aged between 9 and 14 years old.

### 4. RESULTS

Males typically used Mindstorms from a younger age than Females, though our sample is not representative of the UK population and this should be kept in mind. This study does not attempt to make population estimates; Tnor does it document or assume that every participant of the FLL in the UK will have the same experience or learning outcomes. However, we assume that the trends are an indicator of the effect of Mindstorms in education. It is recognised that this sample is limited and a wider range of participants would have been needed for a more in depth study.

#### 4.1 Interest in Computers

The aim of these questions was to gauge how interested pupils were in using LEGO Mindstorms. 81% of males and 85% of females indicated that Mindstorms made them more interested in computers. The results of this section indicate that Mindstorms is popular amongst this cohort and increases the interest in computers for both male and female pupils. Using computers for something other than gaming was a common reason for this that came up on the surveys, as well as engendering quick thinking and creativity. All participants indicated that they wanted to continue to use Mindstorms during the next academic year.

#### 4.2 Careers

The aim of these questions was to understand if LEGO Mindstorms would encourage pupils to consider a career in computing. The results are interesting: even though the participants indicated that they really enjoyed using Mindstorms, their aspirations with regards to computing careers suggested the opposite. 44% of males and only 14% of females indicated that using LEGO Mindstorms made them interested in having a computing job. This suggests that Mindstorms can make male participants more interested in a computing career in some cases, but is not always successful in influencing people's career choices. Male participants gave specific reasons stating that they enjoyed programming, whereas female participants gave reasons that were vague (such as finding it "interesting"). This data suggests that

although both males and females enjoy using Mindstorms and are more interested in technology after using the kits, it does not necessarily mean that Mindstorms can make someone more interested in pursuing a technical career.

### 4.3 Skills

The data we collected suggests that Mindstorms can teach people new skills. The students felt that they had learnt how to work as part of a team, how to communicate effectively with people, and problem solving skills. Additionally, both genders said they had learnt "new skills on the computer", "how to handle problems", and "how to be more creative". However, 85% of females thought they had learnt new skills compared to 66% of males. This data could suggest that females have a more positive experience with Mindstorms than males, and feel that it is more rewarding.

### 4.4 Educational Choices

Almost half of the males said that they were more interested in taking GCSEs in the STEM (Science, Technology, Engineering and Mathematics) subjects after using Mindstorms. Half of the female participants said that Mindstorms had influenced which GCSEs to study and said that they were now going to study ICT, Design Technology, and Further Maths. This data suggests that Mindstorms can influence young adults' educational choices in some cases. This also suggests that Mindstorms made them more aware of the STEM subjects and made the subjects seem more appealing and interesting.

### 5. CONCLUSIONS

LEGO Mindstorms can be used successfully in education; young people learn new skills and are keen to continue with it to widen their knowledge of programming and technology. Some females consider programming to be the best part of using Mindstorms and taking part in the FLL. Although it does not seem to make young people more aware of Computer Science careers, it does enhance their interest in computers and their uses.

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