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Designing Professional Development for Post-Primary Mathematics and Science Teachers: Two Different Approaches Stemming from an Out-of-Field Experience.

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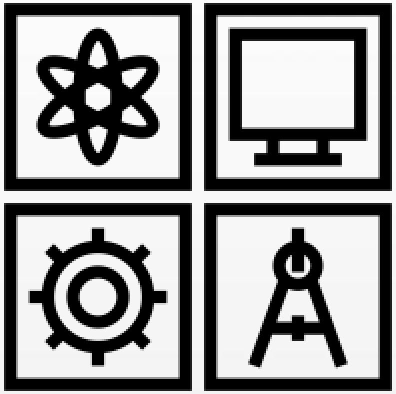
The EPI-STEM Centre

National Centre for STEM Education

The values of EPI•STEM are guided by six core values in the realisation of our vision: excellence, creativity, ethics, sustainability, community and global focus.

- Postgraduate Students
- Research in STEM Disciplines
- Staff from STEM Disciplines
- Funding (DES, Sfi, HEA)
- Outreach Projects
- Conferences
- Visiting Fellows
- Industry Partnerships (ESB and Johnson and Johnson)



www.epistem.ie

Why EPI-STEM for this HEA Funding?

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PDMT – Postgraduate Diploma in Mathematics Education

Why/Who?

- Led by EPI-STEM
- Upskilling OOF mathematics post-primary teachers

How?

- DES Funded
- Blended learning approach
- Significant amount of resources
- Frameworks – Cosán, Teaching Council, JCT, PDST Guidance

Results

- 1100 Teachers completed (Goos, O'Donoghue, Ni Riordáin, Faulkner, Hall and O'Meara, 2020).
- 48% OOF decreased to 25% OOF ; never going to be at zero
- International Reputation
- PDMT positive influence on teachers' efficacy and teaching practices (O'Meara and Fauklner 2021).

HEA Mathematics Project

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Maths Project: Study Aims and Phases

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Phase One

- Review of literature and frameworks
- Framework design
- Existing teaching resources

Phase Two

- Survey to identify mathematics topics
- Identify school cluster/group of teachers
- Design, develop, pilot resources

Phase Three

- Publish resources online
- Monitor engagement/feedback
- Revise framework/resource template

Framework Design

Framework: Professional Development

Desimone (2009):

- the importance of *critical features* of professional development
- content focus, active learning, coherence, duration and collective participation

Loucks-Horsley et al. (2010):

- Effective professional learning – directly aligned to student learning needs
- Learning experiences connected to classroom practices
- Design process: *knowledge and beliefs, context, critical issues, strategies*

Framework: Professional Development

Mathematics Teacher Knowledge and Beliefs

Knowledge & Beliefs

Context

Post-PDMT; Curriculum & Assessment; Online

Covid-19; Teacher Input; Engagement

Critical Issues

Strategies

Needs analysis; Design Based Research

Framework Design

Knowledge & Beliefs

- Mathematics Teacher Knowledge: Teacher quality plays a significant role in influencing student achievement (Darling-Hammond, 2000)
- The Mathematical Knowledge for Teaching (MKT) framework (Ball, Thames and Phelps, 2008)
- Common Content Knowledge (CCK) and **Specialized Content Knowledge (SCK),** Knowledge of Content and Students (KCS), Knowledge of Content and Teaching (KCT) and Knowledge of Curriculum.
- **Practical Emphasis**
- Beliefs?

Knowledge & Beliefs

- Teachers' beliefs account for differences between teachers' practices in the classroom, despite these teachers having very similar knowledge (Ernest, 1989)
- Beliefs about the nature of mathematics (epistemological), mathematics teaching and mathematics learning (pedagogical) (Beswick, 2012)
- Transmission vs Child-centredness
- Other affective factors: Motivation

Knowledge & Beliefs

- Learning Theories: both for the teachers and the students
- Learning Cycle: Engage, explore, explain, elaborate, evaluate (Bybee, 1997)
- Learning as a process of change: Additive and transformative learning (Loucks-Horsely et al., 2010)

Framework Design

Online Teaching & Learning

- Exemplary Approach: Bennison, Goos & Geiger (2020)
- Existing Resources – database to identify gaps
- Potential for open online learning – resources for teachers that addresses their personal learning needs

Methodology and Data Collection

- Design-Based Research
- Ethical approval
- Survey of teachers' professional development needs
- School cluster or group of teachers to collaborate in the design, development and piloting of resources
- Publish resources online and review engagement and feedback -> revise framework if necessary

HEA: Science Upskilling Programme

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Dr Stephen Comiskey
Projects Officer (Science Education)

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Example: Joanne

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B.Sc with Concurrent Teacher Education

Majored in Biology and Agricultural Science

Photo by Jacob Lund from Noun Project

Requirements for Registration

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An Chomhairle Mhúinteoireachta
The Teaching Council

60 ECTS (Phys/Chem/Bio/ Ag.Sci) + 10 ECTS (Phys/Chem/Bio) + 10 ECTS (Phys/Chem/Bio) = Fully Qualified (LC & JC)

What is Joanne Qualified to teach?

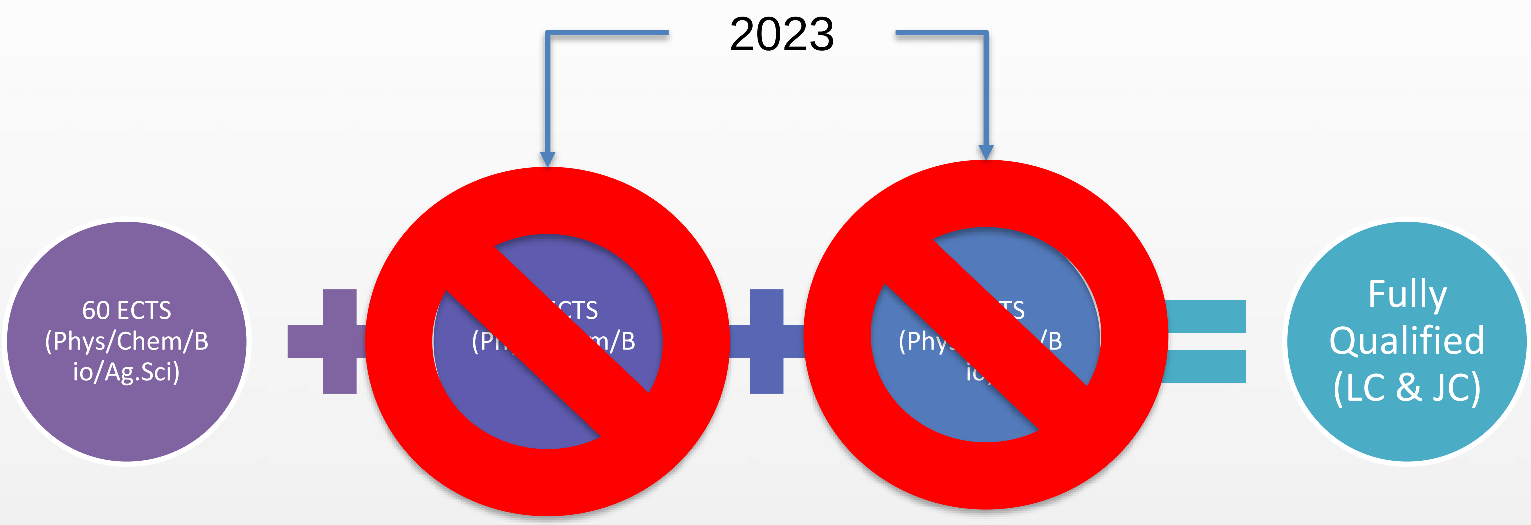
B.Sc with Concurrent Teacher Education

Majored in Biology and Agricultural Science

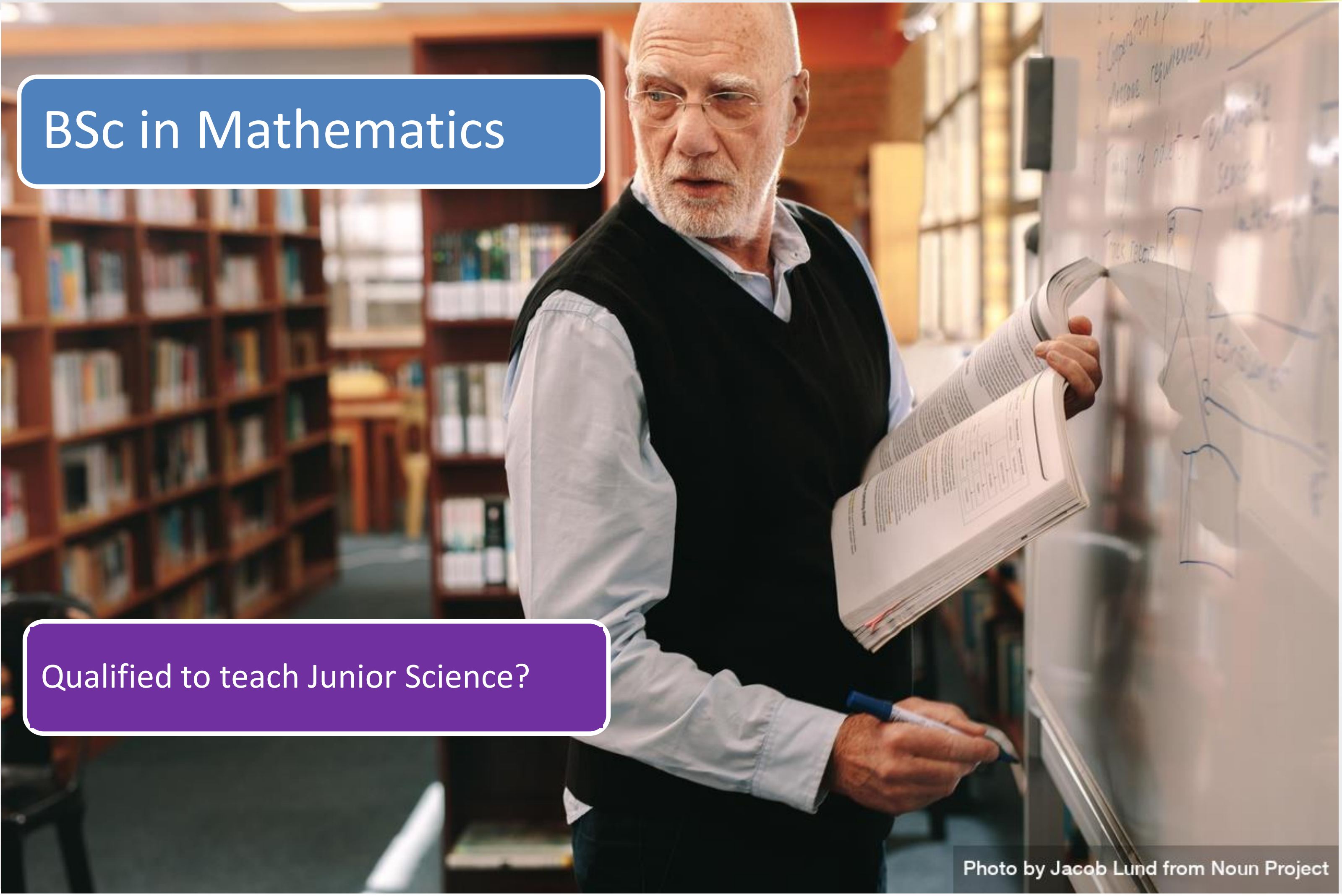
Qualified to teach Biology/Ag Science to LC?

Qualified to teach Junior Science?

Requirements for Registration



Will John be Qualified to teach in 2023?



Out-Of-Field definition

- *"Out-of-field is defined as qualified teachers assigned to teach subjects and year levels for which they are not qualified. It includes trained teachers who teach outside of their area, such as teaching math although they were qualified as a science teacher"* (Du Plessis *et al.*, 2017)
- But how does this apply to science?

Near-Out-Of-Field/Out-Of-Specialisation

Full Alignment

- Has discipline and methodology
- Has a major in Science subject being taught
- E.g.: Chemistry teacher teaching JC chemistry topic

Partial Alignment

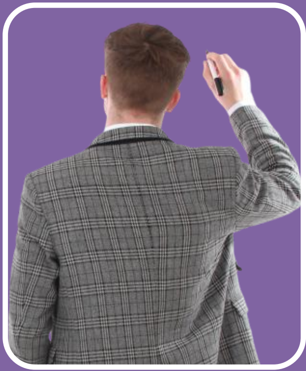
- Has discipline or methodology
- Has a minor in science subject being taught
- E.g.: Chemistry teacher in JC Biology Topic

Technically Out-of-field

- Possess neither discipline nor methodology
- Has no qualification in the discipline area
- E.g.: Metalwork teacher in JC Science Class

This was never possible, but will be from 2023

Current figures



Biology – 3601

Chemistry – 2156

Physics - 1135

Biology – 27063

Chemistry – 8244

Physics - 6583

Why now?

- Student uptake appears dependent on number of qualified teachers in that subject

- Physics based jobs attribute €38bn to Irish economy (IOP, 2017)

- Physics seen as gateway subject to jobs such as engineering

- Removal of Teaching Council requirements for JC Science

Strategy

- Roll out survey nationally
  - Identify attitude, beliefs and trends
  - Isolate problematic areas
- Develop upskilling programme focused on CK and PCK
  - Quicker and more efficient than educating new teachers
  - Lean and agile – adopt to needs

Conclusion

- Science and Math's aspects of the HEA Projects discussed have multiple common threads
- Maths's distributary brings the out-of-field maths experience to the professional development pool to extend to all mathematics teachers. (An almost ‘after’ out-of-field epilogue)
- Science distributary brings the out-field maths experience to a new near-out-of-field science chapter.

Thank You.

Any questions?

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