

From Knowledge Organisation to Knowledge Application: Designing Mind-Mapping Instruction for Senior High School Regional Geography in China

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Abstract

Senior high school regional geography in China requires students to compare regions, explain relationships and consider development problems. Mind mapping can organise knowledge, but a complete diagram does not demonstrate independent knowledge application. This conceptual article develops a four-stage instructional framework through a purposive synthesis of curriculum and geographical education research, mapping literature, and theories of engagement, transfer, scaffolding and formative assessment. Sources are organised by their contributions to learning purposes, representation, learner responsibility and feedback. The framework comprises guided preparation, collaborative inquiry, independent reconstruction and contextual transfer. Its contribution lies in linking contextualised knowledge application with the progressive transfer of responsibility for selecting evidence, explaining relationships and revising judgements. Assessment informs changes in support by examining both the quality of reasoning and whose decisions it represents. A summary table and hypothetical regional development inquiry illustrate the alignment of purposes, teacher roles, learner responsibilities and assessment evidence. The discussion considers curricular adaptation, representational limitations and classroom feasibility. The framework offers a theoretically informed design proposal that requires classroom evaluation; it does not establish instructional effectiveness.

Keywords: Mind Mapping, Regional Geography, Knowledge Application, Upper Secondary Education, Formative Assessment

Introduction

Regional geography provides opportunities for students to connect knowledge about physical environments, human activities and relationships between places. Students need to recognise regional characteristics, but they also need to explain why those characteristics occur, compare development conditions and consider how geographical relationships change. Knowledge of location, relief, climate, population, transport and industry is therefore a foundation for learning rather than its endpoint. This distinction is relevant to senior high school geography instruction in China, where curriculum intentions need to be translated into

tasks that students can undertake, explanations that teachers can examine and feedback that informs subsequent learning. The present article considers mind mapping as one possible means of making this connection.

The relationship between knowing and using knowledge becomes apparent when students encounter a specific regional problem. A student may accurately recall a region's development conditions yet struggle to identify which conditions matter to the question. Another may reproduce a familiar explanation without reconsidering it when the location, scale or development priorities change. Such possibilities illustrate the difference between possessing organised knowledge and applying it appropriately. In this article, knowledge application refers to selecting, organising and adapting knowledge to produce an evidence-informed response to a geographical task. It includes comparing regional differences, explaining phenomena, analysing development conditions and making qualified recommendations. These performances are related but not identical, so a lesson needs to specify the intended form of application rather than treat it as a general outcome requiring no further explanation.

Mind mapping offers a visible structure through which students can organise information and communicate initial understandings. Central topics, branches, keywords and links can bring dispersed content together and provide a shared reference for discussion. However, a map may remain a record of classifications rather than an explanation. Branches labelled transport, resources, labour and policy do not establish how the learner understands their significance in a particular region. Shi, Yang, Dou, and Zeng (2023) report that mind-mapping instruction was generally associated with more positive cognitive learning outcomes than traditional instruction in the studies included in their meta-analysis, while also identifying subject matter and educational level as important moderators. Their findings support interest in mind mapping, but they do not demonstrate uniform benefits or validate every instructional sequence involving maps. The question is consequently more specific than whether mind maps are useful: it concerns what students do with them and how the resulting representations contribute to a defensible response.

Geography-specific evidence gives this question a more concrete basis. Huang et al. (2024) studied geographic subject mind maps with seven teachers and eight classes in China. They reported improved geographical synthetic thinking among 267 students after four to five lessons. The study also connected teachers' implementation of the mapping approach with students' improvement. These findings make the surrounding instruction relevant to the present argument, but they do not test the four-stage sequence proposed here or establish independent transfer to new regional problems. The present article therefore builds on an existing disciplinary application of mapping and asks a narrower design question: how can teachers distinguish reasoning supported by a shared representation from reasoning that an individual learner can justify and adapt?

These studies provide a basis for disciplinary mapping, but the present design problem concerns how the quality of a geographical explanation can be considered together with the learner's responsibility for producing it. The proposed framework builds on established principles rather than claiming that learner independence or responsive support is new. Scaffolding already involves contingency, fading and the transfer of responsibility (van de Pol,

Volman, & Beishuizen, 2010), while formative assessment uses evidence of learning to inform subsequent instructional decisions (Black & Wiliam, 2009). The contribution here is to specify how these principles operate within regional mind-mapping tasks: which geographical decisions students assume, what evidence makes that responsibility visible, and how this evidence informs changes in support.

The framework connects guided preparation, collaborative inquiry, independent reconstruction and contextual transfer through a common instructional decision: whether a learner can select relevant evidence, justify a regional relationship and reconsider its applicability with less assistance. Knowledge application specifies the geographical performance sought; learner responsibility identifies who makes the consequential decisions; formative assessment connects evidence about both to the next teaching action. A well-organised map containing teacher-supplied explanations therefore provides different evidence from an individually justified account, even when their content is similar. Likewise, independently drawing a map is insufficient if its relationships are unsupported. Teachers can reduce prompts when reasoning is both defensible and increasingly learner-directed, retain targeted assistance when justification remains dependent on support, or return to an earlier activity when a changed regional context exposes a difficulty.

The theoretical contribution is thus a discipline-specific synthesis that treats explanatory quality and responsibility as interdependent dimensions of progression. Its pedagogical contribution is to translate that relationship into decisions about tasks, map use and support across the four stages. Building on mapping approaches concerned with the representation of geographical relationships, it explicitly links changes in a map's instructional function to evidence of individual justification and contextual adaptation. It also gives established scaffolding principles a regional-geography specification, without proposing a replacement theory of scaffolding or claiming that this integration is unprecedented. Two questions guide the discussion: what principles can connect knowledge organisation with independent application within the Chinese curriculum context, and how can instructional support and assessment make that connection actionable? The following sections develop the conceptual foundations, present the framework and illustrate its application before examining its contributions and limitations.

Conceptual Approach and Theoretical Foundations

Conceptual Approach and the Chinese Curriculum Context

This article uses a selective conceptual synthesis to develop an instructional framework. Its design is informed by Jaakkola's (2020) account of theory synthesis, in which the contribution depends on explaining relationships across literature streams rather than accumulating summaries of studies. The analytical problem is how a visual representation can support geographical knowledge application while learners assume greater responsibility for the reasoning it contains. The source base is the selected literature identified in the reference list. Sources are relevant to this argument when they clarify disciplinary learning purposes, the affordances and limitations of mapping, the allocation of intellectual responsibility, or the use of assessment evidence to adjust support. Foundational theoretical works establish the concepts, reviews contextualise instructional evidence, and geography-specific studies connect the discussion to disciplinary learning. This selection supports a focused design

argument; it does not represent an exhaustive database search or a systematic estimate of intervention effects.

The synthesis separates three kinds of support. The curriculum standard specifies intended learning, rather than demonstrating how it is achieved. Empirical studies and reviews provide evidence about particular mapping activities and outcomes, with conclusions limited to their designs and settings (Huang et al., 2024; Shi et al., 2023). Theoretical accounts supply the reasoning for connecting activities, responsibility and feedback. Each strand is examined through the same questions: what must the learner do with knowledge, which decisions remain with the teacher, what learner performance makes understanding visible, and how should that evidence affect subsequent support? This common focus enables comparison without treating mind maps, concept maps, retrieval tasks and geographical explanations as equivalent measures. Contrasting findings also inform the synthesis, particularly the comparison of retrieval practice and concept mapping discussed under independent reconstruction (Karpicke & Blunt, 2011).

The four stages are design inferences from these relationships. Guided preparation uses contingent support to make an initial geographical judgement accessible (van de Pol, Volman, & Beishuizen, 2010). Collaborative inquiry uses the distinction between participation and jointly developed reasoning to require explanation and response to peers (Chi & Wylie, 2014). Independent reconstruction makes each learner's selection and justification available for examination; its purpose is individual accountability, not proof that unsupported recall is always preferable. Contextual transfer requires learners to reconsider the applicability of knowledge when relevant conditions change (Barnett & Ceci, 2002). Constructive alignment connects the intended performances with tasks and assessment (Biggs, 1996), while formative assessment supplies the principle for using evidence to adjust support (Black & Wiliam, 2009). No single source establishes this four-stage sequence. The proposal is the article's synthesis of these principles, and its coherence depends on whether each stage makes a distinct contribution to application and learner responsibility.

The Chinese curriculum provides a specific context for this argument. The 2025 revision of the senior high school geography curriculum standard identifies four interconnected core competencies: human–environment coordination, geographical synthetic thinking, regional cognition and geographical practical competence. It includes Regional Development among the selective compulsory modules and addresses regional analysis, comparison and development responses (Ministry of Education of the People's Republic of China, 2025). These English terms are descriptive translations of the Chinese concepts. The present framework primarily connects regional cognition with attention to places, scales and regional relationships, and geographical synthetic thinking with interactions among conditions and processes. This is an instructional interpretation rather than a claim that either competency can be reduced to diagram production. Recognising differences between a coastal settlement and an inland settlement does not itself explain those differences; similarly, knowing a general relationship between accessibility and economic activity does not establish how it operates in either location. The proposed tasks therefore connect regional specificity with relational reasoning.

This curricular positioning also defines the limits of the article. “Regional geography” refers here to instruction that uses regions as contexts for comparison, explanation and problem analysis, rather than to a separate course assumed to be organised identically across schools. Teachers can adapt the framework to selected lessons or units while retaining responsibility for materials and sequencing. Human–environment relationships enter the design when learners examine development priorities and constraints, but source analysis and diagram construction are not presented as a complete approach to geographical practical competence. China is thus the intended curricular setting, not an empirical sample. The framework translates these disciplinary intentions into adaptable instructional decisions.

Mind Mapping for Knowledge Application and Transfer

Within this context, knowledge application requires more than the classification of regional information into physical and human categories. Classification identifies what is available, whereas application introduces questions of relevance, relationships and conditions. When considering whether a location is suitable for an industry, learners need to identify that industry’s requirements and determine what the sources establish. Listing every advantage and disadvantage may produce a comprehensive response without producing a focused analysis. Lu et al. (2022) provide a disciplinary reference for attention to factors, interactions, spatial differentiation and temporal change, suggesting that knowledge use should be geographically qualified. Students should explain where a relationship operates, how it works and whether it changes under different conditions. Thus, a map centred on a region’s name can establish a knowledge overview, while a map centred on a problem can help students select and reorganise that knowledge for a particular purpose.

Transfer extends this requirement beyond the original task. Barnett and Ceci (2002) distinguish multiple dimensions along which learning and application contexts may differ, cautioning against treating all unfamiliar tasks as equivalent. A new case may change transport arrangements, industrial requirements, land use or the scale of analysis. Students therefore need to identify which understandings remain relevant, which relationships require revision and what further information is needed. A meaningful transfer task preserves enough similarity to make prior knowledge relevant while introducing differences that require students to reconsider how that knowledge should be used.

The potential contribution of mapping must be considered in relation to these demands. Davies (2011) distinguishes mind mapping, concept mapping and argument mapping, which respectively emphasise associations around a topic, explicit conceptual relationships, and connections between claims and reasons. The present framework retains a branching structure while permitting relational labels, source annotations and selective cross-links; it consequently shares some features with concept mapping without treating the tools as interchangeable. Novak and Cañas (2008) emphasise meaningful relationships in concept maps, while Nesbit and Adesope (2006) show that outcomes associated with concept and knowledge maps vary with their use and comparison conditions. Huang et al. (2024) more specifically direct attention to factor, spatial and temporal considerations in geographic subject mind maps. Taken together, these contributions suggest that both the activity surrounding a map and the disciplinary meaning of its connections require examination. A line between transport and industry becomes educationally informative when the learner can explain its meaning and relate it to evidence.

Instructional Support and Formative Assessment

The ICAP framework clarifies why visible map-making activity cannot be equated with substantive learning. Chi and Wylie (2014) distinguish passive, active, constructive and interactive engagement. Writing labels or moving nodes may involve activity without generating an explanation, while proposing and defending a relationship places different demands on the learner. Likewise, a shared product does not demonstrate substantive interaction unless students respond to one another's reasoning. This distinction supports the inclusion of individual explanation alongside collaboration, although the ICAP categories do not correspond directly to the four stages proposed here. Constructive alignment provides the organisational principle for combining these activities: expected learning, tasks and assessment should involve compatible forms of intellectual engagement (Biggs, 1996). If learners are expected to evaluate regional development conditions, they need opportunities to evaluate them and feedback that addresses the basis of their judgements, rather than assessment centred only on whether particular labels appear.

Scaffolding explains how these demands can remain accessible without removing the intellectual work from the learner. Vygotsky (1978) and Wood, Bruner, and Ross (1976) provide foundations for supported participation, while van de Pol et al. (2010) identify contingency, fading and transfer of responsibility as central characteristics of scaffolding. Students unable to interpret a source need different assistance from those who identify factors but cannot connect them. A partially completed map, a source-reading prompt or a modelled relationship can provide support, but its value depends on whether it addresses a specific difficulty while preserving opportunities for students to think.

Formative assessment informs the adjustment of that support. Black and Wiliam (2009) locate its formative function in the use of evidence to influence subsequent action. In the proposed synthesis, this means interpreting the geographical quality of a response together with the assistance needed to produce it. A defensible relationship generated after a teacher supplies the explanation calls for a different next task from one that a learner selects and justifies independently. Assessment therefore informs whether to retain, fade or restore support, rather than merely recording completion of a map. The assessment section below develops this instructional interpretation through examples of student reasoning and subsequent teaching decisions.

The Proposed Four-Stage Instructional Framework

The framework comprises guided preparation, collaborative inquiry, independent reconstruction and contextual transfer. The stages distinguish instructional purposes rather than fixed levels of competence, and both organisation and application can occur throughout the sequence. Two dimensions connect them: the quality of knowledge use, including relevance and sensitivity to context, and the learner's responsibility for selecting and defending that use. The sequence therefore changes both what students are asked to do and which decisions they are expected to make. Teachers can distribute it across a regional unit or select stages appropriate to a particular task; transitions should follow evidence of understanding rather than a requirement to complete all four stages within every lesson. Table 1 summarises the purposes, roles and assessment evidence associated with each stage. The sequence permits a return to earlier activities when students need further support.

Table 1

The four stages of mind-mapping instruction

Stage	Purpose	Teacher role	Learner responsibility	Assessment evidence
Guided preparation	Connect regional information to a focused problem.	Select sources; model one relationship; provide prompts.	Select relevant information and justify an initial link.	Annotated map and brief explanation; diagnose needs.
Collaborative inquiry	Examine competing explanations.	Probe evidence and assumptions; address misconceptions.	Defend, question and revise links with peers.	Shared map plus individual justification; give peer and teacher feedback.
Independent reconstruction	Make personal reasoning visible.	Reduce prompts where justified; offer targeted feedback.	Build and defend a personal account; explain revisions.	Individual map and revision commentary; decide what support remains.
Contextual transfer	Adapt knowledge to changed conditions.	Provide a contrasting case; probe limits of prior reasoning.	Retain or revise relationships; justify a conditional judgement.	Comparison across cases and revised argument; assess adaptation.

Guided Preparation

Guided preparation establishes a shared question and an accessible source base. The teacher selects a regional problem and provides maps, texts or other materials suited to students' prior knowledge. A partly completed map can offer structure, but its gaps should require decisions rather than the copying of missing terms. Students might select a relevant factor, explain a relationship or identify a conclusion that the sources do not justify. If a route and a settlement already appear in the diagram, for example, learners can consider whether the route improves access to a market, connects transport modes or merely passes nearby without serving the relevant destination. The activity therefore links information organisation with an initial judgement about how that information contributes to the question.

Modelling should make the reasoning visible without supplying every judgement. The teacher can distinguish a positional observation from an explanatory claim and demonstrate how to qualify it before students attempt a comparable connection. Initial maps may retain uncertain links and unanswered questions, which help determine whether further source guidance, conceptual explanation or a more open task is appropriate. Teachers can select a manageable problem from the regional content already included in their units.

Collaborative Inquiry

Once initial interpretations are available, collaborative inquiry brings alternative uses of knowledge into discussion. Students explain not only what their maps contain but also why particular factors and relationships were included. The purpose is to examine differences

rather than combine every contribution. If one learner prioritises transport while another emphasises land use, the group considers whether the explanations are complementary, differently supported or applicable under different conditions. Teacher questions can help students test what a source establishes, whether a relationship answers the question and where a conclusion may cease to apply. The shared map records judgements and their basis, while provisional connections can remain when evidence is insufficient. Consensus should not replace scrutiny.

Because a group product can conceal uneven understanding, each student should justify a connection or describe how discussion changed a judgement. Rotating source checking, questioning and recording responsibilities creates opportunities to participate, but the teacher still needs to attend to whose reasoning is represented. A student who records the diagram may understand its relationships well, while another who speaks frequently may offer claims that remain unsupported; participation therefore needs to be interpreted rather than inferred from a role. Direct explanation remains appropriate when a misconception cannot be resolved through the available sources.

Independent Reconstruction

Independent reconstruction makes each learner's use of knowledge available for examination. Students organise a personal response rather than reproduce the group's layout. They select a central account, supporting relationships and necessary qualifications, then accompany the map with a brief oral or written explanation. Karpicke and Blunt (2011) found that retrieval practice produced stronger subsequent comprehension and inference performance than concept mapping with access to study materials under their experimental conditions. This does not invalidate mapping, but it cautions against treating redrawing as active reconstruction. Informed by this distinction, the framework proposes a short initial attempt without consulting the group's completed map, followed by source checking and revision. This is a design recommendation rather than an experimentally verified component of the framework.

Students should explain a substantive change, such as excluding irrelevant information, narrowing a causal claim or recognising the need for further evidence. This commentary helps distinguish conceptual revision from changes in colour, spacing or branch arrangement. Teachers must also distinguish memory omissions, factual errors and changes in judgement, since immediate recall is not the sole purpose. Sources and feedback may remain available as long as learners retain responsibility for interpreting and using them.

Contextual Transfer

Contextual transfer introduces a related problem in which changed conditions matter to the analysis. Teachers may first alter a clearly identifiable condition before introducing more complex material, although difficulty also depends on source accessibility, conceptual familiarity and the judgement required. The map can organise an initial conclusion, a changed condition and a revised response, after which students translate selected links into an argument.

Students may conclude that the evidence is insufficient to support a recommendation if they explain what is missing. Local or national cases should be chosen for their instructional

function: a distant region is not necessarily a better transfer task than a nearby one. When this process reveals an earlier weakness, learners can return to preparation, discussion or reconstruction.

Illustrative Application and Formative Assessment

A Regional Development Inquiry

A hypothetical regional development inquiry illustrates how the stages can operate together. The example is designed for adaptation within Chinese senior high school geography; it does not describe a named region, an observed lesson or an actual student response. Its scenario includes a port city, an inland county-level settlement and a connecting transport corridor. The inquiry asks: "Why might industrial activity concentrate near the port, and is improved transport sufficient to justify industrial expansion inland?" The intended performances are to compare development conditions, explain relevant relationships and formulate a qualified recommendation. A source pack would include a location map, transport information and contrasting accounts of industrial needs, land use, labour and development priorities. In classroom adaptation, teachers should replace these schematic conditions with reliable, appropriately dated materials for their chosen Chinese region. Documented conditions must remain distinguishable from interpretations and missing information.

During preparation, the teacher supplies an initial structure and models one supported relationship. Students choose additional information and identify a claim that the sources cannot establish, introducing evidential limits alongside organisation. The resulting interpretations provide material for collaboration, in which groups examine the provisional claim that port proximity sufficiently explains industrial concentration. Where comparable accessibility coexists with different land-use priorities, students need to decide whether transport alone offers an adequate account. The shared map can retain transport as relevant while specifying conditions that limit its influence. This discussion also distinguishes a favourable condition from a sufficient justification for a development decision. Adding more factors is less important than showing how they alter the judgement. Each learner then reconstructs a personal response and explains a revision, such as narrowing an earlier generalisation or identifying further evidence needed before recommending expansion.

The transfer task concerns another inland area with improved access but a competing agricultural or environmental priority. Students examine whether their previous recommendation remains appropriate and explain the effect of changed conditions. A recommendation for expansion, a conditional proposal or a decision to withhold judgement may each be defensible if supported by the materials. Comparing the two recommendations makes visible which relationships students retain, qualify or reject in response to the new evidence.

Assessing Knowledge Application and Providing Feedback

Assessment across the sequence should attend to the reasoning communicated by students' choices and revisions. Relevance concerns what a branch contributes and why information is excluded; a smaller map may provide a stronger answer when selection is purposeful. Relational meaning requires students to express connections as statements, distinguishing classification, association and causal interpretation. A causal claim needs a plausible mechanism and evidence proportionate to the claim. Contextual qualification concerns

where the account applies, whether it addresses internal variation and how changed conditions affect it. Revision should also be examined through its reasons rather than its occurrence alone: a conclusion may appropriately remain unchanged if the new evidence does not undermine it.

These assessment concerns are proposed principles, not a validated scale. Responsibility should be examined alongside explanatory quality by recording whether a learner selects a relationship, provides a reason, and revises or retains it after considering evidence, and whether each action requires a supplied answer, a prompt or no immediate assistance. A correct teacher-modelled link may show access to an explanation without showing independent judgement. Conversely, independently drawing an unsupported link is not evidence of successful application. Brief oral or written explanations and a note of the support provided can help distinguish these cases. Such records would inform feedback and task selection rather than justify fixed ability labels. This interpretation follows the emphasis on contingent support and the transfer of responsibility in scaffolding research (van de Pol et al., 2010) and on the use of evidence to guide subsequent action in formative assessment (Black & Wiliam, 2009).

The formative value of this interpretation depends on the action it produces. Irrelevant selection may lead to another source-screening activity, while a list of disconnected factors may call for comparison of two explanations. Overgeneralisation can be addressed through a contrasting location or a source at a finer scale. Students need an opportunity to use feedback by revising a relationship, qualifying a statement or explaining a changed recommendation. Patterns across responses can also inform whole-class instruction: if several students overlook variation within the inland area, the next source can make that variation visible; if every line is interpreted as causal, the teacher can model distinctions among different types of statements. For feasibility, feedback need not cover every branch. Concentrating on a small number of consequential relationships keeps attention on the learning intention and makes assessment manageable.

Discussion

Contributions to Curriculum and Pedagogy

The framework integrates mapping, scaffolding and formative assessment within Chinese senior high school regional geography. Its contribution is a disciplinary design account: it connects responsibility for evidence selection, explanation and judgement to the demands of regional problems. This emphasis develops the teacher's role as a curriculum maker discussed by Lambert, Solem, and Tani (2015), by specifying how task design can create opportunities for learners to assume consequential intellectual decisions.

The integration makes three aspects of instructional design explicit. Application and responsibility are examined together: progress requires attention to both the geographical quality of an explanation and the learner's role in producing it. The map's function changes accordingly, from a supported entry point to a shared object of critique, an individual account and a resource for contextual adaptation. Assessment links these functions by informing whether the learner needs further modelling, an opportunity for independent justification or a contrasting case. This is a disciplinary specification of contingent scaffolding, not a new claim that support should respond to learning. It adds to the mapping approaches discussed above

by specifying how evidence from map use can guide the transfer of responsibility for regional explanation and judgement.

Independent reconstruction and contextual transfer make different aspects of this contribution observable. Reconstruction asks whether a learner can defend a personal explanation after collaborative work; transfer asks whether that explanation can be adapted when relevant regional conditions change. A learner may succeed in the first task but still need support in the second. Separating these purposes prevents a successful shared map, or even an independently reproduced one, from being treated as sufficient evidence of contextual application. The resulting design proposition is open to evaluation: improved maps without more independently justified and context-sensitive responses would not support the proposed connection between representation and responsibility. The contribution claimed is this explicit instructional account for regional geography; the selected literature does not establish that the integration is unprecedented.

Implementation Conditions and Pedagogical Considerations

An emphasis on application should not be interpreted as a reason to reduce necessary instruction. Students require factual and conceptual knowledge to analyse geographical relationships, and open tasks without that foundation may produce speculation. Support should also respond to the particular need. A learner who understands the sources but cannot organise an argument may benefit from a relational prompt, whereas one lacking conceptual knowledge may require direct explanation. Providing identical scaffolds does not necessarily provide equitable access. Teachers can make the sequence manageable by selecting a few central relationships rather than attempting to represent an entire regional topic at once. Wherever possible, support should preserve the student's key judgement: asking for evidence maintains responsibility, while supplying the conclusion may remove it.

The limitations of representation reinforce the need for selective use. Branching structures can obscure reciprocal relationships, feedback and uncertainty, while excessive cross-links can reduce readability. Comparison tables, causal diagrams or extended arguments may sometimes communicate the required reasoning more effectively, and location maps remain necessary for spatial evidence. Mind mapping should therefore be one option within a broader repertoire. The same principle applies to workload and resources. The four stages do not require four new products; students can revise one representation or use brief explanations for parts of the sequence. Paper-based work can support the proposed reasoning, while digital tools are useful when they facilitate organisation, revision or discussion. Teachers need to adapt the design to their own materials, schedules and learners. Open-ended tasks introduce a further issue concerning evidence and perspectives. Different conclusions do not make every judgement equally defensible. A student may weigh priorities differently from the teacher and still offer a sound account, but a recommendation overlooking a central constraint requires examination. Assessment should address justification rather than agreement. Source selection shapes these possibilities: a task organised only around industrial output may exclude land-use conflict, environmental concerns or livelihoods. Relevant considerations should be made available without encouraging unsupported additions. This also keeps the diagram's initial categories open to scrutiny. Students should be able to ask whether the structure omits an important

consideration and whether further information would change the analysis. Such questioning extends application beyond placing knowledge within predetermined branches.

Teacher preparation can support these decisions through the comparison of alternative representations of the same question. Differences between maps can reveal assumptions about relevance, causation and spatial scale that might otherwise remain implicit. Teachers can then anticipate where students may need explanation, which sources could clarify a disagreement and what feedback would move the analysis forward. The professional task is therefore broader than acquiring skill in drawing or software use. It involves judging how a representation serves a geographical purpose and recognising when it no longer does so.

Limitations and Future Research

The framework remains a conceptual proposal. It has not been empirically evaluated, and theoretical coherence does not establish learning effects, feasibility across schools or superiority to alternative approaches. The literature is selective, and some instructional implications extend beyond the settings of the original studies. Research on concept mapping and retrieval practice informs particular design choices without validating the complete sequence. Similarly, alignment with selected Chinese curricular intentions does not establish implementation quality or make the framework a comprehensive approach to all geographical competencies. Application also includes distinct performances: improvement in an explanation cannot automatically demonstrate improved evaluation of a proposal or transfer to another task. These outcomes require separate consideration.

Future evaluation should examine both the geographical quality of students' responses and the support required to produce them. Successive maps, individual explanations, teacher prompts and responses to a contrasting regional task could provide complementary evidence. A comparison with mapping lessons that do not explicitly organise the transfer of responsibility would be informative only if content, learning time, source materials and feedback opportunities were comparable. Independently judged explanations and delayed transfer tasks would help distinguish short-term reproduction from sustained application. Improvement under the full sequence would not identify which stage contributed most. Such research could also show that particular stages should be combined, reordered or omitted.

Conclusion

Mind-mapping instruction for senior high school regional geography in China should connect knowledge organisation with purposeful application. The proposed sequence of guided preparation, collaborative inquiry, independent reconstruction and contextual transfer provides a design for developing regional explanations through changing tasks and support. Its central contribution is to make the transfer of learner responsibility conditional on evidence of geographical knowledge application, with formative assessment informing these decisions.

The framework gives teachers a basis for adapting regional inquiries to their curriculum and learners while attending to both explanatory quality and independent judgement. Classroom research is needed to evaluate its effectiveness, feasibility and conditions of use.

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