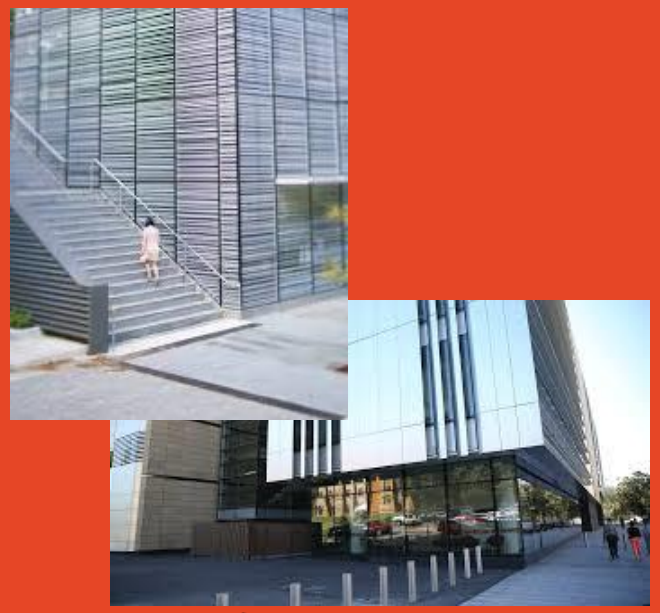
An Ecological Framework and Design Patterns for Developing Teachers' Interdisciplinary Expertise

Lina Markauskaite
with Natalie Spence

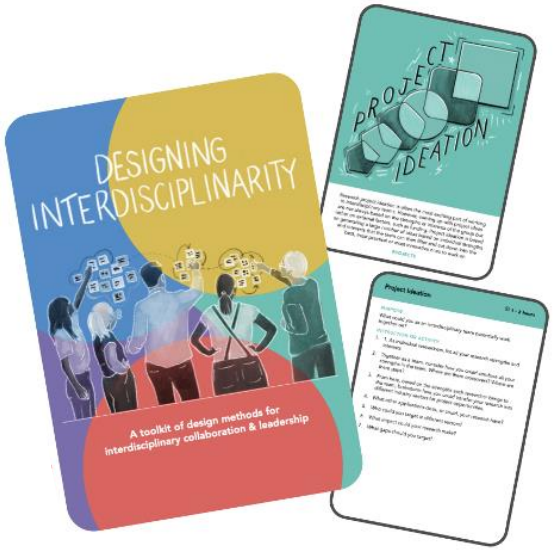


5 June 2025

Funded by Australian Government Australian Research Council

Overview

1. Background
2. Project
   - Approach
   - Scoping study
   - Framework
   - Design resources
3. Your feedback & discussion
4. Workshop
   - Trying out some our design approaches and tools



Context

THE UNIVERSITY OF SYDNEY

Projects

- Developing interdisciplinary expertise in universities, ARC Discovery Project, 2020-26
- **Developing teachers' interdisciplinary expertise, NSW DET Strategic Research Grant, 2021-24**
- Academic hospitality in interdisciplinary education, Research Council of Norway, 2021-27

Main resources

- Project webpage
- Project publications and resources

Our team

Chief investigators

Lina Markauskaite

Peter Goodyear
Emeritus Professor

Cara Wrigley
UQ, ST4

Research associates

Natalie Spence

Teresa Swist
NSW DET project

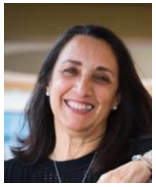
Genevieve Mosely
UQ, ST4

PhD students

Arum Nisma Wulanjani
NSW DET

Amanda Bellaby
ST3

Dwayne Ripley
ST2
(Completed)



Alicia Vallero
ST2

Affiliates

Karla Straker
UQ, ST4

Celina McEwen
UTS, ST1

Murray Simons
UQ, ST4

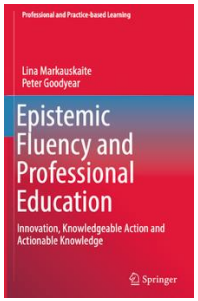
Melinda Pratt
UQ, ST4

Masters and Honours Students

- Sujeewa Tennekoon, Masters student, ST3 (Completed)
- Franco De Joya, Honours student, NSW DET (Completed)

…and MANY other colleagues

Origins: Developing interdisciplinary (ID) expertise in Universities



Purpose: To create a research foundation for explaining:

- How university researchers and students develop ID expertise
- How this development can be enhanced

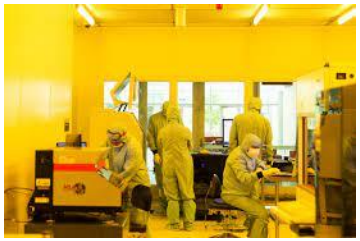
Sites: Sydney Nano and Charles Perkins Centre Research and Educational settings

Foundations:

- Epistemic fluency
- Epistemic practices
- Ecological approach
- Actionable knowledge & knowledgeable action
- Design

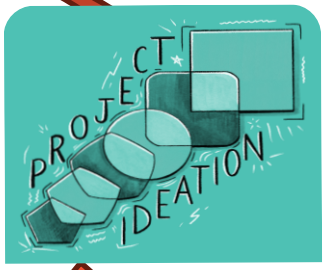
Layers of ID expertise

1. Communities



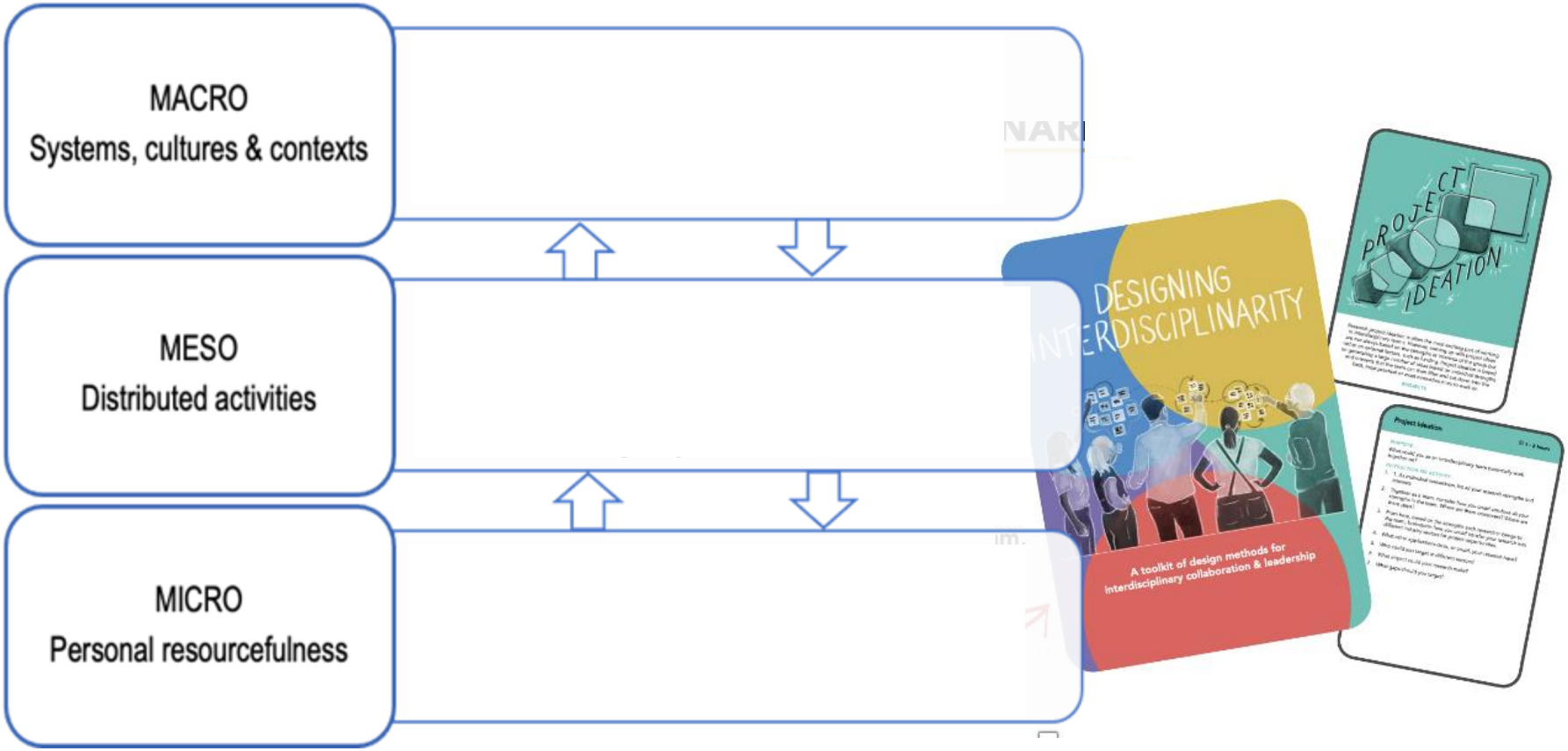
2. Teams

3. Individuals



4. Design

The ecology of interdisciplinary practices



Developing Teachers' Interdisciplinary Expertise

A translational project

THE UNIVERSITY OF SYDNEY

Purpose

Developing teachers' interdisciplinary expertise for and in a complex society

The purpose is to help prepare teachers for teaching in an increasingly interconnected, dynamic and unpredictable world, so that they can help their future students *build on* firm disciplinary foundations and *integrate* different areas of knowledge and ways of knowing.

Aim: To translate some findings from the research project "Developing Interdisciplinary Expertise in Universities" funded by the Australian Research Council to NSW teacher education and professional development.

Objective: To co-create a framework with resources for developing teachers' interdisciplinary expertise

Rethinking monitoring and evaluation in complex systems—when learning is a result in itself by UNDP Strategic Innovation https://link.medium.com/NnXyXaGejzb

Translational research project

1. To identify what constitutes teachers' interdisciplinary (ID) expertise
2. To co-create a framework for developing teachers' ID expertise
3. To co-design shareable design resources for pre- and in-service teacher educators

"a type of work that attempts to bridge the gap between basic research and the world of practice…"

At the core of translational research is "the primacy of feedback loops between researchers and the population they are researching."

Knowledge translation principles

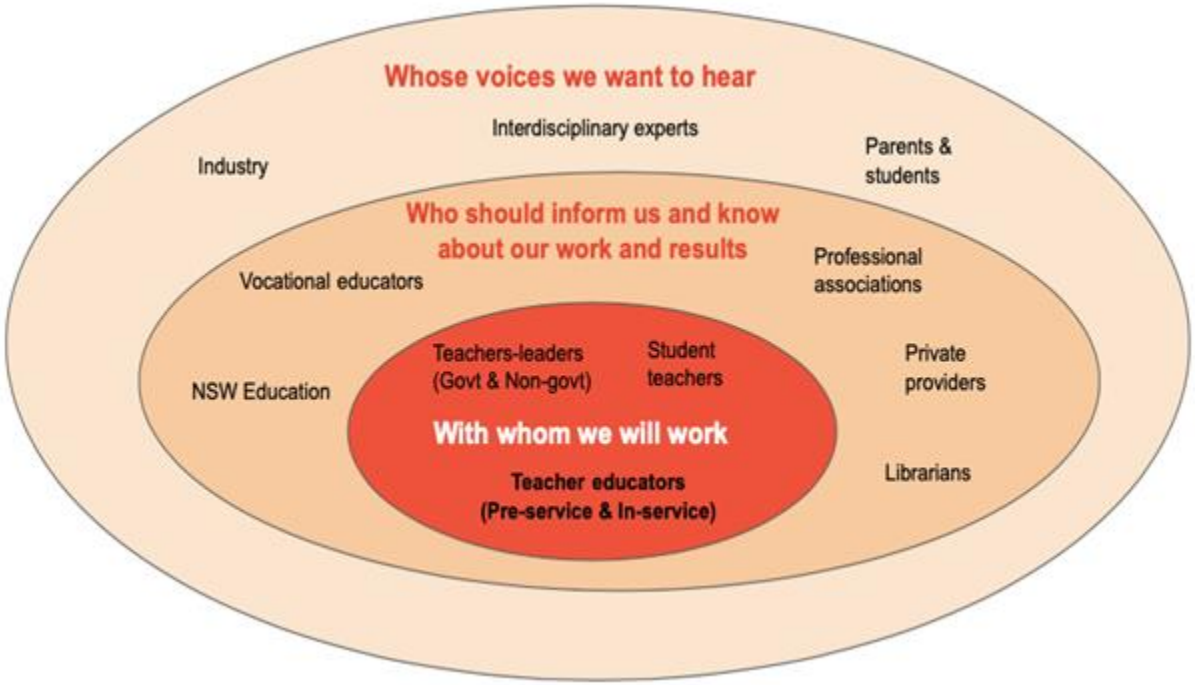
Starting point: The ecological framework

Approach: Co-design

Facilitators: Expert designers-facilitators

Co-designers: Teacher educators and expert teachers

Process: Waves of expert research/design & broader consultations



Knowledge translation process

Phase 1: Consultation and scoping study and initial development of teacher interdisciplinary expertise framework

Phase 2: Co-design of design resources for pre- and in-service teacher education

The scoping review & consultations

1. **To identify what constitutes teachers' interdisciplinary expertise**
2. To co-create a framework for developing teachers' ID expertise
3. • To co-design shareable design resources for pre- and in-service teacher educators

THE UNIVERSITY OF SYDNEY

Scope of interdisciplinary practices

Teachers' interdisciplinary expertise—the capability to work with knowledge from different fields—is key to addressing the complex challenges of 21st-century teaching.

EMAIL | PRINT

CATEGORIES
Teacher education, Uncategorized

TAGS
AARE blog, Cara Wrigley, Genevieve Mosely, interdisciplinarity, Lina Markauskaite, Peter Goodyear, teacher education, Teresa Swist

April 27 2023

Why you need to spot the invisible elephant

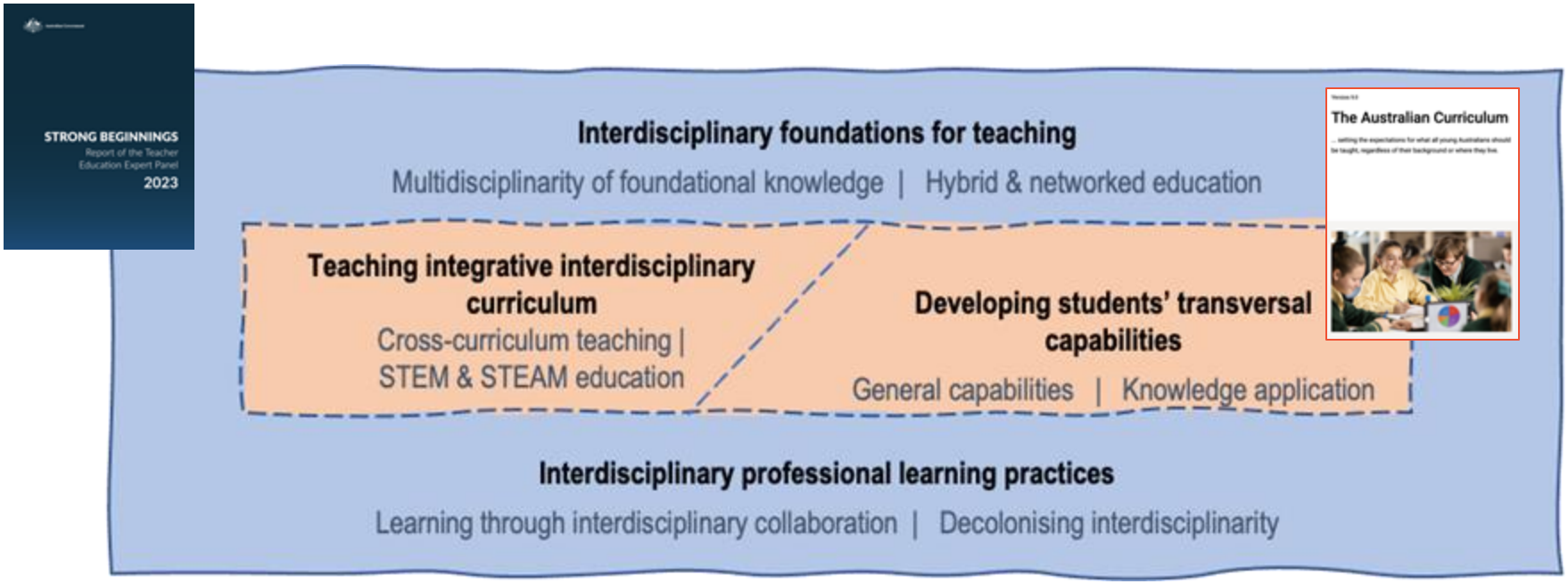
By Teresa Swift, Lina Markauskaite, Peter Goodyear, Cara Wrigley and Genevieve Mosely

TODAY Thursday April 27: Webinar is 4 pm – 5 pm (AEST). For more information and registration, please visit the Webinar page

Let's make this very clear, students need to be taught by disciplinary experts. This research into the interdisciplinary expertise of teachers is not about putting the science teacher in the visual arts class.

But what we have discovered in our research is that students benefit from teachers with skills in making connections to different disciplines. That improves student understanding and engagement in other subjects.

Main facets of teachers' interdisciplinary practices



Insights from consultation interviews

Dispositions for interdisciplinarity (Background Question)
DISPOSITION TO CONNECT SUBJECTS—moving beyond disciplinary bunkers. E.g., building an integrated understanding of a phenomenon.
DISPOSITION TO BE TRANSFORMATIVE—being fearless and resilient. E.g., having courage to try new things.
DISPOSITION TO BE FAITHFUL TO KNOWLEDGE—engaging with knowledge deeply. E.g., understanding knowledge and ways of knowing.
DISPOSITION TO BE ADAPTIVE—tailoring the curriculum for specific contexts. E.g., being flexible and engaging in curriculum-making.
DISPOSITION TO BE RELATIONAL—collaborating with diverse stakeholders. E.g., engaging with ambiguity and negotiating.
DISPOSITION TO BE ACTION-ORIENTED—learning through doing. E.g., focusing on real-world issues.
DISPOSITION TO BE PURPOSEFUL—supporting students understanding. E.g., creating a scaffolded environment for interdisciplinary learning.

Barriers and enablers for developing expertise for interdisciplinary teaching (Question 4)	
Barriers	**Enablers**
• Assumptions, motivation, and capabilities • Constraining stakeholder beliefs and practices • Complexity of practical arrangements • Curriculum and assessment pressures • Schools' differential access to resources • Workforce and organisational tensions	• Teacher expertise, autonomy and dispositions • Formal and informal learning, collaboration, and communication opportunities • Permission to play and be creative as part of the curriculum-making process • Resourcing flexible and 'hands-on' pedagogical approaches • An ecosystem that supports, showcases, and shares successful interdisciplinary practices

Expertise and resources for productive interdisciplinary teaching (Question 2)		
Micro	**Meso**	**Macro**
• Prioritise authentic and supportive teacher interdisciplinary learning experiences. • Encourage confidence and flexibility, foster creative problem-solving, and openness to try new things. • Support teachers' personal investment in interdisciplinary teaching. • Identify and mitigate day-to-day teaching pressures.	• Make space and time for teachers to design curricula together. • Enable teachers to create a shared language for interdisciplinary learning and co-design. • Engage with experts, mentors, peers, and critical friends to guide and support planning. • Adopt a clear curriculum perspective in interdisciplinary teaching. • Support mastery of interdisciplinary pedagogical approaches (e.g., project-based learning).	• Prioritise strong leadership and a strategic approach. • Adopt a whole-school approach, when possible, but value all sustainable steps and initiatives. • Tailor professional learning according to the unique needs of each school or program. • Involve diverse stakeholders (e.g., parents, community, council) in various ways and timeframes. • Enable access to networks and multimodal resources which can be adapted to specific contexts. • Recognise systemic disincentives and barriers, and drive interdisciplinarity at a system level.

Main considerations for pre-service and in-service education	
Areas of teachers' interdisciplinary practices and needs (Question 1)	**Features of effective professional education (Question 3)**
• Identifying 'launchpads' to branch out when engaging in interdisciplinary teaching • Developing (inter)disciplinary fluency and addressing assumptions, biases, habits and fears • Utilising pedagogical approaches that support breaking down subject boundaries • Engaging with and shaping the curriculum in creative ways • Tailoring to pre- and in-service education needs and targeting workforce issues • Collective capacity-building, learning and safety	• Focus on ongoing, practice-based, place-based and systemic interdisciplinary professional learning • Support teachers' immersive and embodied interdisciplinary learning experiences • Create opportunities to observe and discuss diverse teaching practices • Build safe spaces with permission to create, collaborate, and play • Support organic and socially oriented professional learning

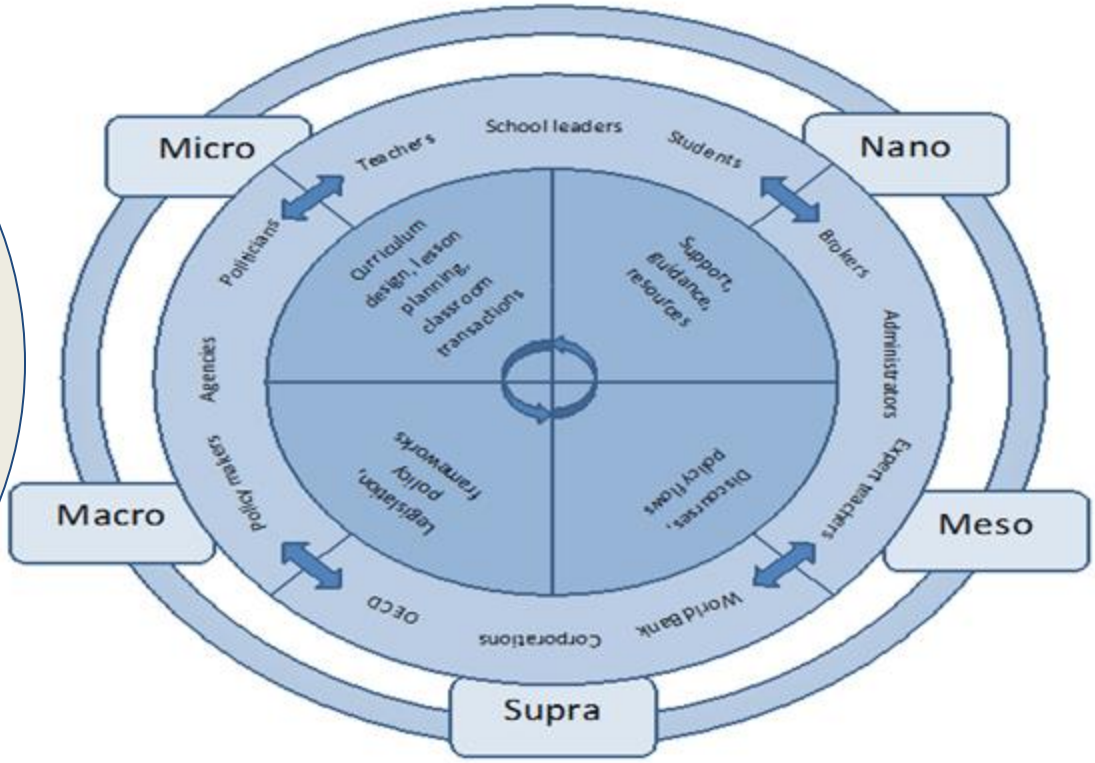
Bringing it all together

Teachers as curriculum makers

"the multi-layered social practices through which education is structured, enacted, and evaluated. Such an approach renders teachers as curriculum makers and emphasises the important role of teacher agency in the process of change." (p. 7)

Priestley & Xenofontos, 2021

Curriculum making is multilayered, systemic, and non-linear



Priestley et al., 2021

Common issue

- Highly centralised educational systems: do not always allow teachers the discretionary space to act as curriculum maker.

- Highly decentralised systems: allow teachers the freedom and space to act as such, yet without necessarily providing them with the tools and opportunities for professional development that would facilitate constructive curriculum making.

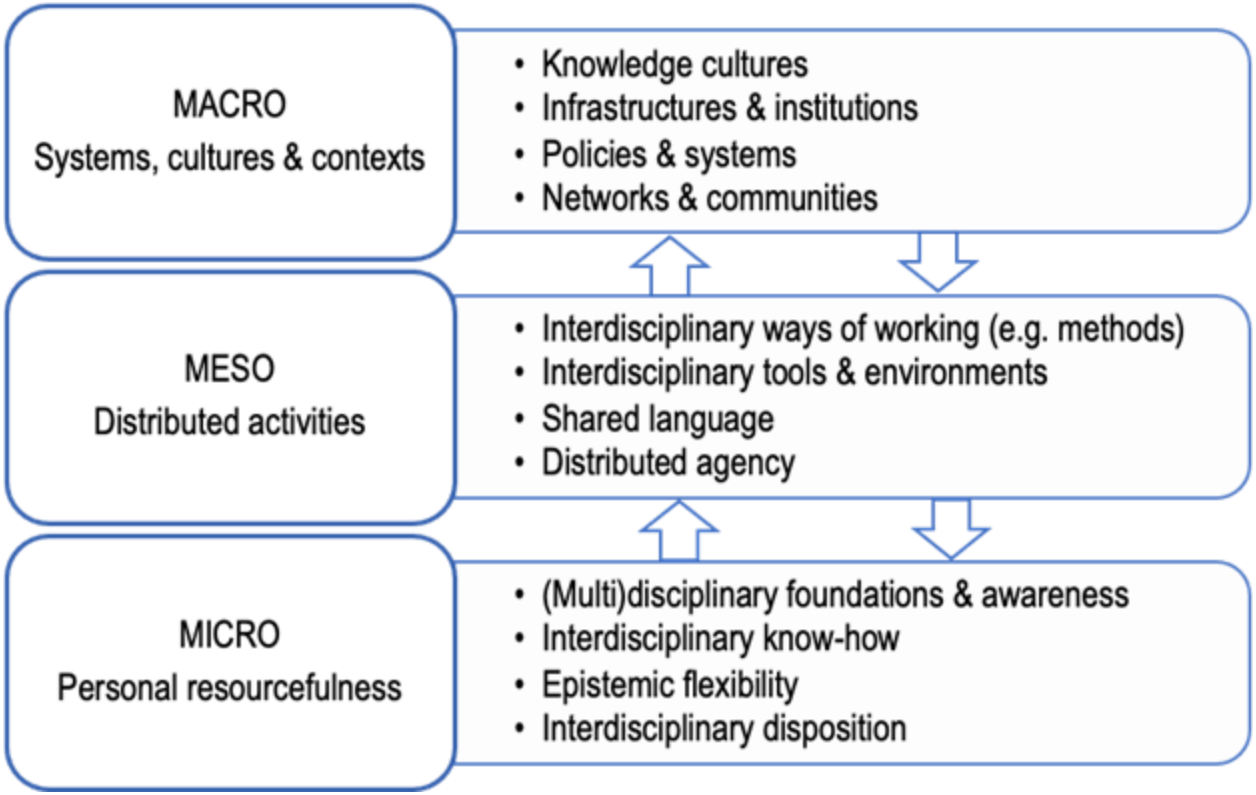
Priestley & Xenofontos, 2021, p.7

The framework

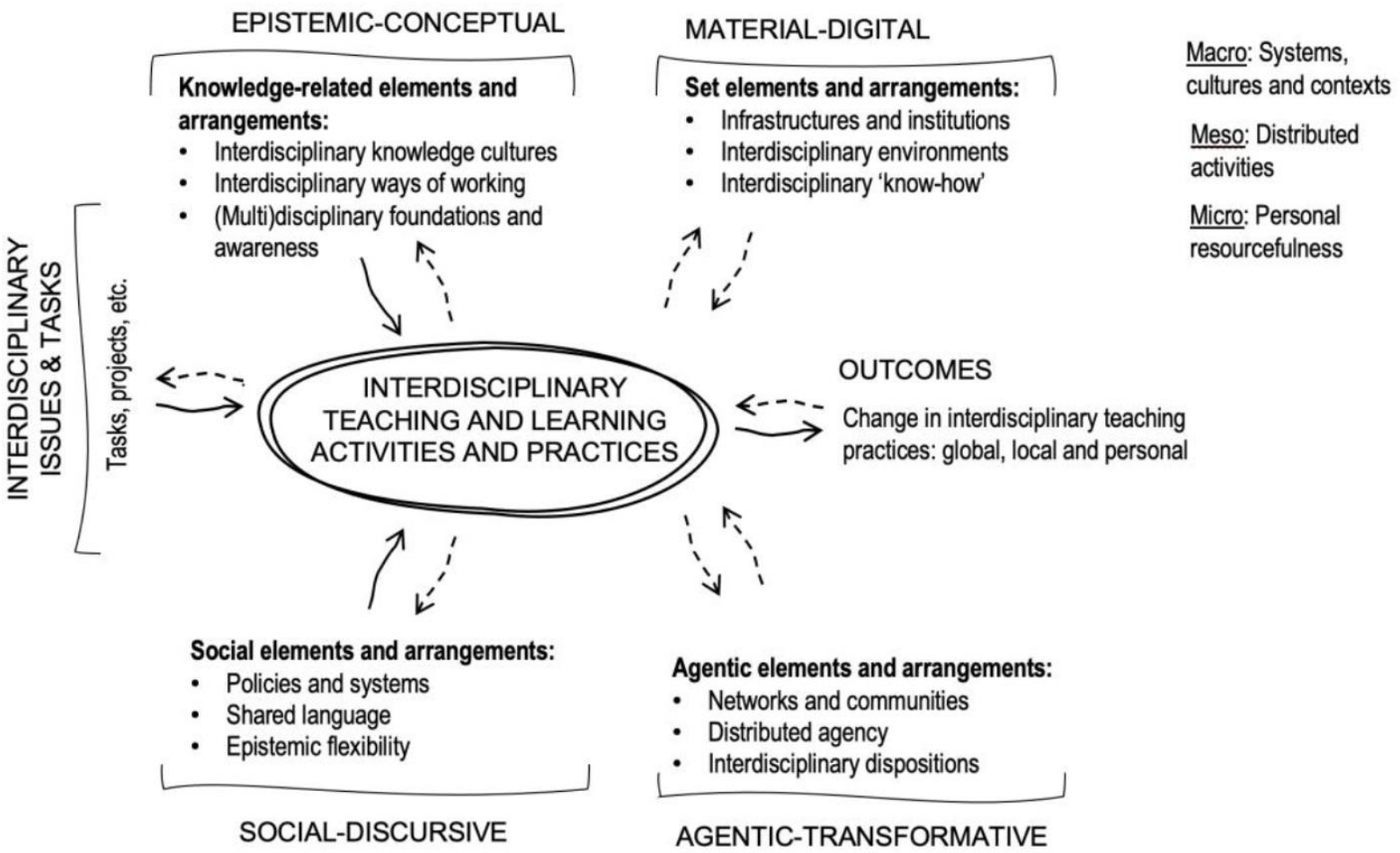
1. To identify what constitutes teachers' interdisciplinary expertise
2. **To co-create a framework for developing teachers' ID expertise**
3. To co-design shareable design resources for pre- and in-service teacher educators

THE UNIVERSITY OF SYDNEY

The ecology of interdisciplinary practices



An ecological space of teachers' interdisciplinary practices

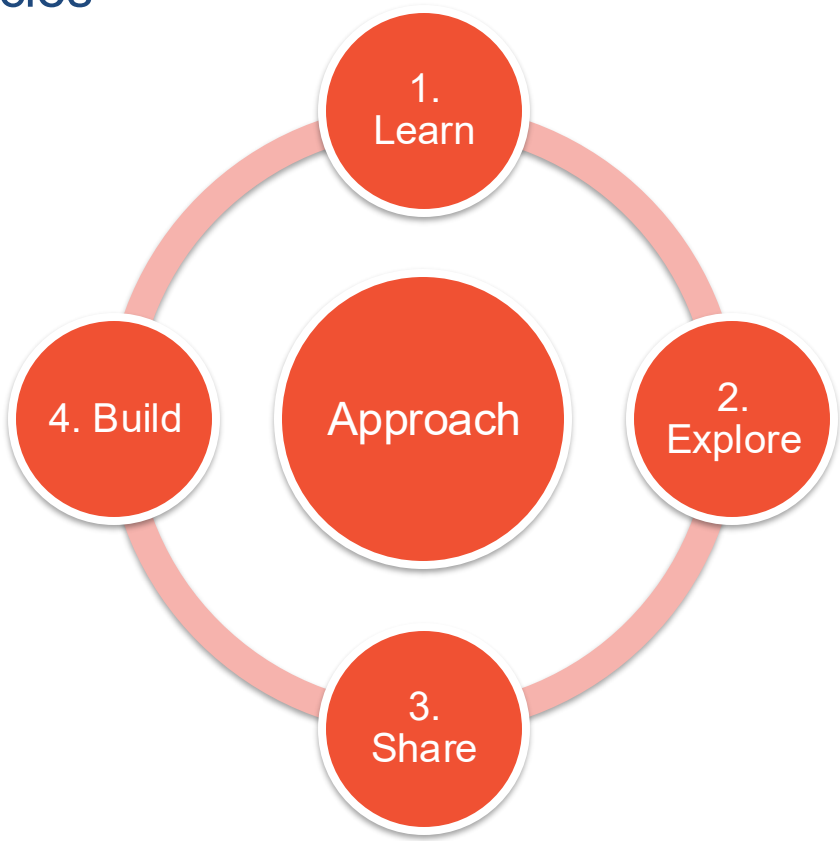


Framework scope and use

Activity- and system-oriented

It does not describe discrete competencies

A *compass* that helps teacher educators navigate the diversity of interdisciplinary teachers' education purposes and approaches by integrating theory and research in practice.



A compass

LEVELS	ASPECTS of ID expertise	RESEARCH-PRACTICE INSIGHTS from the knowledge translation	EXPLORE, SHARE & BUILD activities for co-design
MICRO	(Multi)disciplinary foundations & interdisciplinary know-how	Prioritise epistemically sound, authentic teachers' ID learning experiences tailored to specific purposes & contexts, which expand over time.	Main facets of teachers' ID practices
	Epistemic flexibility & ID dispositions	Build safe, playful professional learning opportunities to engage with uncertainty & develop flexibility & teacher-as-learner confidence.	Dispositions for ID teaching
MESO	ID ways of working, tools & environments	Engage teachers & other stakeholders in co-creating inquiry-specific resources & environments.	Interdisciplinary pedagogical approaches
	Shared language & distributed agency	Make space & time to co-create shared purpose and language.	ID terminology & meanings
MACRO	ID knowledge cultures, infrastructures & institutions	Build ID culture and leadership capacity by bridging research, theory and practice through institutional partnerships.	Infrastructures for ID teaching and learning
	ID policies, systems, networks & communities	Navigate & shape interdisciplinary policies, strategies & curricula by engaging in interdisciplinary networks & communities.	Navigating ID policies & strategies
SYNTHE-SIS	Creating an ID ecosystem	Integrate ID practices across the micro, meso, & macro levels with specific aims & contexts.	A vision of an ID ecosystem
	Considerations for policy & decision-making	Broaden the reach of ID education and equity through system-level policies & support measures.	Broadening the reach of ID education

MICRO LEVEL

(Multi)disciplinary foundations and interdisciplinary know-how

Research-practice insights: Prioritise epistemically sound, authentic teachers' interdisciplinary learning experiences tailored to specific purposes and contexts, which expand over time.

Teachers' interdisciplinary practices include several interrelated facets that broadly fall into two aspects: a) interdisciplinary teaching, such as teaching STEM and general capabilities (see the centre of Figure 3); and b) teachers' broader professional practices and learning, such as hybrid and networked forms of education that include the use of digital technologies (see the outer part of Figure 3). These facets are distinct, though interrelated, and require distinctive knowledge, skills and other personal resources. For example, teaching STEM, general capabilities, cross-curriculum topics, and knowledge application are often discussed together in the context of interdisciplinary teaching; however, each of these facets of interdisciplinary teaching and learning has distinct features and requires distinct disciplinary and pedagogical knowledge and skills.

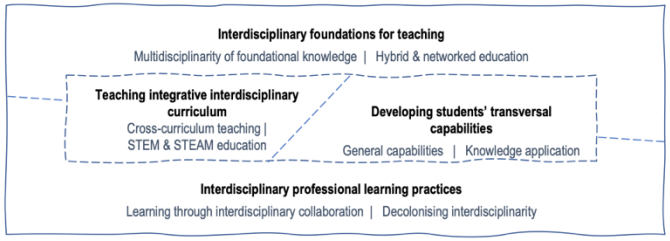


Figure 3: Main facets of teachers' interdisciplinary practices (after Markauskaite, Goodyear et al., 2023)

Therefore, the foundations of teachers' interdisciplinary expertise should be developed in relation to diverse facets. This learning should involve the development of teachers' relevant disciplinary and interdisciplinary understanding and awareness for working and teaching within a particular interdisciplinary area. For example, teachers' education for integrating sustainable development into teaching practices should be underpinned by a sound conceptual understanding of what constitutes sustainable development and how it relates to a broader institutional, policy and community context (UNESCO, 2018); teachers' education for using GenAI in teaching should be grounded in their understanding of how large language models work and surrounding pedagogical, assessment, ethical and other issues (Kasneci et al., 2023). Teacher educators, therefore, should prioritise conceptually and epistemically sound teachers' interdisciplinary learning experiences by focusing on specific purposes and contexts and gradually expanding these experiences to new facets of interdisciplinary practices.

Table 2: Examples of the main facets of teachers' interdisciplinary practices

Facets	Exemplars
Interdisciplinary foundations for teaching	
Multidisciplinarity of teachers' foundational knowledge	Integrate research advances from neuroscience, the developmental and learning sciences on how people learn into teacher education (Darling-Hammond et al., 2021).
Hybrid and networked education	Develop teacher digital capabilities by integrating curriculum-related, ethical and professional uses of digital technologies (Falloon, 2020).
Interdisciplinary professional learning practices	
Learning through interdisciplinary collaboration	Create opportunities for professional learning in interdisciplinary teachers' communities (Grossman et al., 2001) and with experts beyond traditional disciplines, such as Aboriginal cultural educators (Burgess & Harwood, 2021).
Decolonising interdisciplinarity: social, environmental, and epistemic justices	Develop teachers' understanding and commitment to justice by embracing critical pedagogies toward contemporary disciplinary and interdisciplinary knowledge (Quan et al., 2019).
Teaching integrative, interdisciplinary curriculum	
Cross-curriculum teaching and learning	Embed sustainability in teacher education through collaborative action research (Ferreira et al., 2019).
STEM and STEAM education	Prepare teachers to teach STEM by focusing on the integration and connections between STEM disciplines in solving real-world problems (Enderson et al., 2020).
Developing students' transversal capabilities	
General capabilities	Prepare teachers to teach 2st-century skills by focusing on leadership, program design, learning environments, partnerships, and continuous improvement (Greenhill, 2010).
Knowledge application: vocational education and integrated learning	Prepare teachers for programs that combine academic learning with relevant career and other life experiences, such as Big Picture Education (Fischetti et al., 2024), Linked Learning (Saunders et al., 2013).

MICRO LEVEL

Explore Activity: Main facets of teachers' interdisciplinary practices

Figure 3 summarises the main facets of teachers' interdisciplinary practices related to teaching and professional learning (Markauskaite, Goodyear et al., 2023). Table 2 offers some examples. Explore this figure and table and consider the following questions:

1. What other facets are important to consider?
2. How are these facets interrelated?
3. What are the potential benefits and limitations of embedding them in teachers' professional learning separately vs. integrating them with each other?

Discuss broad ideas of how this could be done.

MICRO LEVEL

Share and Build Activity: Main facets of teachers' interdisciplinary practices

Use the research-practice insights above and the prompts in Box 3 to explore how interdisciplinary foundations and know-how are currently developed in your teacher education program or context. Discuss how this focus could be extended or re-imagined.

Knowledge-sharing

a) Describe which interdisciplinary facets you have experience in your pre-service or in-service professional education context.
b) Outline key design features (approaches, scaffolding, etc.) that were critical to make this happen.
c) Explain what enabled or constrained your possibilities to support the development of these foundations and know-how in your context.

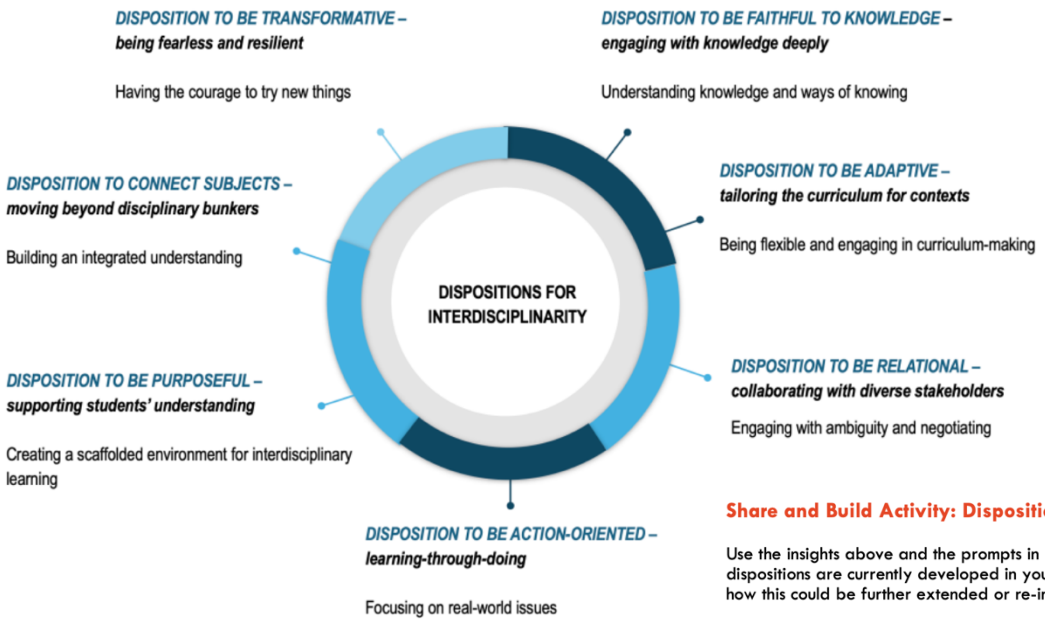
Knowledge-building

a) Describe which new facets of interdisciplinary practices you might like to focus on (and why) in your pre-service or in-service professional development education context.
b) Outline the key design features critical to making this happen in your context.
c) Identify what might enable or constrain your possibilities to support the development of these interdisciplinary foundations and know-how in your context.

MICRO LEVEL

Epistemic flexibility and interdisciplinary dispositions

Research-practice insights: Build safe, playful professional learning opportunities to engage with uncertainty and develop flexibility and teacher-as-learner confidence.



Explore Activity: Dispositions for interdisciplinary teaching

The disposition to be broad and adventurous

Key inclinations: The tendency to be open-minded and to look beyond what is given; the impulse to probe assumptions and examine alternative points of view; the desire to tinker with boundaries and play with new ideas; the urge to speculate, generate many options, and explore multiple interpretations.

Key sensitivities: An alertness to binaries, dogmatism, sweeping generalities, narrow thinking, parochialism, and occasions when alternative perspectives are neglected.

Key abilities: The ability to identify assumptions, to look at things from other points of view, to generate and review multiple options; brainstorming; empathic thinking; flexible thinking.

Box 4: Example of a thinking disposition (from Perkins et al., 1993, p. 7)

Figure 4 presents some interdisciplinary dispositions important for teachers. They are based on a synthesis of consultations with various experts and stakeholders about teachers' interdisciplinary expertise (Markauskaite, Swist et al., 2023). Explore this figure and Box 4 and consider the following questions:

1. What other dispositions are critical?

… are necessary for each disposition?

…eacher education?

…iversity and school communities, …eveloping teachers' dispositions.

Share and Build Activity: Dispositions for interdisciplinary teaching

Use the insights above and the prompts in Box 5 to explore how interdisciplinary dispositions are currently developed in your teacher education program or context. Discuss how this could be further extended or re-imagined.

Knowledge-sharing

a) Describe key interdisciplinary dispositions fostered in your pre-service or in-service teacher professional education context.
b) Consider key course/program design features critical to making this happen.
c) Outline your advice for others who wish to design similar learning opportunities.

Knowledge-building

a) Describe which additional interdisciplinary dispositions you might like to focus on (and why) in your pre-service or in-service professional education context.
b) Consider key design features that will be critical for developing these dispositions.
c) Identify what might enable or constrain your possibilities to support the development of these dispositions in your context.

SYNTHESIS LEVEL

Creating an interdisciplinary ecosystem

Research-practice insights: Integrate interdisciplinary practices across the micro, meso, and macro levels with specific aims and contexts.

Explore Activity: A vision of an interdisciplinary ecosystem

Figure 5 presents an example of an ecosystem for developing expertise for interdisciplinary teaching in a school based on a model co-created by the experts in this study. Explore this model and consider the following questions:

1. Which aspects of each model resonate with you most and why?
2. Which elements of each model would you align to a micro, meso, or macro level of teachers' interdisciplinary learning?
3. What elements would you add, remove or change?

Discuss how such a model could support the development of a shared vision within a school and how it could be translated into a concrete institutional strategy or plan, including specific professional learning activities. Consider how such a model of an ecosystem might look in a pre-service teacher education context.

Share and Build Activity: A vision of an interdisciplinary ecosystem

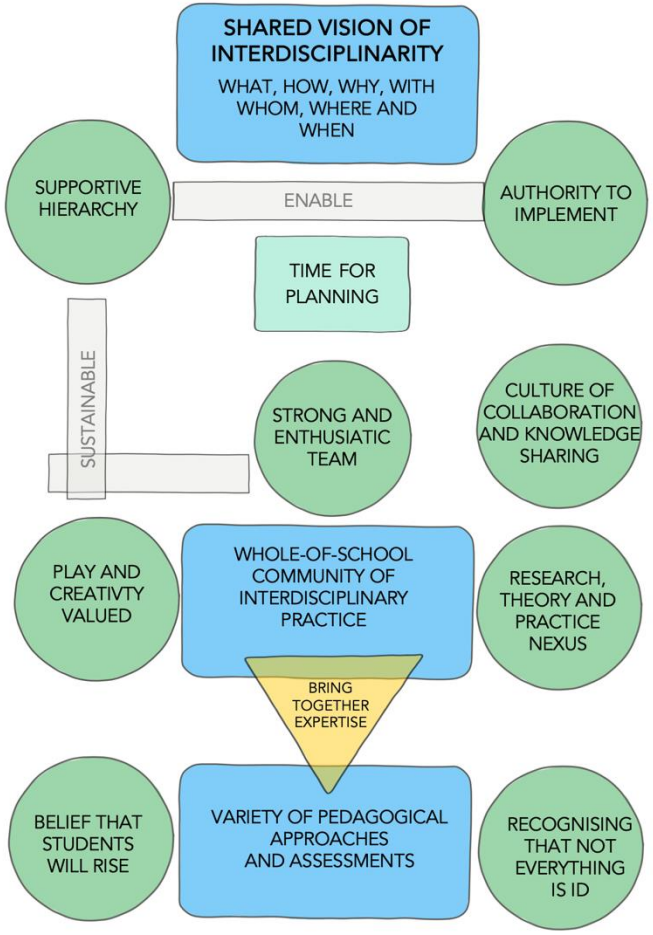
Use Figure 5 and the prompts in Box 12 to create a model of an ecosystem for developing interdisciplinary expertise in your teacher education program or context. Identify the most significant barriers and discuss possible changes.

Knowledge-sharing

a) Draw a diagram that visualises the current ecosystem of interdisciplinary professional learning in your pre-service or in-service professional learning context.
b) Include the main enablers and barriers.
c) Outline the roles of different stakeholders in this ecosystem.

Knowledge-building

a) Draw a model of an ideal future ecosystem for interdisciplinary professional learning in your pre-service or in-service teacher professional learning context.
b) Outline what changes are needed to make this real in your school or university context.
c) Identify what realistically can be done in the short, medium and long term to achieve this vision.



SYNTHESIS LEVEL

Considerations for policy and decision-making

Research-practice insights: Broaden the reach of interdisciplinary education and equity through system-level policies and support measures.

Table 7: Main measures for broadening the reach of interdisciplinary education (after Timmerman, 2019; Warkentien et al., 2022)

Measures	Description
System-level curriculum	National, state and other system-level curriculum "can shift the focus of instruction, quickly reach all students, and signal to educators the educational priorities." (Warkentien et al., 2022, p. II-27); and "curricula should stay flexible enough to keep the autonomy of teachers when they implement cross-curricular teaching" (Timmerman, 2019, p. 10).
Accreditation	Accreditation requirements for schools, teachers, initial education programs, and professional development programs can support interdisciplinary education (Warkentien et al., 2022).
Accountability policies	"what gets tested is what gets taught" (Warkentien et al., 2022, p. II-27). Accountability policies (e.g., standards, high-stakes tests, exams) must encourage schools and teachers to incorporate interdisciplinary education.
Evidence base	Interdisciplinary teaching and learning should be assessed with appropriate evaluation tools (Timmerman, 2019). Diverse indicators and modes of assessment that include traditional assessment and incorporate indicators relevant to the purposes and outcomes of interdisciplinary learning are required (Warkentien et al., 2022).
Resourcing	Resources and support to implement interdisciplinary education across multiple areas and across pre-service and in-service education are needed (e.g., funding, access to courses and curriculum resources, and time allocation) (Timmerman, 2019; Warkentien et al., 2022).
Continuing professional learning	"[W]hile initial training is essential, continuing learning throughout their career is just as important" (Timmerman, 2019, p. 12). This could include support for creating infrastructure for continuing interdisciplinary professional learning (e.g., teaching and learning communities), but also through professional standards for different career stages.
Multipronged and integrated approaches	A shift in educational priorities and practices requires an integrated long-term approach that includes "teacher training, accreditation policies, accountability policies, curriculum development, and capacity development" (Warkentien et al., 2022, p. II-27)

Explore Activity: Broadening the reach of interdisciplinary education

Table 7 summarises some system-level measures critical for broadening the reach of interdisciplinary education reported in the literature (Timmerman, 2019; Warkentien et al., 2022). Explore this table and consider the following questions:

1. What other aspects of policy and decision-making are important for broadening the reach of pre-service and in-service teachers' interdisciplinary education in the NSW context?
2. Which system-level aspects are already conducive to teachers' interdisciplinary education?
3. Which aspects still require change to enhance the reach of teachers' interdisciplinary education?

Discuss actions that can be taken to make changes happen.

Share and Build Activity: Broadening the reach of interdisciplinary education

Literature on interdisciplinary education recognises that either system-level policies must change to encourage and support the broader reach of teachers' interdisciplinary education, or teacher education institutions and schools must find creative ways to broaden teachers' interdisciplinary professional learning within the current policy context (Warkentien et al., 2022). Use the research-practice insights above, and the prompts in Box 13, to explore system-level decisions most affecting teachers' interdisciplinary learning in your teacher education context.

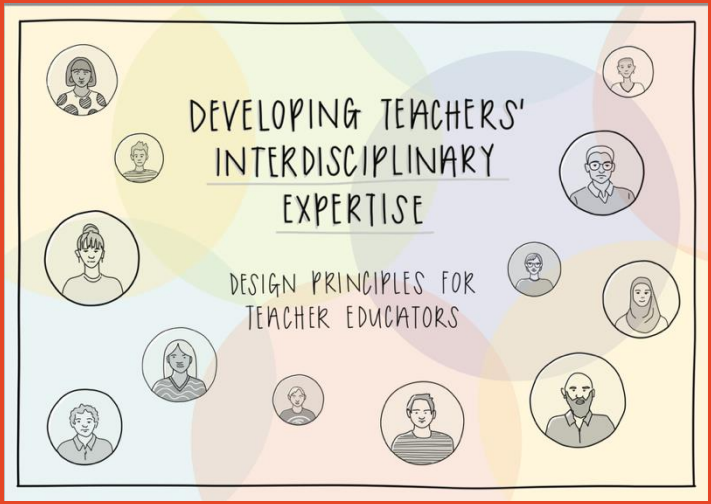
Knowledge-sharing

a) Describe the main system-level policies impacting the adoption of interdisciplinary approaches in your pre-service or in-service professional education context.
b) Discuss what kind of institutional decisions have been taken in your teacher education context to seize opportunities for teachers' interdisciplinary learning within the current policy context.
c) Outline your advice for others who want to take a similar approach.

Knowledge-building

a) Describe what further institutional decisions could be taken to expand the adoption of interdisciplinary education in your pre-service or in-service professional learning.
b) Identify what might enable or constrain your possibilities to do this in your context.
c) Create a list of recommendations for policy and decision-makers at a system level that are critical for broadening the reach and enhancing equity of teachers' interdisciplinary education.

Design resources: principles and cases



1. To identify what constitutes teachers' interdisciplinary expertise
2. To co-create a framework for developing teachers' ID expertise
3. **To co-design shareable design resources for pre- and in-service teacher educators**

THE UNIVERSITY OF SYDNEY

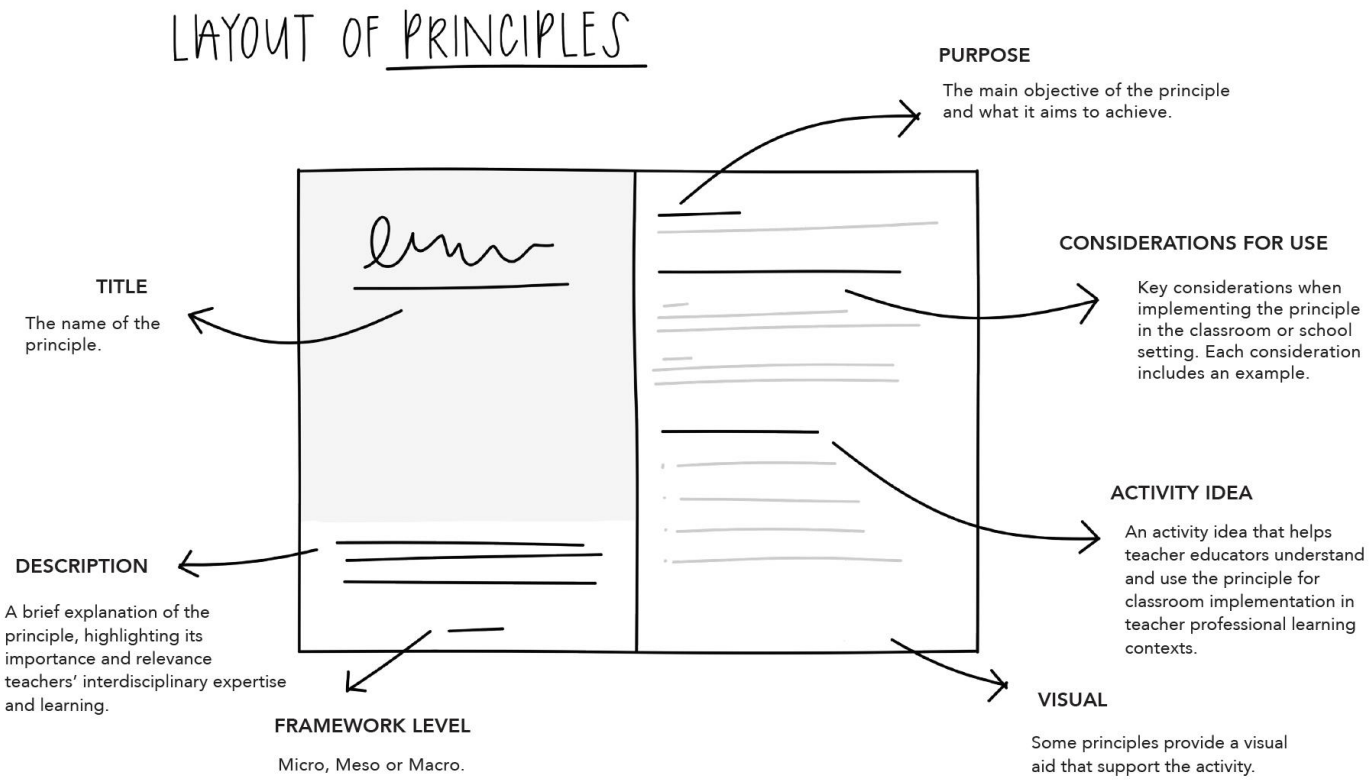
Co-design approach

- Drawing on the scoping study and framework
- Working with a small group of expert teacher educators and teachers
- Generating sets of ideas useful in practice

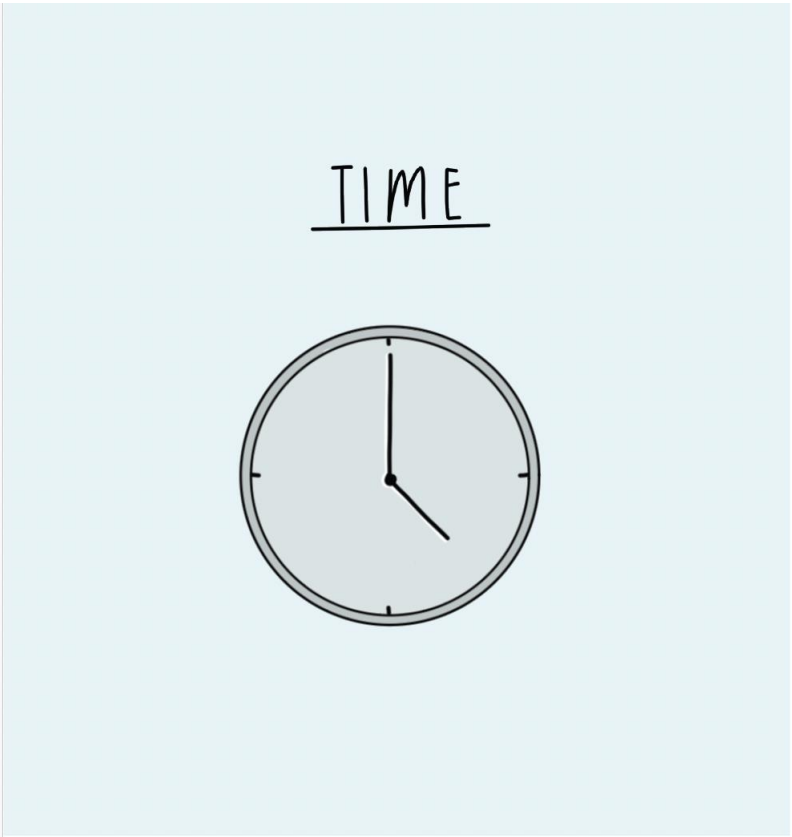
ASPECT / LAYER	EPISTEMIC	MATERIAL	SOCIAL	AGENTIC
MACRO	COLLABORATIVE CULTURE	INSTITUTIONAL SUPPORT	LEADERSHIP	COMMUNITIES OF PRACTICE
MESO	CONNECTING	LESSON CO-PLANNING	GLOSSARY	MENTORS
MICRO	EMPATHY	TIME	ETHICS	DISPOSITIONS

Design principles

Principles as ideas that underpin effective ways for addressing common challenges in developing interdisciplinary expertise



Example: Micro



Teachers often struggle to find the time to integrate interdisciplinary approaches into their busy schedules. The demands of curriculum coverage, lesson planning, assessments, and administrative tasks can leave little room for the additional effort required to design and implement interdisciplinary lessons. Helping teachers to learn productive strategies for addressing time constraints is crucial to making interdisciplinary teaching more feasible and effective for teachers.

MICRO

23

PURPOSE:

Help teachers find practical strategies for incorporating interdisciplinary approaches within the constraints of a busy teaching schedule.

CONSIDERATIONS FOR USE:

Collaborative Planning: Partner with colleagues to co-plan interdisciplinary lessons, sharing the workload. Example: Teaming up with a science teacher to integrate environmental science into a English unit.

Small Steps: Start with small interdisciplinary activities that require minimal extra time. Example: Incorporating a brief maths-related exercise into a history content lesson.

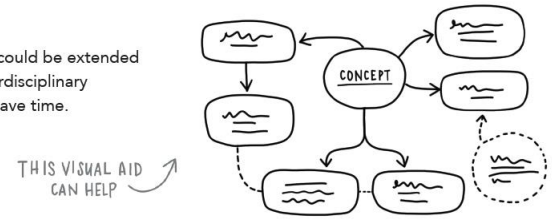
Time Management: Use effective strategies to streamline lesson planning and administrative tasks. Example: Setting aside dedicated time each week specifically for interdisciplinary planning, use templates to guide joint lesson planning

Student Involvement: Learn to engage students in the planning process to create interdisciplinary projects, saving preparation time. Example: Allowing students to choose project themes that combine subjects they are studying.

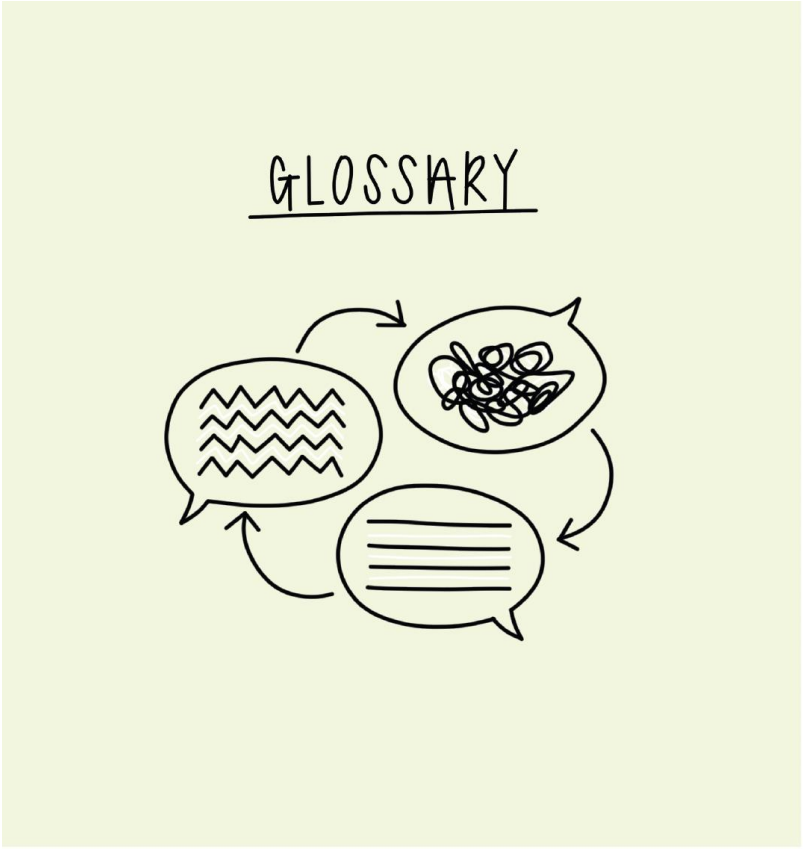
ACTIVITY IDEA: QUICK INTEGRATION BRAINSTORM

1. Provide teachers with a simple template to brainstorm interdisciplinary connections in their current curriculum.
2. Encourage teachers to identify one or two themes that could be easily integrated with their main subject.
3. Ask teachers to come up with short, 10-15 minute activities that link these subjects.
4. Discuss these ideas in small groups, providing peer feedback and additional suggestions, including for joint lessons.
5. Implement one of the brainstormed activities in the classroom and reflect on its effectiveness.

Note: This activity could be extended to discuss how interdisciplinary teaching can help save time.



Example: Meso



Words can have different meanings across various subjects, which can lead to misunderstandings in interdisciplinary collaboration. Developing a shared glossary helps ensure that all teachers have a common understanding of key terms. This resource fosters clear communication, enhances collaboration, and helps teachers see the connections between different fields.

MESO

28

PURPOSE:

To create a shared understanding of key terms used in different disciplines.

CONSIDERATIONS FOR USE:

Identify Key Terms: Determine key terms across multiple subjects. Example: Terms like "energy," "network," and "model" can have different meanings in science, technology, and social studies.

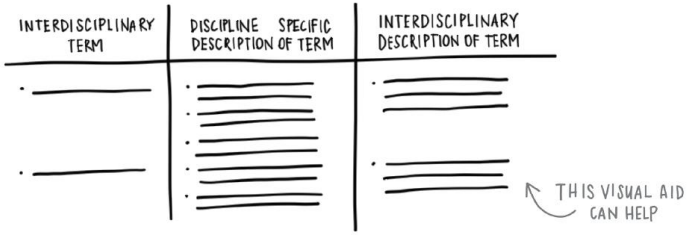
Collaboration: Involve all subject teachers in the creation of the glossary to ensure comprehensive coverage. Example: Have teachers from each discipline contribute definitions and examples.

Ongoing Updates: Keep the glossary dynamic, updating it as new terms and understandings emerge. Example: Regularly review and add new terms.

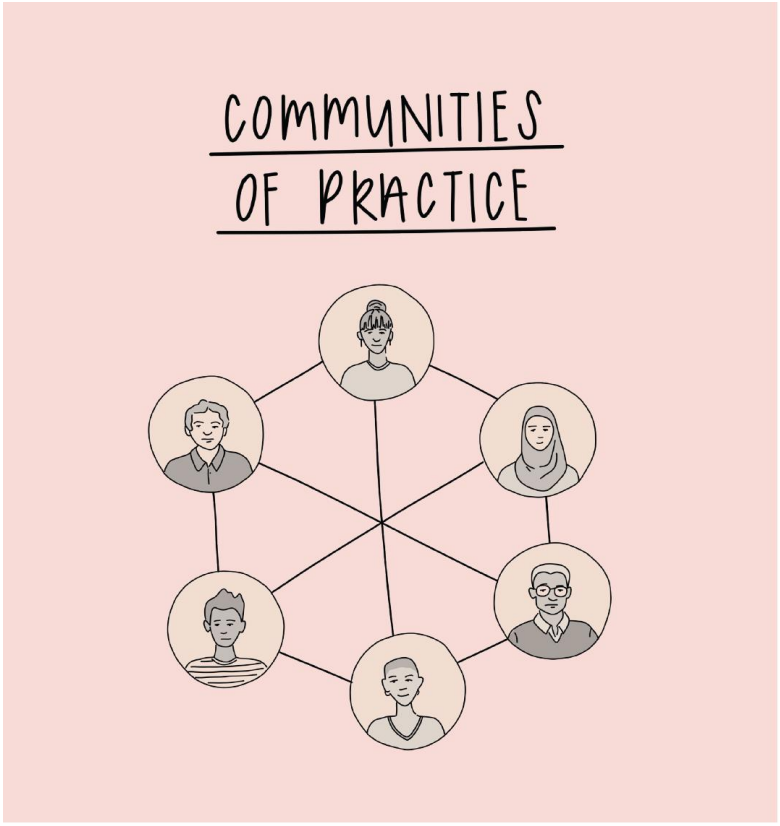
Accessible Format: Make the glossary easily accessible and easy to amend for all teachers. Example: Use digital tools like Google Docs or a classroom wiki for easy access and updates.

ACTIVITY IDEA: CREATE A GLOSSARY THAT CLARIFIES KEY TERMS

1. Form interdisciplinary groups and assign each group a set of common interdisciplinary terms to discuss and define (e.g., model, complex problem, system).
2. Each group researches and writes definitions for their terms, including examples relevant to their disciplines.
3. Compile all definitions into a single shared document.
4. Review the glossary with all teachers, discussing any terms that need further clarification.
5. Encourage teachers to refer to the glossary throughout their interdisciplinary lesson planning and update it as needed.



Example: Macro



Communities of practice are groups of teachers who come together to share knowledge, practices, and experiences. These communities foster continuous learning and improvement, enabling teachers to develop and refine interdisciplinary teaching practices. By participating in communities of practice, teachers can collaborate, innovate, and support each other in their professional growth.

MACRO

32

PURPOSE:

To build and sustain communities where teachers can share and develop interdisciplinary teaching practices.

CONSIDERATIONS FOR USE:

Regular Meetings: Schedule consistent and structured meetings for communities of practice. Example: Monthly meetings with specific agendas and goals.

Shared Resources: Create an online repository for sharing lesson plans, materials, and research. Example: Using an online platform like Google Drive or a dedicated website.

Peer Support: Encourage peer mentoring and collaborative problem-solving. Example: Pairing experienced teachers with newcomers for mentorship.

Reflective Practice: Incorporate reflection and feedback into community activities. Example: Reflective discussions and feedback sessions at the end of each meeting.

ACTIVITY IDEA: ESTABLISH A COMMUNITY OF PRACTICE

1. Identify interested teachers and form a core group.
2. Hold a kick-off meeting to discuss the purpose, goals, and structure of the community.
3. Establish regular meeting times and communication channels.
4. Develop a shared vision and plan for the community's activities.
5. Start with an initial project or topic to build momentum and engagement.
6. Identify emerging leaders and empower them to shape community activities.

Note: This activity can also extend beyond your physical school community. Use digital tools go reach and connect across multiple school communities.


ENHANCING PEDAGOGY FOR INTEGRATING SCIENCE AND LANGUAGE
IN-SERVICE TEACHERS' PROFESSIONAL INTERDISCIPLINARY LEARNING
'GENAI' IN INITIAL TEACHER EDUCATION – ENHANCING STUDENT TEACHERS' INTERDISCIPLINARY EXPERTISE AND AGENCY
PRE-SERVICE TEACHERS' PROFESSIONAL INTERDISCIPLINARY LEARNING
UNITING A VARIETY OF KLA OUTCOMES TO REACH A SHARED LEARNING GOAL
IN-SERVICE TEACHERS' PROFESSIONAL INTERDISCIPLINARY LEARNING
EXPLORING WIND TURBINES
IN-SERVICE TEACHERS' PROFESSIONAL INTERDISCIPLINARY LEARNING
CASE STUDIES
LEARNING BY DESIGN FOR PLAYFUL LEARNING OF INTERDISCIPLINARY TOPICS
PRE-SERVICE TEACHERS' PROFESSIONAL INTERDISCIPLINARY LEARNING

PURPOSE OF FRAMEWORK

Create a framework that articulates what interdisciplinary expertise entails and guides how it can be effectively facilitated and developed. By clearly identifying the key concepts of **interdisciplinary teaching expertise**, this framework aims to make informed decisions about **curriculum** and their development.

The purpose of this activity is to provide a flexible but structured approach to understanding and enhancing teachers' **interdisciplinary expertise**. It will help **teacher educators** and teaching teams identify key areas of expertise, recognise enablers and barriers, and define the capabilities required for productive interdisciplinary teaching. This serves as a tool for creating a framework that then would be used for planning and implementing interdisciplinary teaching practices and professional learning.

FRAMEWORK COMPONENTS

TRIANGLE

What are the key needs for conducive professional learning?

RECTANGLE

What are the most important areas of teachers' interdisciplinary practices?

CIRCLE

What are the main enablers for developing expertise for interdisciplinary teaching in pre- and in-service teachers' education?

CONNECTOR SHAPES

Use the connector shapes to link shapes (ideas) together. These connectors will help visualise how different aspects of interdisciplinary expertise interact and support each other.

HEXAGON

What are the main barriers to developing expertise for interdisciplinary teaching in pre- and in-service teachers' education?

DEVELOP YOUR OWN FRAMEWORK OF INTERDISCIPLINARY EXPERTISE

INSTRUCTIONS FOR DEVELOPING YOUR OWN FRAMEWORK

1. **CUT OUT SHAPES**

   Cut from thick coloured pieces of paper 4 sets of shapes (up to 15 of each shape).

   Yellow Triangle: What are the key capabilities required for interdisciplinary teaching?

   Blue Rectangle: What are the most important areas of teachers' interdisciplinary practices and needs for professional learning?

   Green Circle: What are the main enablers for developing expertise for interdisciplinary teaching in pre- and in-service teachers' education?

   Red Hexagon: What are the main barriers to developing expertise for interdisciplinary teaching in pre- and in-service teachers' education?

2. **IDENTIFY KEY DIMENSIONS:**

   Begin by identifying aspects of expertise that are crucial for effective interdisciplinary teaching. Use the provided shapes to represent different dimensions and aspects of interdisciplinary teaching.

3. **USE KEY SHAPES**

   Each shape in the framework represents a specific aspect of interdisciplinary expertise. Use these shapes to structure your framework.

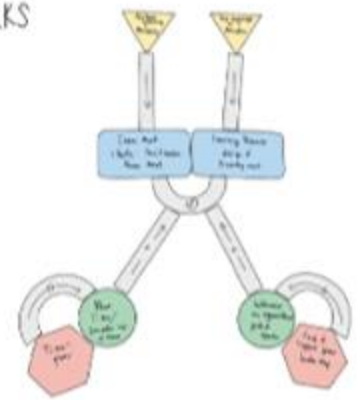
4. **CONNECT THE SHAPES**

   Use the connector shapes to link shapes (ideas) together. These connectors will help visualise how different aspects of interdisciplinary expertise interact and support each other.

5. **CONTEXTUALISE YOUR FRAMEWORK:**

   Tailor your framework to the specific context and needs of your pre-/in-service teacher education program. Consider the unique challenges and opportunities within your educational context.

EXAMPLES OF FRAMEWORKS



Main takeaways

- There is no single way to develop such expertise: a flexible approach that acknowledges the interconnectedness and complex multilayered nature of teachers' interdisciplinary practices is required.
- The ecological framework and resources offer an approach to building and supporting a community of teacher educators interested in developing teachers' interdisciplinary expertise.

THANK YOU

About us
www.interdisciplinaryexpertise.org

Get in touch
Lina.Markausaite@sydney.edu.au
Natalie.Spence@sydney.edu.au

THE UNIVERSITY OF SYDNEY

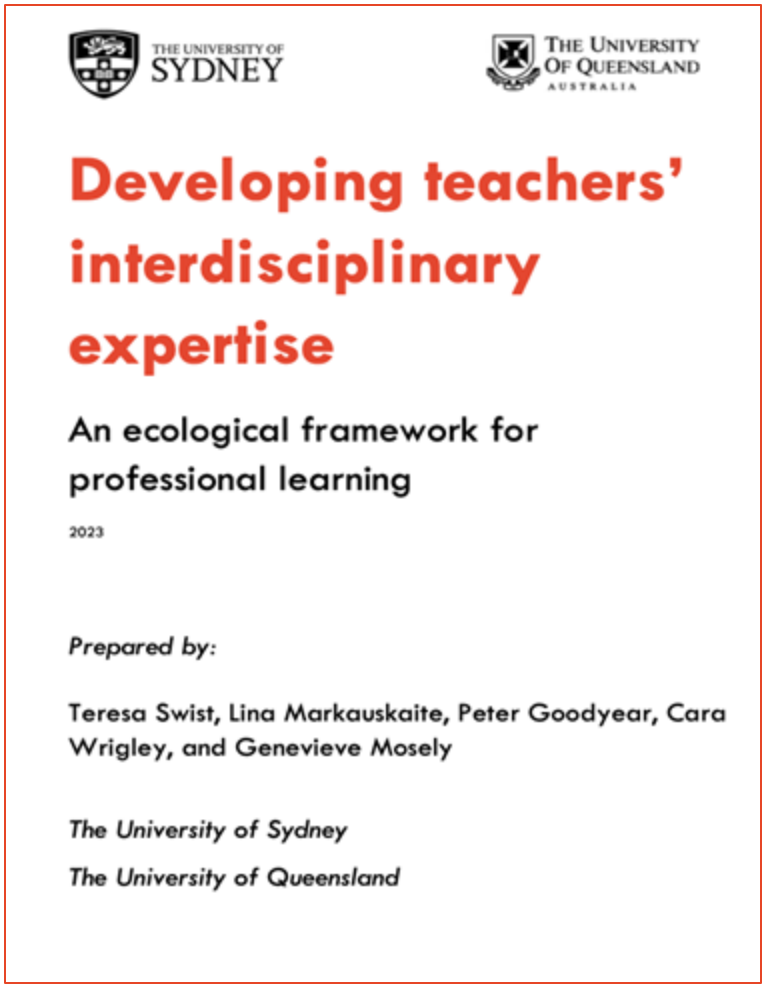
Workshop
Developing Teachers' Interdisciplinary Expertise

Lina Markauskaite
with Natalie Spence

5 June 2025

Funded by
Australian Government
Australian Research Council

Design resources



THE UNIVERSITY OF SYDNEY

THE UNIVERSITY OF QUEENSLAND AUSTRALIA

Developing teachers' interdisciplinary expertise

An ecological framework for professional learning

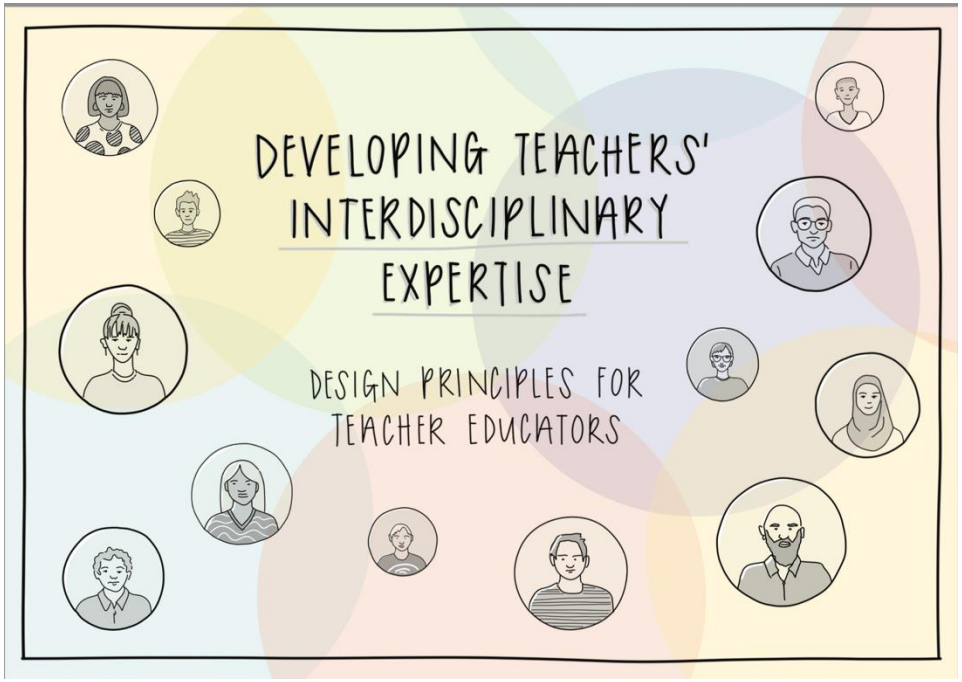
2023

Prepared by:

Teresa Swist, Lina Markauskaite, Peter Goodyear, Cara Wrigley, and Genevieve Mosely

The University of Sydney

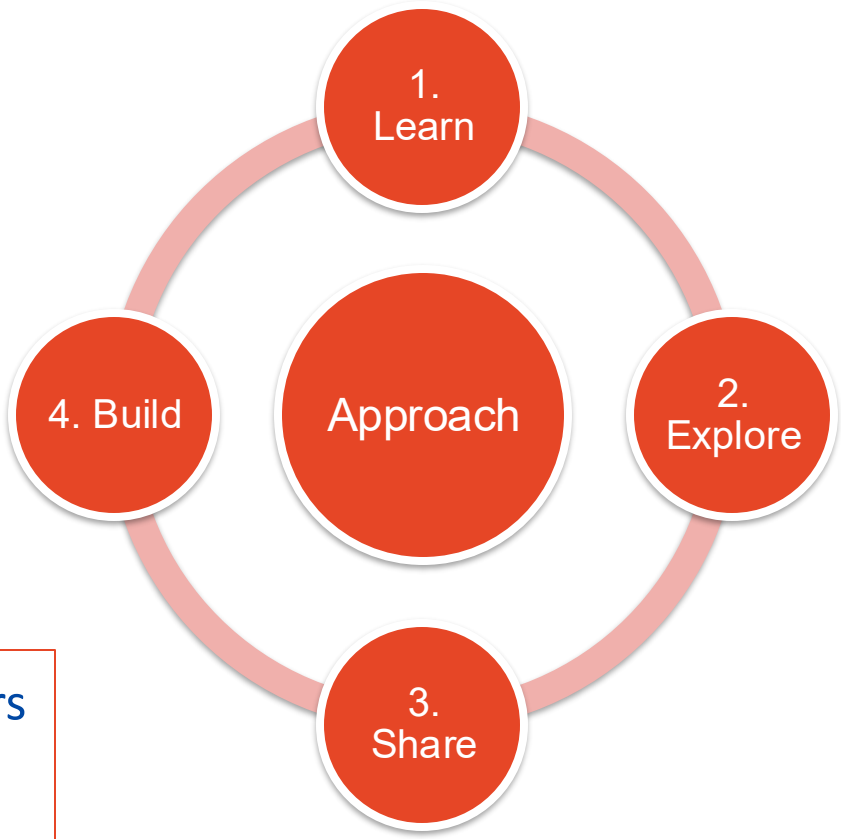
The University of Queensland



The ecological framework and resources offer an approach to building and supporting a community of teacher educators interested in developing teachers' interdisciplinary expertise.

Framework scope and use

A *compass* that helps teacher educators navigate the diversity of interdisciplinary teachers' education purposes and approaches by integrating theory and research in practice.



Framework/compass

LEVELS	ASPECTS of ID expertise	RESEARCH-PRACTICE INSIGHTS from the knowledge translation	EXPLORE, SHARE & BUILD activities for co-design
MICRO	(Multi)disciplinary foundations & interdisciplinary know-how	Prioritise epistemically sound, authentic teachers' ID learning experiences tailored to specific purposes & contexts, which expand over time.	Main facets of teachers' ID practices
	Epistemic flexibility & ID dispositions	Build safe, playful professional learning opportunities to engage with uncertainty & develop flexibility & teacher-as-learner confidence.	Dispositions for ID teaching
MESO	ID ways of working, tools & environments	Engage teachers & other stakeholders in co-creating inquiry-specific resources & environments.	Interdisciplinary pedagogical approaches
	Shared language & distributed agency	Make space & time to co-create shared purpose and language.	ID terminology & meanings
MACRO	ID knowledge cultures, infrastructures & institutions	Build ID culture and leadership capacity by bridging research, theory and practice through institutional partnerships.	Infrastructures for ID teaching and learning
	ID policies, systems, networks & communities	Navigate & shape interdisciplinary policies, strategies & curricula by engaging in interdisciplinary networks & communities.	Navigating ID policies & strategies
SYNTHE-SIS	Creating an ID ecosystem	Integrate ID practices across the micro, meso, & macro levels with specific aims & contexts.	A vision of an ID ecosystem
	Considerations for policy & decision-making	Broaden the reach of ID education and equity through system-level policies & support measures.	Broadening the reach of ID education

MICRO LEVEL

(Multi)disciplinary foundations and interdisciplinary know-how

Research-practice insights: Prioritise epistemically sound, authentic teachers' interdisciplinary learning experiences tailored to specific purposes and contexts, which expand over time.

Teachers' interdisciplinary practices include several interrelated facets that broadly fall into two aspects: a) interdisciplinary teaching, such as teaching STEM and general capabilities (see the centre of Figure 3); and b) teachers' broader professional practices and learning, such as hybrid and networked forms of education that include the use of digital technologies (see the outer part of Figure 3). These facets are distinct, though interrelated, and require distinctive knowledge, skills and other personal resources. For example, teaching STEM, general capabilities, cross-curriculum topics, and knowledge application are often discussed together in the context of interdisciplinary teaching; however, each of these facets of interdisciplinary teaching and learning has distinct features and requires distinct disciplinary and pedagogical knowledge and skills.

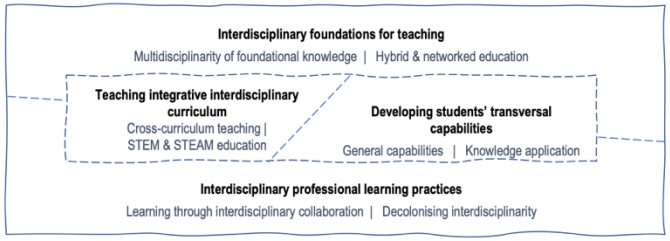


Figure 3: Main facets of teachers' interdisciplinary practices (after Markauskaite, Goodyear et al., 2023)

Therefore, the foundations of teachers' interdisciplinary expertise should be developed in relation to diverse facets. This learning should involve the development of teachers' relevant disciplinary and interdisciplinary understanding and awareness for working and teaching within a particular interdisciplinary area. For example, teachers' education for integrating sustainable development into teaching practices should be underpinned by a sound conceptual understanding of what constitutes sustainable development and how it relates to a broader institutional, policy and community context (UNESCO, 2018); teachers' education for using GenAI in teaching should be grounded in their understanding of how large language models work and surrounding pedagogical, assessment, ethical and other issues (Kasneci et al., 2023). Teacher educators, therefore, should prioritise conceptually and epistemically sound teachers' interdisciplinary learning experiences by focusing on specific purposes and contexts and gradually expanding these experiences to new facets of interdisciplinary practices.

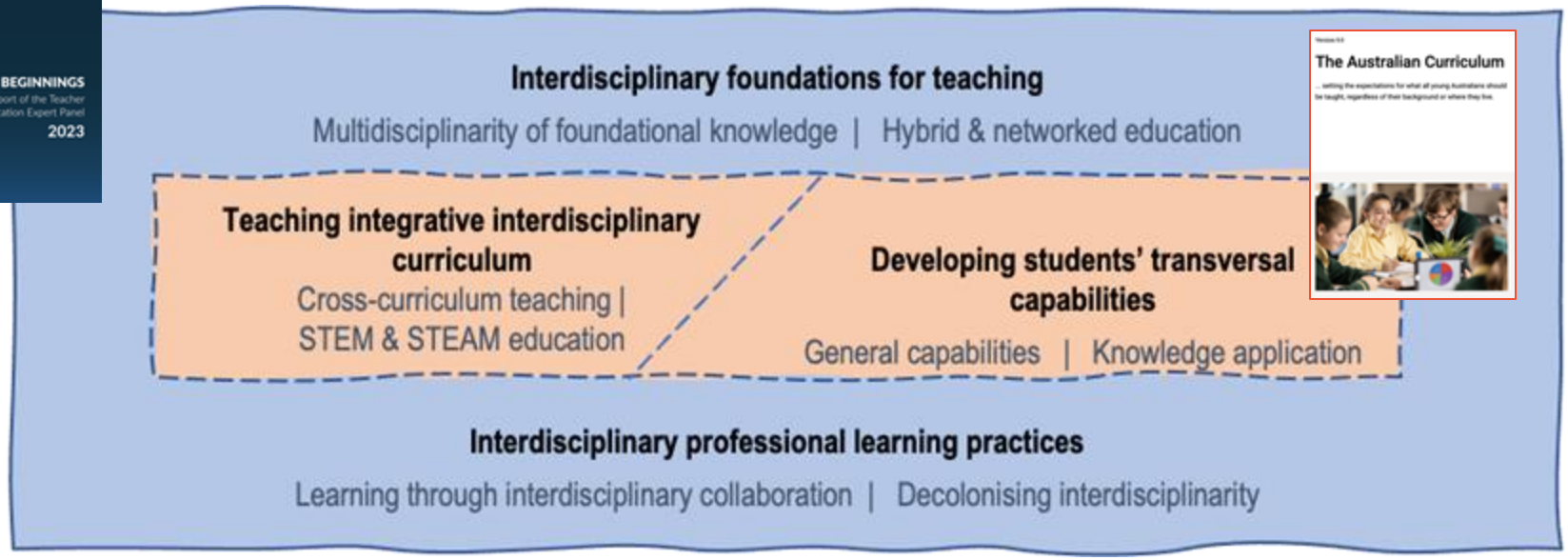
Table 2: Examples of the main facets of teachers' interdisciplinary practices

Facets	Exemplars
Interdisciplinary foundations for teaching	
Multidisciplinarity of teachers' foundational knowledge	Integrate research advances from neuroscience, the developmental and learning sciences on how people learn into teacher education (Darling-Hammond et al., 2021).
Hybrid and networked education	Develop teacher digital capabilities by integrating curriculum-related, ethical and professional uses of digital technologies (Falloon, 2020).
Interdisciplinary professional learning practices	
Learning through interdisciplinary collaboration	Create opportunities for professional learning in interdisciplinary teachers' communities (Grossman et al., 2001) and with experts beyond traditional disciplines, such as Aboriginal cultural educators (Burgess & Harwood, 2021).
Decolonising interdisciplinarity: social, environmental, and epistemic justices	Develop teachers' understanding and commitment to justice by embracing critical pedagogies toward contemporary disciplinary and interdisciplinary knowledge (Quan et al., 2019).
Teaching integrative, interdisciplinary curriculum	
Cross-curriculum teaching and learning	Embed sustainability in teacher education through collaborative action research (Ferreira et al., 2019).
STEM and STEAM education	Prepare teachers to teach STEM by focusing on the integration and connections between STEM disciplines in solving real-world problems (Enderson et al., 2020).
Developing students' transversal capabilities	
General capabilities	Prepare teachers to teach 2st-century skills by focusing on leadership, program design, learning environments, partnerships, and continuous improvement (Greenhill, 2010).
Knowledge application: vocational education and integrated learning	Prepare teachers for programs that combine academic learning with relevant career and other life experiences, such as Big Picture Education (Fischetti et al., 2024), Linked Learning (Saunders et al., 2013).

MICRO LEVEL

(Multi)disciplinary foundations and interdisciplinary know-how

Research-practice insights: Prioritise epistemically sound, authentic teachers' interdisciplinary learning experiences tailored to specific purposes and contexts, which expand over time.



MICRO LEVEL

Explore Activity: Main facets of teachers' interdisciplinary practices

Figure 3 summarises the main facets of teachers' interdisciplinary practices related to teaching and professional learning (Markauskaite, Goodyear et al., 2023). Table 2 offers some examples. Explore this figure and table and consider the following questions:

1. What other facets are important to consider?
2. How are these facets interrelated?
3. What are the potential benefits and limitations of embedding them in teachers' professional learning separately vs. integrating them with each other?

Discuss broad ideas of how this could be done.

MICRO LEVEL

Share and Build Activity: Main facets of teachers' interdisciplinary practices

Use the research-practice insights above and the prompts in Box 3 to explore how interdisciplinary foundations and know-how are currently developed in your teacher education program or context. Discuss how this focus could be extended or re-imagined.

Knowledge-sharing

a) Describe which interdisciplinary facets you have experience in your pre-service or in-service professional education context.
b) Outline key design features (approaches, scaffolding, etc.) that were critical to make this happen.
c) Explain what enabled or constrained your possibilities to support the development of these foundations and know-how in your context.

Knowledge-building

a) Describe which new facets of interdisciplinary practices you might like to focus on (and why) in your pre-service or in-service professional development education context.
b) Outline the key design features critical to making this happen in your context.
c) Identify what might enable or constrain your possibilities to support the development of these interdisciplinary foundations and know-how in your context.

SYNTHESIS LEVEL

Creating an interdisciplinary ecosystem

Research-practice insights: Integrate interdisciplinary practices across the micro, meso, and macro levels with specific aims and contexts.

Explore Activity: A vision of an interdisciplinary ecosystem

Figure 5 presents an example of an ecosystem for developing expertise for interdisciplinary teaching in a school based on a model co-created by the experts in this study. Explore this model and consider the following questions:

1. Which aspects of each model resonate with you most and why?
2. Which elements of each model would you align to a micro, meso, or macro level of teachers' interdisciplinary learning?
3. What elements would you add, remove or change?

Discuss how such a model could support the development of a shared vision within a school and how it could be translated into a concrete institutional strategy or plan, including specific professional learning activities. Consider how such a model of an ecosystem might look in a pre-service teacher education context.

Share and Build Activity: A vision of an interdisciplinary ecosystem

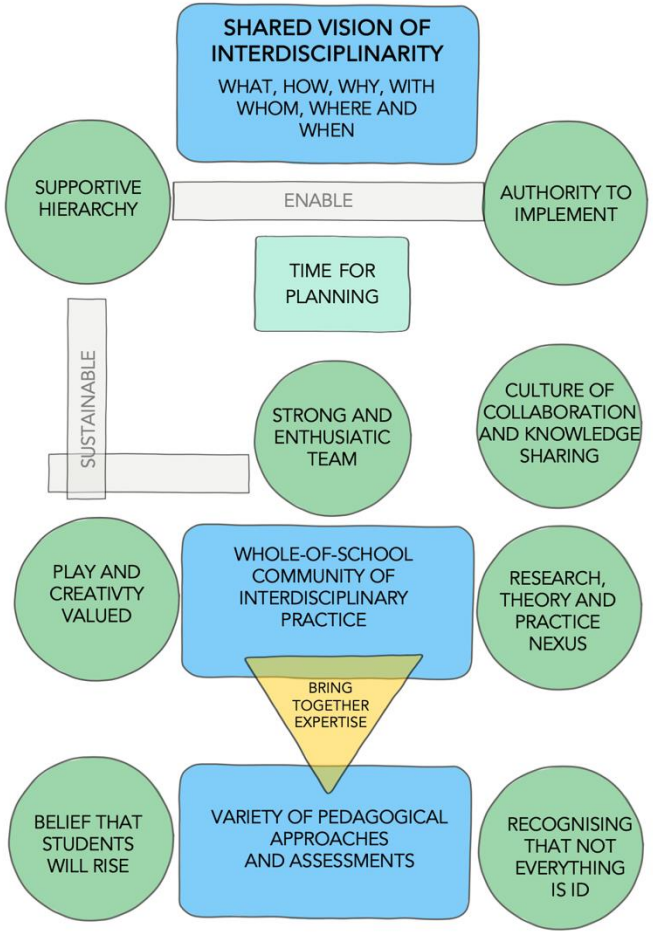
Use Figure 5 and the prompts in Box 12 to create a model of an ecosystem for developing interdisciplinary expertise in your teacher education program or context. Identify the most significant barriers and discuss possible changes.

Knowledge-sharing

a) Draw a diagram that visualises the current ecosystem of interdisciplinary professional learning in your pre-service or in-service professional learning context.
b) Include the main enablers and barriers.
c) Outline the roles of different stakeholders in this ecosystem.

Knowledge-building

a) Draw a model of an ideal future ecosystem for interdisciplinary professional learning in your pre-service or in-service teacher professional learning context.
b) Outline what changes are needed to make this real in your school or university context.
c) Identify what realistically can be done in the short, medium and long term to achieve this vision.

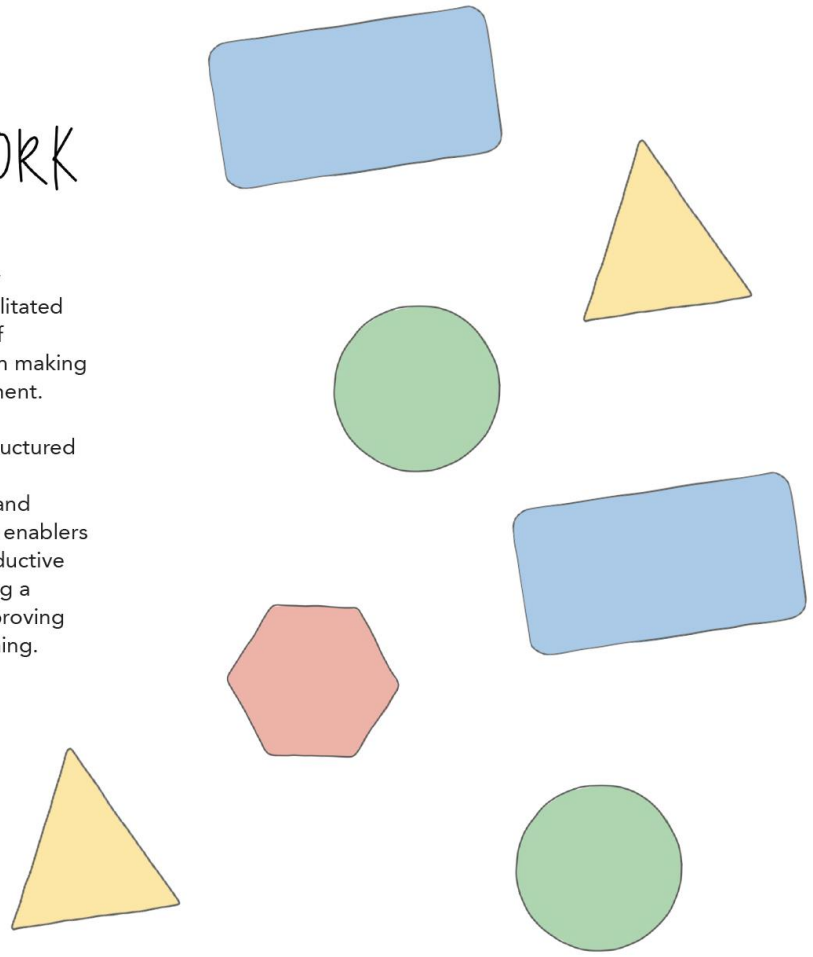


DEVELOP YOUR OWN FRAMEWORK OF INTERDISCIPLINARY EXPERTISE

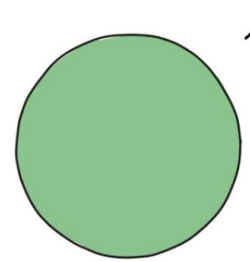
PURPOSE OF FRAMEWORK

Create a framework that articulates what interdisciplinary expertise entails and guides how it can be effectively facilitated and developed. By clearly identifying the key concepts of interdisciplinary teaching expertise, this framework aids in making informed decisions about capabilities and their development.

The purpose of this activity is to provide a flexible but structured approach to understanding and enhancing teachers' interdisciplinary expertise. It will help teacher educators and teaching teams identify key areas of expertise, recognise enablers and barriers, and define the capabilities required for productive interdisciplinary teaching. This serves as a tool for creating a framework that then would be used for planning and improving interdisciplinary teaching practices and professional learning.

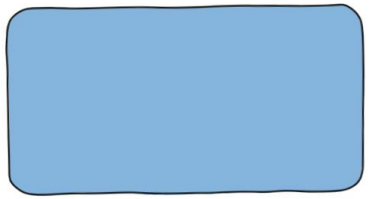


FRAMEWORK COMPONENTS



CIRCLE

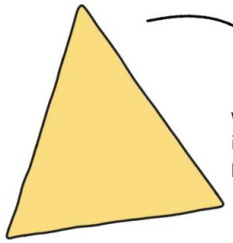
What are the main enablers for developing expertise for interdisciplinary teaching in pre- and in-service teachers' education?



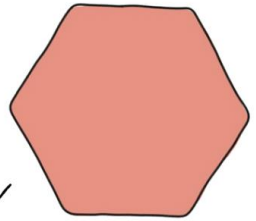
RECTANGLE

What are the most important areas of teachers' interdisciplinary practices?

TRIANGLE



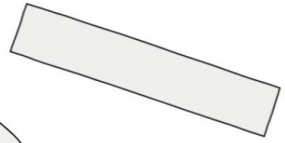
What are the key needs for interdisciplinary professional learning?

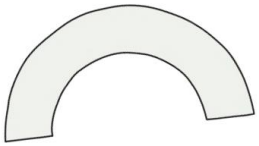


HEXAGON

What are the main barriers to developing expertise for interdisciplinary teaching in pre- and in-service teachers' education?

CONNECTOR SHAPES





Use the connector shapes to link shapes (ideas) together. These connectors will help visualise how different aspects of interdisciplinary expertise interact and support each other.

INSTRUCTIONS FOR DEVELOPING YOUR OWN FRAMEWORK

1. **CUT OUT SHAPES:**

Cut from thick coloured pieces of paper 4 sets of shapes (up to 15 of each shape).

Yellow Triangle: What are the key capabilities required for interdisciplinary teaching?

Blue Rectangle: What are the most important areas of teachers' interdisciplinary practices and needs for professional learning?

Green Circle: What are the main enablers for developing expertise for interdisciplinary teaching in pre- and in-service teachers' education?

Red Hexagon: What are the main barriers to developing expertise for interdisciplinary teaching in pre- and in-service teachers' education?

2. **IDENTIFY KEY DIMENSIONS:**

Begin by identifying aspects of expertise that are crucial for effective interdisciplinary teaching. Use the provided shapes to represent different dimensions and aspects of interdisciplinary teaching.

3. **USE KEY SHAPES**

Each shape in the framework represents a specific aspect of interdisciplinary expertise. Use these shapes to structure your framework.

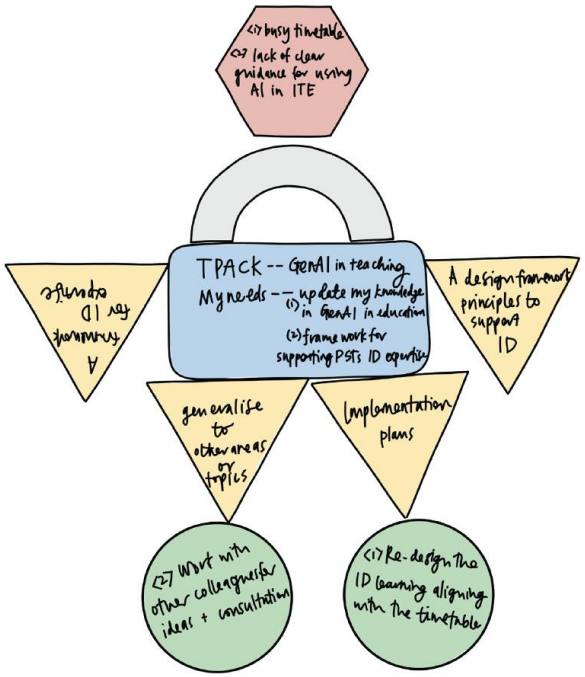
4. **CONNECT THE SHAPES:**

Use the connector shapes to link shapes (ideas) together. These connectors will help visualise how different aspects of interdisciplinary expertise interact and support each other.

5. **CONTEXTUALISE YOUR FRAMEWORK:**

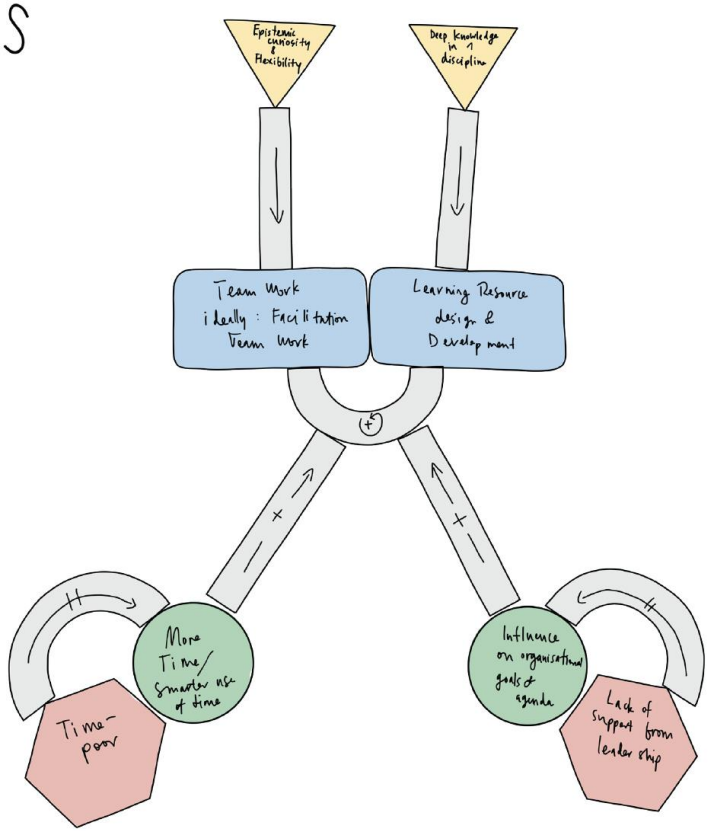
Tailor your framework to the specific context and needs of your pre-/in-service teacher education program. Consider the unique challenges and opportunities within your educational context.

EXAMPLES OF FRAMEWORKS



EXAMPLE ONE: Framework mapping out components of using generative AI for interdisciplinary teaching and learning.

NOTE: ITE – Initial Teacher Education
TPACK – Technological Pedagogical Content Knowledge
AI – Artificial Intelligence
ID – Interdisciplinarity



EXAMPLE TWO: Framework highlighting team work and learning resource design and development to help develop epistemic flexibility and deep knowledge within discipline.

THANK YOU

About us
www.interdisciplinaryexpertise.org

Get in touch
Lina.Markausaite@sydney.edu.au
Natalie.Spence@sydney.edu.au

THE UNIVERSITY OF SYDNEY