

Mind Mapping and Cognitive Load in Vocational Teachers' Lesson Planning

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Abstract

Vocational teachers face a distinctive planning burden: a single lesson must integrate disciplinary content, pedagogical method, and practical or skill-based steps into one coherent sequence. This study asks whether mind mapping, understood through cognitive load theory, can reduce that burden, and grounds the question in existing quantitative evidence rather than in argument alone. Two bodies of research are drawn on directly: a meta-analysis of 142 effect sizes from 55 studies showing that learning with concept maps produces a moderate benefit overall (Hedges' $g = 0.58$), with self-constructed maps outperforming studied, pre-made maps ($g = 0.72$ versus $g = 0.43$) (Schroeder et al., 2018), and a recent controlled experiment showing that more interconnected, structured concept maps significantly reduce extraneous cognitive load without increasing intrinsic or germane load (Costley et al., 2025). Building on these findings together with cognitive load theory (Sweller, 1988) and Shulman's (1987) account of pedagogical reasoning, the study derives three testable propositions about mind mapping and lesson planning specifically, framed for future empirical study with vocational teachers rather than presented as already confirmed for that population. The study also identifies conditions, drawn from research on pedagogical beliefs and practical knowledge (Ertmer, 2005; Wei, 2019), under which the propositions are more or less likely to hold.

Keywords

Mind Mapping; Cognitive Load Theory; Lesson Planning; Vocational Teacher Education; Testable Propositions.

1. Introduction

1.1. Research Background

Planning a lesson is, among other things, a memory problem. A vocational teacher preparing a single class session must simultaneously keep track of the discipline's content, the sequence of activities meant to teach it, and, in many vocational subjects, a set of practical or skill-based steps that carry their own internal order. Cognitive load theory offers a vocabulary for the cost this integration carries: Sweller (1988) distinguishes between the load imposed by a task's inherent difficulty and the load imposed merely by how information for that task is presented or organized, arguing that the second kind of load can crowd out the mental capacity needed to build usable knowledge structures. A substantial body of quantitative research already exists on concept and mind mapping's relationship to cognitive load and learning, but almost all of it concerns learners studying content, not teachers planning it. This background motivates a narrow, evidence-anchored question: can the pattern of results already documented for learners plausibly extend to the teacher who is doing the planning, and if so, in what specific, testable form?

1.2. Research Purpose and Significance

The purpose of this study is to build a set of testable propositions about mind mapping and lesson-planning load, derived explicitly from existing quantitative findings rather than proposed on theoretical grounds alone. Theoretically, the study connects two literatures that have developed largely apart: meta-analytic research on concept-map effectiveness (Nesbit & Adesope, 2006; Schroeder et al., 2018) and experimental research on concept-map structure and cognitive load (Costley et al., 2025), reading both through the lens of lesson planning specifically. Practically, propositions stated in testable form give future research — including research with vocational teachers directly — a concrete starting point, rather than leaving the question of whether mind mapping helps planning as a matter of opinion.

1.3. Research Status at Home and Abroad

International research on concept and mind mapping is unusually well quantified compared to most areas of instructional-tool research. Nesbit and Adesope's (2006) meta-analysis of 67 effect sizes from 55 studies established that concept mapping is associated with increased knowledge retention across grade levels and subject areas, and the later meta-analysis by Schroeder, Nesbit, Anguiano, and Adesope (2018), synthesizing 142 effect sizes from over 11,000 participants, refined this into a specific, numeric finding: constructing a concept map produces a larger benefit than merely studying one already made. More recently, Costley, Kapuza, Gorbunova, and Shcheglova (2025) tested cognitive load directly, finding that concept maps with more interconnections reduced extraneous cognitive load without a corresponding increase in intrinsic or germane load. In China, research on visual thinking tools and teacher decision-making has developed along a related but separate line: work on data-driven instructional decisions (Feng, 2020) and on teachers' practical knowledge (Wei, 2019) treats planning as a cognitively demanding activity in its own right, while applied studies of mind mapping in vocational subjects such as language teaching (Hu, 2024) and clinical nursing instruction (Liang, 2025) report favorable outcomes for learners. None of these applied studies measured the teacher's own planning load, leaving the specific question this study addresses — what the quantitative concept-mapping literature implies for lesson planning — open.

1.4. Research Methods and Innovations

This study proceeds by evidence-based conceptual synthesis: it draws together numeric findings from concept-mapping meta-analyses and experiments (Nesbit & Adesope, 2006; Schroeder et al., 2018; Costley et al., 2025) with cognitive load theory (Sweller, 1988) and pedagogical reasoning theory (Shulman, 1987), and uses them to derive a small number of explicit, testable propositions about lesson planning specifically. Each proposition is stated together with the finding it is derived from and a note on what would be needed to test it directly. The innovation of the study is this derivation step itself: rather than arguing in the abstract that mind mapping should help planning, or reporting new data that do not yet exist, it specifies exactly what existing evidence would predict if it extended to vocational teachers' planning, in a form that can be confirmed or disconfirmed by future research.

2. The Planning Load Vocational Teachers Carry

2.1. Content, Method, and Skill in a Single Sequence

Shulman's (1987) account of pedagogical reasoning describes the demanding step of transformation: content a teacher understands must be reshaped into a form a learner can follow, a process that involves selecting representations, sequencing sub-topics, and anticipating where learners are likely to struggle. In a vocational classroom, this transformation is compounded by a third strand beyond content and method: the practical or skill-based steps that many vocational subjects require, which carry their own internal logic and cannot simply

be folded into a content outline without distortion. Schön (1983) describes professional practice more generally as an act of imposing structure on situations that do not present their structure ready-made, and lesson planning fits this description directly: before a lesson can be taught, its structure must first be built by the teacher, not simply read off the content. A three-strand lesson written out as continuous prose imposes what Sweller (1988) calls extraneous load simply because prose is linear and the underlying structure is not; the teacher must hold branches, exceptions, and orderings in mind that the written format does not itself display.

2.2. Mind Mapping as an Externalized Structure

Mind mapping, as systematically described by Buzan and Buzan (1993), organizes information around a central theme and extends outward through branches rather than a linear sequence, a format that corresponds more closely to how a three-strand lesson is actually structured than a page of prose does. Novak's (1998) related account of concept maps emphasizes precisely labeled relationships between ideas, and Vygotsky's (1978) broader account of mediating tools for thought offers a rationale for why an external artifact can do this kind of work at all: a tool positioned between a person and a problem can carry part of the cognitive burden the problem would otherwise place directly on the person. Whether this externalizing function actually reduces load, however, is not something theory alone can settle; it is an empirical claim, and Section 3 turns to what has actually been measured.

Table 1. Three Components of Cognitive Load and Their Relevance to Vocational Lesson Planning

Load Type	Definition (Sweller, 1988)	Relevance to Vocational Lesson Planning
Intrinsic Load	Demand arising from the inherent complexity of the content itself	Set by how difficult the discipline's content and skill sequence are, largely independent of how the lesson is planned
Extraneous Load	Demand arising from how information is presented or organized	Raised by holding a lesson's structure in mind while also composing it in linear prose
Germane Load	Demand devoted to constructing and refining schemas	Available for pedagogical judgment — deciding how content should be taught, not just what it contains

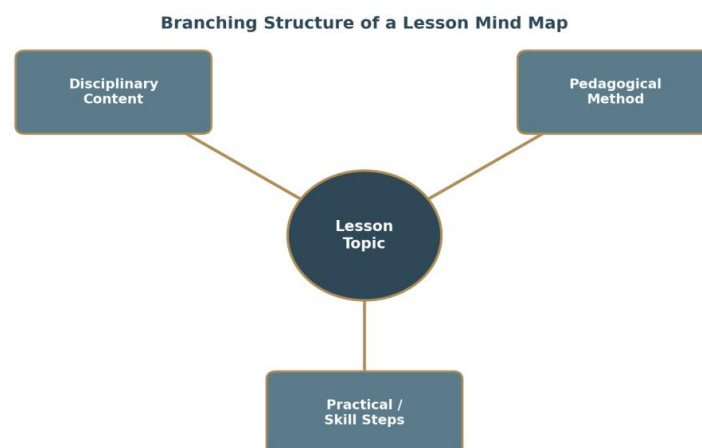


Figure 1. The branching structure of a lesson mind map, holding content, method, and skill strands side by side rather than in a single linear sequence.

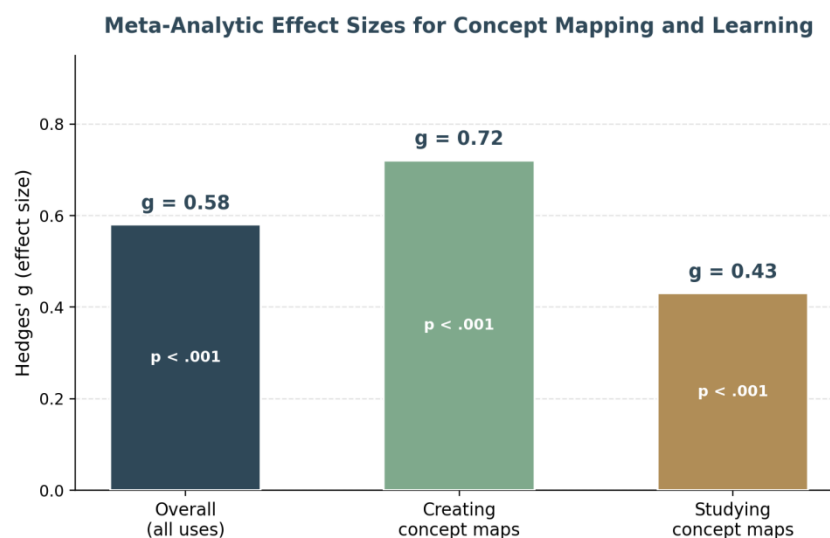
3. Empirical Evidence on Mapping and Cognitive Load

3.1. Evidence That Concept and Mind Maps Aid Learning and Retention

The strongest available quantitative evidence on concept and mind mapping comes from two meta-analyses. Nesbit and Adesope (2006) synthesized 67 standardized mean-difference effect sizes from 55 studies involving 5,818 participants across grade levels from Grade 4 to postsecondary and across domains including science, psychology, statistics, and nursing, finding that concept mapping was consistently associated with increased knowledge retention, with effect sizes ranging from small to large depending on how the maps were used. Schroeder, Nesbit, Anguiano, and Adesope (2018) extended this analysis to 142 independent effect sizes from over 11,000 participants and reported a moderate, statistically significant overall effect (Hedges' $g = 0.58$, $p < .001$). Critically for the argument developed here, their moderator analysis distinguished between two ways of using a concept map: constructing one's own map produced a larger effect ($g = 0.72$, $p < .001$) than studying a map someone else had already made ($g = 0.43$, $p < .001$). This distinction is directly relevant to lesson planning, where a teacher is always the one constructing the map rather than studying a ready-made one.

Table 2. Quantitative Findings on Concept and Mind Mapping Relevant to Cognitive Load

Comparison	Hedges' g	p value	Source
Concept/knowledge maps vs. all comparison conditions (overall)	0.58	$< .001$	Schroeder et al. (2018), $k = 142$, $n = 11,814$
Constructing a concept map (self-generated) vs. comparison	0.72	$< .001$	Schroeder et al. (2018)
Studying a pre-made concept map vs. comparison	0.43	$< .001$	Schroeder et al. (2018)
Interconnected (more structured) vs. sparser concept maps, extraneous load	significant reduction	reported significant	Costley et al. (2025), $n = 81$



Source: Schroeder, Nesbit, Anguiano, & Adesope (2018); $k = 142$ effect sizes, $N = 11,814$.

Figure 2. Meta-analytic effect sizes for learning with concept maps, showing a larger benefit for constructing maps than for studying pre-made ones (Schroeder et al., 2018).

3.2. Evidence on Cognitive Load Specifically

Learning benefit is not the same measure as cognitive load, and the clearest direct evidence on load comes from Costley, Kapuza, Gorbunova, and Shcheglova (2025), who randomly assigned 81 first-year postgraduate students to study concept maps with either fewer or more interconnections. Their results showed a significant reduction in extraneous cognitive load for the more interconnected maps, with no significant difference in intrinsic or germane load between conditions. The authors interpret this as evidence that interconnections function as structuring elements rather than as additional interactive elements competing for working-memory capacity — in other words, more structure did not cost more load, and in the extraneous component it cost less. This finding, together with the constructing-versus-studying distinction from Schroeder et al. (2018), supplies the two empirical anchors the propositions below are built from: mapping benefits construction more than passive use, and a well-interconnected map's structure specifically lowers extraneous load.

4. Testable Propositions for Vocational Teachers' Lesson Planning

The propositions below are stated as claims about vocational teachers' lesson planning specifically. None of the cited studies tested this population or this task directly; each proposition names the finding it extends and what would need to be measured to test it.

Proposition 1. A vocational teacher who constructs their own mind map while planning a lesson will report lower extraneous cognitive load during planning than a teacher who plans using a linear, prose-format lesson template of equivalent content.

Basis: Extends the interconnection finding of Costley et al. (2025), in which more structured concept maps reduced extraneous load relative to less structured ones, to a comparison between mapped and unmapped planning formats. Testing this proposition would require a within- or between-subjects comparison of vocational teachers' NASA-TLX or similar load ratings while planning matched lessons in each format.

Proposition 2. The planning-load advantage of mind mapping, if it exists, will be larger when the teacher builds the map themselves than when the teacher is given an already-completed map to consult.

Basis: Extends the constructing-versus-studying distinction reported by Schroeder et al. (2018), where self-generated concept maps produced a larger learning benefit ($g = 0.72$) than studying pre-made ones ($g = 0.43$), to the planning context: if the same asymmetry holds for load rather than learning, self-built planning maps should outperform supplied ones. Testing this would compare load or planning-quality outcomes between teachers who build their own lesson maps and teachers given equivalent pre-built maps.

Proposition 3. Capacity freed from extraneous load during mind-map-based planning will be associated with planning decisions that show more explicit attention to pedagogical transformation — for instance, more explicit notes on how content will be adapted for learners — rather than with faster planning alone.

Basis: Extends Sweller's (1988) capacity-sharing assumption, under which load freed from one demand becomes available for another, together with Shulman's (1987) description of transformation as the pedagogically demanding stage of planning. Testing this would require coding the content of lesson plans produced under mapped versus unmapped conditions for evidence of transformation-related decisions, not simply timing how long planning takes.

5. Conditions That May Moderate These Propositions

The propositions above describe a pattern that existing evidence makes plausible, not one that is guaranteed to hold for every teacher. Ertmer (2005) argues that a tool's place in a teacher's

practice depends as much on the teacher's existing pedagogical beliefs as on the tool's own design; a teacher who already approaches planning as an act of structuring content is more likely to experience mapping as load-reducing than a teacher who experiences planning mainly as producing a required document. Wei's (2019) account of how teachers' practical knowledge develops through cycles of experience suggests a second moderator: judging which branches of a lesson matter enough to map is itself a skill that accumulates with experience, so novice and experienced teachers may not show the same pattern. A third likely moderator is familiarity with mapping itself, since building a map draws on some of the same attentional capacity the map is meant to free — consistent with the fact that even in Costley et al.'s (2025) study, the benefit appeared specifically in the extraneous-load component, with no corresponding change in germane load, suggesting the benefit is narrower than a blanket claim that “mapping reduces effort” would imply. None of these considerations overturn the propositions; they specify populations and conditions under which each proposition is more, or less, likely to be confirmed.

6. Summary

This study set out to ground a claim about mind mapping and vocational teachers' lesson-planning load in existing quantitative evidence rather than in argument alone. Two bodies of research supplied that grounding: meta-analytic evidence that concept mapping benefits learning overall, and specifically that self-constructing a map benefits more than studying one already made (Schroeder et al., 2018), and experimental evidence that more interconnected concept maps reduce extraneous cognitive load without a corresponding cost to intrinsic or germane load (Costley et al., 2025). Neither literature tested vocational teachers planning lessons directly, so the study's contribution is the derivation of three explicit, testable propositions that extend these findings to that specific task and population, each stated together with the evidence it follows from and the kind of study that would test it. The propositions were then qualified by research on teachers' pedagogical beliefs and practical knowledge (Ertmer, 2005; Wei, 2019), which suggests the predicted pattern is more likely to hold for teachers who already approach planning as structuring work and who are already familiar with mapping as a practice. The next step for this line of inquiry is direct empirical testing: measuring vocational teachers' planning load under mapped and unmapped conditions using an established instrument such as the NASA Task Load Index, in the manner already applied to learners by Costley et al. (2025), would confirm or disconfirm the propositions this study has derived but not yet tested.

References

- [1] Buzan, T., & Buzan, B. (1993). *The mind map book*. New York: Penguin Press.
- [2] Costley, J., Kapuza, A., Gorbunova, A., & Shcheglova, I. (2025). How adding structure reduces complexity: More interconnections in concept maps do not increase cognitive load. *Instructional Science*, 53(5), 1243–1262.
- [3] Ertmer, P. A. (2005). Teacher pedagogical beliefs: The final frontier in our quest for technology integration? *Educational Technology Research and Development*, 53(4), 25–39.
- [4] Feng, Y. (2020). A review of research on data-driven teacher instructional decision-making. *China Distance Education*, (4).
- [5] Hu, G. (2024). Exploring a discovery-oriented instructional model based on mind mapping: A case study of an intercultural communication course. *Journal of Anhui University of Technology (Social Sciences Edition)*, (6).
- [6] Liang, Z. (2025). The application of mind mapping combined with the Feynman learning method in obstetric clinical nursing teaching. *International Journal of Nursing and Health*, 6(7).

- [7] Nesbit, J. C., & Adesope, O. O. (2006). Learning with concept and knowledge maps: A meta-analysis. *Review of Educational Research*, 76(3), 413–448.
- [8] Novak, J. D. (1998). *Learning, creating, and using knowledge: Concept maps as facilitative tools in schools and corporations*. Mahwah, NJ: Lawrence Erlbaum Associates.
- [9] Schön, D. A. (1983). *The reflective practitioner: How professionals think in action*. New York: Basic Books.
- [10] Schroeder, N. L., Nesbit, J. C., Anguiano, C. J., & Adesope, O. O. (2018). Studying and constructing concept maps: A meta-analysis. *Educational Psychology Review*, 30(2), 431–455.
- [11] Shulman, L. S. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review*, 57(1), 1–22.
- [12] Sweller, J. (1988). Cognitive load during problem solving: Effects on learning. *Cognitive Science*, 12(2), 257–285.
- [13] Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.
- [14] Wei, G. (2019). Shifts in the research interests of Western studies on teachers' practical knowledge. *Comparative Education Review*, (10), 45–51.