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# A perspective on Exposure and Boundary Work from the use of Magic in Education

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A perspective on Exposure and Boundary Work is given from the point of view of an educator using Magic to create curiosity and enhance learning through wonder as well as a device to provide a counterpoint when teaching the scientific method.

KEYWORDS: Magic, Wonder, Exposure, Scientific Method, Curiosity, Education, S.T.E.A.M.

## A PERSPECTIVE ON EXPOSURE AND BOUNDARY WORK FROM THE USE OF MAGIC IN EDUCATION

First of all, I want to thank the authors for the excellent article that really reframed my thinking about exposure in many points and triggers, which I hope will lead to important work. I work as a professor of Electrical Engineering at a small university in Germany. Among other things, I teach the scientific method to engineering students and also host STEM (now STEAM) workshops for high school students in grades 9 to 11 to encourage them to pursue an engineering career. I use Magic as a method of teaching support in two ways. Firstly, I use it to create moments of astonishment to nourish a sense of wonder and curiosity that helps the students to engage with the topic and improves retention (for some background see (Cruz, 2024) for the general effect of "wonder", (Gruber, Gelman, & Ranganath, 2014) for mechanisms which lead to better learning through curiosity and for example (Tyler & Likova, 2012) and the keynote at the Learning at City Conference 2021 by Gustav Kuhn (Kuhn, 2021)).

Secondly, I use specific magic tricks to provide a fictitious reality for students to examine when teaching scientific work. In both cases, the question of exposure and the movement of the boundary arises.

In the first instance the matter arises from the need to provide a teaching format that can be deployed by me an in addition by one or more teaching assistants in case of large groups of students. Therefore, the magic methods must be taught to the assistants, and they must be "sworn to secrecy." This is a case sitting between teaching of non-magicians that want to know how it is done and teaching non-magicians that need to help with the performance. They are paid for helping, but they not only help, but they also perform the tricks themselves. So far, I mostly perform myself and instruct assistants in some cases, and I do consider this a case of teaching interested magicians. Of course I use only methods that are available publicly. This has been covered well in the paper.

The second instance is more complicated, and I will explain one example for the sake of the discussion). I use a trick called Switchboard (Available here: (Andersen, 2020)) where circuit board is shown with 4 switches with different coloured sleeves are clearly connected to 4 lamps with likewise coloured bulbs. Flipping each switch will turn on the lamp connected to it via the circuit board. I let the students explore the board, form a hypothesis about how it works, conduct experiments, and conclude their findings. I then discuss how this will never prove their hypothesis but only make it plausible. Standard introduction to scientific work on an interesting example (I think). Depending on the group I will discuss the different views of Popper and Bayesians ( (Chivers, 2024) page 107). Then to prove my point I declare that the circuitry has nothing to do with the switching of lights that the link is all in the colour of sleeves and bulbs and I demonstrate by reordering the sleeves on the switches and now each switch does not turn on the lamp connected to it on the circuit board, but the one with the same colour. This process of demonstrating an illusory reality, deriving a hypothesis, letting the students play with them and experiment and then changing to a new one is repeated a few times using the secret methods. The takeaway for the students is very strong, as they clearly experience that even a simple switching board is too complicated to just guess a hypothesis of operation and that nothing can be proven. I did not do a proper study on it yet (though I have now acquired public funds to do so from 2025 and am starting here) but feedback even after 2 years makes it clear that they remember.

Now for the exposure part. I have tried several ways to end the session, and I have found the following: If I leave the trick unexplained, the students tend to believe that I did something that was outside the system as the perceived it, some magic thingy. So far no one guessed the right solution, as they did not look at a technical solution, but at me. My issue with that is, that this takes away from the learning that systems are usually much more complex than we give them credit for and that this needs to be considered in scientific work.

When I allude to the fact that there is a technical solution implicit in the device is involved, the students start to appreciate the nature of the problem that they face and build a better bridge to the difficulty of creating good hypothesis even for simple questions. That also fits better my role as a scientist doing magic, rather than a magician attempting to explain science. I am perceived there as a scientist and need to stay close to that role, but a bit misaligned with their expectation for best impact (see my chapter in the Magiculum II (Pfeil, 2020)). It is important to note that the device is so obviously simple that a very complex solution (like an app) is not considered.

I will not tell them the method, yet doing some border work (thanks to the publication for that concept, which I did not know that it has been described so) to shift their perception to does help me to achieve the impact with the magic that I want. It is astonishing for them, even after I allude to where the method could hide, as they still cannot see it, but they realize how little they understand of what they have in front of them.

This is similar for other effects I use, and I for myself came to the following point of view (and I want to thank the authors of the commented paper for widening that view!): I will not expose methods to my students, as they hold up the mystery. But, as spectators are not stupid and they implicitly know that there must be a method, hinting in a direction suitable to the desired perception of the magic is not only possible but also at times desirable. This can be in a faux method approach or in the real direction. I believe that giving the audience a general knowledge (as in the example of the marked cards) of a method is not damaging, as they will not directly link it to anything they see right now, and it does not tell them how to apply it to a new effect.

So, for me an important direction into which to take research on exposure is the element of border work and how this can lead the perception of magic in the effect as well as in general. Again, I thank the authors for opening the field.

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