Nurturing Epistemic Agency: How interdisciplinary enquiry develops research-engaged practitioners

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Epistemic knowledge describes what student-teachers and their pupils learn about the methods, processes and norms of thought related to distinct disciplines. OECD considers such knowledge imperative for the 21st century (OECD, 2018, 2021). Epistemic knowledge enables student-teachers and their pupils to think and act like scholars. It provides relevance and purpose to their learning and develops 'disciplinary knowledge' (Ofsted, 2021). The Epistemic Insight (EI) initiative at Canterbury Christ Church University allows student-teachers to create pedagogies for developing pupils' epistemic insight and agency in schools (Billingsley, Nassaji et al., 2018).

Three case studies illustrate how student-teachers could become research-active practitioners with the tools to develop children's epistemic curiosity and interdisciplinary thinking. Student-teachers explored the impact of teaching approaches that cross disciplinary boundaries in placement schools.

The first case study illustrates the potential of scientific observation for furthering primary student-teachers understanding of the nature of science. With this understanding, they can support their pupils' articulation of the importance of observations in advancing scientific knowledge. The other two emphasise how primary and secondary classroom-based research projects enable student-teachers to investigate their epistemic insight. In each case study, student-teachers gain the agency to research aspects of their teaching and respond to the unique perspectives of their pupils. Such experiences prepare student-teachers to become leaders of learning and reflective practitioners.

<A>Case study 1: A focus on the critical role of observation in science

Through incorporating epistemic insight into curriculum assignments, student-teachers research why teachers must understand the importance and limitations of scientific observation. They gain epistemic knowledge: an understanding of the critical role of observation in science as a method of enquiry. They can recognise some methods are more scientific than others. They can use this knowledge to promote positive attitudes towards scientists and their societal roles amongst pupils.

Through constructing a lesson plan and suitable assessment-for-learning strategy, student-teachers critically analyse how they can support students' observation skills development. Through testing the plan, they evaluate the quality of pupils' scientific observations and potential factors influencing their observations. They become equipped with the understanding needed to help pupils comprehend that science begins with them making observations of the world and constructing ways to explain them. The assessments challenge student-teachers to move beyond teaching lessons that focus on transmitting scientific knowledge and the provision of 'recipe-style' experiments. They generate pedagogies that foster children's critical thinking skills. Having analysed potential barriers to

observation, they reflect on strategies for overcoming these and what pupils should observe to understand the chosen phenomena.

Through research-informed practice, trainees become enthused about teaching practical science. They and their pupils learn science methods to answer questions about their world. An extract from one trainee's Scholarship Day presentation illustrates how the assessment enabled her confidence to plan 'interesting' science lessons (**Figure 1**). She communicated how observations form 'a fundamental part of the learning process'. She appreciated the importance of teachers scaffolding students' observations while facilitating their autonomy to raise questions for investigation and test ideas. She devised the science question, 'How do plants grow?'. She learned that scientific methods involve prediction, testing, observation, undertaking measurements, pattern-seeking and causation.

<INSERT FIGURE 1 HERE>

She invited students to grow plants from mustard seeds in different conditions. 'Observing plants growing 'captured students' interest', promoted positive engagement in the learning process and 'challenged students' naïve theories about the world'. She discovered that using a card 'peephole' and a magnifying glass focused students' observations on the evidence relevant to plant growth. She also reflected on the questions teachers should pose to facilitate observation: What changes could they find on a single leaf on each plant over time? Students drew and made sense of the changes in leaf colour, size and texture resulting from differences in the light and water that each plant received. They made predictions based on their existing ideas and interpreted test-based evidence. She concluded that 'peer-to-peer and whole-class discussions allowed for greater reflection on the learning processes'.

Module tutors signpost trainees to EI pedagogies developed and tested in schools by the University's Epistemic Insight research team. Student-teachers found Essential Experiences in Science investigation cards helpful when planning 'hands-on' science. Lesson plans guide teachers through exploring the nature of science and 'big questions' that cross disciplinary boundaries (Billingsley et al., 2020). The big question card 'How do clouds stay up?' explores how clouds are made up of water droplets held together in the earth's atmosphere and explains why it rains (**Figure 2**).

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Having researched one discipline in depth, student-teachers devise a 'big question' for pupils to investigate. They learn the types of knowledge and methods that different subject disciplines contribute to an investigation. The question 'Why did the *Titanic* sink?' invites exploration of how science and history scholars approach the question. They evaluate the strengths and limitations of each discipline.

<A>Case study 2: Researching teaching and learning in the primary classroom

PGCE student-teachers gain the skills they need to be research-engaged practitioners when they plan, implement and present small-scale qualitative classroom-based research project. A module focussed

on researching teaching and learning provides them with opportunities to investigate pupils' ideas about the distinctive nature of disciplines and their responses to big questions, and they co-create and evaluate the use of pedagogies that inspire interdisciplinary enquiry. They learn about inclusive data-collection methods that promote student voice. Both trainees and students develop epistemic curiosity and interdisciplinary modes of thinking. They gain awareness about how knowledge works and can be applied through interdisciplinary approaches to learning. Trainees become scholarly and independent practitioners, capable of creating innovative research-engaged approaches. They can disseminate these to the wider educational community.

Trainees respond creatively to the challenge, capitalising on their interests and disciplinary expertise. Two trainees exhibited curiosity about Year 5 and 6 students' ideas about 'What are the origins of the universe?' They investigated students' views on the relationship between science and religion. One trainee devised a creative lesson that crossed disciplinary boundaries. He sought students' views on this question before and after they discussed creation narratives and the 'Big Bang'. While most students initially perceived that science provided the answer to this question, he noticed a shift in students' thinking after his teaching. He reflected that those students learned that religion and science contributed valuable perspectives and were surprised that scientists could hold religious beliefs. Both trainees sought to provide opportunities for students to explore big questions and discuss the science–religion relationship as early careers teachers.

Figure 3 represents an extract from a PGCE primary trainee teacher's presentation for the Scholarship Day. She was interested in whether students could connect their learning in science in the classroom to real-world contexts. She built on students' interest in space exploration as a stimulus for research. Students investigated 'How do astronauts live in space?' She was surprised that students had a limited understanding of what scientists do. They failed to see themselves as scientists in the classroom. They looked to their teacher to provide the answers to their questions, rather than finding things out for themselves. She noticed how students drew on their own food choices based on previous learning about healthy eating in school when suggesting what astronauts might eat in space. She concluded the need for students to explore more examples of the application of science in real-life contexts.

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A trainee interested in archaeology explored 'How do students perceive the ways in which evidence is used in history and science?' She demonstrated epistemic agency by enabling students to think like historians and scientists. In history, students reflected on what they learned about the Roman clothes in Pompeii by exploring mosaics. In science, students investigated the construction and use of materials in mosaic-making. She found that they gained a complete understanding of an ancient artefact using the methods and norms of thought associated with two disciplines. Her study reflected how historians use sources of evidence to construct a knowledge of the past that is open to interpretation, and scientists use evidence to test ideas and support or refute arguments. Her students gained knowledge about how to critique and evaluate sources of evidence.

Trainees became curious, creative and reflective critical thinkers. They gained the capacity to influence or transform pedagogical practices in schools. Students gained awareness of the nature of science, its

powers and limitations and its role in society. They could compare the methods that scholars of different disciplines use to investigate big questions.

<A>Case study 3: Secondary PGCE trainee teachers' research and enquiry in education

Secondary PGCE trainees are encouraged to become research-active practitioners and change agents for the curriculum of the future. This goal includes nurturing essential postgraduate expertise, including critical thought and developing personal and professional skills. To achieve this, trainees explore pedagogic practices during their Collaborative Teaching Phase (CTP) and conduct individual research in the Research, Enquiry in Education (REE) module. Both activities have the explicit higher education objective of 'exciting curiosity [and] opening minds' (OfS, 2018).

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The REE module requires participants to reflect upon their professional practice through research to develop their practice. Students can explore cross-disciplinary learning strategies through theoretical and applied perspectives to enhance learners' epistemic insight. Trainees collect data using applied research methods within secondary schools, and their subsequent analysis of the data informs trainees' individual research reports and presentations. They evaluate cross-disciplinary learning strategies designed to enhance learners' curiosity and epistemic insight. The CTP involves students' research engagement with questions relating to subject pedagogy and interdisciplinary practice.

Regarding the former, trainees are asked how they can help students to appreciate the strengths and limitations of different disciplines and how this understanding might inform how they respond to a big question. Regarding the latter, trainees investigate a question from two disciplinary viewpoints to build a student's appreciation of the distinctive questions, methods and norms of thought used within each discipline. To enhance trainees' learning experiences, they present their research during the Scholarship Day. The day is student-led to give them ownership over their scholarship and provide greater experience of academic dialogue and leading professional developmental practice.

One group of trainees explored the discipline of history in relation to other disciplinary insights while investigating the Beaney House of Art and Knowledge in Canterbury. By exploring a range of artefacts, trainees generated innovative ways in which these resources could inform interdisciplinary questions and investigations. Trainees could consider how the curriculum might be approached outside the classroom to engage students' curiosity. The question that the trainees chose to ask students was: 'Why has hop-picking been important to the community?' The trainees orientated various active learning exercises around several artefacts, including stilts, videos, songs and paintings (**Figure 4**). Trainees developed an appreciation of how their questions in a real-world context facilitated students' critical insights through various disciplinary lenses. They provided relevance to students' learning concerning their community and sense of human personhood.

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<A>Conclusion

Incorporating epistemic insight into ITT courses transformed trainee teachers' understanding of the distinct nature of disciplines and how they interact with exploring questions that require a cross-disciplinary perspective. Case study examples illustrate how trainees can develop innovative

approaches to teaching that facilitate students' critical and scholarly thinking. Trainees become equipped with the competencies, skills and methods to be early career teacher-researchers. They develop the potential to adapt school pedagogical practices as teacher-leaders, while promoting students' epistemic curiosity and interdisciplinary understanding.

The authors would like to acknowledge the tutors and trainees facilitating the construction of this article, including Emily Sayers and Lizzie Burton.

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