

Designing, delivering, and consolidating learning in higher education: A meta-review of cognitively grounded instructional principles



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Background

Higher education increasingly emphasises **active learning**, understood as teaching in which students are actively involved in their own learning through activities, exercises, and interactions (Bonwell & Eison, 1991; Prince, 2004). **Cognitive theories of learning** identify conditions for managing cognitive demands, fostering active processing, and strengthening retention and transfer. These principles can support teachers in **designing, delivering, and consolidating learning activities** that promote meaningful cognitive engagement.

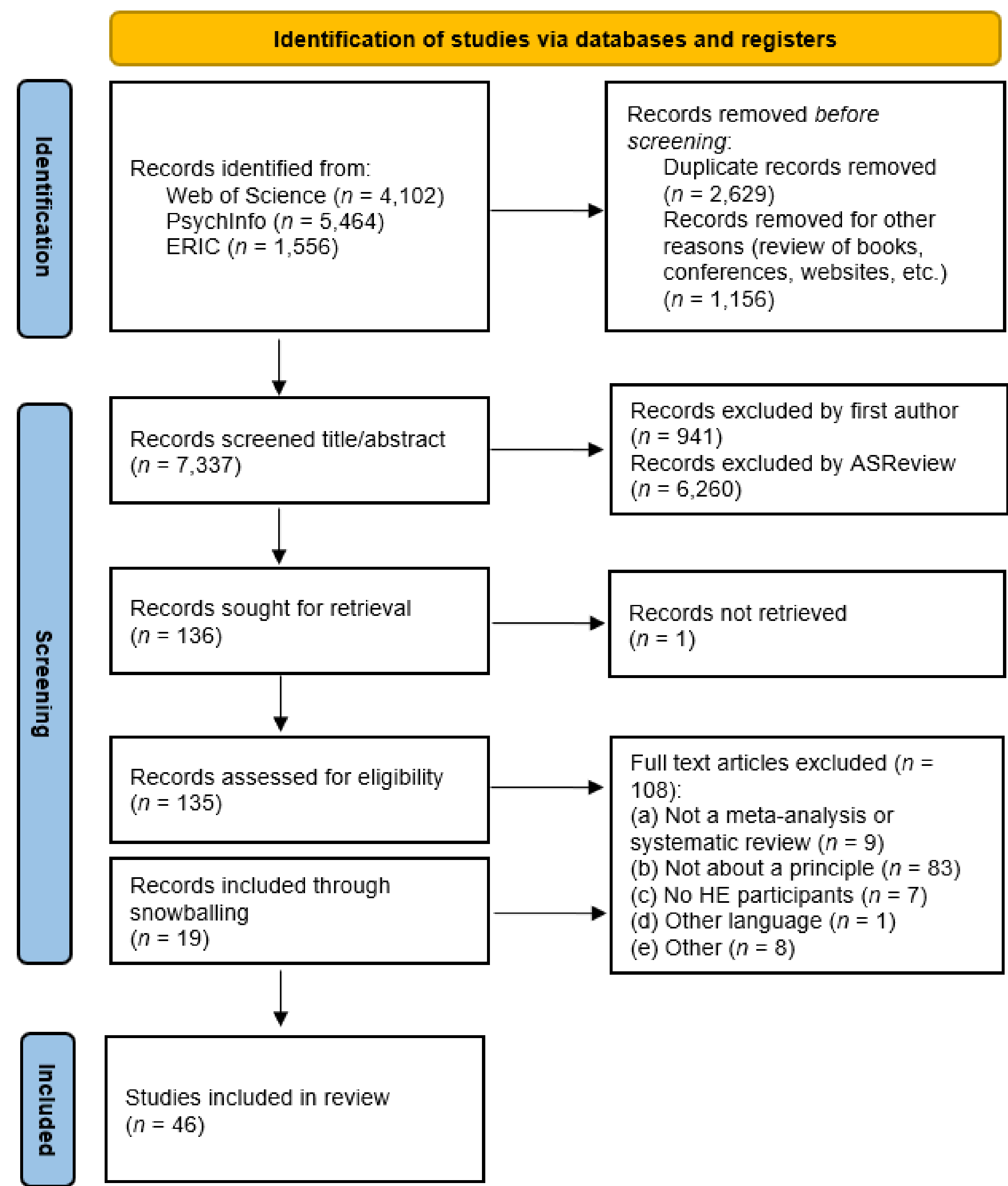
Aim

Much of the evidence for these principles comes from laboratory research or reviews that combine educational levels and settings, limiting its direct application to higher education classrooms (e.g., Agarwal et al., 2021). Our aim was therefore to **map review-level evidence on cognitively grounded instructional principles** for designing, delivering, and consolidating learning in **higher-education classrooms**. Our main research question was:

To what extent do meta-analyses and literature reviews provide empirical support for cognitively grounded instructional principles related to designing, delivering, and consolidating learning in higher education practice?

Method: Meta-review

Figure 1 PRISMA 2020 Flow Diagram of the meta-review



Results

The total of 46 reviews covered 11 of 14 included instructional principles.

Table 1 Summary of reported effect sizes for cognitively grounded instructional principles in higher education relevant contexts

Pedagogical responsibility	Instructional principle	Reported mean effects across educational levels, regardless context	Reported mean effects for higher education participants, regardless context	Reported mean effects in higher-education practice
Designing learning experiences	Split attention / spatial-temporal contiguity	●	●	●
	Coherence	●	●	●
	Redundancy	●	●	●
	Modality	●	●	●
	Segmentation	● ●	●	●
	Signalling	● ●	● *	●
Delivering learning experiences	Pre-training	No records found	No records found	No records found
	Worked examples	● ●	●	●
	Completion problems	No records found	No records found	No records found
	Self-explanation prompts	● **	●	●
	Spaced practice	●	●	●
Consolidating learning	Retrieval practice	● ● **	●	●
	Interleaved practice	●	●	●
	Varying conditions of practice	No records found	No records found	No records found

● = Small ● = Medium ● = Large ● = Inconsistent ● = Not reported

Note. Effect size categories are based on Kraft (2018): Small < 0.05, medium 0.05 to < 0.20, large ≥ 0.20. 'Not reported' indicates that no review-level mean effect sizes were provided. *Inconsistent: in one review effect sizes varied substantially (range: $r = -0.26$ to 0.50). **Inconsistent: In one review effect sizes depended on outcome type and assessment timing (range: $r = -0.05$ to 0.46). ***Majority medium-large.

Discussion & conclusion

- Evidence is **unevenly distributed**: consolidating learning, especially retrieval practice, has the strongest classroom-relevant support in higher education.
- Principles for designing and delivering learning are theoretically well grounded, but often supported by **laboratory-based or weakly contextualised evidence**.
- Active learning should promote meaningful cognitive engagement, with instructional principles applied through **context-sensitive professional judgement**.

Future research

- Define key constructs more clearly** and consistently, particularly learning outcomes and higher-education classroom context, so that findings can be compared across studies and reviews.
- Examine effects of instructional principles specifically in **authentic higher-education classrooms**.
- Investigate **how higher-education teachers perceive, select, adapt, and apply** cognitively grounded instructional principles in practice, including the opportunities and barriers they experience.

References

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Bonwell, C. C., & Eison, J. A. (1991). Active Learning: Creating Excitement in the Classroom. *ASHE-ERIC Higher Education Report No. 1*. The George Washington University, School of Education and Human Development.

Prince, M. (2004). Does active learning work? A review of the research. *Journal of Engineering Education*, 93(3), 223-231. <https://doi.org/10.1002/j.2168-9830.2004.tb00809.x>