



Introduction

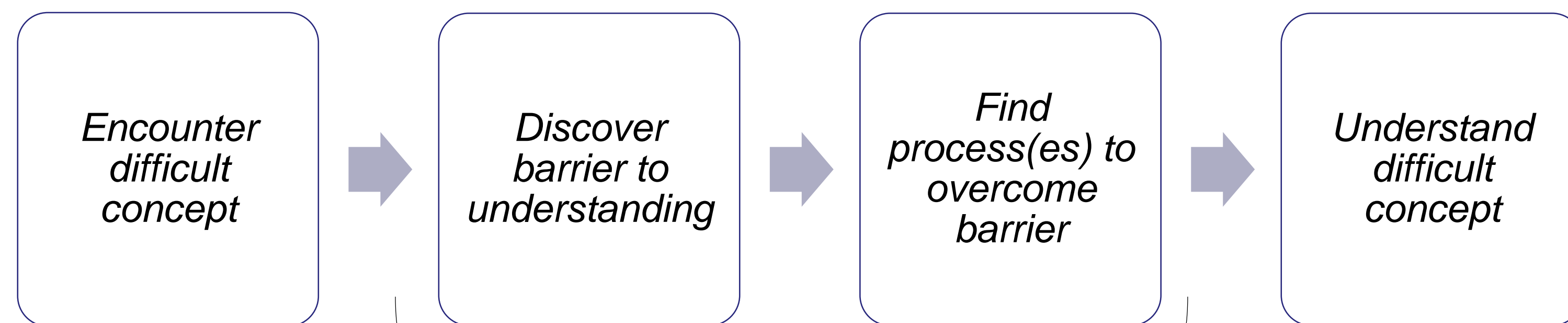
Aims of Project

1. Identifying threshold concepts
2. Understanding the most effective processes
3. What can universities do?

Threshold Concepts

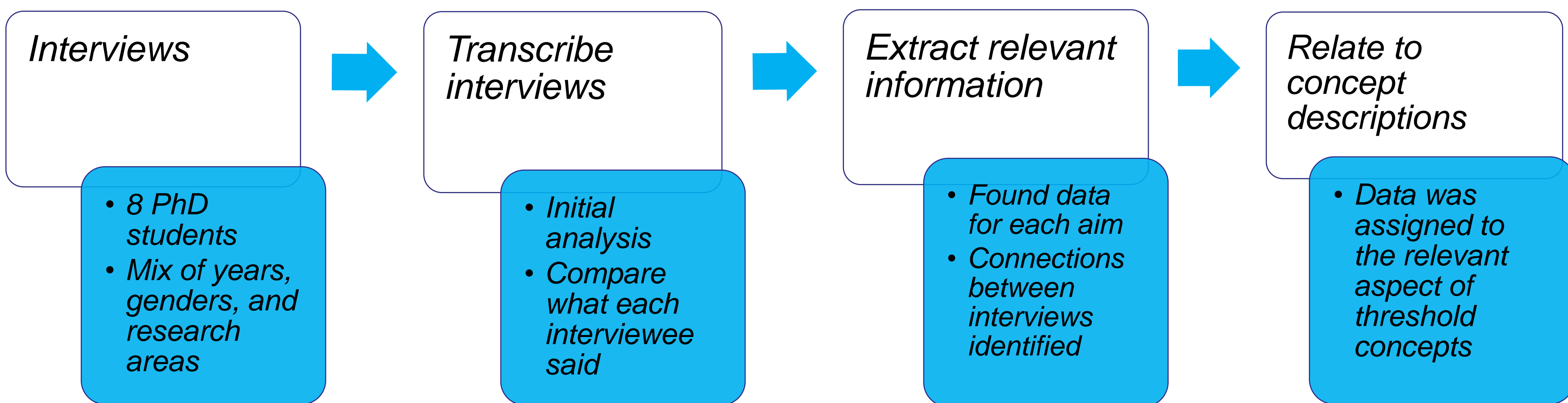
The key aspects of Threshold Concepts are:

Transformative
Troublesome
Irreversible
Integrative
Bounded
Constitutive
Discursive^[1]



Liminal Stage – state of flux between novice and expert^[2]

Method



Example of Questions for Interviews

1. Tell us a little about yourself (Name, age, undergraduate degree and university, current area of study)
2. Did you ever have a “lightbulb moment” during your undergraduate degree?
3. What kind of study do you think was most helpful? Group work? Lectures? Labs?
4. What do you think would have made the experience easier? Is there any way the university could have helped?
5. Do you feel like it had an effect on your understanding of other areas of physics?

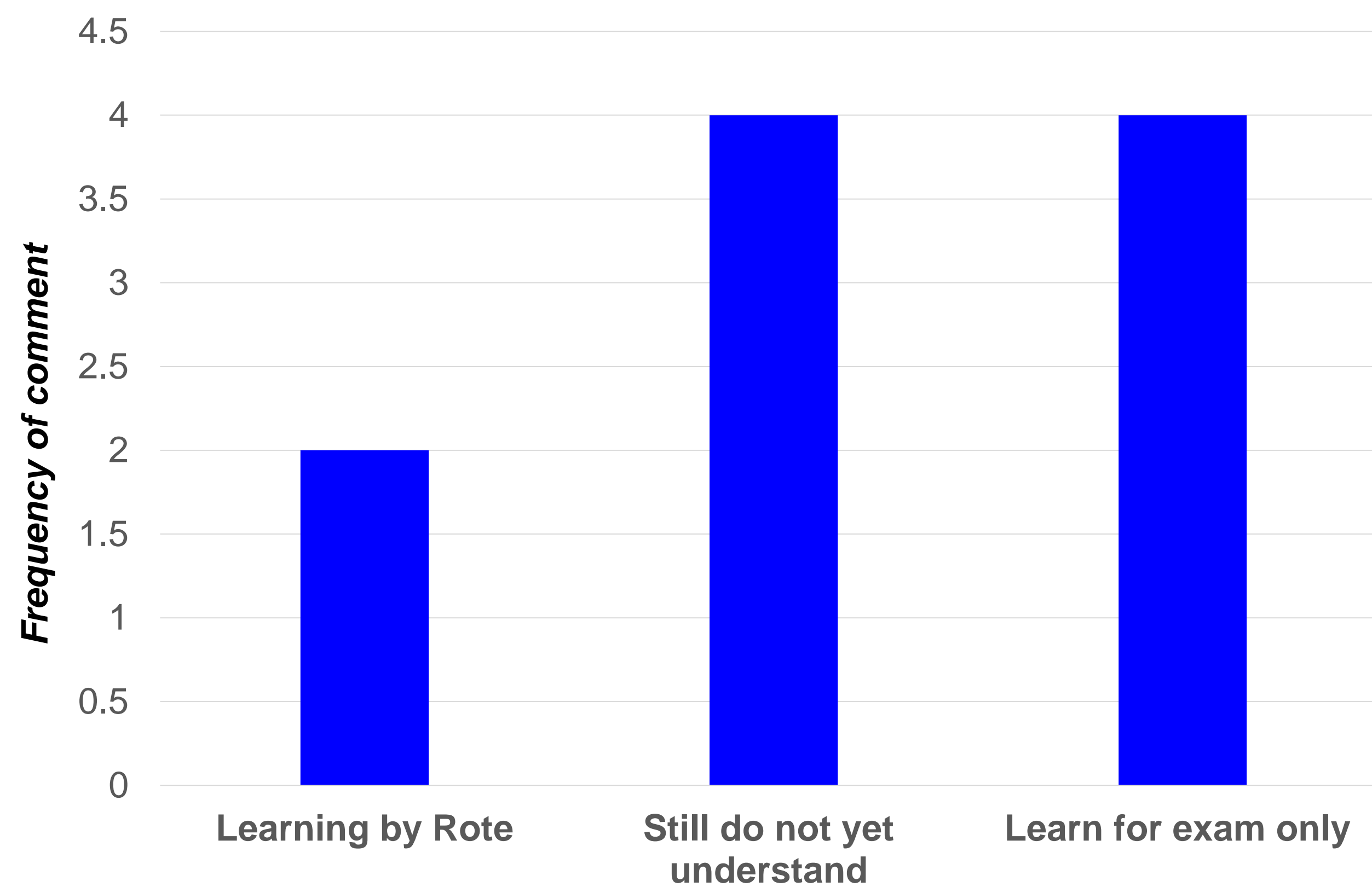
Results

■ Troublesome ■ Integrative ■ Constitutive

Identified Concepts	Processes	What Universities Can Do
Math Methods II	Group work	Less content
Circuits & Systems	Relate to simple problem	Discussion with Professors/lecturers
Fourier Transform	Finding the right explanation	Point out links in courses
Quantum Mechanics	Linking to real world	Link lectures and labs
Quantum Field Theory	Linking different knowledge/courses	Link to real world
Maxwell's Equations	Different contexts	Providing various notes
General Relativity		

Concepts were identified by relating what interviewees had said to each of the definitions of threshold concepts. Each of the processes used and suggestions for what universities could do were related to aspects of threshold concepts. Mostly these processes and suggestions were related to the integrative or constitutive descriptions. This links well to the concepts identified as they tended to be relevant to many fields in physics or are not intuitive and require a new way of thinking.

Liminal Stage



It was assumed that all interviewees had passed through this liminal stage for the previous analysis, but this may not be an assumption that can be made. Much of the language used during the interviews implied that the PhD students are still moving through this stage. Also, many of the concepts mentioned are quite vague. It is possible that only through using these concepts practically, as the PhD students are doing now, that one can fully understand them and pass through this liminal stage.

Conclusion

Identified were: seven threshold concepts, six helpful processes and many suggestions for what universities can do to help support student learning.

Although experts in their own fields, our interviewees, PhD students, may have yet to passed through the liminal stage of some of the identified threshold concepts. Therefore, the data collected may not represent the complete picture of threshold concepts in undergraduate physics. Nevertheless, processes which helped them during their degrees can still be valuable pointers for current undergraduate students and form the basis of suggestions for practical steps the universities can take to support students in mastering difficult concepts. The most obvious of these is that students want the links between courses, practical applications and the real world to be made more obvious. This would be something that could be added to most courses simply.

References:

- [1] Meyer J H F and Land R 2003 'Threshold Concepts and Troublesome Knowledge 1 – Linkages to Ways of Thinking and Practising' in *Improving Student Learning – Ten Years On*. C.Rust (Ed), OCSLD, Oxford
- [2] Land, R., Rattray, J. & Vivian, P. *High Educ* (2014) 67: 199. doi:10.1007/s10734-013-9705-x
- [3] *Proceedings of the 16th UniServe Science Annual Conference*, 2010, 2010, pp. 98 - 103