

DEVELOPMENT AND ASSESSMENT OF SCIENTIFIC LITERACY THROUGH STUDENT- LED SOCIO-SCIENTIFIC RESEARCH IN PRE- SERVICE TEACHER EDUCATION

Ruth Chadwick, Dr. Eilish McLoughlin, Dr. Odilla Finlayson

CASTeL, Dublin City University

Outline

- I. Scientific literacy
- II. Socio-scientific research for the development and assessment of scientific literacy
- III. Student-led socio-scientific research in a pre-service teaching module.
- IV. Pre-service teachers' experiences of socio-scientific research
- V. Scientific literacy competencies used in socio-scientific research
- VI. Conclusion and implications

PISA 2015 - Scientific Literacy

Scientific Literacy is the ability to engage with **science-related issues**, and with the **ideas of science**, as a **reflective citizen**.

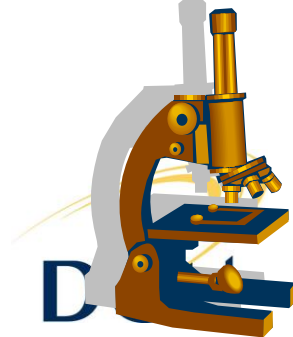
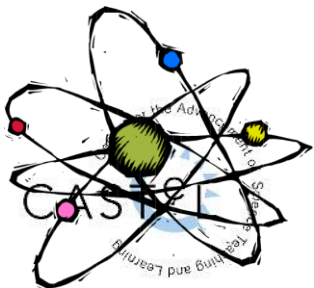
A scientifically literate person, therefore, is **willing to engage** in reasoned **discourse** about **science** and **technology**...

PISA 2015 - Scientific Literacy

... which requires the competencies to:

1. Explain phenomena scientifically
2. Evaluate and design scientific enquiry
3. Interpret data and evidence scientifically

OECD 2013



1. Explain phenomena scientifically

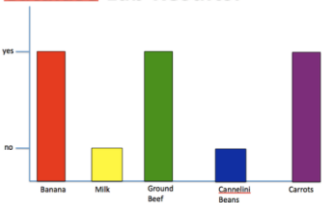
- A. Recall and apply appropriate **scientific knowledge**;
- B. Identify, use and generate explanatory **models** and **representations**;
- C. Make and justify appropriate **predictions**;
- D. Offer **explanatory hypotheses**;
- E. Explain the potential implications of scientific knowledge for **society**.

2. Evaluate and design scientific enquiry

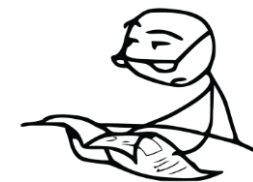


- Identify the question** explored in a given scientific study;
- B. Distinguish questions** that are possible to investigate scientifically;
- C. Propose** a way of exploring a given question scientifically;
- D. Evaluate** ways of exploring a given question scientifically;
- E. Describe** and **evaluate** a range of ways that scientists use to ensure the **reliability** of data and the **objectivity** and **generalisability** of explanations.

OECD 2013



3. Interpret data and evidence scientifically



Transform data from one representation to another;

Analyse and interpret data and draw appropriate **conclusions**;

- C.** Identify the assumptions, evidence and reasoning in **science-related texts**;
- D.** **Distinguish between arguments** which are based on scientific evidence and theory and those based on other considerations;
- E.** **Evaluate** scientific arguments and evidence from **different sources (e.g. newspaper, internet, journals)**.

PISA Scientific Knowledge

In addition to the three competencies, the scientifically literate person has the following types of knowledge:

- Content knowledge

Previously known as
knowledge **of** science

- Procedural knowledge

- Epistemic knowledge



Previously known as
knowledge **about**
science

Incorporates elements of
Nature of Science

Socio-scientific research

- Student-led socio-scientific research tasks can be used to develop and assess many of the competencies associated with scientific literacy.
- The benefits of such tasks are...
 - They provide real life contexts.
 - They can be personalised by the student to suit their own interests.
 - Topics tend to be more contemporary and can focus on cutting edge science, increasing student interest.

Zeidler & Nichols 2009

- The Science in Society Investigation (SSI) in Irish Junior Cycle, The National 5 Assignment in Scottish Curriculum for Excellence.

Socio-Scientific Research in Irish Junior Cycle

- “
- The student will
 - Research a socio-scientific issue
 - Analyse information/secondary data
 - Evaluate the claims and opinions studied
 - Draw evidence based conclusions about the issues involved

“Students will collaborate as they prepare scientific communications for a variety of purposes and audiences.”

“They will learn about, and make informed decisions about, their own health and wellbeing, and about science-related issues of social and global importance”

Student-led socio-scientific research in a pre-service teaching module.

- The study was conducted over two years with two cohorts of pre-service teachers (PSTs), a total of 50 students.
- Students were in their second year of a four year undergraduate degree in mathematics, chemistry and physics teaching.
- The task was based on the Junior Cycle Science in Society Investigation.

Student-led socio-scientific research in a pre-service teaching module.

Phase 1: Research

Pre-service teachers carried out research over 3 hours. PSTs were given one week to upload an electronic document containing their research information and sources.

Phase 2: Communicating Findings

PSTs were given one hour to use complete a report using only the information gathered previously

Phase 3: Evaluation of the task



Pre-service teachers' experiences of socio-scientific research

After completion of the SSI the PSTs completed a questionnaire reflecting on their experience...

Think about your experience of the National 5 Assignment as a whole from the introductory lesson(s) to the research stage to the communication (report-writing) stage. The following questions ask you to talk about your own experiences and how you felt the National 5 Assignment went for you. This includes the skills and knowledge you feel you, personally developed through carrying out the Assignment.

START OF QUESTIONS

- What do you think are the learning intentions and success criteria of the National 5 Assignment in Science?
- From your experience of carrying out the National 5 Assignment, list the top 3 things you learnt? This may be knowledge or skills or something else. Give an example for each.
- What about the National 5 Assignment went particularly well for you? Give examples.
- What about the National 5 Assignment was particularly challenging for you? Give examples.
- If you had the chance to complete the Assignment again, what changes, if any, would you make to how you carried out your assignment?

Scientific literacy competencies used in socio-scientific research

...and completed a checklist of PISA competencies used

National 5 Assignment Scientific Literacy Answer Grid

Competency or Knowledge type		Skill used (✓ /X)	If skill was used, give examples of when or how you used this skill during the Assignment
a	Recall and apply appropriate scientific knowledge;		
b	Identify, use and generate explanatory models and representations		
c	Make and justify appropriate predictions		
d	Offer explanatory hypotheses		
e	Explain the potential implications of scientific knowledge for society		

Pre-service teachers' experiences of socio-scientific research

- Thematic analysis was carried out on the students reflections.
- The method used was based on Braun & Clarke (2006)

PSTs experience of the SSI



Skills

Knowledge

**Impact on
society & the
environment**

Thematic analysis identified three main themes

Researching
and
managing
information

Differentiating between sources
Evaluating sources
Finding information
Selecting information
Organising information
Comparing information

Skills

Presenting

Report
writing

Communicating
Structure

Questioning

Choosing questions

Asking questions

Answering
questions

Personal

Working independently

Planning

Forming an opinion

Knowledge

How & What

Stated “fact” /
knowledge related to
topic

Impact on society & the environment

Global/ National/
Personal & the
environment

Application

Benefits

Disadvantages

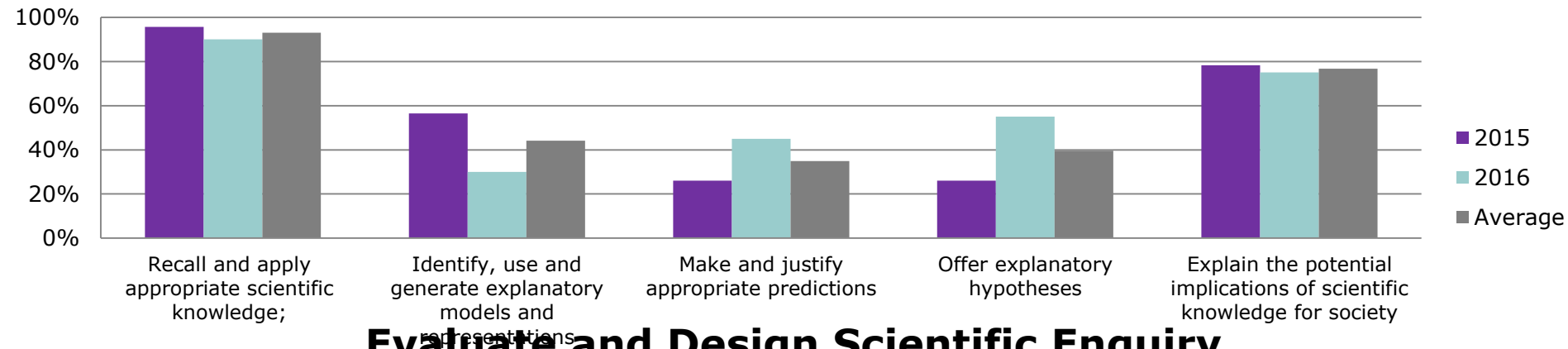
Pre-service teachers' experiences of socio-scientific research

- PSTs talked about their experience in terms of three themes:
 - Skills
 - Knowledge
 - Impact on society & the environment
- The largest theme was skills, consisting of four sub-themes:
 - Researching and managing information
 - Questioning
 - Presenting & report writing
 - Personal

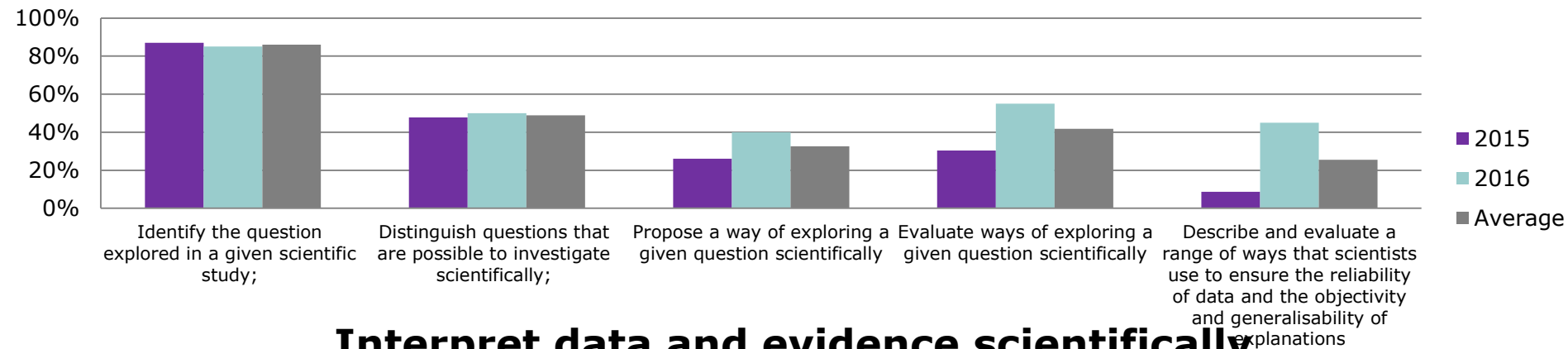
Scientific literacy competencies used in socio-scientific research

- Quantitative analysis was used to identify which competencies students felt they had used in completing the SSI.

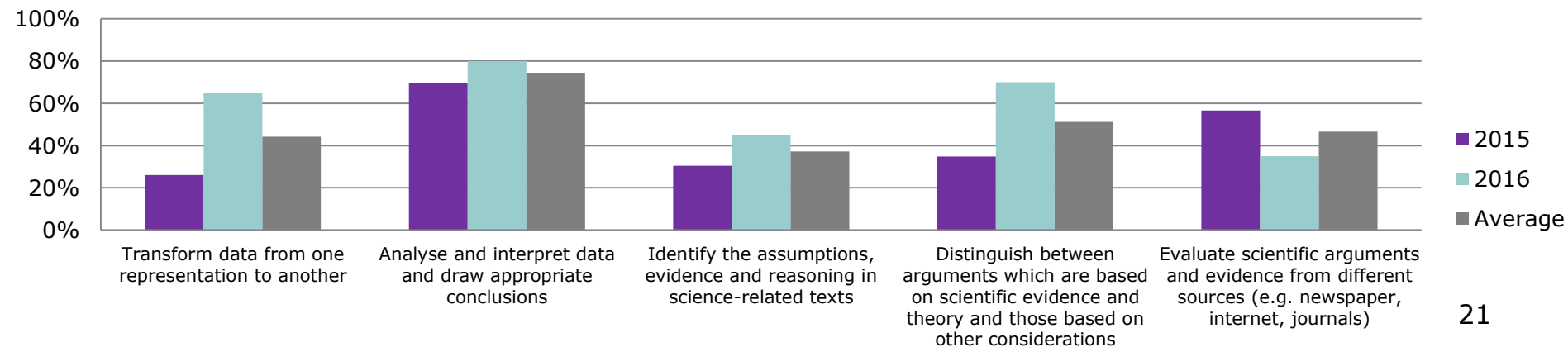
Explain Phenomena Scientifically



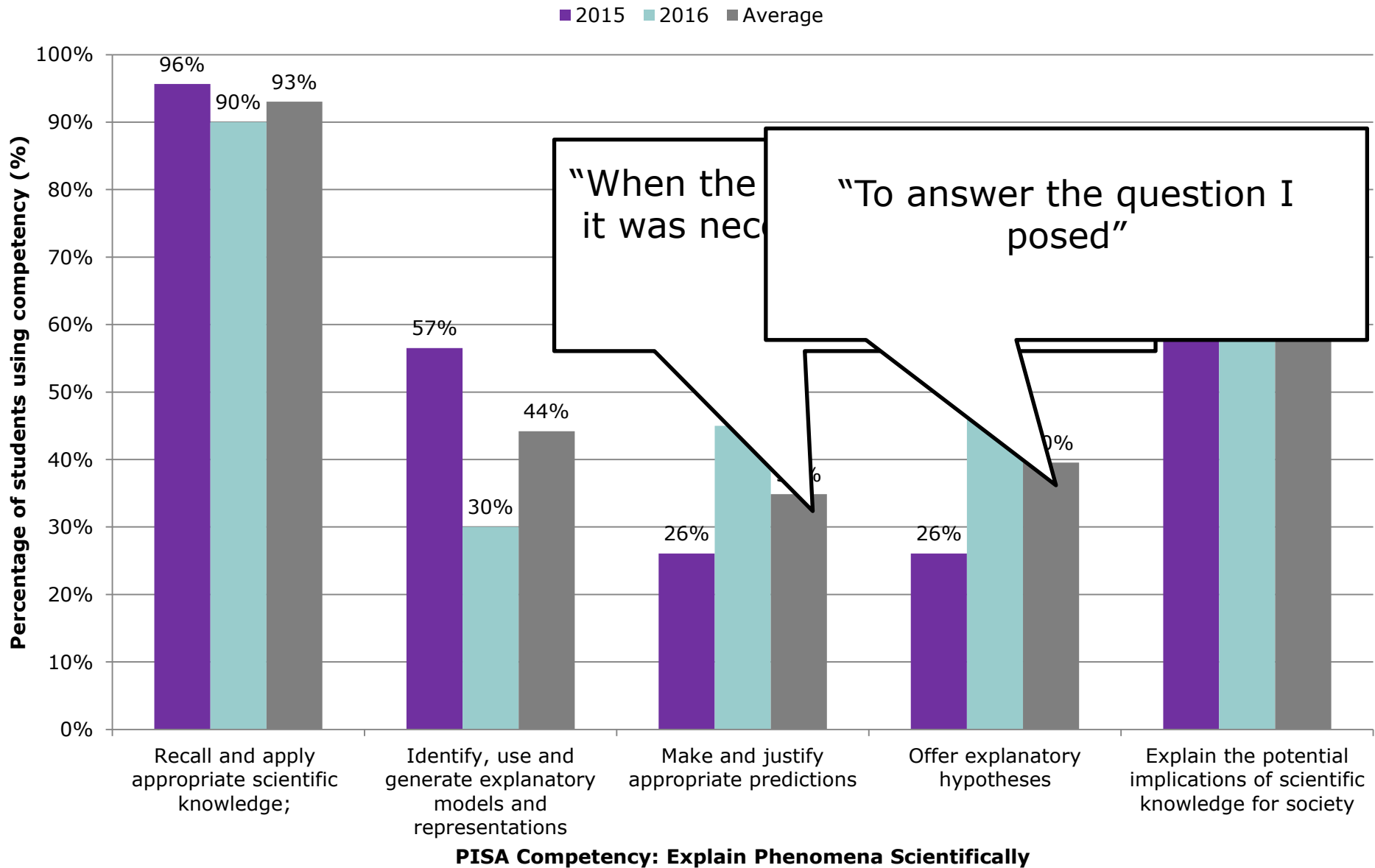
Evaluate and Design Scientific Enquiry



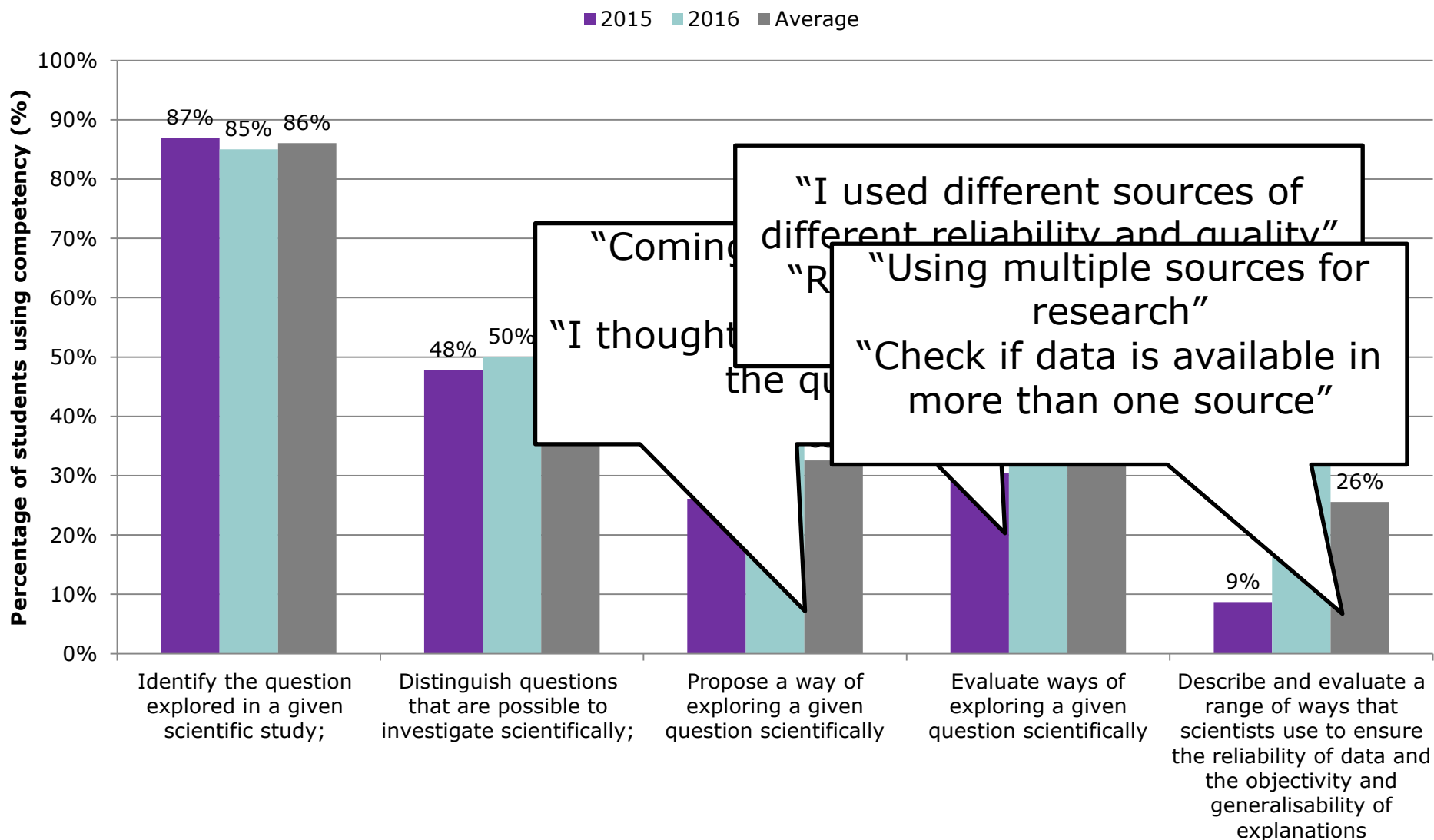
Interpret data and evidence scientifically



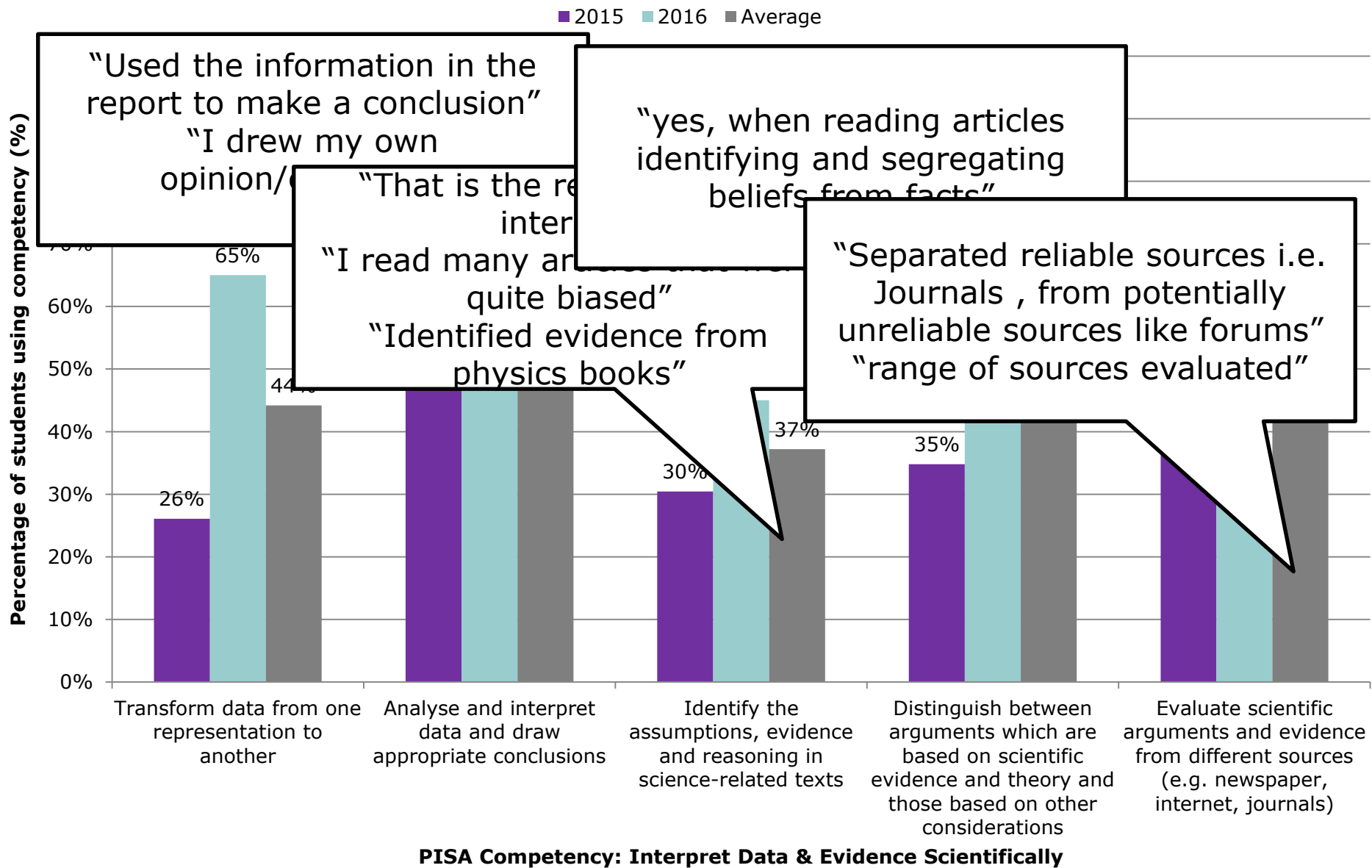
Explain Phenomena Scientifically



Evaluate & Design Scientific Enquiry



Interpret Data & Evidence Scientifically



Scientific literacy competencies used in socio-scientific research

	Average	
	2015	2016
Explain phenomena scientifically	56%	59%
Evaluate and design scientific enquiry	40%	55%
Interpret data and evidence scientifically	43%	59%

- Each competency was used by at least 25% of students
- Evaluate and design scientific enquiry was the least used competency
- The cohort in 2016 felt they used more competencies of scientific literacy than the cohort in 2015.

Conclusions and Implications

- Pre-service teachers (PSTs) carried out a student-led socio-scientific research task based on the Irish Junior Cycle Science in Society Investigation.
- PSTs experience focused on the skills used during the SSI.
- PSTs self-identified scientific literacy competencies used in socio-scientific research
- What are the implications of this for second level students?

Development or Assessment of scientific literacy?

“The purpose of assessment and reporting at this stage of education is to support learning.”


NCCA 2015 P21

“Students should have developed sufficient knowledge, skills and understanding over the course of first, second and third year to undertake an SSI in the middle of third year.”

NCCA 2016 p24

References

- Virginia Braun & Victoria Clarke (2006) Using thematic analysis in psychology, *Qualitative Research in Psychology*, 3:2, 77-101
- National Council for Curriculum and Assessment (NCCA) 2015. *Junior cycle science: Curriculum specification*. Ireland: National Council for Curriculum and Assessment (NCCA).
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Thank you for listening

Ruth Chadwick

Postgraduate Researcher

CASTeL DCU

Email: ruth.chadwick3@mail.dcu.ie