

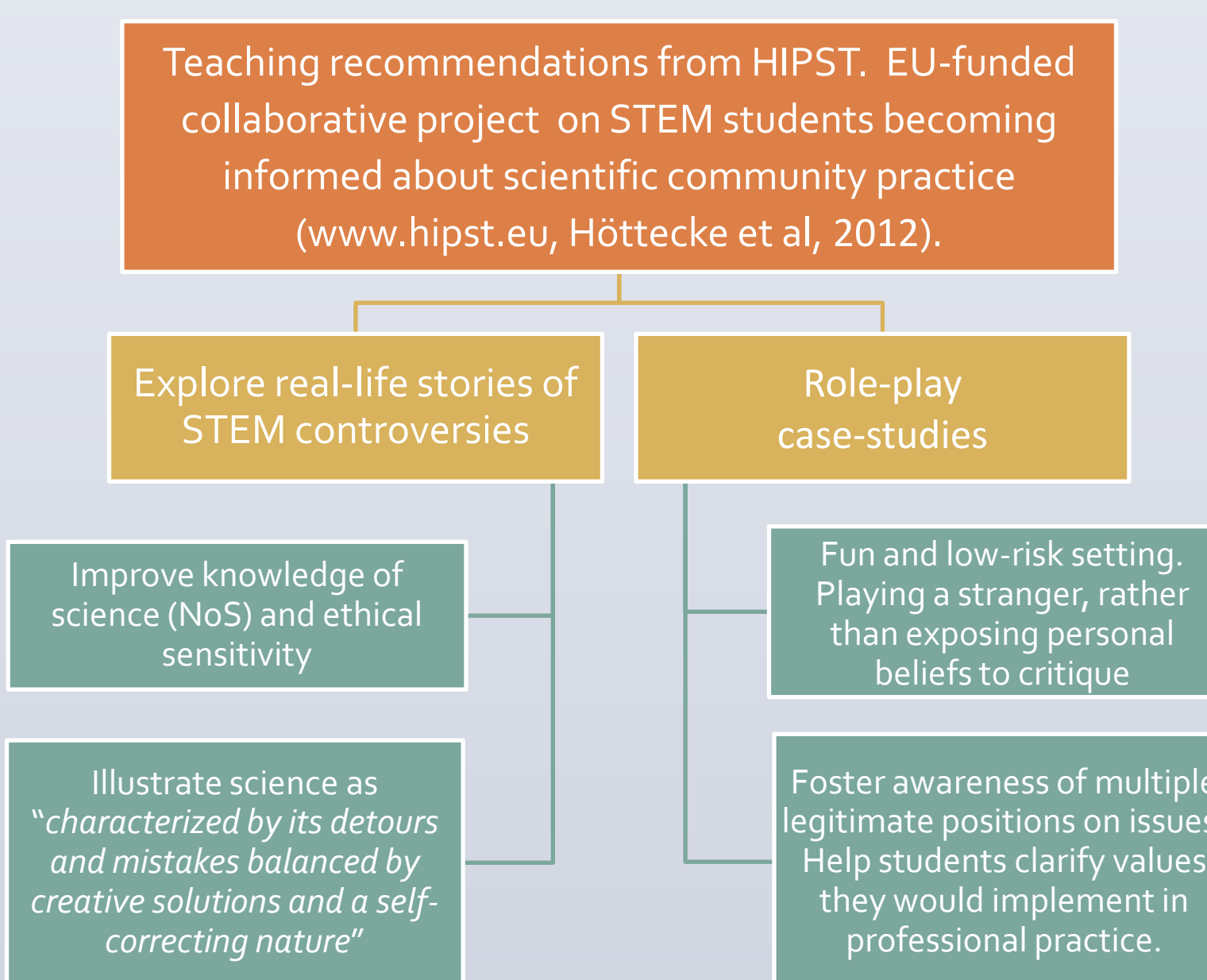
# Tunnock's Teacakes and Felt-tip Pens: Improving Engagement and Learning In HPS Seminars



Learning-by-doing through role-play, games, and hands-on activities can improve on the traditional reading-and-discussion HE social science seminar format. This study shows how creatively purposing a small toolkit of crafts and items reinvented a theoretical and abstruse Sociology of Science course, enhancing engagement and learning.

## 1. Teaching HPS: The Literature

A snowballing body of scholarship shows the value of integrating History and Philosophy of Science (HPS) into science curricula. However it also suggests STEM students struggle with HPS views of intellectual authority (textbooks without 'right' answers) and good academic practice (actively expressing opinion). To STEM students HPS can seem **"difficult, repellent, uninteresting, irrelevant, pointless or simply weird"** (Gooday, 2002: 142).



See: Strohmets & Skleder, 1992; Cantor, 2001; Illingworth 2004; Henke et al, 2009; Johnson, 2010; Höttecke et al, 2012; Matthews, 1994; Monk and Osborne, 1997; Bartholomew et al, 2004; Rudge and Howe, 2007.

## 2. Making Philosophy of Science Seminars Interesting

Seminars are for reinforcing and extending *understanding* of material. They focus on skills development, knowledge application, and epistemological maturity. In Summer 2012 an international pathway pre-Masters HPS module for STEM students was redesigned in line with pedagogic evidence, using a diverse 'tool-box' of activities.

Wk	Seminar Topic	HPS literature	What Happened?
1	Scientific 'facts'	Role play	Students devised a classification scheme for a set of galaxy images and peer reviewed it at an imaginary "Conference of Very Important Astronomers". We discussed how the scientific community scrutinises and adjudicates on science.
2	Scientific debates	Stories of real science	Groups were given a set of scientific scenarios which had been affected by social factors (e.g. acceptance of the Big Bang theory). These were presented as a short reading passage with comprehension and discussion questions.
3	History of STEM	Stories of real science	The classroom was turned into a timeline using masking tape and coloured pens. Students researched and added historical scientists and scientific discoveries. We walked the timeline as a group to get the 'grand narrative'.
4	Merton's model of scientific norms	Aronson (1978) Jigsaw method	Small groups made and presented a poster on one aspect of the sociology of science using paper, coloured pens and reading resources from the VLE. Topics jigsawed together such that all were needed to understand the whole topic.
5	Commercial ethics	Role play	Case study of a company renovating a children's home. Students discussed which sustainable supplier to use to fulfil a like-for-like contract involving RED-listed endangered wood, and read about the ethical consequences of that choice.
6	Research ethics	Stories of real science	Students watched a TED.com video by Ben Goldacre on drugs companies hiding trial outcomes. They then read and discussed the case of John Darsee who fabricated test results and the effect this had on his colleagues.
7	Managing risk	Role play	Class role-play of a 'public meeting' on plans to clean up polluted land for urban development. Students first prepared their role as one of the stakeholders (engineers; environment campaigners; local government; public etc).
8	Popper's theory of falsification	Simulations of the scientific method	Students moved round game stations using deductive or inductive reasoning (card games/ jigsaws/ logic puzzles etc). They then competed in teams to build the tallest spaghetti tower to hold a Tunnock's Teacake, recording the falsification process as they designed.
9	Kuhn's theory of paradigm shifts	Stories of real science	Using a pre-formatted poster, pairs of students used the internet to research a famous example of Kuhn's model of paradigmatic revolution, filling in the stages of the cycle. Posters were presented to the class.



Seminar 8: the tallest tower. Summer 2013.

## 3. Understanding, Enjoyment and Learning?

The project triangulated survey (fig 1) and focus group evidence to establish if students:

Understood the purpose of each seminar?

Enjoyed the format of each seminar?

Learnt from each seminar?

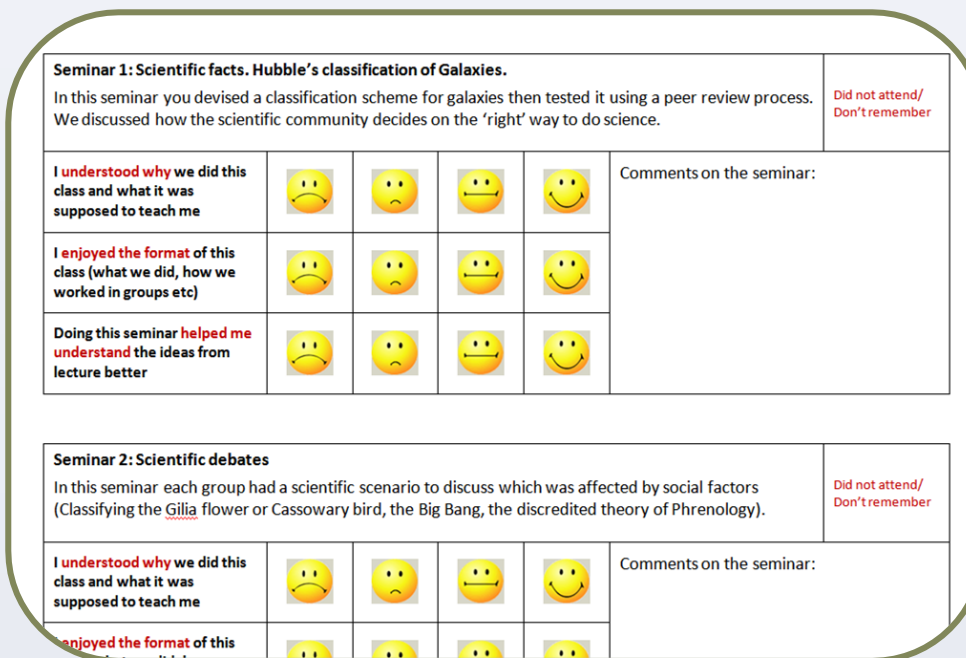
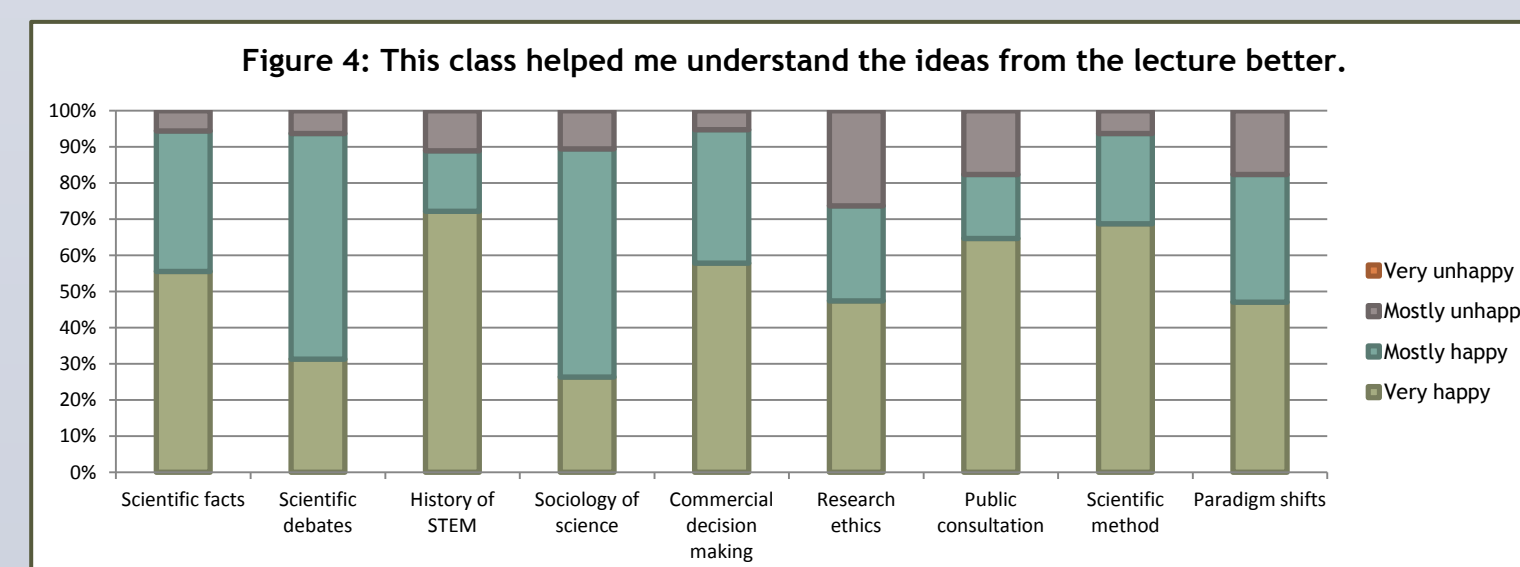
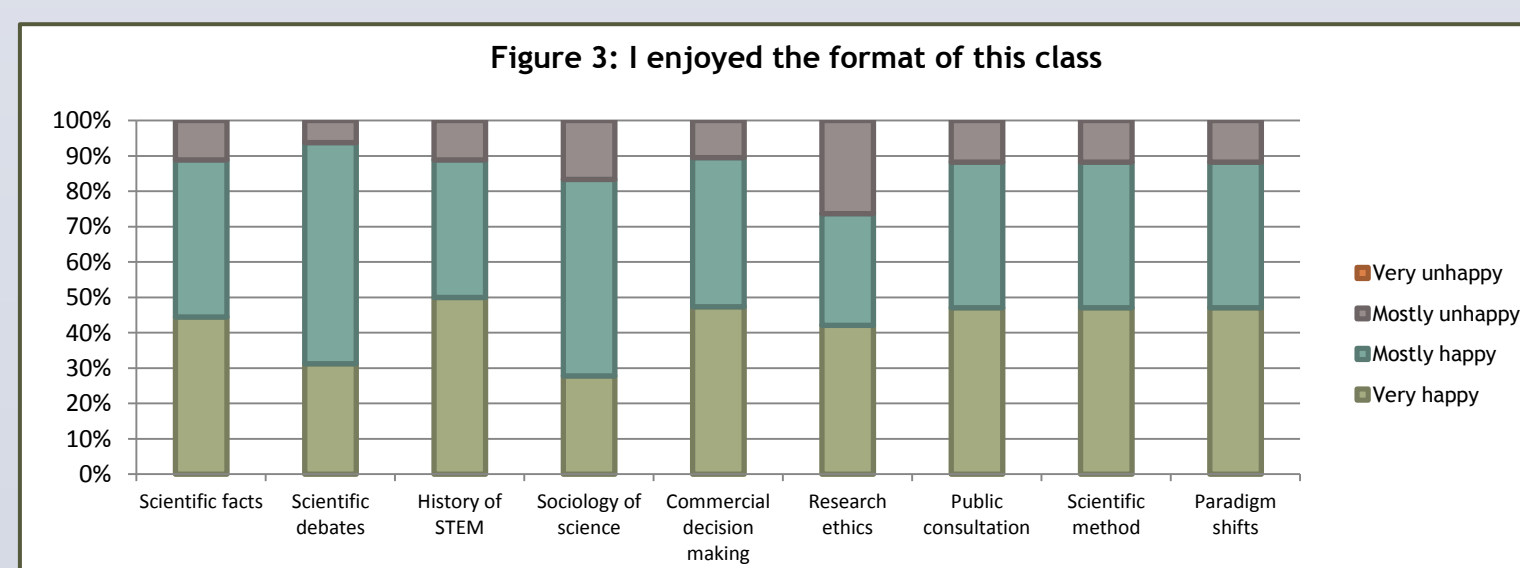
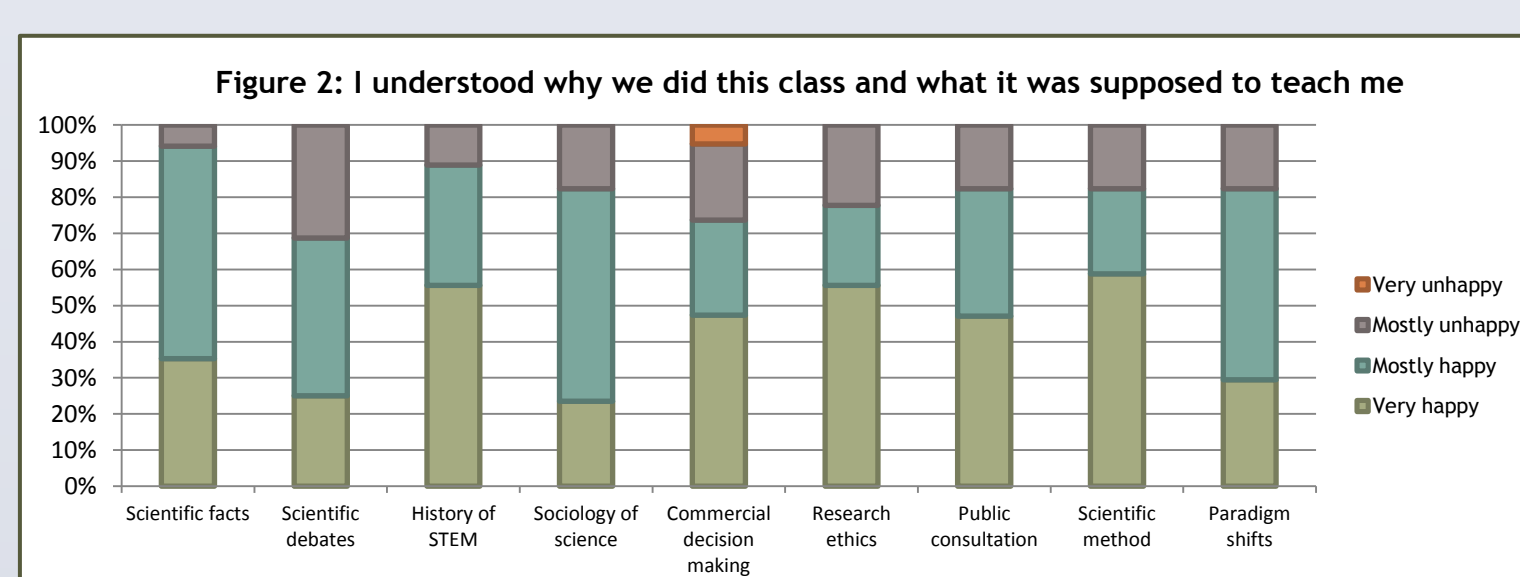


Figure 1: Questionnaire research tool

The **hands-on or role-play** lessons (3, 7, 8, history timeline, role play public meeting, scientific games) were best rated in all measures.

Contrastingly **reading and discussion oriented** lessons (2,5,6: scientific debates, commercial decision making, video and text on research ethics) didn't command high levels of understanding, enjoyment or learning.

Future study might explore the generalising of these findings.



## 4. Doing & Debating > Discussing & Cooperating

"In seminar 2 maybe there's too much text to read, maybe play the video?"

"I think the topics were a bit, at least the one I had was phrenology, it was a bit tricky to grasp. I can't speak for everyone but it was a bit dull, I thought."

"Seminar 6? (sniggering) well maybe it's just my preference for not liking to read too much [...] Did we discuss things about the topic afterwards, did we share opinions? I can't remember..."

"If we do the poster maybe we might forget or leave some information that is included in the lesson. In my opinion I would like you to give more tasks to argue together [...] In one some students ask me why I trust the engineers [...] after that we must give a reason. It's very fun, like we have to protect us: 'oh we're not wrong'. It's good for me and useful"

"The posters kind of hinged on how well the other people prepared as well, so if they didn't prepare well and they present, you don't really get a good understanding of the topic"

Reading and interpretation questions never fostered student interest even with real life case studies (Rudge and Howe, 2009). Students think such classes have overly high reading loads, even if comparable to other classes.

Students disliked cooperatively trusting each other for knowledge (e.g. jigsaw lessons, Aronson, 1978). However they really valued confrontational role play debates as a route to constructing meaning together.

**Delivery approach, not difficulty of content, determined student-reported understanding, enjoyment, and learning**

"The ones that stood out for me all exhibited some sort of similarity. They used good practical examples of the theories that you taught in class, bringing across the information"

Students strongly valued seminars for the practical construction of knowledge. Especially when these use hands-on guided inquiry (Höttecke et al, 2012)

Students valued learning they can see real-life application for, such as practicing professional relationships or ethics

"Sometimes when I listen to your lecture I feel quite confused, especially with paradigms. But when I did the poster of the paradigm shift I honestly understood what was the progress of science."

"Seminar 1, in theory to say things are standardised, there's only so much we could understand it. When we actually did the exercise in class and we all came to some common agreement, it gave you a much better grasp of what peer review was."

"Seminar 8 was fairly complex topics, but I found that the games, apart from being fun, also has a very simple and effective way of helping you understand."

"Seminars 5 and 7 I think useful for our future career, because in the future we all go to a company or a factory. When we do construction, when we sign a contract with another company or other client, we must meet this same situation."

"Also working in teams, you know to compromise to find a solutions to a problem, is something that we have to learn for our careers, it's a very useful exercise. It gives you experience of what it's like to work in a team and go up against people in other teams."

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