Some challenges for teaching and learning science at third level

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Introduction

I taught chemistry at 3rd level from 1970-2010.

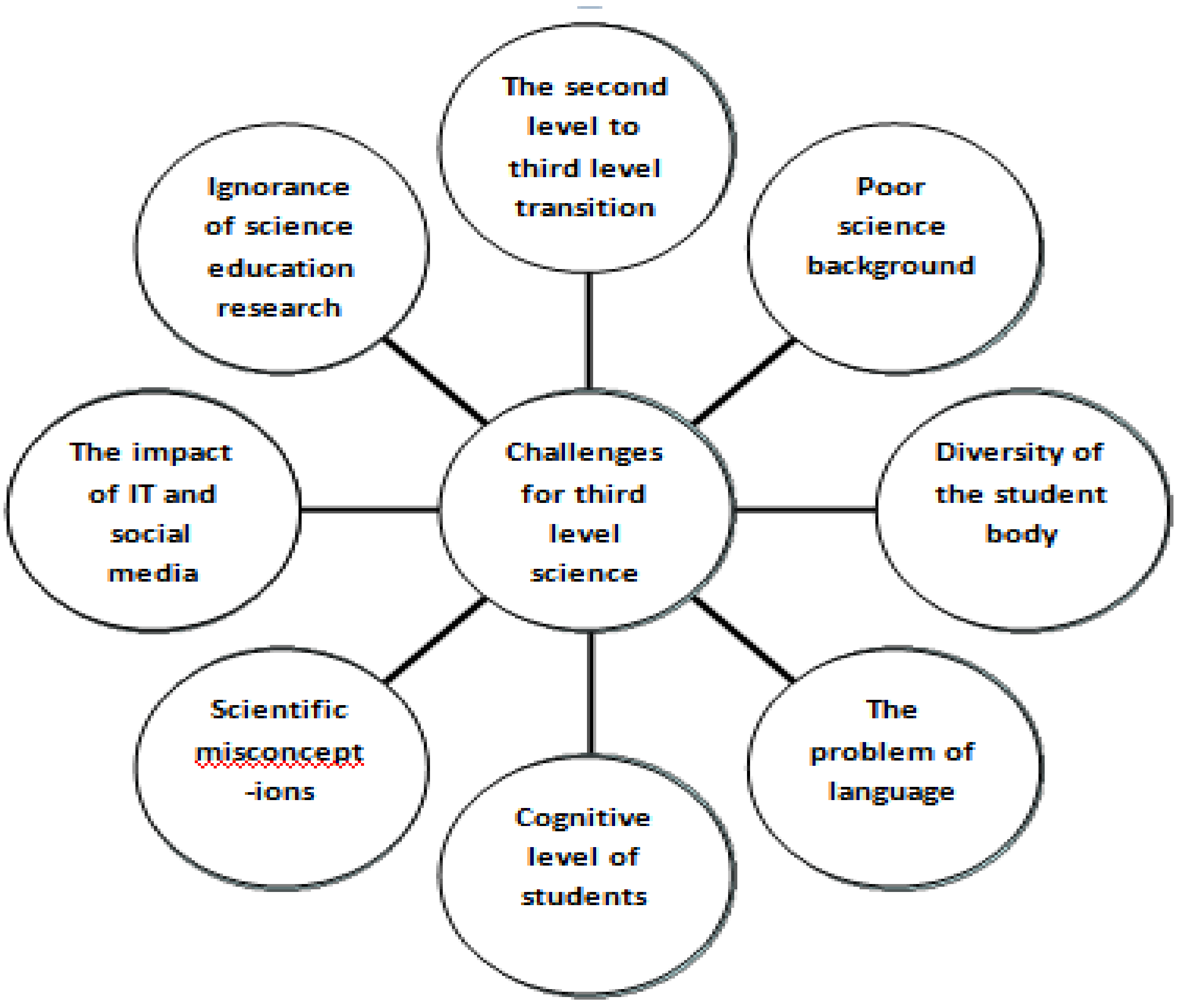
I have also been involved in 2nd level chemical education and chemical education research.

On the basis of my experience I want to reflect on some of the challenges for teaching and learning science at 3rd level in 2015.

Childs, P.E. (2014) The state of chemical education in Ireland, *Irish Chemical News*, 1, 16-25 Available online at http://www.chemistryireland.org/docs/news/Irish-Chemical-News-2014-Issue-1.pdf Accessed 24/4/14

Outline

1. The second level to third level transition;
2. The science background of undergraduates;
3. The diversity of the student body;
4. The problem of the language of science/literacy;
5. The cognitive level of first year students;
6. The prevalence of students' scientific misconceptions;
7. The impact of IT on teaching and course delivery
8. The lack of awareness of, and interest in, CER among most third level Chemistry lecturers;


The second level to third level transition
Ignorance of science education research
Poor science background
The impact of IT and social media
Challenges for third level science
Diversity of the student body
Scientific misconcept-ions
The problem of language
Cognitive level of students

1. The second level to third level transition

Factors rele

“I expect you all to be independent, innovative, critical thinkers who will do exactly as I say!”

- Changes i … um – less science, le
- Changes i … educed content a
- Change in … 3rd level: depender … .
- Sudden ju … ence from HS to first year university.

What can we do about it?

Be aware of the problem!

Take ac… …ident expe…

Provide…

Ease st… …style.

"Rats! I thought lanthanoids and actanoids were gonna be giant robots or something."

2. The science/maths background of undergraduates

- Variable science and maths background of undergraduates.
- Students may not have done a science subject in school that they do at university. E.g. ~15% of the Irish LC cohort do Chemistry.
- Students come in with a variety of HS maths skills – from 0 to 100%
- Wide variation in practical/laboratory skills.

e.g. A majority of those doing first year chemistry courses may have NOT done HS chemistry.

What can we do about it?

- **Be aware of the problem!**
- Separate 1st year courses for those with and without high school sciences.
- Use diagnostic tests to identify problem areas.*
- Remedial classes/tutorials for those without science or maths.
- Pre-university foundation courses (e.g. Germany).

If we do not take account of this fact then we will have large failure rates and drop-outs from 1st year.

*Childs, P. E. and Sheehan, M. (2009) 'What's difficult about chemistry? An Irish perspective' *Chem. Educ. Res. Pract.*, 10, 204

3. The diversity of the student body

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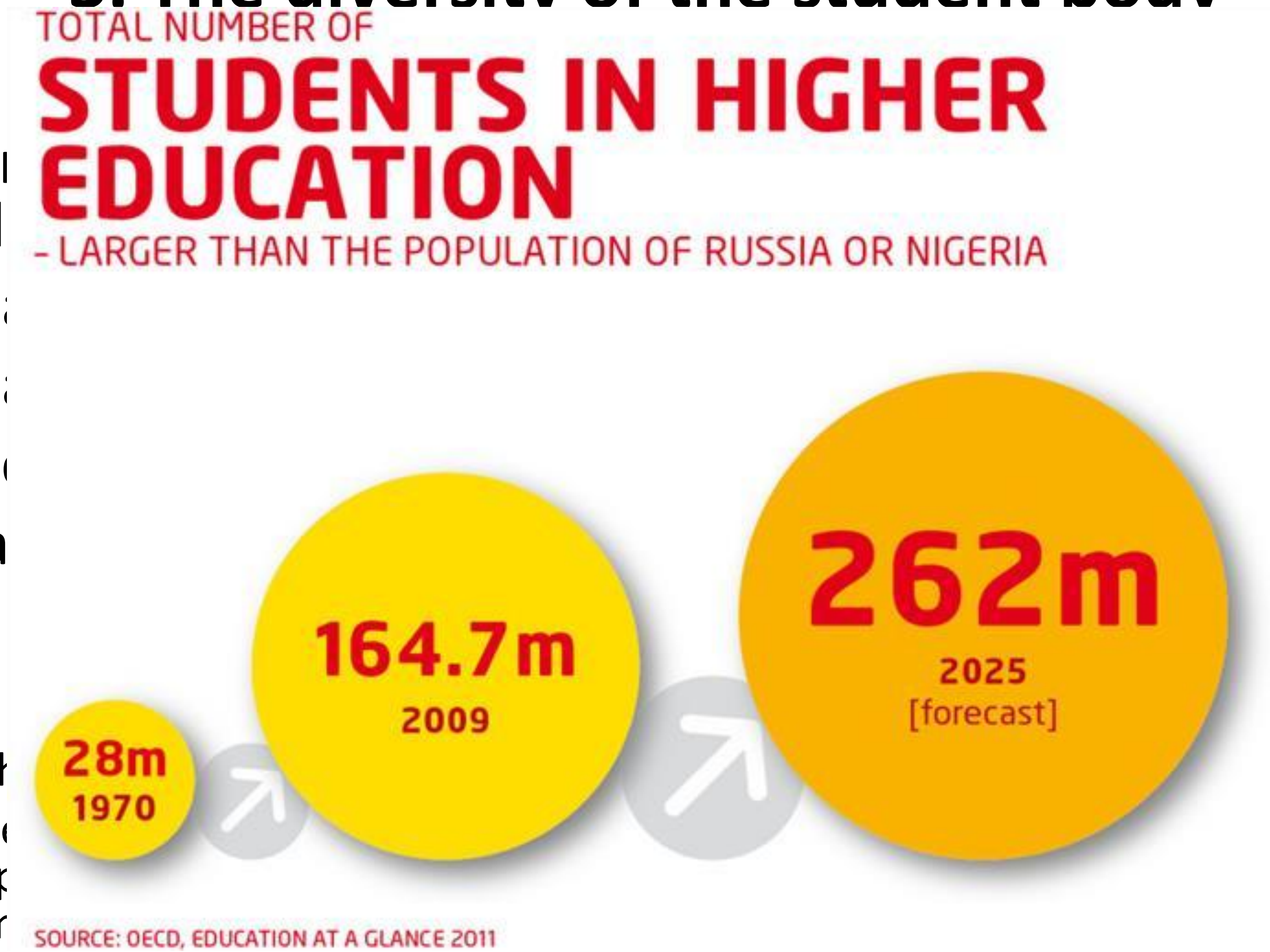

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What can we do about it?

- **Be aware of the problem!**
- We can do nothing about the diversity – result of political and social decisions.
- We should try to take account of relevant factors in our teaching.

4. The problem of the language of science and literacy

3rd level lecturers (experts) rarely think about the proble
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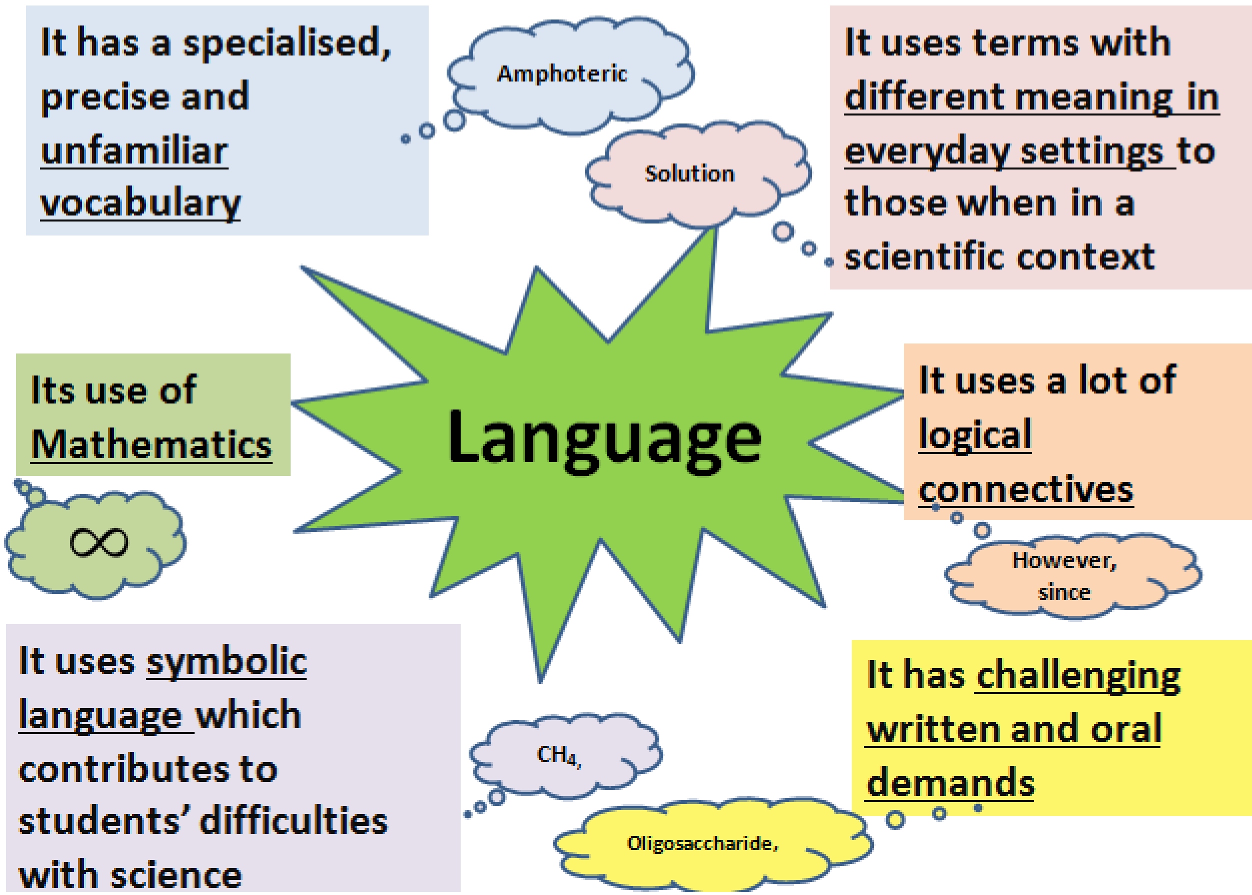
There are m
chemistry

General literacy skills are falling.

Some aspects of the language of science/chemistry



What can we do about it?

Be aware it is a problem and a barrier for students.

Identify problem words (technical and non-technical) and e

Clarify command v ... xams.

Encourage studen ... ew terms.

Ensure consistent ... ools across courses.

Develop and support basic literacy skills.

5. The cognitive level of students

We assume that our students can function at a high enough cognitive level to understand the abstract ideas and concepts we use.

As experts we understand scientific ideas concepts and assume our students can too.

Most of our first year students will not be operating at a formal operational levels needed to understand abstract concepts.

e.g. Cognitive level of Irish students

Study done by Maria Sheehan for her PhD (University of Limerick, 2010).*

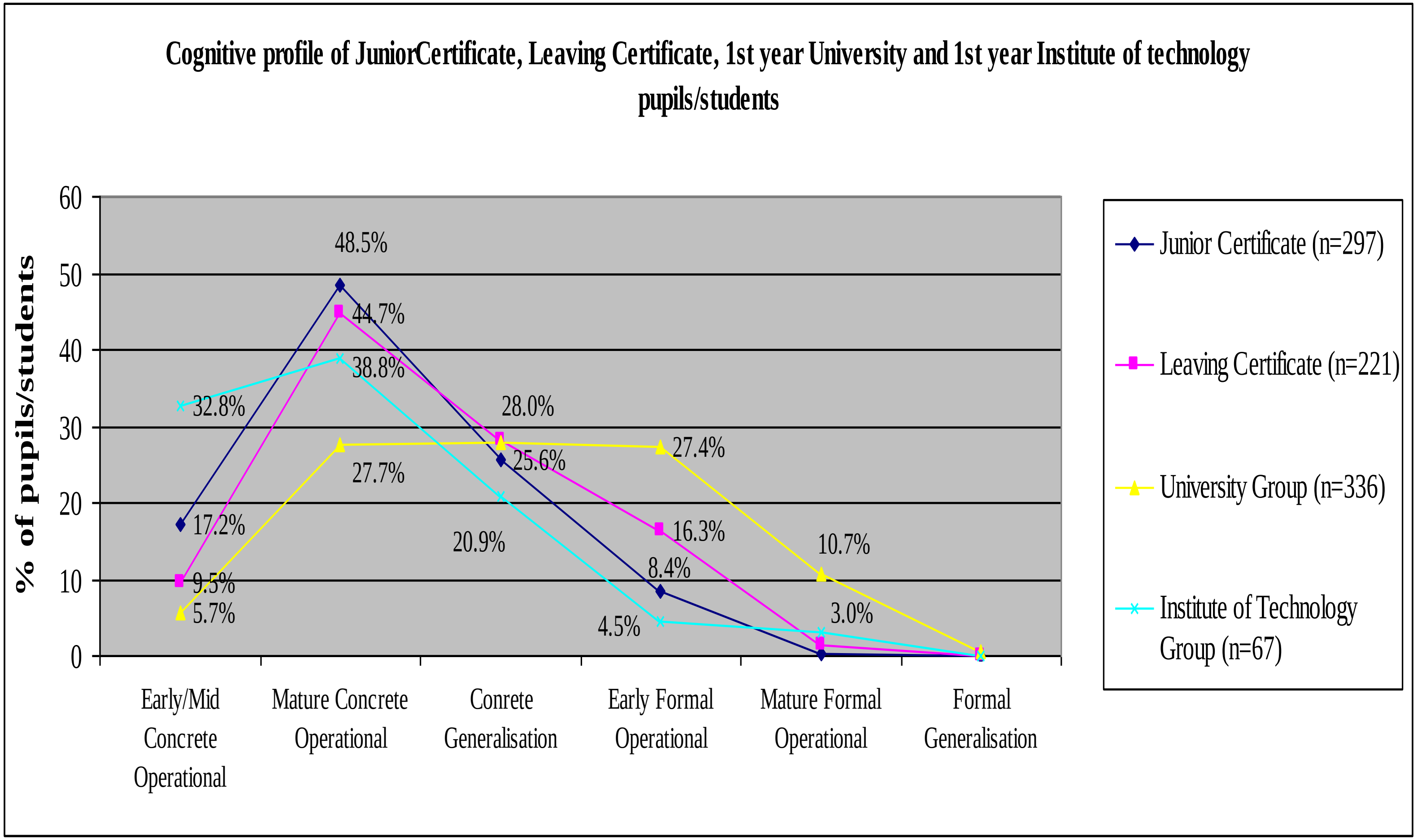
- Original test = Reasoning task number 4 (Equilibrium in the Balance). Developed by Shayer and Adey

- Original test had a practical demonstration accompanying it, this was altered for ease of administration in this investigation, by using a worked example.

- Test was content independent and did not require any previous or background knowledge.

* Sheehan, M. and Childs, P.E., 2009, ‘Does the Irish second-level system produce pupils who can think?’, ESERA, Istanbul

Comparison of Cognitive Levels for all four cohorts



Main Findings

The courses with the largest number of students operating at the formal operational stage of cognitive development are engineering courses .

	Engineering	Education	Science
% concrete	40.5%	67.9 %	77.3 %
% formal	59.6 %	32.1 %	22.7 %

Significant link with LH maths.

	University	IT
% formal (Higher level Maths)	55.0%	23.0%
% formal (Ordinary Level Maths)	11.9%	4.2%

What can we do about it?

Recognise the problem exists!

Provide opportunities for cognitive development in science courses, especially in first year.

Move from the concrete to the abstract – link concepts to the real world or to models.

Reduce level of abstraction, use of symbolic language.

6. The prevalence of students' scientific misconceptions

Misconceptions (alternative conceptions) are misunderstandings, wrong ideas and explanations picked up by students before and during 3rd level.

Some are students' own ideas, some come from their teachers and some from textbooks.

Such wrong ideas are persistent and hard to eradicate.

Study of pre-service science teachers' chemical misconceptions

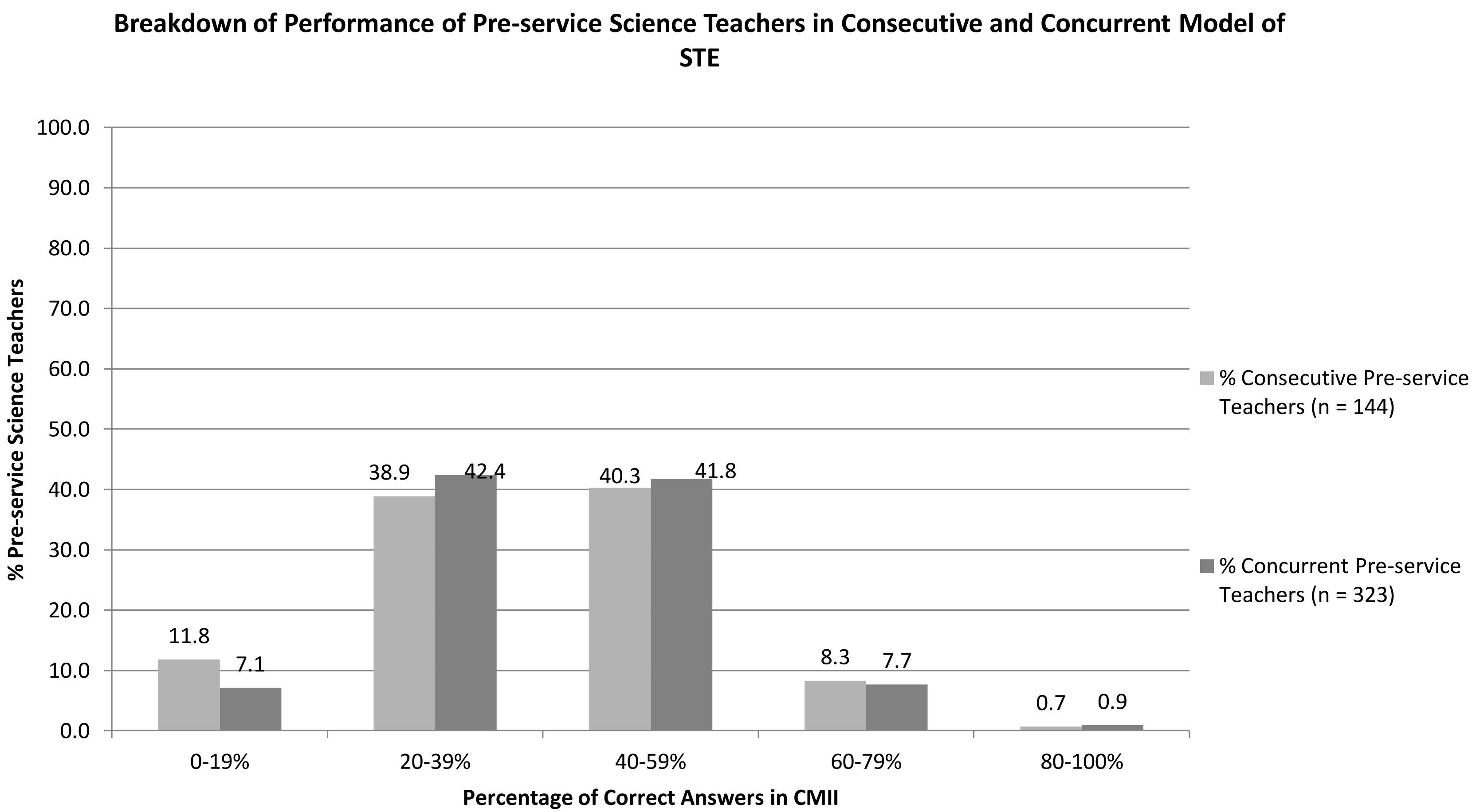
PhD study by Muireann Sheehan (University of Limerick).

Chemical Misconceptions Identification Instrument developed for basic chemical ideas.

Given to a total of 467 students on concurrent (323 over 4 years) and consecutive (144 postgraduate) science teacher training courses in Ireland.

Level of misconceptions

Sheehan, M. and Childs,P.E., 2013, ESERA 2013 Conference Proceedings



Main findings*

- 63.8 % of PSSTs overall scored ≤ 40% (average score 37.4%)
- No difference between concurrent students (1st to 4th year) or consecutive students.
- **Understanding of basic chemical ideas does not depend on the amount of formal chemistry courses done!**
- **Passing chemistry exams does not mean one understands chemistry.**

*Sheehan, M. and Childs, P.E., Proceedings ESERA 2013, A survey of chemistry misconceptions held by Irish pre-service science teachers and the development of strategies and materials to promote understanding, http://www.esera.org/media/esera2013/Muireann_Sheehan_06Jan2014.pdf

What can we do about it?

- **Recognise the problem exists!**
- Use early diagnostic tests to identify common student misconceptions.
- Address common misconceptions in lectures and in tests.
- Use formative testing to highlight and address misconceptions.
- Provide opportunities in tutorials for students to identify their own misconceptions and address them through discussion.

7. The impact of IT on teaching and course delivery

ICT has and will have increasing impact on student learning and our teaching:

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Students ar resources than with

8. The relative lack of awareness of CER among most 3rd level Chemistry lecturers

Most 3rd level chemistry lecturers are appointed and promoted on the basis of their research.

Teaching is often seen as a secondary activity.

The purpose of university teaching is often seen as direct transmission of knowledge and skills.

Learning is seen as the responsibility of the students.

"I give them information, they write it down, they learn it."

Retired chemistry professor

(P. Adey, (2001) *SSR*, 82 (300), 41-48)

What can we do about it?

Recognise the value of science education research (SER).*

Recognise teaching and research into teaching and learning for appointment and promotion.

Implement SER in our own teaching and learning and share ideas with our colleagues.

Encourage our colleagues to attend science education meetings.

Bring relevant science education articles materials and projects to our colleagues' attention.

* Childs, P. E., (2009) 'Improving chemical education: turning research into effective practice', *Chemistry Education Research and Practice*, 10, 189 – 203

Conclusions

There are many challenges in 3rd level science in 2015 and for later years.

Some of them are long-standing and others are new.

There is more awareness now than when I started about the issues involved in the teaching and learning in science.

There has been more SER and more evidence to draw on to improve teaching and learning.

There is still not enough use of SER to inform teaching at third level.*

*Childs, P.E., From SER to STL: translating science education research into science teaching and learning', *JOURNAL OF SCIENCE EDUCATION (Revista de Educación en Ciencias)* 14(2), 55-60

Thanks for listening