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# Teaching HCI Through Magic

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**Abstract**

We discuss our use of magic to enthuse students about HCI and teach core concepts. We describe the format we trialed with student groups with a wide range of background from whole year groups to groups of gifted students. We conducted post-event surveys with students for two events and obtained teacher feedback from five others. We discuss the results of that data, showing that magic can be effective method for teaching HCI. The same tricks have since been used as part of an Interactive Systems Design MSc course.

**Author Keywords**

human computer interaction; magic; teaching; secondary school students; public engagement

**Introduction**

Since 2006 we have used magic tricks and shows as part of a 'serious fun' approach to teaching computer science concepts, including algorithms, the software engineering process, formal methods, binary numbers, data structures, networks, artificial intelligence, business and legal issues. More recently, we have focused on HCI, developing a magic show linked to our CHI+MED research project ([www.chi+med.ac.uk](http://www.chi+med.ac.uk)) on the HCI of safer medical devices. Underlying this 'serious fun' approach is the pedagogical philosophy that using interactive 'fun' activities is one way to teach difficult content, and to enthuse and engage students.

We perform the magic show at schools and universities around the UK; have trained undergraduates, PhD students and Postdocs to be confident to tour the UK with us performing magic tricks as part of high-profile science festivals (e.g., The Royal Society Summer Science Exhibition, Manchester Science Festival, and Brighton Science Festival); have a section of the cs4fn website dedicated to magic and its links to computer science ([www.cs4fn.org/magic](http://www.cs4fn.org/magic)); and produced two professional quality, full-colour, glossy books "The Magic of Computer Science" and "The Magic of Computer Science II: Now We Have Your Attention". The latter focuses on interaction design and specifically our research on human error. We freely distribute these to students and teachers. They include how to do the tricks and the science principles specific to each trick.

The show's length can be modified to last between one and three hours. We perform the tricks with the expected flair of 'real' magicians, challenge participants to work out how they are done, and ask them to speculate about the computer science behind them. We use this strategy of posing questions to the participants as a way of encouraging their reflective thinking. We then show them the secret and explain the science.

In this paper we focus on these magic shows and the evaluation of their effectiveness for teaching and enthusing secondary school students from a variety of backgrounds, including gifted and talented students and whole year groups. In particular, here we focus specifically on how HCI can be taught through magic.

### **HCI and Magic**

There is a deep connect between magic and HCI: the mechanics and presentation of magic tricks mirror

issues of algorithms and interfaces. In a magic trick presentation is critical. The same trick can fall flat in one presentation and have a serious 'OMG Factor' the next time. We use this parallel to introduce the importance of taking human factors into account in software development. Just as software can fail to be used because of poor interface design, a technically brilliant magician might fail due to poor showmanship.

An early HCI-linked trick we used was based on magic squares. Players take turns to choose the numbers one through nine. The aim of the game is to be the first player to hold three numbers that total to 15 (a variety of numbers and totals can be used to make the necessary mental calculations more impressive). The magician challenges someone to a game, and both are given clipboards to do calculations. The magician is not only lightening fast in making moves but wins. The secret is that the magician writes the numbers out as a magic square, essentially playing Noughts and Crosses/Tic-Tac-Toe. We use this to illustrate how the presentation of information affects how easy it is to complete a task: humans are much better at processing visual patterns, such as a Noughts and Crosses board, than other mental tasks, like calculation or language processing. This illustrates one aspect of why GUIs can be easier to use: they rely on visual recognition.

More complex links to HCI also arise when we consider the importance of understanding how human attention works. The dynamics of human attention are crucial to the success of magicians' misdirection. Similarly, just because a designer has presented information on the interface of a medical device, say, it does not necessarily follow that a nurse will see the information.

Magicians' misdirection depends on the failure of their audience to see. The systems used in magic are designed to ensure that the audience fails to notice things that are there to be seen. For example, we use a trick called 'The Four Aces' where aces move location in plain sight. In contrast, the usability engineer aims to do the reverse: to design the system so that user attention is directed to critical elements when needed. In a different trick we 'show' that a volunteer is 'psychic' when they match two cards from 10 without seeing any of them. After the applause we reveal that they are even more remarkable as they paired *all* cards. We use this extra reveal to discuss user experience and show how delight can be engineered into a system.

### **Evaluation of Approach**

We have trialed variations of our show to a variety of groups from whole year groups to specialist classes. We describe here feedback from a gifted group aged 14-17 and to a computer science session for 13-14 year olds who signed up for a series of weekend classes on a Mathematics enrichment programme. We also obtained feedback from teachers from five additional HCI-focused shows to wide-ranging groups with an average audience of 100 students each. Feedback from students and teachers was excellent.

#### *Gifted and Talented Students*

The main show to gifted and talented students was three hours long and consisted of 14 tricks/illusions covering HCI related issues as well as other computer science topics (e.g., algorithms, testing, formal verification, error correcting codes, head-up displays, computer vision, and medical tomography). The students had signed up for the event voluntarily

following a national advertising campaign by the UK's gifted and talented student organization.

We collected formal feedback via a post-event survey that the students completed at the end of the session. There were 43 participants (20 female and 23 male). They were aged 14-17 (14 years: 35%; 15 years: 43%; 16 years: 17%; and 17 years: 5%). This was the first outreach event that 60% of participants had attended, 33% had attended a few events previously, and 5% had attended more than five other events.

There was overwhelming support for the statement that the session *had increased their interest in the subject*; 38% strongly agreed with the statement and an additional 51% agreed. Only one student (2%) disagreed. Similarly, 47% strongly agreed that the course had *improved their understanding of the subject*, and an additional 47% agreed with the statement. Again, only one student responded negatively. All but one student (98%) stated that they would *recommend the course to others*; the other student did not answer the question. The student who disagreed that the course had raised their interest in the subject and further disagreed that it had improved their understanding, would still recommend it to others.

#### *Weekend Mathematics Students*

We performed a two-hour show one weekend to 40 students (18 female; 22 male) who were enrolled on a Mathematics enrichment programme. Our feedback mechanisms were slightly different here. We used open-ended questions on our survey to capture qualitative sentiments from the students. A wide range of trick segments was referenced when students detailed *the best part* of the programme. We take this

as evidence that the wide variety of tricks performed was a good approach for enthusing students.

We asked students *what we should change* as a way to improve our show. Most students, 70%, stated that nothing should change; 12.5% wanted more tricks. The other responses were from one student each: to make the show longer, more jokes/comedy, and to make use of more members of the audience.

We also asked students "what *did you learn*". Almost half, 47.5%, indicated that they had learned something computer science or mathematics related (e.g., how computer programs work and links between magic and computer science), A further 7.5% gave the general answer that they had learned "a lot". 20% indicated that they learned "nothing" or left their answer blank.

#### *General HCI-focused shows*

We performed five further shows with a main focus on HCI where the teacher who invited us gave post-event feedback via a feedback form. The students, more than 500 in total, were aged 11 to 18, 40% were at mixed gender schools, 40% female only and 20% male only. All five teachers rated the shows "very good" on a five-point scale with 'very good' the highest rating. All agreed that "the lecture improved the understanding of the students of the subject" and that "as a result of the lecture one or more students is now more likely to consider taking computing subjects further at school". All five teachers said that the magic show met their needs and would recommend it to other teachers.

## **Discussion**

Magic provides an excellent way to engage students with HCI topics. In particular tying concepts to the mechanics and presentation of tricks can be used to get the attention of a wide range of students, of various ages, and of a range of abilities. Whilst our shows were developed to enthuse school students, we have since incorporated the HCI tricks into an MSc course on Interactive Systems Design; for example, using misdirection to illustrate how systematic human error can be designed into or out of a system.

We have outlined how we perform these tricks. Our initial evaluation has shown that the format of a) presenting a trick; b) challenging the audience to work out how it was done and the computer science linked to the trick; and c) ending with our explaining the trick and describing the linked computer science, works well to enthuse – at least in the short term – students who are either gifted and talented or motivated but also general audiences. Further studies are needed, including an examination of the effectiveness of magic to enthuse students who are unmotivated or disinterested as well as an examination to evaluate if immediate enthusiasm with the experience of the magic show translates into deep understanding and ongoing interest in HCI.

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