Strategies for Assessment of Inquiry Learning in Science

# TEACHING IDEAS SHARED FROM SAILS TEACHER EDUCATION PROGRAMME

Cookie Mining

*This resource has been developed through the SAILS Teacher Education Programmes (2012-2015) but was not developed as a finalized SAILS Inquiry and Assessment Unit. These materials are shared to inspire further use of inquiry and assessment of inquiry skills in the science classroom.*

SAILS
Strategies for Assessment of Inquiry Learning in Science


| | |
|---|---|
| **Author[s]** | Stephen Phillips, Christine Harrison, Sally Howard |
| **Organisation** | King's College London & Therfield School, UK |
| **Project Coordinator** | Dr. Odilla Finlayson, Dublin City University. |
| **Website** | www.sails-project.eu |
| **Email** | info@sails-project.eu |



This resource has been produced within the scope of the SAILS Project. The utilisation and release of this document is subject to the conditions of the contract within the Seventh Framework Programme. The SAILS Project has received funding from the European Union's Seventh Framework Programme for research technological development and demonstration under grant agreement no 289085.

# *Inquiry question*: How do you mine a cookie for chocolate?
# *Inquiry activity:* Devise the most effective method for mining chocolate from a cookie

SAILS Strategies for Assessment of Inquiry Learning in Science

KING'S College LONDON

| 'Cookie Mining' Key ideas & concepts: | • Learning *about* inquiry skills (as opposed to learning through inquiry, or learning through doing an inquiry).<br>• This is an *open* inquiry because there are many possibilities<br>• Activity can be linked to projects on mining for minerals and the environmental and economic issues |
|---|---|
| **Age range** | • Upper primary, lower secondary & older students who are new to inquiry based science education |
| **Inquiry skill focus** | • Collaboration & team work<br>• Critiquing methods |
| **Assessment approaches** | • Teacher stands back to observe & listens into the discussions the groups have as part of the inquiry process and during the group presentations<br>• Teacher uses higher order questions to tease out student's understanding & challenge their thinking. Socratic question stems are a useful aid to planning these rich questions in advance<br>• Peer & self assessment using the guidance criteria such as the 'arrow progression sheet'<br>• Self assessment as a group using 'RAG cups' (Red cup means urgent help needed, Amber cup means need some help, Green cup means we are fine )<br>• Groups presenting to each other & giving feedback to peers<br>• Final products such as student's poster presentations |
| **Equipment** | Easy access to a wide range of usual lab apparatus as there are many possibilities associated with this inquiry such as; 250ml beaker, funnel & filter paper, tea strainer, forceps, tweezers, mounted needle/awl, plastic spoon, string, scissors, magnifying glass, safety specs, access to hot & cold water and at least 2 chocolate cookies per group. |
| **Suggested guidance for teaching** | There is ample opportunity for student's to explore many different avenues including the economic factors of leaving chocolate behind within the cookie, or the impurity aspect of having biscuit bits still attached to the chocolate. The extraction process may including picking bits out with tweezers to melting the chocolate . Not all methods are equally effective. The sessions requires about 60 - 70 minutes duration.<br>Explain to the class this is an inquiry session and explain how science is about being curious about the world they live in. It is a collaborative task, which requires the teacher to actively consider how the groups are constructed. The choice of grouping is based on the need's of the learners in terms of developing the focus inquiry skills and supporting their social and emotional needs. Aim for groups of 3 – 6, mixed attainment and mixed gender. |
| *Exploration is a key part of planning* | Equipment is available centrally for groups to select from and they can ask for additional equipment. Do not separate the planning from the doing of the inquiry as exploration is essential and includes 'playing' with the equipment to understand how it works. Ideas & lines of inquiry need to be kept 'open' unless there are health and safety reasons. Disproof, and learning from mistakes is an important part of working like a scientists. Students should be encouraged to keep thinking about how is what they are doing answering their question or not. Opportunities for self and peer assessment need to be planned into the teaching so that assessment is integral to the learning and not an add on at the end. |
| *Gathering evidence of learning needs to be part of the teaching process* | Introduce the inquiry question and activity as above. And discuss the criteria to recognise success by Introducing the rubric criteria. As individuals they have 5 minutes to think about their approach to the question. This can be written down on mini-white boards or Placemats. A cookie should be given to each group to help this planning stage. As a small group they listen to each other's ideas and then agree on the one approach they will take. The teacher will observe the groups interacting and note who is taking a lead role or being passive, what sort of questions they ask of each other, how do they resolve conflict and then make assessment notes on a couple of groups or specific students. |
| *Quality questions to tease out student's understanding require planning in advance* | 20 - 30 minutes to undertake their chosen methods and critique it. To help the teacher tease out the group's reasoning and understanding of the science behind their choices, the teacher should devise a few good questions in advance. Socratic questions are useful; such as 'Say some more about why you all decided to do this X and not that Y' 'what other alternatives were there?' 'how will you know when you have enough evidence?'<br>15 -20 minutes before the end of the sessions each group presents and explain their work to the class or at least one other group and receive peer feedback and consider how they would act on this feedback |
| *Self & peer assessment contributes to the teacher's assessment evidence* | 1/3 way into the session, students are stopped and instructed to use the arrow progression sheet to self assess placing '1' into the best fit description about how they feel they are doing. This is repeated at 2/3 point and at the end. Reminded student's they can 'move' in either direction on the arrow. The final self assessment is then shared with a partner and a discussion is had about the aspects of 'critiquing a method' and 'team work 'they should focus on more and develop. The strategy '2 stars and 1 wish' works well. The teacher pulls together the various learning points in the plenary through carefully constructed questions such : 'So having heard from every group , which method is 'bets' and why?' 'Think of one new thing have you learnt today and one thing you now know you need to develop' |

# Cookie Mining

This inquiry activity was developed by the UK SAILS team from a SATIS activity originally published by Andrew Hunt (SATIS 10). In the SAILS project, this activity was done by most of our teachers with many different year groups. It has since proved popular in both primary and secondary schools as a way of introducing a more inquiry student-centred approach in science.

The Cookie Mining inquiry provides students with a real life scenario that they can explore within the classroom from a practical inquiry viewpoint. It models what happens in the mining industry when metals are extracted from their ores. Using a chocolate chip cookie, the students work in groups to decide which is the best way to separate the chocolate from the biscuit. The activity provides students with an opportunity to think about the effectiveness of their methods to compare how they went about the activity with the ways that other students attempted the activity and so starts to help them develop the language and skills to develop a critical evaluation of their methods.

Students are provided with a few cookies. They discuss in groups possible effective ways of removing the chocolate and try some of these out before returning to the idea of what it means to be effective in mining chocolate from the cookies. The students should be provided with a range of apparatus that enables them to remove the chocolate (for example, beakers, tiles, spatulas, filter funnels and paper, mounted needles, a nail, a sieve or tea strainer) and there should also be weighing scales available in the room,

What is important here is for students to reach a consensus on what they believe the term effective to be in this context. Is it to do with the quantity of chocolate extracted, the proportion of chocolate compared to the biscuit, the time it takes to extract a specific amount of chocolate, the complexity and difficulty of the techniques used, the quality or purity of the chocolate extracted etc. These are decisions that the students need to debate and argue and while the teacher has an important role to play in questioning what they mean by effective, it is essential that the teacher encourages debate and decision making by the students and does not provide what s/he judges is the best definition of effective.

Questions teachers might use are:
Where any methods you tried better or worse than others?
Are there any other ways you might try which may overcome that problem?
What are your reasons for choosing that method as the best and does it have any weaknesses as well?
What evidence do you have for that?
What criteria are you using to decide what effective means?
Have you balanced up the input resources against what you are getting as an output?
How confident are you that yours is the most effective way?

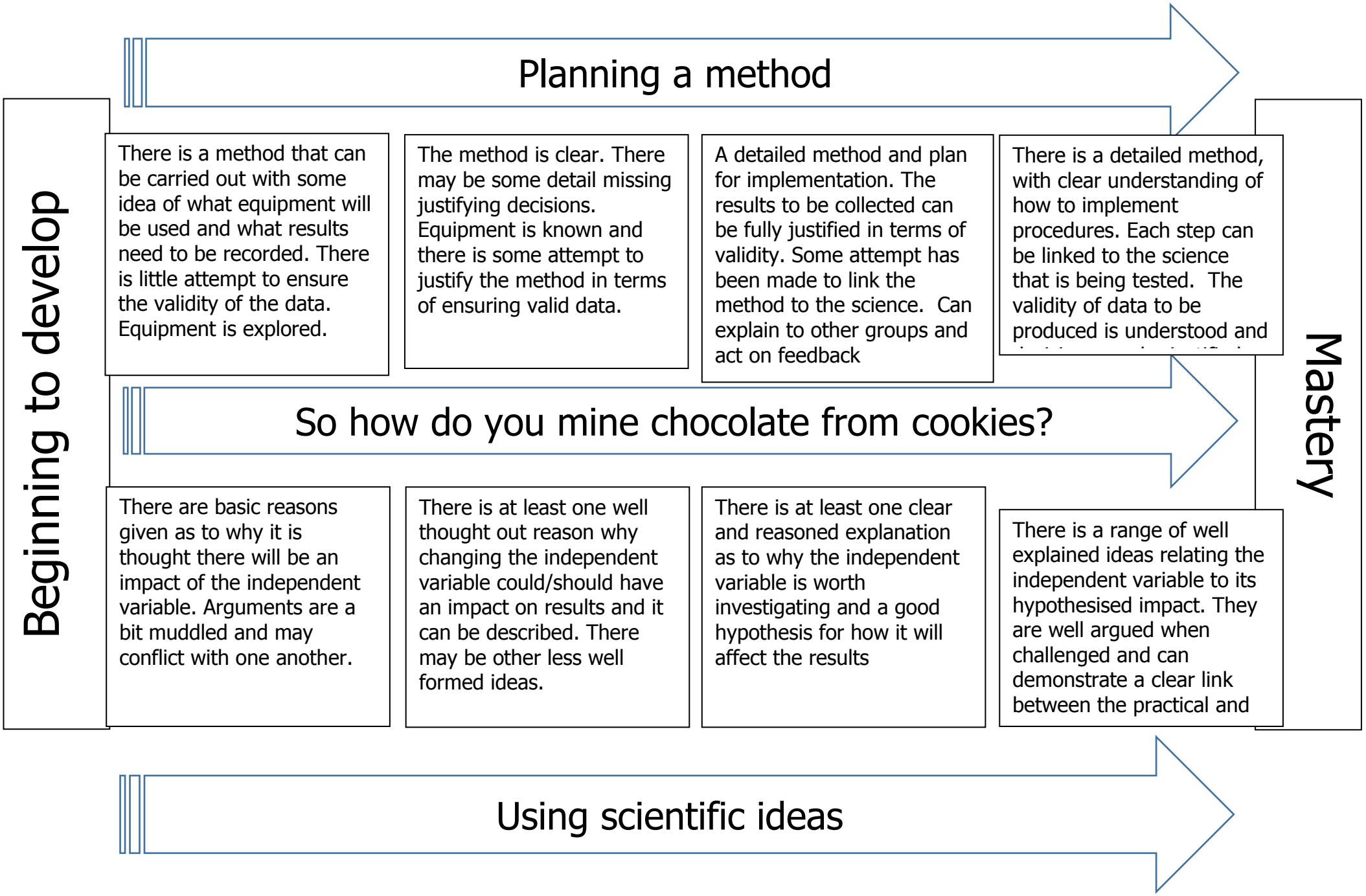
Some of the teachers used Assessment for Learning activities to support the learning environment during the Cookie Mining inquiry. A popular one was using traffic light cups. Each group are provided with a red, orange and green cp. They put these into a pile with the uppermost one indicating how confident they feel they are doing with the activity as it

progresses. So if the group feels they are making good progress towards a solution they will have the green cup on top. If they are struggling and need some teacher intervention, they place the red cup at the top of the pile. This signals to the teacher that the group needs help. If they are working okay but raising one or two questions or cannot quite decide which method to adapt, then they might display an orange cup. So the learners are in control of how much support and intervention they want from the teacher but are encouraged to work out a solution to the inquiry problem by using one another as a resource first. This approach is a good method for providing feedback to the teacher on how confident students are in their work. It also helps keep the inquiry as open and student-led as possible.

## Assessment

In this activity, the teachers developed a four scale rubric so that students could assess how successful each group had been in deciding and arguing about their method. The students had gradually been trained to use these generalised rubrics for a number of inquiry skills to both identify what they had achieved and also to target how they might improve that skill in a later inquiry.

An example criteria 'arrow rubric' where students self-assess at three distinct points in the lesson, using these descriptors & make a 'best fit' judgement.



## How do you mine a cookie for chocolate?

- You will have thought of a how to construct a successful method
- You will be able to evaluate and improve a method
- You will have taken time to reflect on your own ability and see progression

## How do you mine a cookie for chocolate?

Devise a method for mining chocolate from a cookie – you can use any equipment in the lab

Through the lesson you will be working in groups

You will be asked 3 times in the lesson to self assess how well you think you are doing

Lesson structure

Initial ideas → first self assessment

Decide on ONE method for your group → record in your books → second self -assessment

Carry out method

Evaluation → share findings with another group → DIRT final self-assessment

# How do you mine a cookie for chocolate?

SELF-ASSESS!!!

## Initial ideas – 5 minutes

Get in your groups and just come up with some ideas for the most 'successful' way of mining the cookie for chocolate.

Write ideas in your book

## Choosing a method - use RAG cups to indicate where you think you and your group are

You now have to reach a ***consensus*** (everyone must agree) on a method.

Think about: How successful will this method be?

What does successful mean?

How will you know you have been successful?

Write chosen method.

SELF-ASSESS!!!

# How do you mine a cookie for chocolate?

## MINE YOUR COOKIE!

Is everyone doing something?

Is it working?

Should you change anything during experiment?

Is it repeatable?

Are you collecting any data to support 'success'?

Does it work for all cookies?

Write down your 'results'

## How do you mine a cookie for chocolate?

- Were you successful?
- One person from each group move to another. 1 minute talking about your group.
- Go back to your original groups to feedback

## How do you mine a cookie for chocolate?

- Write down briefly anything you could have done to improve your method to make the experiment more 'successful'

SELF-ASSESS!!!

- All books handed in, self assessment arrow stuck in. Homework should be there too!!!