# Using the Q-method to gain insights into pupils' perceptions of teaching learning and assessment in science and mathematics.

FASMED PROJECT

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FaSMEd

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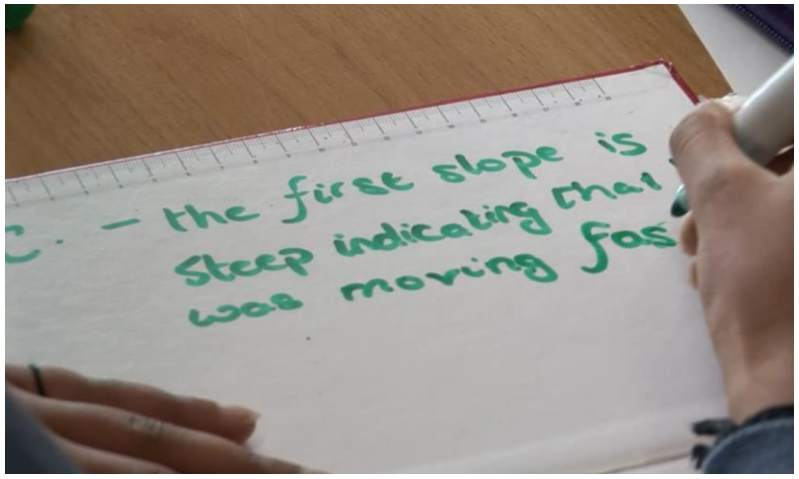
# Raising Achievement through Formative Assessment in Science and Mathematics Education (FaSMEd)

# FaSMEd

- FaSMEd is an EU- FP7 project. There are 9 partner institutions in 8 partner countries (UK (Lead), France, Germany, Holland, Italy, Norway, South Africa, and Ireland).
- Aim: to investigate how technology can be used in formative assessment to raise achievement in science and mathematics at second level.
- Each partner institution worked with a cluster of schools. We will report on the Irish cluster. This consisted of three schools, which involved 6 mathematics and 7 science teachers.

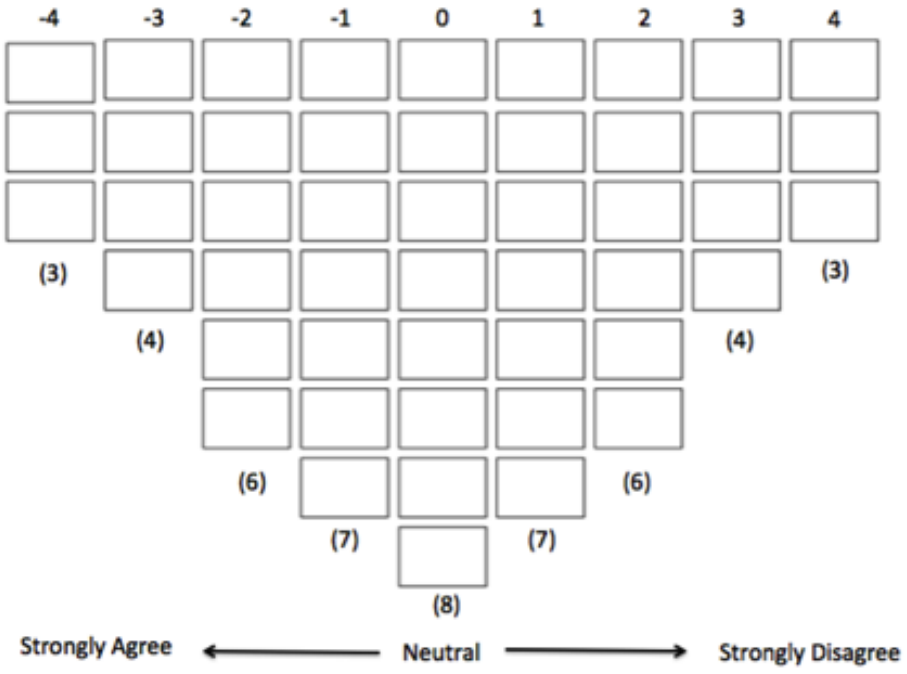
# Data Collection Methods

- Semi-structured interviews with teachers at the beginning and end of the research.
- In-class observation of formative assessment methods.
- Video data analysis of recorded in-class curricular/formative assessment activities.
- **Semi-structured interviews with students at the end of the research with the focus on a Q-Sort activity.**
- **Questionnaires collected from all students.**

# Q-Methodology

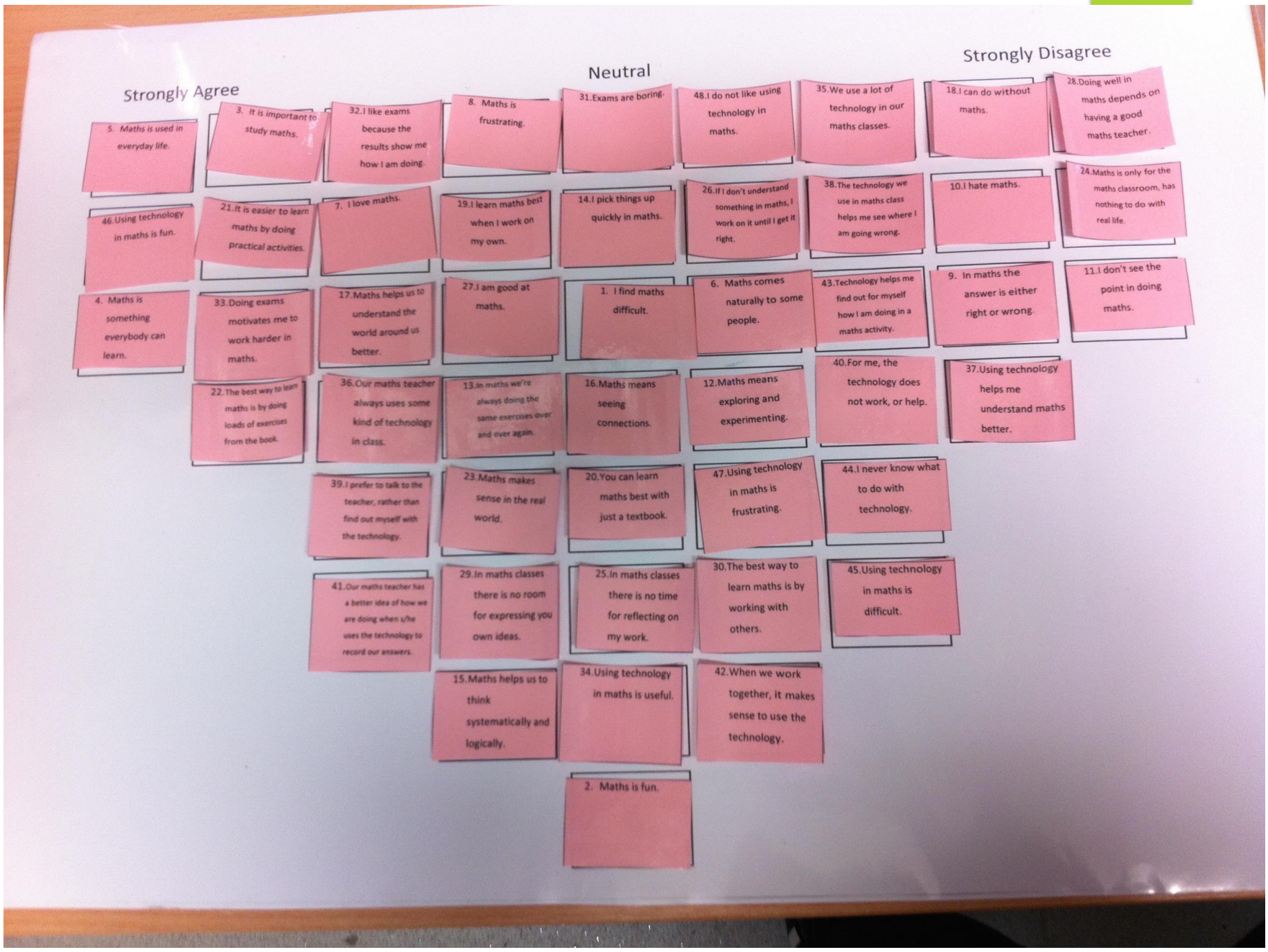
"Most typically in Q, a person is presented with a set of **statements** about some topic, and is asked to **rank-order** them (usually from "agree" to "disagree"), an operation referred to as Q sorting. The statements are **matters of opinion** only (not fact), and the fact that the Q sorter is ranking the statements from his or her own point of view brings **subjectivity** into the picture."

(Brown, 1993, p. 93)



# Method

- **Participants**
  - 24 first year science and mathematics students from three schools in Ireland.
  - 10 students completed mathematics Q-Sort (five male and 5 female, all from the same school).
  - 14 students completed science Q-Sort (seven male and seven female, from all threes schools).
  - Mixed ability classes.
- **Materials**
  - 48 statement cards (the Q-*samples*) relating to science and mathematics teaching, learning and assessment.
  - placemat onto which students were to arrange their statement cards in a fixed quasi-normal distribution.
  - Statements were finalised after a concourse of 91 statements were examined and 48 were chosen.
  - Phrasing of statements altered for students.


Strongly Agree
Neutral
Strongly Disagree
5. Maths is used in everyday life.
3. It is important to study maths.
32.I like exams because the results show me how I am doing.
8. Maths is frustrating.
31.Exams are boring.
48.I do not like using technology in maths.
35.We use a lot of technology in our maths classes.
18.I can do without maths.
28.Doing well in maths depends on having a good maths teacher.
46.Using technology in maths is fun.
21.It is easier to learn maths by doing practical activities.
7. I love maths.
19.I learn maths best when I work on my own.
14.I pick things up quickly in maths.
26.If I don't understand something in maths, I work on it until I get it right.
38.The technology we use in maths class helps me see where I am going wrong.
10.I hate maths.
24.Maths is only for the maths classroom, has nothing to do with real life.
4. Maths is something everybody can learn.
33.Doing exams motivates me to work harder in maths.
17.Maths helps us to understand the world around us better.
27.I am good at maths.
1. I find maths difficult.
6. Maths comes naturally to some people.
43.Technology helps me find out for myself how I am doing in a maths activity.
9. In maths the answer is either right or wrong.
11.I don't see the point in doing maths.
22.The best way to learn maths is by doing loads of exercises from the book.
36.Our maths teacher always uses some kind of technology in class.
13.In maths we're always doing the same exercises over and over again.
16.Maths means seeing connections.
12.Maths means exploring and experimenting.
40.For me, the technology does not work, or help.
37.Using technology helps me understand maths better.
39.I prefer to talk to the teacher, rather than find out myself with the technology.
23.Maths makes sense in the real world.
20.You can learn maths best with just a textbook.
47.Using technology in maths is frustrating.
44.I never know what to do with technology.
41.Our maths teacher has a better idea of how we are doing when s/he uses the technology to record our answers.
29.In maths classes there is no room for expressing you own ideas.
25.In maths classes there is no time for reflecting on my work.
30.The best way to learn maths is by working with others.
45.Using technology in maths is difficult.
15.Maths helps us to think systematically and logically.
34.Using technology in maths is useful.
42.When we work together, it makes sense to use the technology.
2. Maths is fun.

# Data Analysis

- **Quantitative factor analysis.**
- PQ method software used (Schmolck & Atkinson, 2002).
- Principal components analysis followed by a varimax rotation to determine what factors would emerge.
- The Q-sorts of students who loaded significantly and a particular factor were merged and became a factor array or factor exemplar (Shinebourne, 2009).

- **Qualitative Thematic Analysis.**
- MAXQDA used.
- Comments on statements grouped into one of six categories:
  - view of science/mathematics (9)
  - use of technology in learning (12)
  - perceptions of examinations (3)
  - usefulness of science/mathematics (7)
  - science/mathematics teaching and learning (12)
  - nature of science/mathematics(5)

# Mathematics and Science Factors

- **Mathematics (n=10).**
- Two emergent factors.
- Factor 1 (n=6).
  - Strong opinions on the usefulness of mathematics.
  - Enjoy practical lessons.
  - Strong intrinsic motivation.
- Factor 2 (n=4).
  - Strong opinions on the usefulness of mathematics.
  - Familiarity with technology.
  - Lacking intrinsic motivation.

- **Science (n=14).**
- Three emergent factors.
- Factor 1 (n=9).
  - Strong opinions on the usefulness of science.
  - Enjoy using technology in class.
- Factor 2 (n=3).
  - Work individually.
  - Importance of examinations.
- Factor 3 (n=2).
  - Reliance on teacher.
  - Lacking autonomy.

# Sample Results: Mathematics

**Factor 1:**

*(six out of 10 students)*

| Statement | Theme | Z-Score |
|---|---|---|
| **If I don't understand something in maths I work on it until I get it right** | MTL | -1.650 |
| **It is easier to learn maths by doing practical activities** | MTL | -1.519 |
| **The best way to learn maths is by working with others** | MTL | -1.410 |
| **Maths is something everybody can learn** | NOM | -1.372 |
| **Maths is used in everyday life** | UOM | -1.297 |

**Statements students strongly agreed with**

| Statement | Theme | Z-Score |
|---|---|---|
| **I can do without maths** | UOM | 1.861 |
| **You can learn maths best with just a textbook** | MTL | 1.682 |
| **The best way to learn maths is by doing loads of exercises from the book** | MTL | 1.629 |
| **Maths is only for the maths classroom and has nothing to do with real life** | UOM | 1.561 |
| **In maths classes there is no room for expressing your own ideas** | MTL | 1.415 |

**Statements students strongly disagreed with**

# Sample Results: Mathematics

"If there's someone with a problem and you can explain it to them, you understand it better as well."
(XMB_S4)

"I just think in group work many minds can work it out together."
(XMB_S24)

"I think that its better to interact with people when doing maths because it's easier to understand and other people can explain it rather than the teacher, because they actually know how you're feeling because they probably went through it." (XMB_S24)

# Sample Results: Science

**Factor 1:**
*(nine out of 14 students)*

| Statement | Theme | Z-Score |
|---|---|---|
| **Science is used in everyday life** | UOS | -1.619 |
| **It is important to study science** | UOS | -1.529 |
| **Science helps us to understand the world around us better** | UOS | -1.361 |
| **Science helps us to think systematically and logically** | NOS | -1.311 |
| **Science makes sense in the real world** | UOS | -1.242 |

**Statements students strongly agreed with**

| Statement | Theme | Z-Score |
|---|---|---|
| **I hate science** | VOS | 1.908 |
| **Science is only for the science classroom and has nothing to do with real life** | UOS | 1.673 |
| **I don't see the point in doing science** | UOS | 1.645 |
| **I do not like using technology in science** | UOT | 1.464 |
| **For me, the technology does not work, or help** | UOT | 1.383 |

**Statements students strongly disagreed with**

# Sample Results: Science

"I don't think that you can really learn science from a textbook because science is something that's all around us and you need to do experiments as well and stuff to get a better understanding of the actual experiment than just reading about it."
(YSA_S3)

"When he (the teacher) records our answers he'll be able to know what we don't really know and more people can ask a questions rather than just keeping it to themselves and being scared to talk." (XSA_S20)

"Well they can see what we've done better, it's hard to explain, if we do stuff on technology they can save it they, can see it…it's hard for them to know how we're getting on except by exams."
(YSA_S3)

# Q-Sort Findings

- Students held the strongest opinions about the *Usefulness of Maths/Science* theme, with strong opinions about other themes occurring more sporadically.
- Majority of science students see the benefit of studying science at school as it has many applications in the wider world.
- Science students felt that using technology helped them to learn and they believed they benefitted from the teacher using technology to construct useful feedback.
- Mathematics findings generally indicate that participating in practical activities during maths lessons is important for students.
  - The factor one students held strong opinions about doing practical activities in class, participating in group work and avoiding repeated use of the textbook during maths lessons.

# Comments on the Q-Method

- The concept of subjectivity is fundamental in the Q-method as its purpose is to reveal the subjective "structures, attitudes, and perspectives from the standpoint of the person or persons being observed" (Brown, 1996, p. 565).
- Less invasive than one-to-one interviewing alone.
- Students are forced to decide on the order of statements creating rich interactions between student and interviewer.
- Room for flexibility and creativity.
- Depends on the " meticulous and thoughtful sampling of the propositions (statements)" (Cross, 2005, p. 212).
- Time consuming.
- Using the software is tricky!

# Data from the Questionnaires

- Questionnaires containing the 48 Q-sort statements were distributed to all students (mathematics n=168, science n=147) participating in the study.
- After discussion by the researchers, the 48 questions were organised into six scales : View of Science/Maths, Technology, Usefulness of Science/Maths, Nature of Science/Maths, Science/Maths Teaching and Learning, Examinations.
- These scales were analysed using Rasch Analysis.
- We found that the View of Science/Maths, Technology, Usefulness of Science/Maths, and Examinations scales were robust.

# View of Science/Maths Scale

- This scale consisted of 6 Likert-scale questions. The items related to the students' personal view of the subject:
- *I find science/maths difficult.*
- *I hate Science/Maths.*
- *Science/Maths is fun.*
- *Science/Maths is frustrating.*
- *I love Science/Maths.*
- *I am good at Science/Maths.*

The scale worked well (all Rasch fit statistics were good) and the Cronbach alpha was 0.878.

# Use of Technology Scale

- This scale consisted of 10 Likert-scale questions. The items related to the students' view of the use of technology in their classes. For example:
- *Using technology in Science/Maths is useful.*
- *I do not like using technology in Science/Maths.*
- *The technology we use in Science/Maths class helps me see where I am going wrong.*
- The scale worked well (all Rasch fit statistics were good) and the Cronbach alpha was 0.839.

# Usefulness of Science/Maths and Examination Scales

- The Usefulness scale consisted of 7 Likert-scale questions. The items related to the students' view of the usefulness the subjects. For example: *Maths/Science helps us to understand the world around us better.*
- The Examinations scale consisted of only 3 questions: *Exams are boring; I like exams because the results show me how I am doing; Doing exams helps me to work harder in Maths/Science.*
- Both scales worked well (all Rasch fit statistics were good) and the Cronbach alphas were 0.785 and 0.686 respectively.

# Comparison of the Science and Maths Groups

- We computed scores on each of these scales for each student (using Rasch analysis).
- We found no significant differences between the groups on the Usefulness and Examination scales.
- We found statistically significant differences between the means of the two groups on both the View of the subject and Technology scales ($p<0.001$ in both cases).
- The students in the Science group had a better view of themselves in relation to the subject on average than the Mathematics students.
- Similarly, the Science students had, on average, a more positive view of the use of technology in the classroom than the Mathematics group.

# Views of Learning

- Let's look at some responses to questions on learning in these subjects.
- ***The best way to learn maths/science is by doing loads of exercises from the book*** *- 52% of Maths students agreed, while 23% of Science students agreed.* A chi-square test showed that the answers to this question were not independent of subject ($p<0.001$).
- ***Maths/Science means exploring and experimenting*** – 25% of Maths students agreed , while 69% of Science students agreed. There was a significant difference here ($p<0.001$). Note that 45% of Maths students were not sure about this item.

# Conclusion

- The questionnaire data confirmed much of the Q-sort data.
- Both groups were positive about the usefulness of their subjects and also (on the whole) about their self-confidence in relation to the subject.
- The Science students were more positive about the use of technology in the classroom – but this may be due to more exposure.
- There is evidence that students welcome a move from traditional teaching methods.

# Key Readings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