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Creating a Low Threshold High Ceiling Classroom

Age 5 to 18
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Published 2017 Revised 2019

In our article Low Threshold High Ceiling - an Introduction /10345 , we outline what we mean by 'low threshold high ceiling' and why we like low threshold high ceiling tasks. In this article, we build on those ideas to discuss the key features of a low threshold high ceiling classroom.

A low threshold high ceiling (LTHC) task offers the opportunity for everyone to get started and everyone to get stuck. However, in reality, the task alone is not enough. An LTHC classroom is one in which the teacher has an LTHC approach, which implies a certain pedagogy as well as the use of LTHC tasks. An LTHC approach is grounded in a growth mindset philosophy (Dweck, 2007): everyone can do well in mathematics, regardless of their prior attainment, and making mistakes, struggling and persevering are all important. In addition, fundamental to the approach is a belief that mathematics is an 'open, growing subject, (as opposed to a closed, fixed subject); and that communicating, reasoning about, and justifying ideas are central acts in the work of mathematics' (Boaler, 2019).

Using an LTHC task in the classroom 'fits' nicely with a growth mindset belief. It allows everyone to demonstrate what they can do, without worrying about what they can't do. As everyone is given the same task, no-one's achievement is limited before even beginning. However, in a growth mindset classroom, there are also implications for the way the teacher facilitates mathematics learning and the mathematical behaviours that are valued.

What might an LTHC lesson look like?
To illustrate what an LTHC lesson might look like, let's imagine we are using the task Neighbourly Addition /housenumbers with a class. Before reading further, you might want to have a go at the task for yourself.

Having introduced the task, we would invite learners to find some other totals by adding together the house numbers of three (odd) next-door neighbours. After giving learners some thinking time, perhaps individually at first, and then time working with a partner, we could bring the class together to share initial ideas (a mini plenary). At this point, we might invite some learners to describe how they were going about choosing their three numbers and to share the totals they have found. Writing examples up on the board means that everyone's contribution is valued and a collective piece of mathematics is gradually built up. Having the same starting point allows the less confident to stay close to the original task and consolidate their understanding while the more confident have a chance to explore. In general, a mini plenary like this, after around ten minutes of initial exploration, gives an opportunity for others to comment on, or ask questions about, the different approaches and/or the findings so far, but it also provides potentially useful ways of progressing if needed.

We could then draw learners' attention to the different totals that have been found and ask, "Do you notice anything about them?". Again, we might write up their noticings on the board for everyone to see, trying not to validate their responses or to pass judgement. Learners could choose one of the noticings and talk with a partner about how they can explain, justify or prove it. While they are working, our role as teachers is to listen and observe as learners work, so we can offer prompts when required, ask probing questions

to assess and challenge, and encourage learners to ask, and pursue, their own questions. Here are some examples of the sort of questions and prompts we might use:

What is the relationship between two consecutive odd numbers?

How could you represent the three house numbers? Using multilink/squared paper/algebra?

Can you see anything in your examples that would work in exactly the same way if you used three different consecutive odd numbers?

What's the same and what's different when you add three consecutive even numbers rather than three consecutive odd numbers?

Although the above questions relate specifically to Neighbourly Addition /housenumbers , prompts that encourage learners to represent their thinking, using an image or concrete materials, for example, are generally very useful in many contexts. Asking what is the same and what is different can be the starting point for generalisations, and can help learners to develop conjectures and eventually proofs.

Going back to our Neighbourly Addition /housenumbers lesson, we could choose some learners who have different ways of explaining to feed back to the whole class. (Examples of possible representations that might emerge can be found in the teachers' resources https://nrich.maths.org/14222/note section of the task.) At this point, there's an opportunity to go beyond our own classrooms by sharing the students' solutions published https://nrich.maths.org/14222/solution on NRICH. Using NRICH solutions can be beneficial for many reasons - it is perhaps easier to critique a solution written by someone whom your learners do not know, and the published solutions might showcase a wider variety of approaches that otherwise would not emerge.

We can then ask learners to come up with their own mathematically interesting questions about the house numbers and to choose one to explore. Providing choice in this way gives learners more ownership of the mathematics and a greater sense of purpose. The closing plenary is a chance to facilitate the sharing of some learners' findings. As everyone has a sense of the task, everyone can appreciate what others have worked on even though it could be quite different from what you have done. It can be hard for us as teachers to say very little and invite members of the class to offer their thoughts and suggestions, rather than the comments coming from us. If we value learners' multiple approaches and different ways of thinking about a task, their sense of themselves as mathematicians will grow. It is important to focus on developing the mathematician as well as developing the mathematics. Facilitating discussion to share these differences (and commonalities) also helps to demonstrate the value of collaboration and to deepen learners' appreciation of the mathematical community as a whole.

The teachers' resources section of NRICH tasks always offers extension ideas, which push the ceiling even higher, by suggesting a further line of enquiry or sometimes a follow-up task. In this case, you could offer the task Summing Consecutive Numbers /507 , which focuses on consecutive numbers rather than consecutive even and odd numbers. A challenging further extension could be to explore the numbers that it is not possible to make by adding together neighbouring house numbers.

What next?

We have outlined in detail what a lesson for Neighbourly Addition /housenumbers might look like if you use an LTHC approach. Why not try out some of these other LTHC tasks (don't forget to read the Teachers' Resources section) and have a go at creating your own LTHC classroom?

Poly Plug Rectangles /7511
Totality /1216
The Remainders Game /6402
Odds, Evens and More Evens /7529
Hollow Squares /11257

References

Boaler, J. Our Teaching Approach https://www.youcubed.org/evidence/our-teaching-approach/ accessed 24 Sep 2019

Dweck, C. (2007) 'Boosting Achievement with Messages that Motivate /content/id/14404/boosting_achievement_dweck.pdf ' Education Canada 47 (2) 6-10