Characteristics and Development of Teacher Adaptive Expertise: Findings from a scoping review

Lihua Xu, Kennedy Chan, Amanda Berry, Joseph Ferguson, Gahyoung Kim, Jan van Driel, Colleen Vale, and Wanty Widjaja

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Project team

Our team represents a collaboration between researchers at Monash University, Deakin University and University of Melbourne.

Investigators

Professor Mandi Berry
Monash Education
(Chief Investigator)

Professor Colleen Vale
Monash Education

Professor Jan van Driel
University of Melbourne

Associate Professor Wanty Widjaja
Deakin University

Dr Lihua Xu
Deakin University

Research Fellows

Dr Joseph Ferguson
Deakin University and University of Melbourne

Dr Gahyoung (Jinny) Kim
Monash Education

International Advisory Board

The International Advisory Board connects the project with leading international experts and institutions and enhances opportunities for dissemination of outcomes and future international collaborative projects. The Board provides feedback on data gathering, analyses, interpretations, overall project progress and dissemination.

Associate Professor Karen D. Könings
Maastricht University, Netherlands

Dr Kennedy Kam Ho Chan
The University of Hong Kong

Professor Russell Tytler
Deakin University, Australia

Emeritus Professor Peter Sullivan
Monash University, Australia

Professor Tamara Moore
Purdue University, USA

Project Website:
https://www.monash.edu/education/research/projects/primary-teachers-adaptive-expertise-in-interdisciplinary-maths-and-science

Project Aims and Research Questions

Project aims: to improve theoretical and practical understanding of the nature and development of primary teachers' adaptive expertise in interdisciplinary mathematics and science.

Key research questions:

1. How can primary teachers' adaptive expertise in interdisciplinary mathematics and science be characterised in terms of components and levels?

2. To what extent, and how, does primary teachers' adaptive expertise change and develop during a trajectory across three school years aimed at interdisciplinary mathematics and science in a co-plan, co-teach and co-reflect approach?

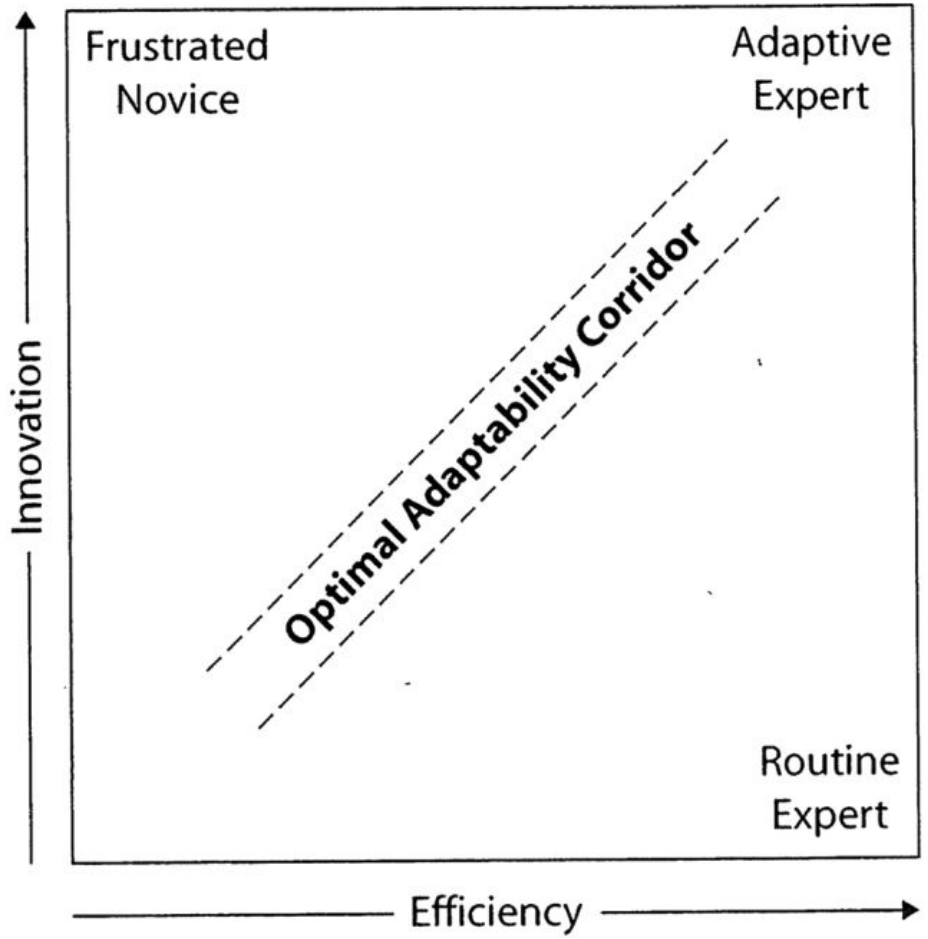
Adaptive and Routine Expertise

Hatano and Inagaki (1984) differentiated between adaptive and routine expertise:

- *Adaptive experts* are “those who not only perform procedural skills efficiently but also understand the meaning of the skills and nature of their object” (p.28)
- *Routine experts* are “outstanding in terms of speed, accuracy, and automaticity of performance, but lack flexibility and adaptability to new problems” (p.31)

Bereiter and Scardamalia (1993) distinguished between crystallized and fluid expertise:

- *Crystallized expertise* consists of intact procedures that have been thoroughly learned through experience, brought forth and used in relatively familiar tasks.
- *Fluid experts* appear to learn throughout their careers, bringing the expertise they possess to bear on new problems, and finding ways to tie the new situations they encounter to the knowledge base they have.



The trajectory towards adaptive expertise balances efficiency and innovation via the optimal adaptability corridor (Schwartz, D. L., Bransford, J. D., & Sears, D. , 2005).

Dimensions and Characteristics of Adaptive Expertise (Carbonell et al. 2014)

1) **Domain specific knowledge and skills:** declarative, procedural, and conditional knowledge.
2) **Domain-independent skills**: cognitive flexibility and analogical problem solving.
3) **Regulation processes**: self-efficacy, goal-setting and goal achievement, and regulation of emotions.

Carbonell, K. B., Stalmeijer, R. E., Könings, K. D., Segers, M., & van Merriënboer, J. J. (2014). How experts deal with novel situations: A review of adaptive expertise. *Educational Research Review*, *12*, 14-29.

Earlier research on Adaptive Expertise

Psychological development Literature	Expertise Literature	Teacher Education Literature	Science Education Literature
Adaptive Expertise (Hatano & Inagaki, 1986)	Dreyfus & Dreyfus (1986)		
	Holyoak (1991)		
	Gott (1992)		
	Expertise as a process (Bereiter & Scardemalia, 1993)	**Teacher learning through practices** (Ball & Cohen, 1999)	
	Expert Flexibility (Feltovich et al., 1997)		
	Wineburg (1998)	**How teachers learn & develop** (Hammerness et al., 2005)	
	How people learn I (National Research Council, 2000)		**Adaptive Expertise in Science Teaching Adaptive practices** (Crawford et al., 2005)
Adaptive Expertise (Hatano & Ouraz, 2003)			
	Efficiency & Innovation (Schwartz et al., 2005)		
	How experts deal with novel situations (Carbonell et al., 2014)	**PD framework for teachers and school leaders** (Timperley, 2011)	
		Learning to practise (Timperley, 2013)	

Research Questions:

1) How is AE conceptualized, developed, and measured in the context of education?
2) Which aspect of AE is domain specific and which aspect is domain general?
3) What implications can we draw from this review to inform our understanding of teacher AE in interdisciplinary science and mathematics?

Scoping Reviews:

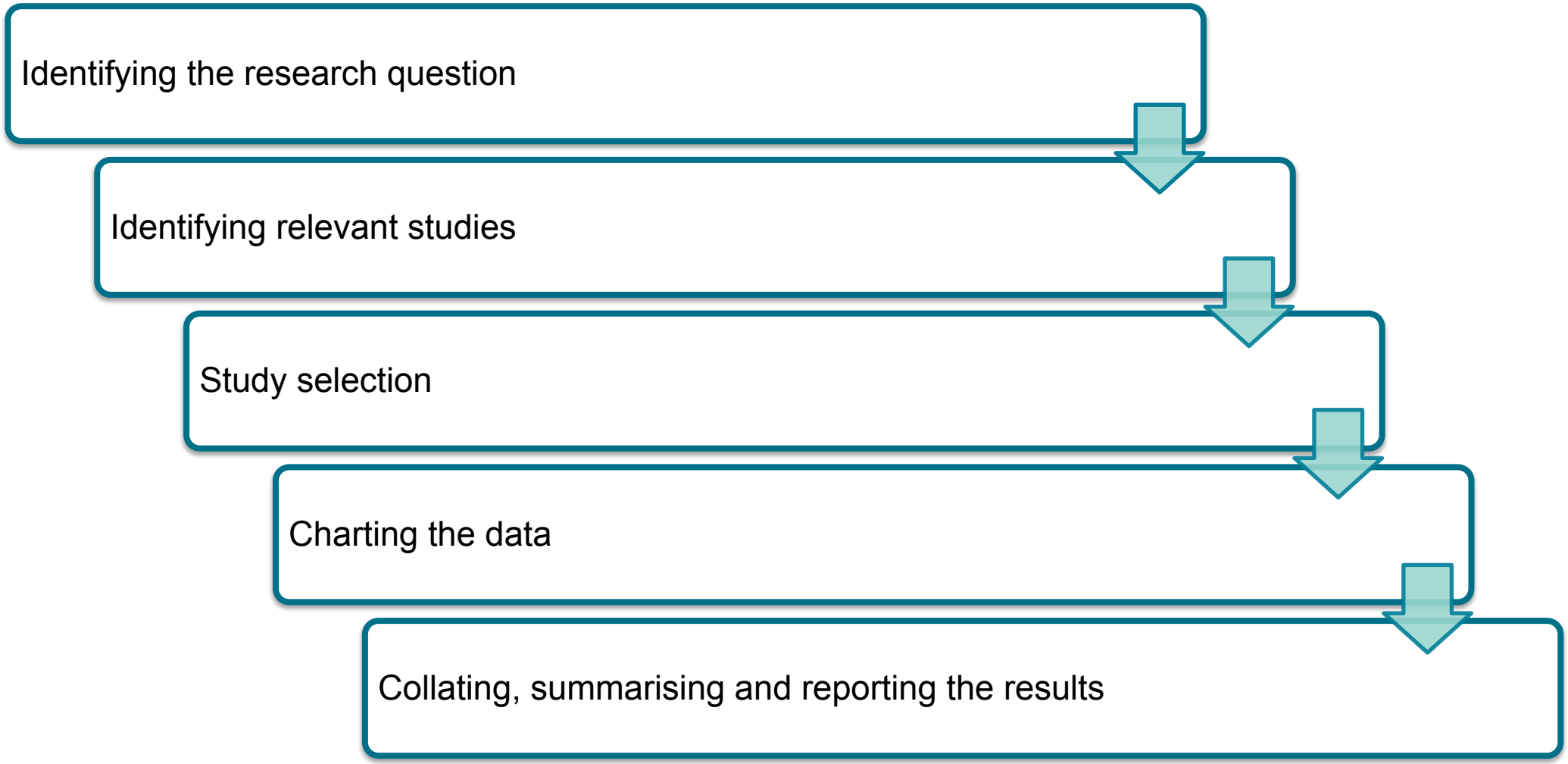
Tend to be broader in scope than systematic reviews and seek to explore and map overall themes and gaps in the available research literature on a broad topic.

Searching is systematic and transparent, with criteria modified as review proceeds.

Purposes of a scoping review (Munn et al., 2018):

- To clarify key concepts/definitions in the literature.
- To examine how research is conducted on a certain topic or field.
- To identify key characteristics or factors related to a concept.
- To identify and analyse knowledge gaps.

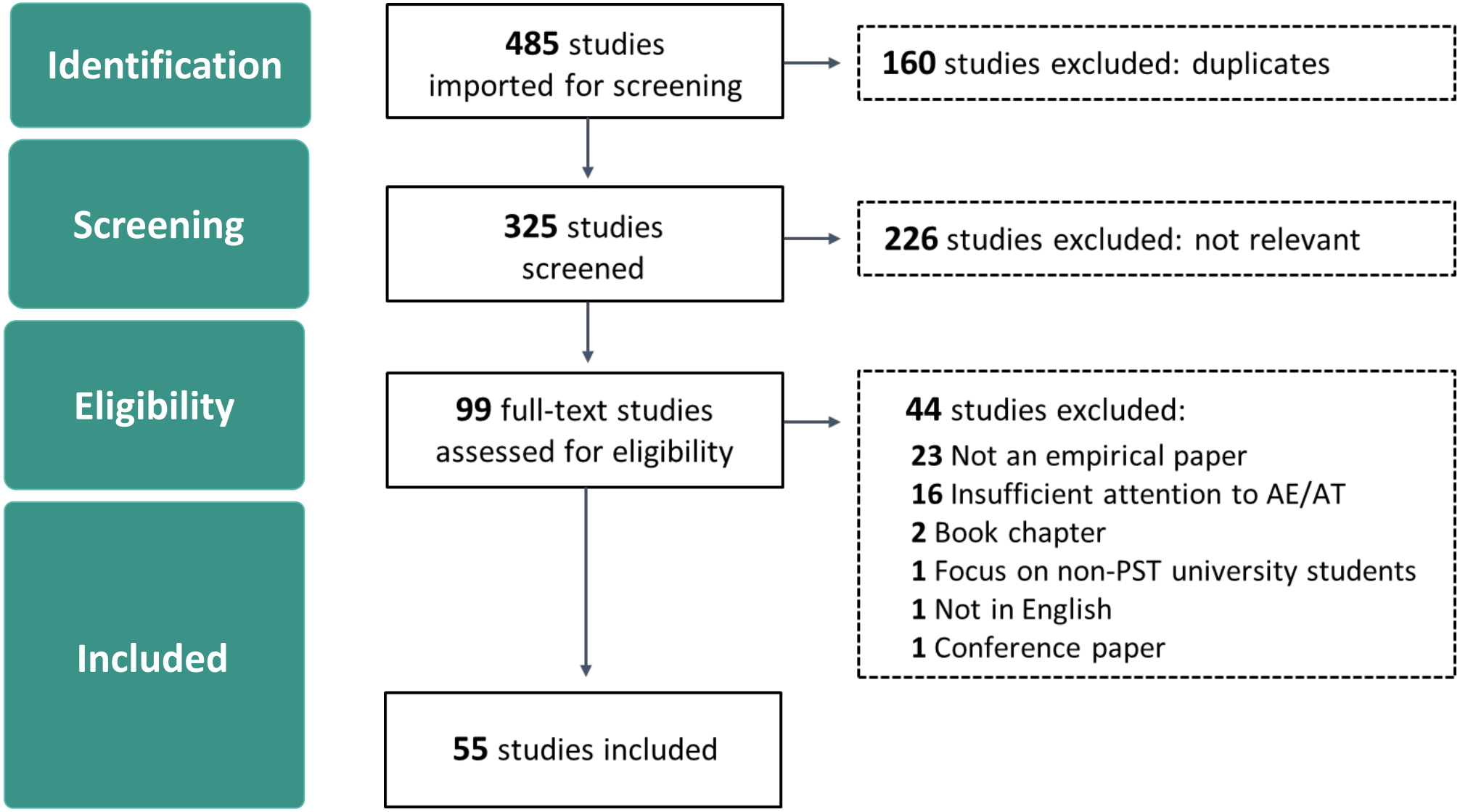
Scoping Reviews (Arksey & O'Malley, 2005)



Deciding on the Inclusion and Exclusion Criteria

Criterion	Inclusion	Exclusion
1. Source	Peer-reviewed journals	Conference papers/proceedings, book chapters, non-peer-reviewed journals
2. Language	English	Non-English
3. Type of publication	Empirical research	Literature reviews, editorials, position papers or commentaries
4. Research focus	Adaptive expertise is a substantial focus Adaptive teaching is clearly conceptualised and operationalised	Adaptive expertise is only mentioned in passing Adaptive systems Adaptive teaching is mentioned but without clear conceptualisation
5. Subject domain	All	All
6. Participants	Pre-service and in-service teachers Teachers of all levels (e.g schools, university) and fields (e.g. medical, engineering)	School and university students

PRISMA Flowchart of Study Selection Process



Our Extraction Framework

Category	*Codes*	*Short description*
Number	-	Articles in alphabetical order.
Authors	-	Names of author and co-authors.
Year	-	Year the article has been published.
Location of study	-	Country where the study was conducted.
Research design	*Quantitative*	Numerical data is collected and analyzed.
	Qualitative	Non-numerical data is collected and analyzed.
	Mixed methods	Both qualitative and quantitative data are collected and analyzed in the same study.

Category	*Codes*	*Short description*
Type of Participants	*Pre-service primary teacher*	Including student teachers, candidates, or novices trained for primary teaching (Foundation to Grade 6).
	Pre-service secondary teacher	Including student teachers, candidates, or novices trained for secondary teaching (Grades 7-12).
	In-service primary teacher	Fully certified teachers responsible for primary teaching (Foundation to Grade 6).
	In-service secondary teacher	Fully certified teachers responsible for secondary teaching (Grades 7-12).
	Other	Other than pre/in-service primary or secondary teachers, such as early childhood teachers, higher education lecturers, trainers, etc.
Number of participants		Maximal number of participants. Sample size refers to the number of persons whose AE/AT was investigated.

Our Extraction Framework

Category	Codes	Short description
Field of study	*Mathematics*	Subject is mathematics in which AE/AT is empirically investigated or measured.
	Sciences	Subject is (natural) sciences (e.g., chemistry, physics, biology) in which AE/AT is empirically investigated or measured.
	Literacy	Comprehension and communication in which AE/AT is empirically investigated or measured.
	Integrated	A mixture of subject areas.
	Other subjects	Subjects (e.g., arts, geography, history, music, sports, or languages such as Spanish, English, or English as a foreign language) in which AE/AT is empirically investigated or measured.

Category	Codes	Short description
Research focus	*Nature and content*	Investigating adaptive expertise at one moment in time.
	Development	Investigating adaptive expertise at multiple moments, with or without an intervention.
	Relationship with other constructs	Investigating the qualitative and/or quantitative relationships between adaptive expertise/teaching and other educational constructs (e.g., reflection, student learning outcomes).
	Instruments for capturing/measuring	Describing (the development/refinement of) an instrument/method to investigate/capture/measure AE/AT.
	Others	None of the aforementioned research foci.

Our Extraction Framework

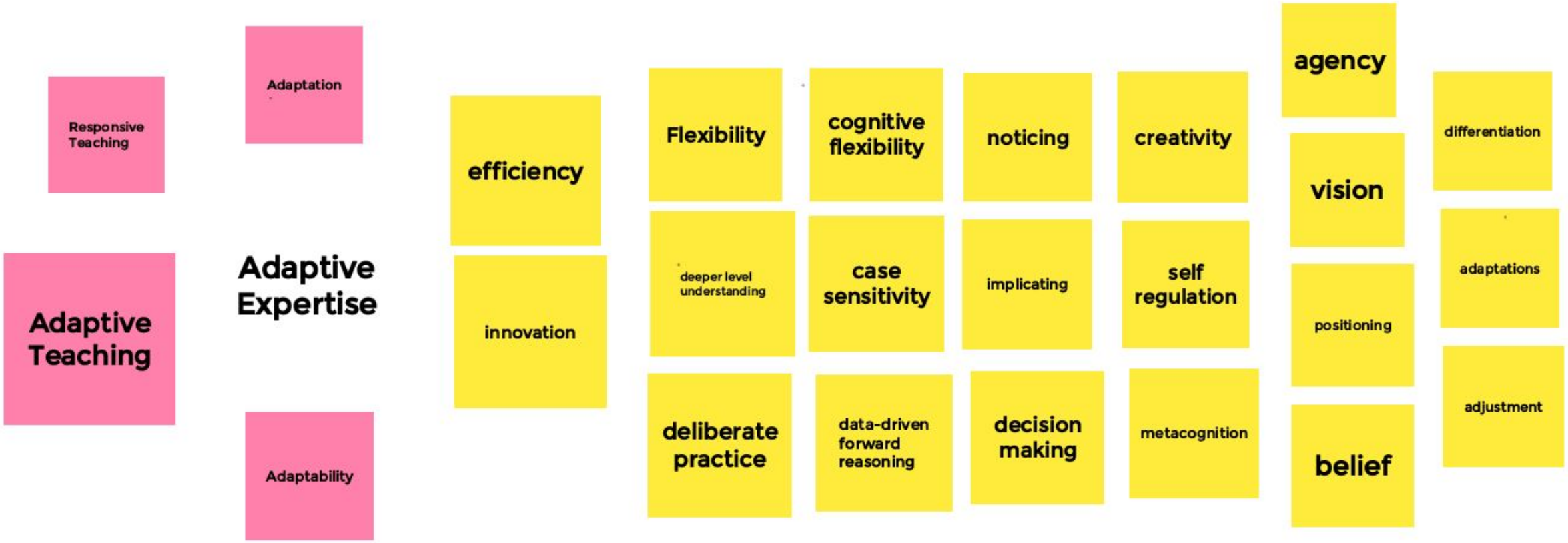
Category	*Codes*	*Short description*
Connection to routine expertise	Yes	The relationships/differences between routine expertise and adaptive expertise are explicitly described as per Hatano & Inagaki (1984).
	No	The relationships/differences between routine expertise and adaptive expertise are not explicitly described as per Hatano & Inagaki (1984).
Intensive or restricted conceptualisation	*Intensive*	The term AE or AT is referred to constantly throughout the publication, and explicitly articulated in the conceptualisation and the results of the study.
	Restricted	The term AE or AT is referred to in limited places in the publication. The role of AE/AT in the study remains unclear.

Category	*Codes*	*Short description*
Component or holistic conceptualisation	*Holistic views*	AE is framed as a whole process without further distinguishing between facets or sub-processes.
	Component views	AE is deconstructed into distinct subcomponents which are investigated in the study.
Components of AE/AT	*Domain specific knowledge and skills*	Declarative, procedural, and conditional knowledge.
	Domain independent skills	Cognitive flexibility and analogical problem solving.
	Regulation processes	Self-efficacy, goal-setting and goal achievement, and regulation of emotions.

Analytical questions for guiding the review

1. What aspect of expertise is being foregrounded (e.g. behaviours, practice, cognition, knowledge, meta-cognition and dispositions)?
2. What literature did the authors draw upon in their conceptualisation of AE/AT?
3. What are the components (e.g. attributes, dimensions, characteristics) of AE/AT and how are they defined?
4. What levels are these components operating at, e.g. grain size (macro, micro adaptation, planning versus in the moment)?

Aspects of expertise foregrounded



Components and Characteristics of Science Teachers' Adaptive Expertise (Yoon et al. 2019)

Component	Manifestation
Flexibility: the ability to opportunistically plan, change enactments faster than non-experts, and flexibly and critically apply their knowledge to new situations while constantly learning.	One's ability to integrate aspects of teacher knowledge in relation to the teaching act with the goal of improving outcomes while responding to their specific contexts.
Deep-level understanding addresses the need to not only have acquired content and pedagogical knowledge, but to have a deep understanding of it in order to use such knowledge effectively.	One's ability to recognise meaningful patterns quickly, allowing one to attend to deeper-level problem solving and in turn perform at a higher level.
Deliberate practice addresses the need for teachers to receive feedback about and reflect upon their teaching either directly from their observations, from student outcomes, or from outside perspectives, with the intent to shift their practice based on feedback and reflection.	One's ability to engage in reflection, conscious deliberation, and regulation processes.

Yoon, S. A., Evans, C., Miller, K., Anderson, E., & Koehler, J. (2019). Validating A Model for Assessing Science Teacher's Adaptive Expertise with Computer-Supported Complex Systems Curricula and Its Relationship to Student Learning Outcomes. *Journal of Science Teacher Education*, *30*(8), 890-905.

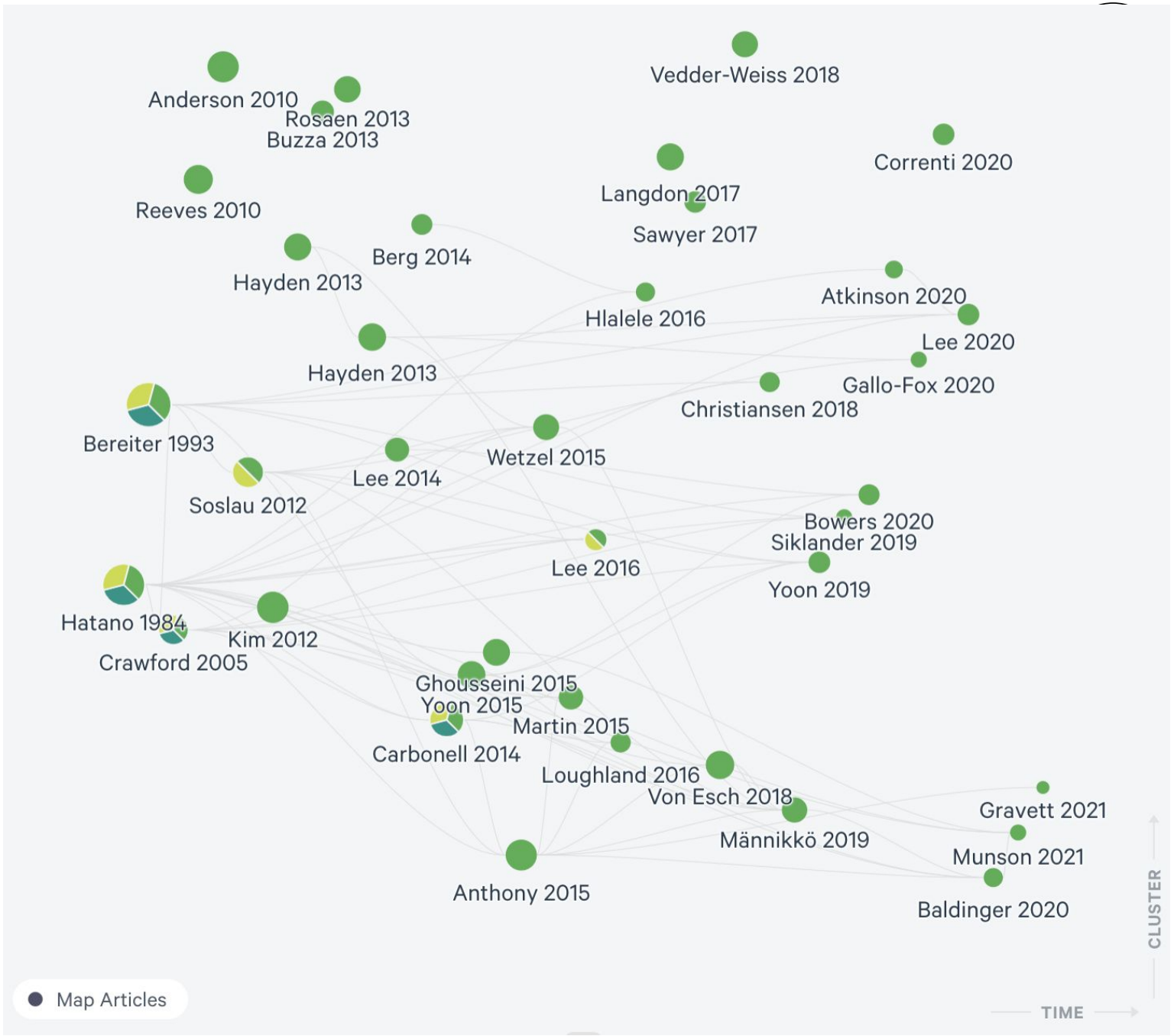
Components and Characteristics of Teachers' Adaptive Expertise in rehearsal debriefs (Baldinger & Munson, 2020; Munson, Baldinger, Larison, 2021)

Component	Manifestation
Cognitive flexibility (Crawford et al., 2005; Feltovich et al., 1997): the propensity to revise one's thinking, as one remains open to new, inconsistent, or nuanced information.	One's ability to entertain multiple ways of interpreting student thinking and ask questions that test these hypotheses before committing to a single, perhaps more nuanced, interpretation.
Case sensitivity (Feltovich, Spiro, & Coulson, 1997): they hold their knowledge of a domain at a distance (Crawford et al., 2005).	One's ability to resist applying known procedures, as they consider whether the contextual features may demand adaptation.
Data-driven forward reasoning (Patel & Groen, 1986): such reasoning sits in contrast to patterns of more routine experts, who may attempt to make data fit into a predetermined response or interpretation.	One's ability to select specific details in the environment and make sense of those details, adhering meaning to them.

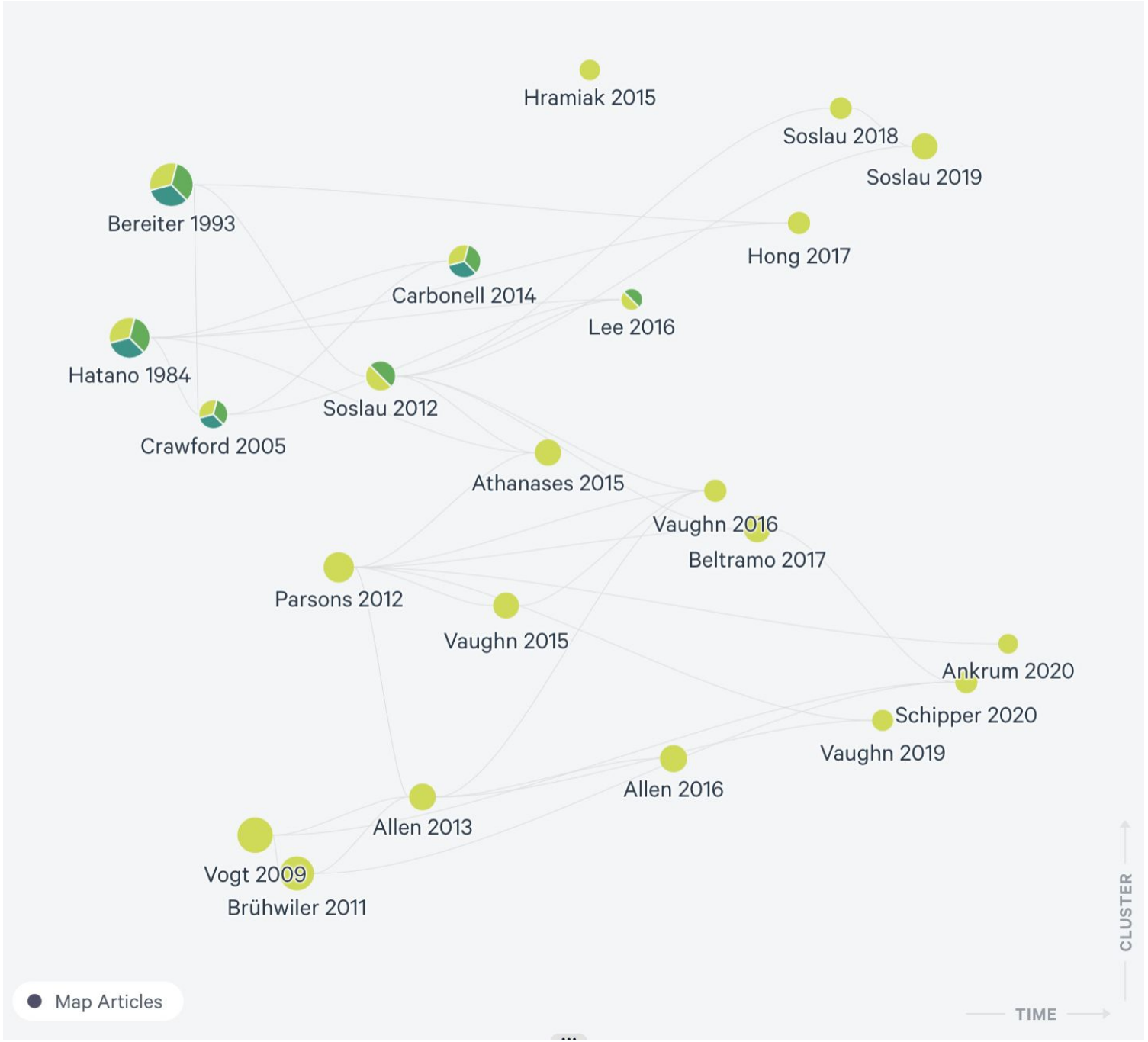
Baldinger, E. E., & Munson, J. (2020). Developing adaptive expertise in the wake of rehearsals: An emergent model of the debrief discussions of non-rehearsing teachers. *Teaching and teacher education*, *95*, 103125.

Munson, J., Baldinger, E. E., & Larison, S. (2021). What if…? Exploring thought experiments and non-rehearsing teachers' development of adaptive expertise in rehearsal debriefs. *Teaching and teacher education*, *97*, 103222.

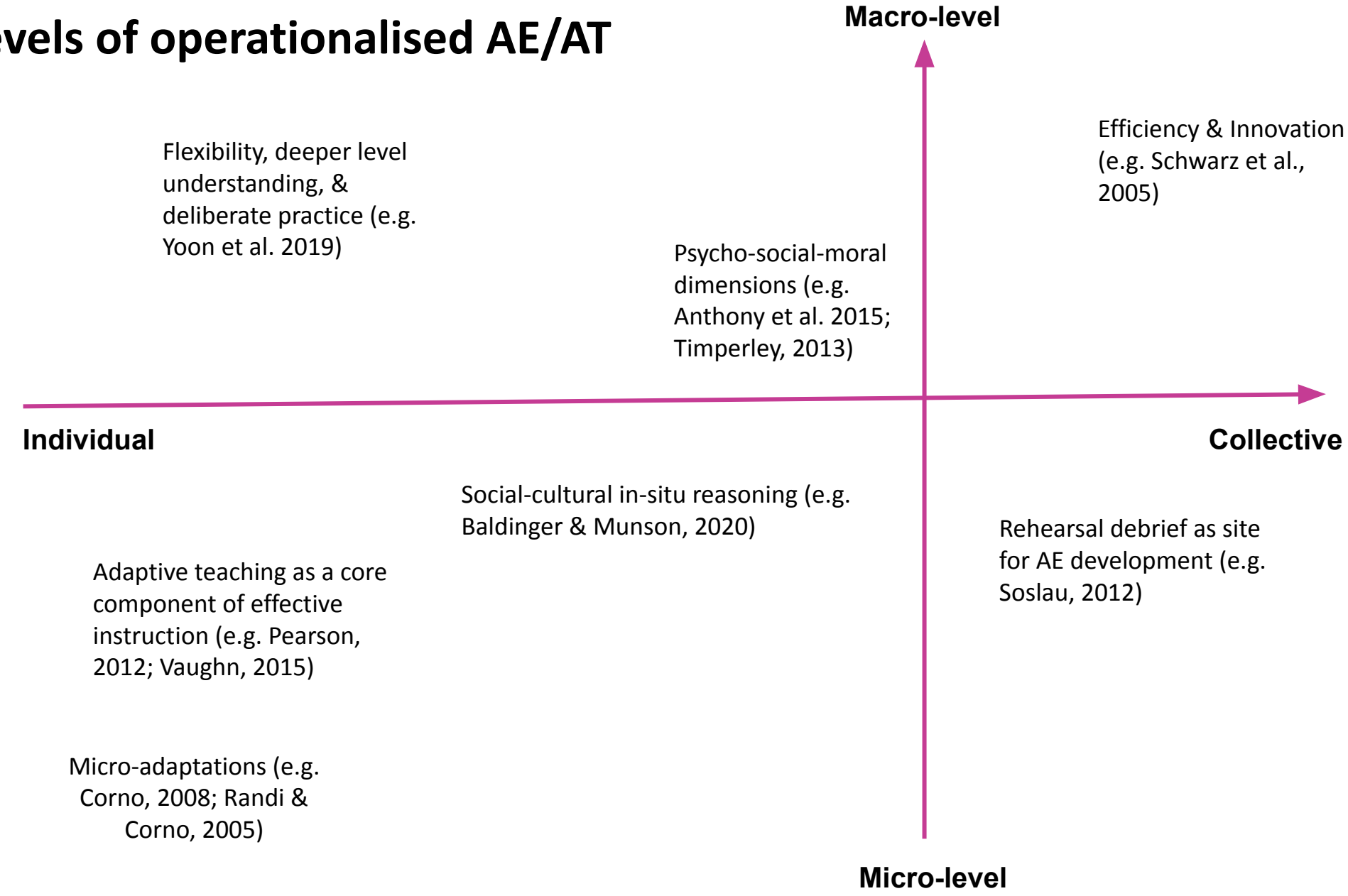
Adaptive Expertise Literature Map



Adaptive Teaching Literature Map



Levels of operationalised AE/AT



Some findings so far

- The tensions between ‘conservative’ and ‘ambitious’ reform agendas seem to be used as either an explicit or implicit rationale for the advocacy of AE/AT.
- There is a great diversity in both conceptualization and approaches to investigate the characteristics of AE (and its development) in a wide range of educational contexts.
- The AT literature has predominantly focused on micro-level adaptations to instruction, often in the context of literacy, with a strong focus on inclusivity and equity.
- The AE literature seem less coherent with differing theoretical underpinnings and several diverging streams of research generated to identify the characteristics and development of teacher adaptive expertise.
- While both AE and AT literature refers to the seminal work by Hatano and Inagaki to various extent, researchers tended to ‘cherry pick’ aspects of the earlier conceptual work to align with their research agenda.
- There is limited research focusing on domain-specific aspects of adaptive expertise, in particular, in the area of interdisciplinary science and mathematics.

Thank you!

amanda.berry@monash.edu
colleen.vale@monash.edu
jan.vandriel@unimelb.edu.au
lihua.xu@deakin.edu.au
w.widjaja@deakin.edu.au
kennedyckh@hku.hk
joe.ferguson@deakin.edu.au
jinny.kim@monash.edu

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