

Teacher's Guide to UnLocke

Contents

Contents	1
Registration information	1
Overview: What is the UnLocke project?.....	2
The science behind UnLocke	3
UnLocke Sessions: A break-down	5
Running UnLocke sessions	10
Teacher FAQs	13
Troubleshooting	14
References	15
Contact us	15

Registration information

School ID: _____

Class ID: _____

Email (username): _____

Password: _____

Teacher Web-Dashboard can be accessed at: unlocke.me



Overview: What is the UnLocke project?

UnLocke: Understanding Learning of Counterintuitive Concepts through Knowledge Interference Control in Science and Mathematics Education

UnLocke is a research project taking place at the Centre for Educational Neuroscience, funded by the Education Endowment Foundation and the Wellcome Trust. UnLocke has been developed by neuroscience and educational experts to help children think carefully when tackling difficult concepts in maths and science.

When learning new concepts, we often need to suppress our impulsive or intuitive response. Using a computer-based learning activity '**Stop and Think**', pupils are encouraged to inhibit this impulsive response, i.e. to stop and think, before answering maths and science problems. The activity is set-up like a game show (Figure 1), in which a character named Andy acts as the host, posing maths and science questions to the pupils. Andy and three virtual game show contestants will guide pupils through the tasks, providing prompts and demonstrating ways to think about these tricky concepts.



Figure 1. UnLocke 'Stop and Think' game show environment

The science behind UnLocke

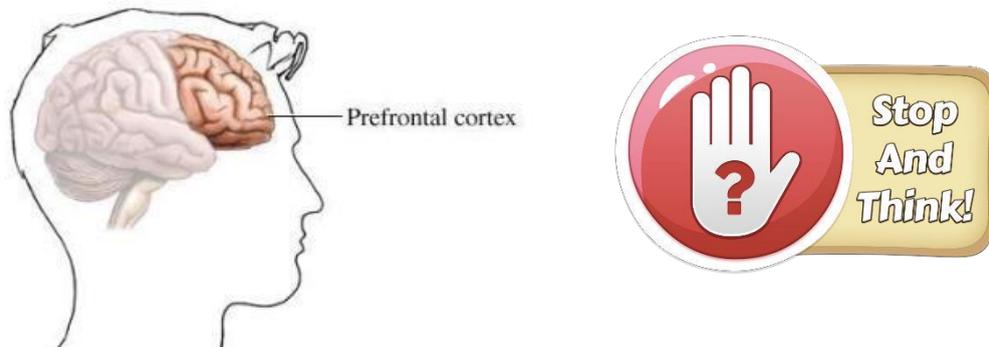
Counterintuitive concepts

There are many common misconceptions in maths and science. This is because some concepts can be counterintuitive (e.g. the Earth rotates around the Sun). The child's prior knowledge and beliefs, as well as irrelevant information or perceptual cues, can interfere with the learning of new concepts ^[1, 2]. For example, based on their experience of seeing the Sun change position in the sky, children may intuitively think that it is the Sun that rotates around the Earth.

UnLocke is a computer-based learning activity designed to help children overcome these misconceptions by encouraging pupils to inhibit their initial intuitive reaction in favour of a more delayed and reflective response, i.e. to **stop and think**.

Inhibitory control

Inhibition is one of the key cognitive control skills (or 'executive functions') necessary for learning and goal achievement, directed by the prefrontal cortex of the brain ^[3].



Two types of inhibitory control are particularly important when tackling counterintuitive concepts in maths and science:

1. **Cognitive inhibition** involves putting aside a previous belief or learnt fact, rule, or procedure, which does not apply to the current problem. For example, in maths children learn positive integer numbers in sequence, i.e. 1, 2, 3, 4, 5 etc. This is practiced until they are very quick to say that 5 is larger than 1. Later, children are taught about negative numbers. Children now need to inhibit their prior knowledge that 5 is greater than 1 in order to correctly identify -1 as greater than -5.
2. **Perceptual interference control** may also be needed to ignore distracting visual or audio cues that are irrelevant to the current task. For example, children become familiar with the appearance and habitat of fish (i.e. streamlined body with fins, swims in the sea). When presented with a dolphin, the child needs to inhibit these visual cues and instead think about the properties of fish and mammals (e.g. gills vs. lungs) to recognise that a dolphin is a mammal not a fish.

In the **Stop and Think** learning activities, children practice this 'stop and think' skill while tackling maths and science problems. Importantly, there is evidence to suggest that it is critical to train cognitive control *within* the specific domain of interest, in this case maths and science, in order to show benefits, which generalise beyond the training sessions into the classroom and learning more broadly ^[4].

Maths and science content

The tasks have been carefully developed in collaboration with education experts and primary school teachers to meet the content of the national curriculum for the pupil's age group. Pupils will engage in tasks from the current academic year and also those relating to topics from the previous academic year. I.e. Year 3 pupils will engage in tasks designed to support common misconceptions relating to topics covered in years 2 and 3 of the national curriculum, whilst Year 5 pupils will engage in topics covered in the Year 4 and 5 curriculum. This allows pupils to practice using the 'stop and think' skill with topics that they are familiar with before moving on to utilise this skill in their everyday learning of new concepts (especially if using the programme near the start of the academic year).

Some maths and science misconceptions may be present across year groups and even into adulthood. For example, the immediate response that a cow drinks milk or that a dolphin is a fish. Therefore, tasks relating to these misconceptions will be presented to both year 3 and year 5 pupils.

Important: You will likely find that pupils are familiar with some of the topics, while other concepts are new to them, depending on the time of year in which you teach the different topics. Please note that while each task has been designed in accordance with the national curriculum, the aim of this programme is to practice inhibitory control in the **context** of a maths or science lesson, rather than to teach new maths and science content. Therefore, the specific maths and science content of the programme is of less relevance than the learning of the '**stop and think**' skill. By practicing inhibitory control in this way, it is believed that children will transfer this skill to their learning outside of the UnLocke sessions and have a positive impact on their academic success.

UnLocke Sessions: A break-down

Session structure

The intervention session structure is set out in Figure 2. The programme has 30 sessions in total. These are to be run **three times every week** at the start of a **Maths or Science lesson**, for 10 weeks.

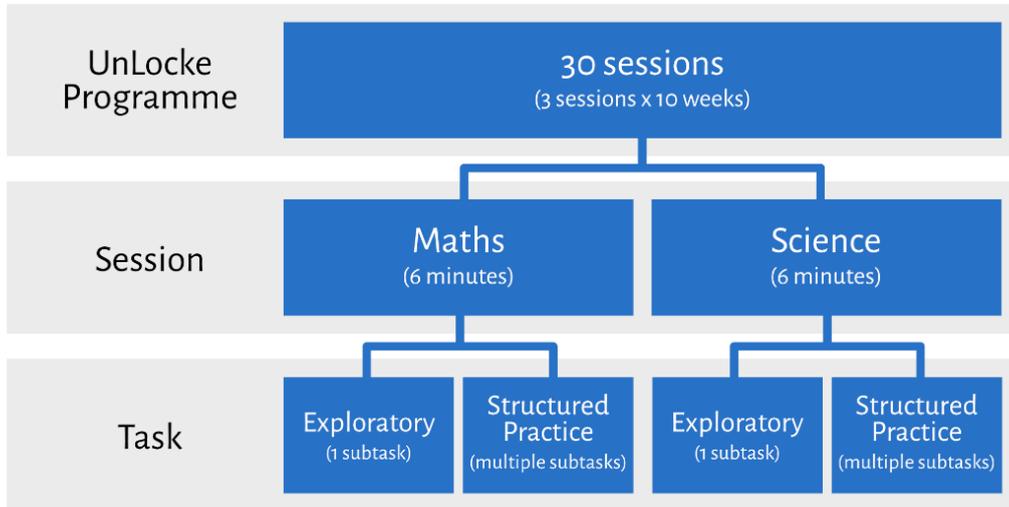


Figure 2. UnLocke session structure

Each session runs for approximately 12 minutes and each session is split equally between Maths and Science content. The order in which maths and science content are delivered within a session will be randomised, i.e. sometimes pupils will work through a maths task first followed by science and other times they will work through science first followed by maths.

Within each maths or science block, pupils will be presented with one Exploratory task followed by multiple Structured Practice subtasks. The number of subtasks completed in any session will depend on how quickly your classroom works through them. It does not matter how many tasks you get through in a session, we are more interested in the practice of inhibitory control during the session, than trying to cover all the maths and science content. After all subtasks for that session are complete, or 12 minutes have elapsed, the session will automatically end. You can then continue your lesson as usual.

Levels of support and progression

The computer-based learning activity is set-up like a game show, in which the host Andy poses questions to the pupils and three virtual game show contestants. These characters guide pupils through the maths and science tasks, providing prompts and demonstrating the correct way to think about these concepts. Andy and the game show contestants offer different levels of support dependent on pupils' response.

Each session starts with an **Exploratory** subtask. The Exploratory subtask allows multiple attempts to correctly complete the activity, with progressively greater levels of support offered each time an incorrect response is given. Once the correct response is entered, the game show moves on to a 'Bonus Round' comprising of Structured Practice subtasks. **Structured Practice** subtasks provide pupils with the opportunity to practice more questions on the same topic; consolidating their understanding of the maths or science concept that was introduced in the Exploratory phase and giving pupils more opportunities to practice the 'stop and think' skill.

Exploratory subtask

Within each subtask, Andy presents a question, asking pupils to either sort, order, or select images on the screen or enter a numerical response. Andy reminds pupils to 'stop and think' about their answer and the screen is briefly locked on a pulsing 'stop and think' logo. When the logo stops pulsing, the user can now interact with the screen in their first attempt at answering the question. The user then needs to click on the green 'check answer' button at the bottom of the screen. See figures 3 and 4 below for an example.

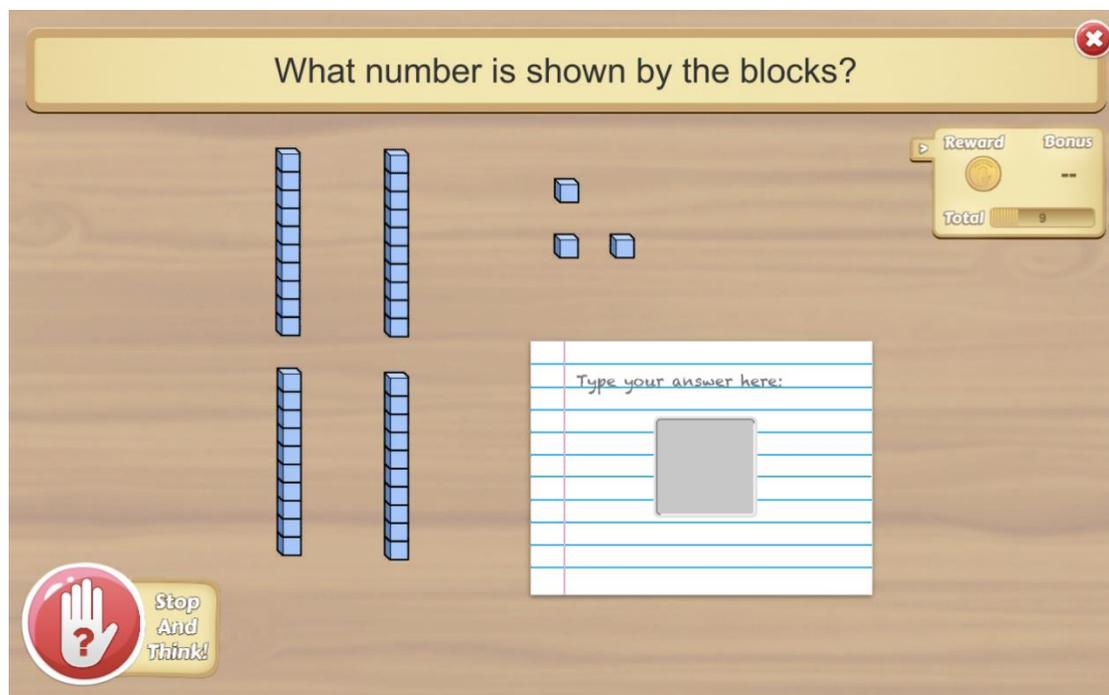


Figure 3. Example of Year 3 maths task: Stop and Think logo pulsating in the corner.

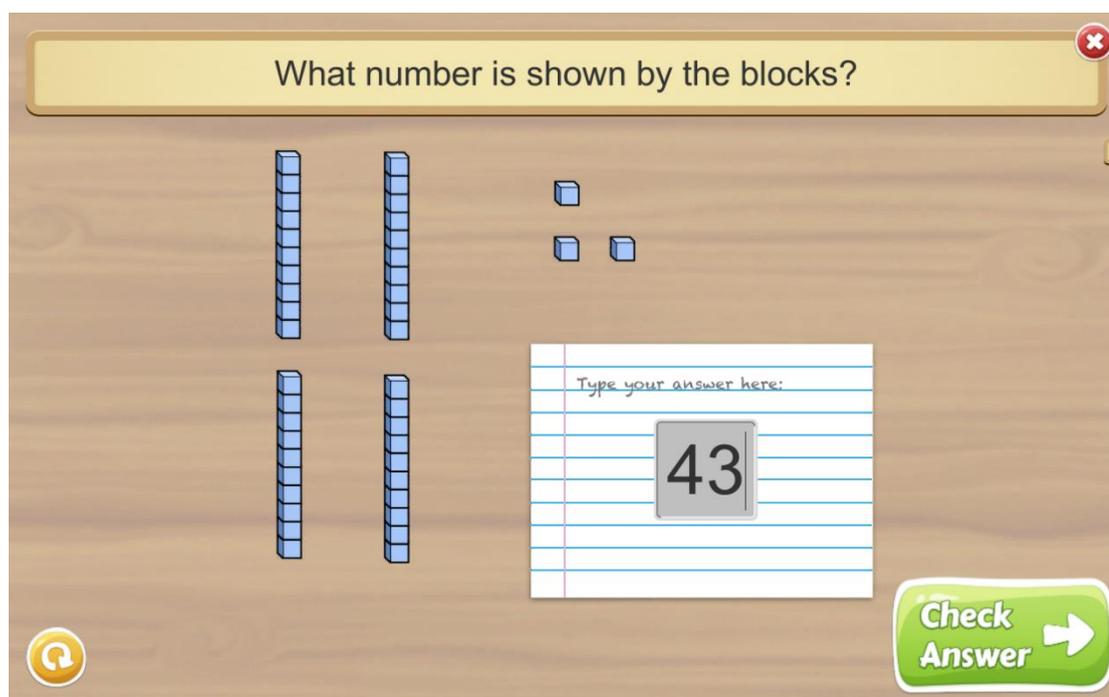


Figure 4. Example of Year 3 maths task: Pupil's typed response and 'check answer' button

Following a correct response on any Exploratory task, pupils are given feedback and then shown the three virtual contestants giving their own thoughts about the question (Figure 5). Pupils are asked to select which contestant has the correct reasoning. This is designed to consolidate the reasoning behind the correct answer, encouraging pupils to think things through rather than just going with their intuitive response. Following this, the game show moves on to the Bonus Round (or Structured Practice subtasks).



Figure 5. Contestants' reasoning

If the first attempt is incorrect, Andy asks pupils to have another go. If still incorrect upon a second try, pupils are guided through the following levels of support (see Figure 6):

Support A: Pupils are shown the virtual contestants giving their thoughts about the question. One contestant will have the correct reasoning, while the other two will have incorrect reasoning. This is designed to encourage pupils to think about the concept rather than just go with their impulsive response or to keep guessing. The pupil then has another attempt at the initial question.

Support B: If incorrect again, pupils are shown which contestant had the correct reasoning. The pupil now gets a final attempt at the initial question.

Support C: If incorrect again, Andy gives a verbal prompt. E.g. "Think about..." Or "Remember what you have learnt about...". The correct answer is then revealed, and the pupil is moved on to the Structured Practice subtasks (time-permitting).

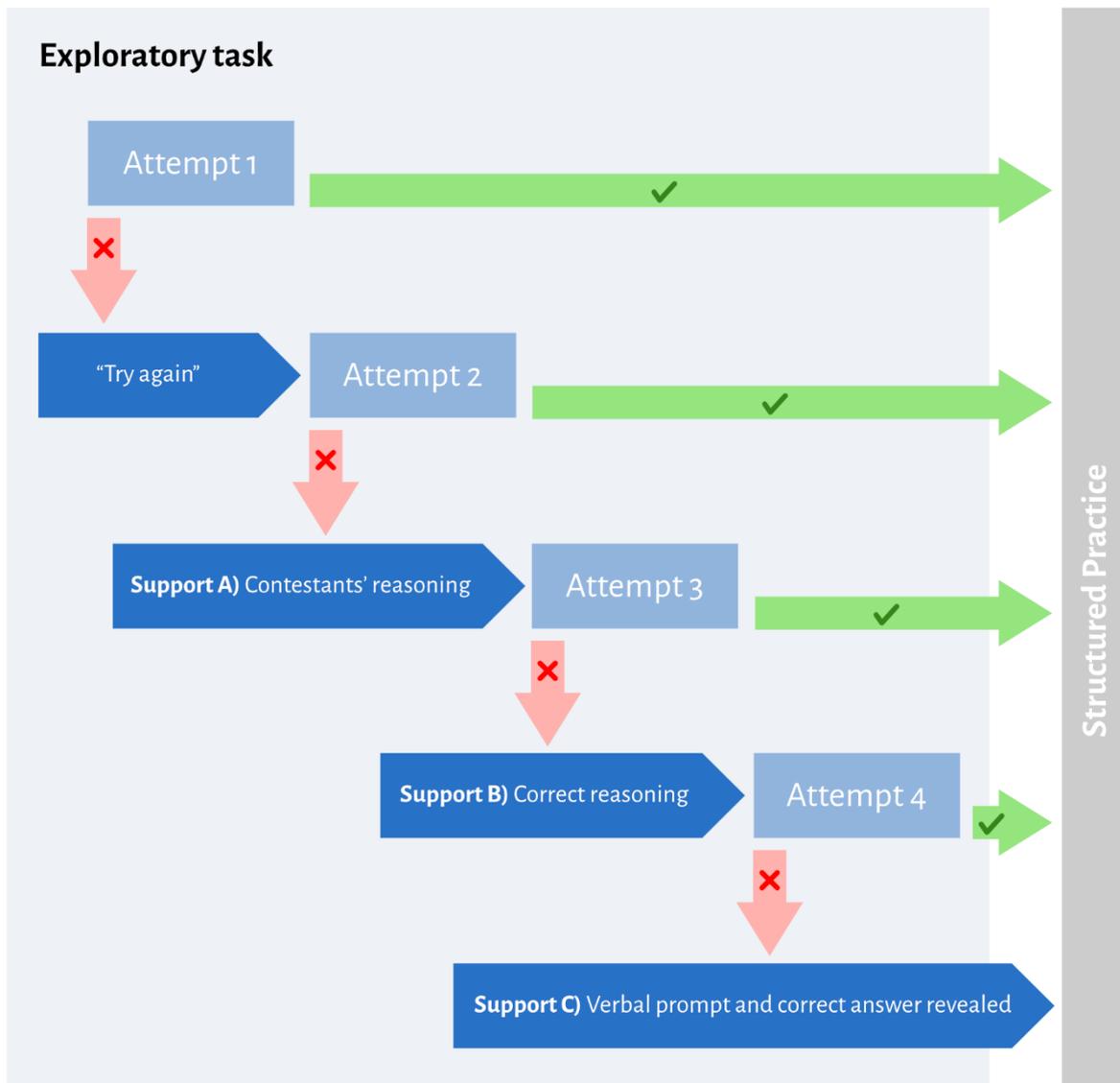


Figure 6. Progression through an Exploratory subtask.

Structured practice subtasks

Structured practice subtasks look very similar to the Exploratory phase, but do not progress through these same levels of support. Instead, children are given two attempts with the initial ‘Stop and Think’ prompt.

There are four types of Structured Practice subtasks for each concept designed to consolidate the understanding about the concept presented in the Exploratory subtask (Consolidate); generalise this understanding to new stimuli or a new type of question (Re-presentation); or extend this understanding to a related concept (Extension). There will also be subtasks with questions drawn from the same maths or science topic, but which do not include a common misconception. This ensures pupils are not trained to think that there is always a ‘trick’ question, or that their initial thought is always incorrect.

Completing ‘Stop and Think’ tasks earns the class tokens (e.g. Figure 7), which can then be spent in the Avatar Shop on the teacher web-dashboard. But don’t worry about getting wrong answers... most tokens are earned from completing achievements, such as participating the learning activities three times per week and actively engaging in ‘stopping and thinking’. Check out the Leaderboard for details at unlocke.me.

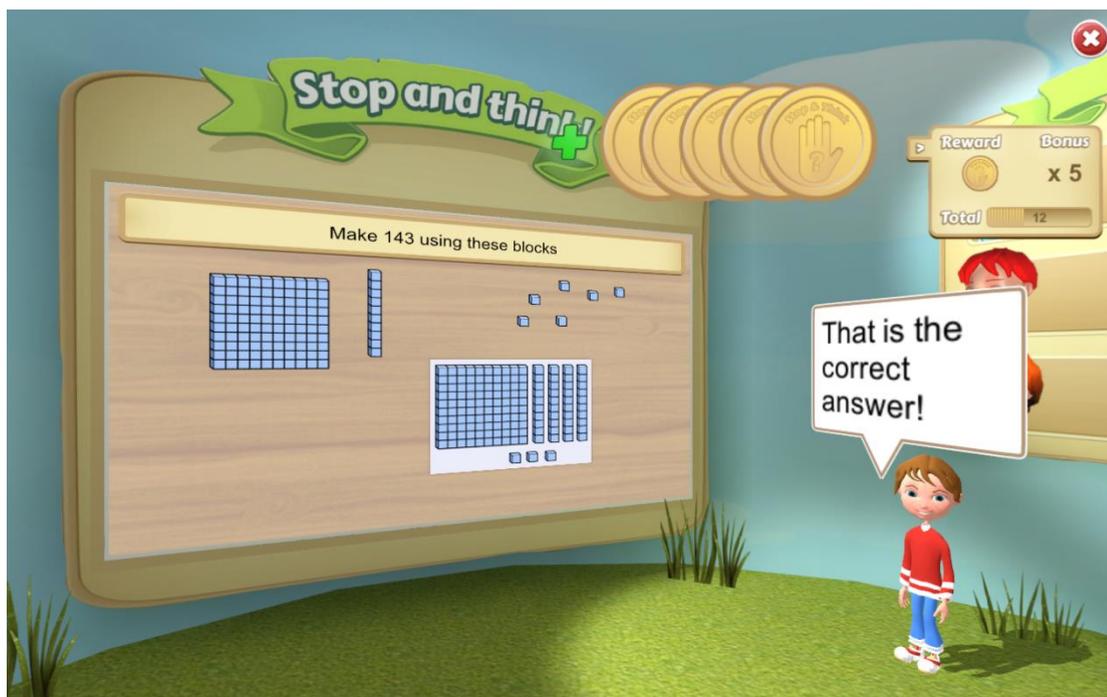


Figure 7. Completing tasks earns tokens!

Running UnLocke sessions

Before the first session

If you want to customise the order of topics presented in Stop and Think, login to the teacher web-dashboard at unlocke.me. Choose the “Topic Picker” tab, sort the order of topics, and click submit (Figure 8). Watch a [video](#) on the unlocke.org website for details on how to use the web-dashboard. Otherwise, simply launch the software and it will assume the default order.

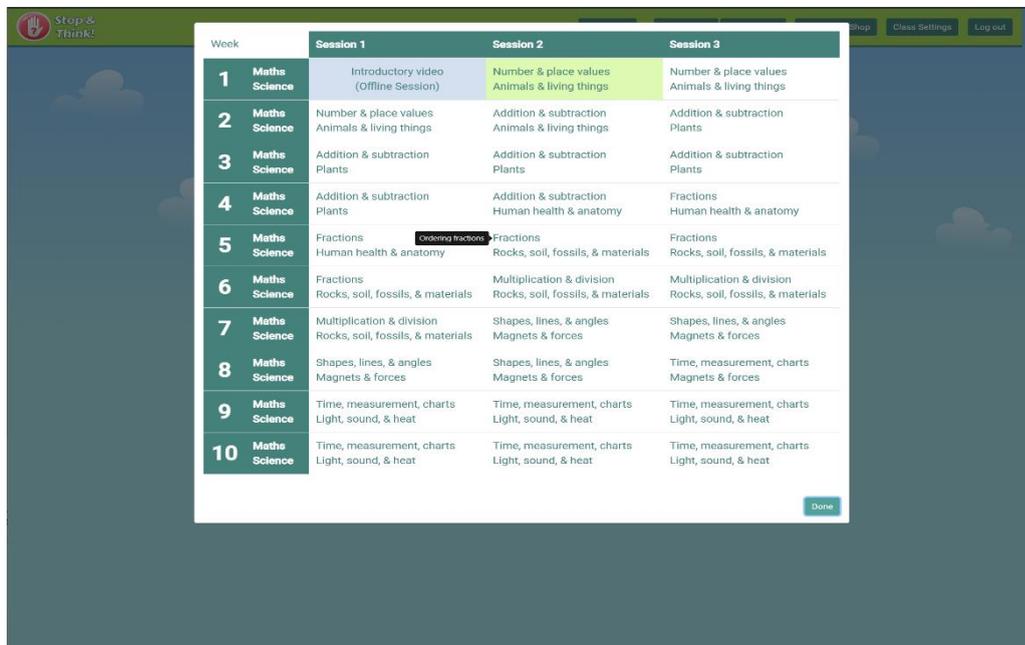
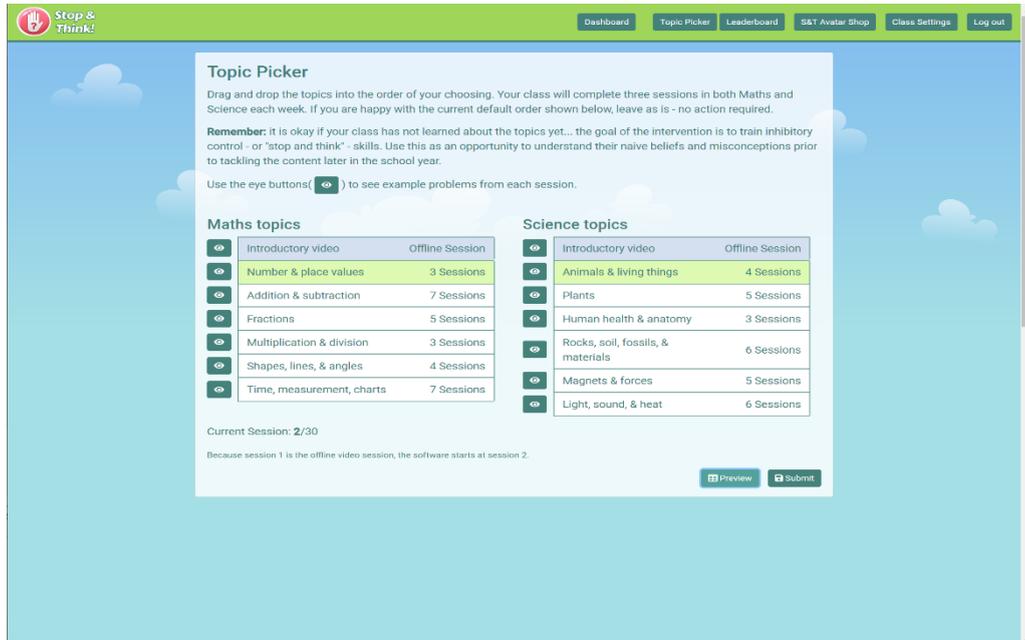


Figure 8. Top: Topic Picker – sort topics into a desired order. Bottom: Preview of topic order – hover your cursor over topics to see details about the session.

The first session

Please introduce UnLocke and the Stop and Think game to pupils using the ‘Introducing UnLocke to pupils’ video. This short video can be found on your computer, on the [unlocke.org website](http://unlocke.org), and/or on the [teacher web-dashboard](#) by clicking on the eye button beside the video topic card.

Starting the software

To start a session, double click on the red Stop and Think icon on your computer.

The software can be used in two modes: *Online* mode and *Offline* mode. We suggest you **try using it Online mode first**, so that your class can benefit from the features offered on the web-dashboard, e.g. the Leaderboard, Avatar Shop, and customised order of topics made through the Topic Picker. **ONLY resort to using Offline mode if you have consistent connectivity issues.**

Online mode

Type in your teacher username and password (Figure 9, left) provided by the UnLocke team. It is very important that you use the same login details for every session so that we can track each class’s progress and interactions with the learning activity. Upon logging in, you will select your class from a dropdown menu. If you are only responsible for one class, there will only be one option. Press Continue, then Start on the next screen to play the game.

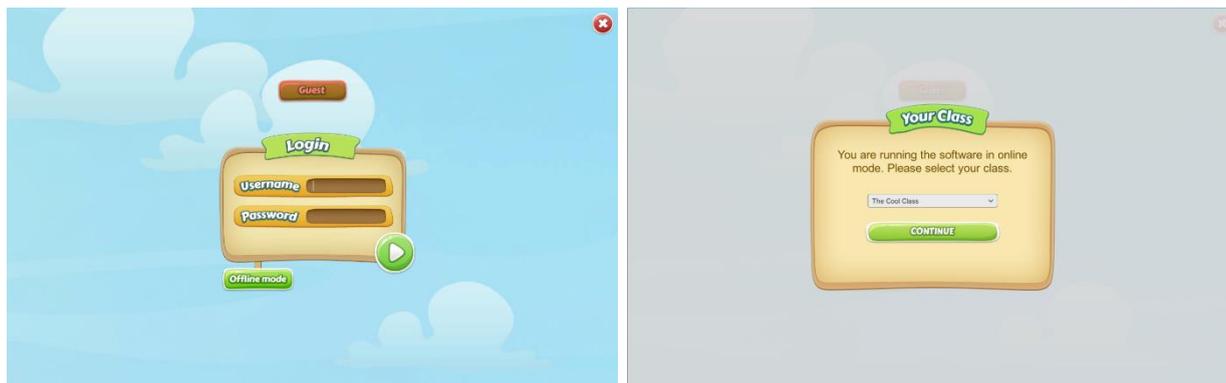


Figure 9. Left: Login screen for Online mode. Right: Select a class.

Offline mode

ONLY consider using Offline mode if you have *consistent* internet connectivity issues. **Once you go offline, you cannot return to Online mode**, as your data will not be backed up to the database. Your classe’s information will not be updated on the leaderboard/avatar shop and you will not be able to update the order of activity topics. Therefore, you may want to wait a day or two until your connectivity issues are resolved before resorting to Offline mode.

To go Offline, click the green “offline mode” button on the login screen (visible in Figure 9, left). If this is your first Stop and Think session, you will be prompted to register your classroom (Figure 10); use the credentials provided to you by the UnLocke Team (written on the front of this guide), then press OK to continue in the software as normal. You will not be prompted for this information again. Alternatively, if you have already completed some sessions in *Online* mode, then you will not be asked to register your class, and the intervention will resume where you left off.

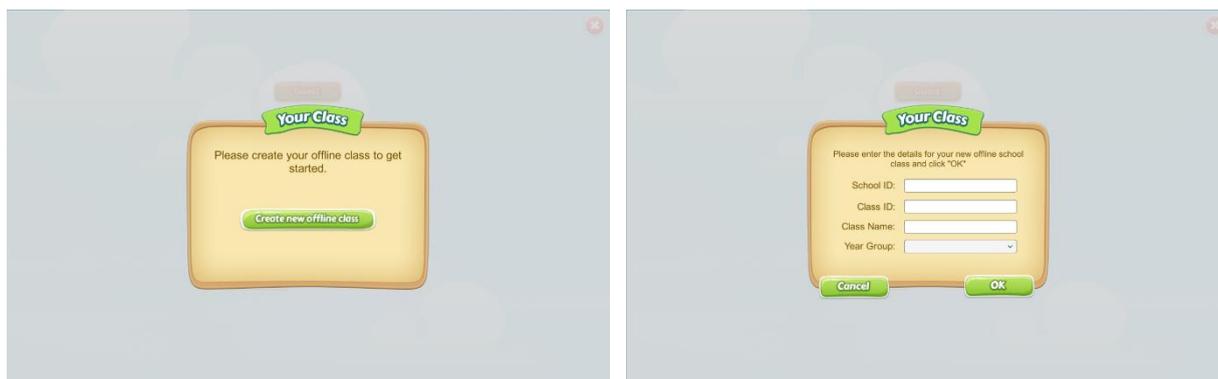


Figure 10. Left: Prompt to create an offline class. Right: Classroom registration – you will only be asked this once, and only if the software has never been used in Online mode.

During the session

You as the teacher can decide how pupils interact with the software during any other part of the activity. For example, you may wish pupils to sit at their desks and have a pen and paper or a whiteboard at hand to write down an answer or to help them work out their answers. Or you may ask pupils to sit on the carpet and put their hand up to offer an answer. You may like to enter the response into the software yourself, or you might ask pupils to take it in turns to come up and enter the answer on the computer themselves.

After the session

If you are using the software in Online mode, consider accessing the Leaderboard and Avatar Shop (Figure 11) via the web-dashboard (unlocke.me) to keep the classroom engaged in the intervention. Or, let pupils access these features on their own time with the link provided under the “Class Settings” tab (check out the [how-to video](#) on the UnLocke website for instructions how).



Figure 11. Left: Leaderboard. Right: Avatar Shop.

Teacher FAQs

Do I need to prepare anything?

The programme requires little input from the teacher in terms of preparation for the session. **Only login with your password once you are starting the sessions with the pupils**, as this will start the 10-week programme.

Will I know what topic will be covered in each session?

You can log into the [teacher web-dashboard](#) to choose the ordering of topics presented in Stop and Think (note that this only works when using the software in “Online” mode). In the dashboard, use the eye-buttons to preview a problem indicative of the session. Please remember that while each task has been designed in accordance with the national curriculum, the aim here is to practice inhibitory control in the context of maths and science education. Therefore, the specific maths and science content is of less relevance than is learning the ‘stop and think’ skill (see page 4).

How should I run “sorting” or “ordering” tasks?

You as the teacher can decide how pupils interact with the software (see suggestions on page 12). Some tasks ask pupils to sort images into buckets (e.g. fish or mammals) or to order (e.g. sequencing numbers). These may be less well-suited to some methods, such as taking a class vote. It is ok to run each type of task differently where needed. Some teachers have reported taking a class vote (hands up or answers on whiteboards) on single-response tasks, but have asked for a volunteer to come up and use the software themselves on multiple-response tasks, such as sorting animals or ordering numbers.

Can pupils discuss their answers during the session?

It is important that pupils are **not talking when the ‘Stop and Think’ logo is on the screen**. This is their thinking time. Discussion during other parts of the activity is your decision and will depend on how you decide to run the sessions.

Should I correct pupils if they offer an incorrect response?

It is your decision as the teacher how much input you would like to offer pupils while using the learning activity. For example, you may wish to help by re-reading text to pupils if requested or re-iterating any instructions or prompts in the tasks (such as “remember to stop and think”). However, it is important that pupils are given the opportunity to get the answer wrong so that they can take advantage of the levels of support offered within each Exploratory subtask (i.e. practicing stopping and thinking, using Andy’s prompts and considering the three contestants’ ideas).

What should I do if some pupils find the tasks easy, while others are finding the tasks more difficult?

While some pupils may find the tasks easier than others, all children can still benefit from learning to stop and think before rushing ahead with their response. Therefore, please remind pupils to **use the stop and think time wisely** to think about their answer before offering their response. For example, they could think about how they can to their answer, OR how they might explain their answer to others.

Do I need to use the web-dashboard?

No, using the teacher web-dashboard is completely optional and you can use Stop and Think in the classroom without accessing these additional features.

Troubleshooting

What to do if...

I cannot run all 3 sessions in the week

It is important that UnLocke runs for 12 minutes **three times per week** in order for your school to keep on track with the programme and to evaluate this level of exposure for all pupils. If you cannot run three sessions in the week, please contact the UnLocke evaluation team as soon as possible, so that we can advise you accordingly based on your particular circumstances.

The class teacher is absent

Please run the sessions as normal with a substitute teacher or rearrange the session for an alternate day that same week **during a maths or science lesson** (i.e. still run three sessions per week).

A pupil misses a session, arrives late for a session, or needs to leave early

You do not have to do anything. The pupil can join in as and when they are present.

A pupil asks the teacher for the answer to a particular task after the session

Please discuss anything covered in the Stop & Think activity outside sessions as and when you feel it is appropriate. You may wish to remind pupils of the 'stop and think' skills and encourage pupils to use this within their usual lessons.

A session is interrupted, e.g. fire alarm

The software will automatically time-out after 12 minutes. On return to the classroom, just close the software and continue lessons as usual. You do not need to do anything else. The data from any interaction with the software prior to the interruption will be logged and the next session will still start as it should when you begin your next scheduled UnLocke session on another day.

There are technical issues, e.g. I cannot log in, the software freezes, the sound is not working

Please contact your school IT support team to check whether the technical issue is a general computer issue rather than specific to the Stop & Think software. If the problem persists, please contact your local UnLocke researcher as soon as possible so that we can address the problem.

A parent/guardian would like more information about the project

Parents/guardians will have received a letter and information sheet about the purpose of the project and opted in if they were happy for their child to participate in the research. If they did not receive this information or would like to see it again, please re-send the letter which should be held by the UnLocke contact in the school (in most cases the Head Teacher). If you cannot access this information or would like any additional information, please get in touch with the UnLocke evaluation team.

A parent/guardian asks to withdraw from the UnLocke project

If a parent/guardian verbally asks for their child to be withdrawn from the project, please inform the parent/guardian that we will destroy any pre-/post-testing data already collected for that pupil. Please inform the UnLocke evaluation team.

References

- [1] Stavy, R., & Tirosh, D. (2000). How students (mis-) understand science and mathematics.
- [2] Dunbar, K. N., Fugelsang, J. A., & Stein, C. (2007). Do naive theories ever go away? Using brain and behavior to understand changes in concepts. In M. C. Lovett & P. Shah (Eds.), *Thinking with data: 33rd Carnegie symposium on cognition* (pp. 193–206).
- [3] Ridderinkhof, K. R., Van Den Wildenberg, W. P., Segalowitz, S. J., & Carter, C. S. (2004). Neurocognitive mechanisms of cognitive control: the role of prefrontal cortex in action selection, response inhibition, performance monitoring, and reward-based learning. *Brain and cognition*, 56(2), 129-140.
- [4] Diamond, A., & Lee, K. (2011). Interventions shown to aid executive function development in children 4 to 12 years old. *Science*, 333, 959–964.

A more detailed exposition of the evidence underlying the UnLocke project can be found in: Mareschal, D. (2016) The neuroscience of conceptual learning in science and mathematics. *Current Opinion in Behavioural Sciences*, 10, 14-18. doi:10.1016/j.cobeha.2016.06.001

Contact us

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