Building LEGO® Models To Teach Three Dimensional, Mechanical Concepts In Optometry

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Abstract:
This reflection piece describes a LEGO® kit building exercise, carried out in a flat lecture theatre with 80 to 90 second year Optometry students at the University of Manchester. The aim of the activity was to give students hands-on experience of the moving parts of a complex ophthalmic instrument (the slit lamp bio-microscope) prior to smaller scale lab-based practical sessions. The outcome of the exercise was prescribed and building instructions were provided, hence this was not an example of LEGO® SERIOUS PLAY®. Instead, the learning came from the act of building and team co-operation. The activity also provided students with the opportunity to manipulate their moving model once complete, allowing delivery of more complex theories later in the lecture.

The logistical aspects of delivering the session are reflected upon and the results of a basic evaluation exercise are described. Feedback was generally positive in terms of understanding compared to the intended learning outcomes and student enjoyment. These tactile, interactive learning activities could readily be utilised in teaching other aspects of health sciences.

Keywords: LEGO®, Teaching, University, Mechanics, Optometry, Lecture

Received: 1 Nov 2018
Revised: 27 Nov 2018
Accepted: 10 Dec 2018

ISSN 2056-757X

https://doi.org/10.18646/2056.54.18-018

1. Introduction

Much of the recent literature on the use of LEGO® in higher education focuses on SERIOUS PLAY®. In fact I was inspired to use LEGO® for teaching as a result of attending a creative 'SERIOUS PLAY' type session at an education conference. However, in this reflective piece I will outline how I have used LEGO® in a markedly different way: to overcome issues around teaching three dimensional concepts and simple mechanics. I will describe how I delivered session in which 80 to 90 undergraduate Optometry students constructed a moving LEGO® model of a slit lamp bio-microscope (a common piece of ophthalmic equipment), see Figures 1 and 2. The aim was to combine theoretical and practical learning in the lecture setting prior to smaller 'lab' sessions where students receive hands on training on how to use the instrument. I will reflect on the rationale for introducing the activity, the delivery of the session and the impact of the exercise on my students, using a 'what, so what, now what?' approach similar to that outlined by Driscoll and Teh (2001).

Figure 1: A Slit Lamp Biomicroscope (left)

Figure 2: A Moving LEGO® Model of A Slit Lamp Biomicroscope (right)

2. (What?) The Rationale

The use of interactive activities has long been recognised as a way of promoting student engagement in higher education and an effective practice case study involving LEGO® and mechanics was included in the final report of the 'What Works? Student Retention & Success Programme' (Thomas 2010). However, I wanted to use LEGO® not just as a way of capturing students' attention but also as a way of solving a genuine issue I had meeting a particularly difficult intended learning outcome (ILO).

The problem was one of chicken and egg. How could I usefully fill a two-hour initial lab slot, with student/ supervisor ratios of around 6 to 1, if I had not lectured on the theory of the techniques they would be learning? And conversely, how could I lecture to the whole cohort on how to use an instrument before they had even touched one?

Having taught as a supervisor in the labs before becoming unit co-ordinator I was aware of the amount of invaluable hands-on time wasted in the 'labs-first'-approach. Here, students looked on as supervisors demonstrated the controls and mechanics with a slit lamp at the front of the class. In my first year as unit co-ordinator I moved to a 'lecture-first' approach with an exercise allowing the students to 'explore' the instrument in pairs at the start of the practical. Unfortunately, putting the theory first led to a lot of lost looks on faces. My lecture's key ILO was for students to understand that both the microscope and the lamp (on the instrument) are linked by a common pivot, allowing both to focus at exactly the same point, regardless of the direction they are pointed from. It became clear to me that a written or spoken description such as this, even when accompanied by animations and short videos, was not adequately conveying the message when after the lecture one of the students came and asked me "What exactly is a pivot?"

I needed the students to be able to see the instrument's components in three dimensions and to handle the moving parts for the lecture to make sense. Bringing the large, expensive table-top mounted slit lamps to the lectures was not an option but building small scale moving replicas out of LEGO® was. This appealed to me on a number of levels, not least my longstanding love of LEGO®. As a trained primary school teacher, I was aware that getting students to build a specific, prescribed model did not constitute construc*tiv*ist teaching as described by Piaget (Ackermann 2001). Nevertheless it would not be without pedagogic value and could perhaps be described as construc*tion*ist. As Papert and Harel (1991, p. 2) state "constructionism boils down to demanding that everything be understood by being constructed".

3. (What?) The Activity

2018 was my second year delivering this activity. Essentially, it was presented as a team game, where the 80 to 90 students were split into groups of around four or five and competed to build their LEGO® slit lamp in the fastest time. A flat lecture theatre was used to facilitate group working. Table 1 summarises the changes implemented in 2018 after reflecting on the first attempt at delivering the exercise in 2017, giving a justification for each.

Table 1: The evolving use of LEGO® in Optometry lectures

	Delivered in 2017	Change for 2018	Reason for change
Pre-activity	10 LEGO® kits	Increase in number of LEGO® kits to 20	Groups sizes of 8 to 10 students considered too large for all students to participate fully
	Colour coded instruction sheets	Non- colour coded instruction sheets	Each kit is made up of parts with different colours due to the difficulty of sourcing standardised pieces. With 20 kits in 2018, making individualised instructions for each kit seemed prohibitively time consuming.

	Separation of kit pieces into 3 bag, each containing a 'component'	All kit pieces in one bag	Smaller group sizes reduced the necessity for us to split the components into bags as there would be less need for teams within teams.
Content Delivery	Activity stopped when the first group had won the 'race' to construct their slit lamp	Continue activity till all groups had constructed their slit lamps	The idea was to have a working model accessible to each student during the lecture. Time concerns led me to move on from the activity prematurely in 2017
Staffing	2 members of staff present (1 lecturer and 1 technician)	4 members of staff present (2 lecturers and 2 technicians)	This was actually more down to staff volunteering because they had heard the session was coming up and wanted to attend for the activity
Post-activity	No feedback gathered other than conventional unit survey carried out several weeks after the activity	Feedback gathered using a 'fairground' style 'throw-the feedback-in-a-bucket' game	The overall unit feedback from 2017 mentioned LEGO® amongst a number of other interactive activities I employ throughout the semester. I wanted feedback specific to this activity

Once the activity was complete, each group had a moving model slit lamp complete with a rotating pivot. The action of the slit lamp was then demonstrated using my teacher's kit, via table-mounted CCTV linked to the projector screen.

4. (So what?) My Perceptions of the Activity

As always before running an interactive session with over 80 students, I felt a great deal of trepidation before the lecture. I always try and tell myself that if things go spectacularly wrong the students are still likely to prefer it to a conventional lecture and it may even make the content *more* memorable.

I felt more relaxed about the timings than I had in 2017 as I knew what to expect and I knew that it was possible to complete the kits in around 10 minutes. I also felt more aware of the issues students would raise, for example claiming that they were "missing pieces", when in fact they had used them in the wrong place. In addition, I knew I had more staff on hand to help the groups.

During the activity I was surprised at how hard it was to get round all of the teams as they got stuck. Although I had more staff, there were also more groups. I hadn't anticipated how much the lack of colour coding on the instructions would impact the difficulty of the task. I was also spending time trying to encourage one or two students who seemed to have disengaged from the task, possibly due to team dynamics or due to the fact that the LEGO® did not enthuse them in the way it did the other students.

My biggest disappointment was that not all of the groups completed the build. Staff actively encouraged the groups finishing first (at around 12 minutes) to move round and support those still working but on the whole they were more interested in celebrating their success and playfully taunting those who had not completed. While the atmosphere remained positive and light-hearted, I realised that if we continued until all the kits were built it would become increasingly hard to manage those with nothing left to do.

Bringing the cohort back together to recommence the lecture was easier than anticipated though there were a few complaints from those still working. I felt particularly sorry for these groups as I knew they would not have a completed model to work with as I moved onto the theory. On reflection I do not think this was a huge issue as I think most of the groups had at the very least constructed a working base and pivot.

5. (So what?) Student's Perception of the Activity

My evaluation of the session was fairly rudimentary. I asked two 'Yes/No' questions and an open question. Ninety-two percent of respondents said they found building the LEGO® slit lamp helped them understand how the instrument worked. Ninety-seven percent of respondents said they "found it fun". Responses to the open question "What did you learn from the exercise?" generally matched my ILO, for example:

- *The idea of a common pivot was more understandable*
- *Helped me gain a more physical representation of the drawings and see the 3 main parts of the slit lamp*
- *That the parts are separately rotatable. Rotatable + joystick movement & how they're different*
- *I learnt the parts that make the instrument- pivot, lamp and observation system. Also a group exercise is very engaging*

The only negative comment was from a student who said they did not learn about the workings of the slit lamp because they did not finish building it in time.

The response rate was good, with 65 out of eighty to ninety students providing feedback. I attribute this to the 'fair-ground' style game used to collect the forms. Students were asked to make a paper aeroplane from their sheets and to try to throw them into a bucket placed around 3m away. Prizes (chocolate eyeballs) were given to the successful students. This took around 3 to 4 minutes at the end of the lecture. More time consuming was the job of unfolding and flattening the forms out in order to process the data later that day.

6. (So What?) Reflection on the Feedback

On reflection the feedback questions asked could have been less 'leading'. I should perhaps have asked an open question about the lecture as a whole, to see if the LEGO® activity was identified by the students as key to their understanding. In an ideal world, I would have carried out a simple assessment before and after introducing the LEGO® exercise to gauge the difference in student performance. This could have been incorporated into the first lab session (rather than after the lecture) as this is where I would have hoped to see any improvement.

Without this kind of formal evaluation the session's impact on student performance is hard to gauge, other than to say there is a feeling that supervisors had to field fewer questions about slit lamp fundamentals in the early practicals.

7. (Now What?) Future Actions

In terms of the activity itself, I think it is important that all students complete the task. In order to give the slower groups sufficient time I will need to manage the students who have finished more effectively. Providing colour-coded instructions and blocks separated into bag for each component may speed things up and reduce the gap between the fastest and the slowest groups. This should be easy to achieve for next year.

In terms of wider actions, I intend to carry out more rigorous evaluation next year with a view to disseminating the results across my division, school and faculty. There are numerous examples of difficult three-dimensional, mechanical concepts in Optometry and I imagine many more in health sciences as a whole. For example LEGO® has been used to teach cardiovascular mechanics in high schools in the US (Hobbs et al 2006). I could envisage similar applications across the University of Manchester's Faculty of Medicine, Biology and Health.

Acknowledgements:

I would like to thank my technician Stephen Craig for his help designing and sourcing the LEGO® kits.

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