Cognitive Accessibility in Inclusive Art Education: A Cognitive Science Perspective on Students with Learning Differences

Huqiu Zhou

Sichuan Normal University, China

Abstract

Drawing upon core principles from the field of cognitive science, this paper explores how pedagogical practices can be restructured to better serve students who demonstrate atypical learning patterns. The main argument is that inclusion should not stop at physical placement in the classroom. What matters is also whether students can actually reach, work with and express what is being taught. By examining cognitive mechanisms such as selective attention, encoding, retention, comprehension, and knowledge articulation, educators can uncover obstacles that remain concealed beneath seemingly typical classroom engagement. The essay uses the concept of cognitive accessibility and places it within art education, a subject where learning often depends on visual interpretation, symbolic meaning, memory, planning and creative expression. It examines dual coding, concrete examples, retrieval practice, elaboration and spaced practice as possible design principles for inclusive teaching. At the same time, it does not treat cognitive science as a complete answer. It needs to be read together with Universal Design for Learning, culturally responsive teaching and more critical views of inclusion.

Keywords: *cognitive science; inclusive teaching; learning differences; cognitive accessibility*.

1. Introduction

Inclusive education cannot be reduced to students sharing the same classroom space. A learner might sit among peers and complete the assigned activity, yet still remain outside the real learning process. This situation typically arises when instructional designs implicitly presuppose that every learner absorbs content, structures thoughts, and expresses comprehension through uniform modalities. For learners with different cognitive needs, the obstacle is not always the diagnosis itself. It can be created by the teaching design: instructions given all at once, examples that are not clear enough, weak connections with prior knowledge, or a response format that leaves little room for difference.

The present paper contends that insights derived from cognitive science enable educators to refine inclusive pedagogy by positioning cognitive accessibility as a foundational principle in curriculum planning. Cognitive accessibility means arranging learning so that students with different cognitive profiles can access, process, remember and communicate knowledge. It is not about making the work easier. Instead, the paper explores the means by which rigorous academic objectives can be achieved via well-structured content progression, intentional material presentation, scaffolded rehearsal, and actionable feedback tailored to learners' needs.This view is close to inclusive approaches that plan for learner diversity from the beginning (Schmidt & Harriman, 1998). It also connects with UDL as a form of anticipatory design (Sewell et al., 2022), and with Kennette and Wilson's (2019) view that UDL removes learning barriers from the outset rather than adding support only after problems appear.

I develop this argument through art education. At first glance, art lessons can seem naturally inclusive because they involve images, materials and some degree of choice. But this can be a little misleading. Art learning is not only about making things. It also asks students to interpret, remember, plan and communicate meaning. An activity that appears open-ended and imaginative may nonetheless prove challenging to engage with unless learners receive guidance in linking observed elements to the conceptual understanding and outputs that are required of them. Inclusive art education therefore needs both parts: space for creative freedom, and enough cognitive structure to help students move from seeing, to understanding, to making.

2. Reframing Learning Differences as Cognitive Accessibility

2.1 From Physical Inclusion to Cognitive Accessibility

Learning differences should not be treated as fixed labels or simple measures of ability. Students differ in many ways: attention, memory, language, processing speed, planning, confidence and expression. A cognitive perspective is useful because it shifts attention away from broad labels and towards the points where learning tasks become unnecessarily difficult.

This change also reshapes the question of what inclusion means in practice. It is not enough for students to take part in the same classroom activity. The activity also has to offer a possible path into the concept being taught. One learner may finish the assigned work yet fail to grasp the underlying concept the activity was designed to cultivate. A second pupil, conversely, might comprehend the intended notion but encounter difficulty articulating that knowledge through the specific format selected by the instructor. In both situations, the difficulty does not belong only to the student. It is also linked to the way the task has been designed. The path into learning may be too limited, or the method for showing learning may not match what the student is actually able to communicate.

It also challenges support that begins only after failure. When help is added at the end, the original design remains untouched. Aleven and Koedinger (2000a) show that students do not always know when they need help or use support effectively when it is left entirely to them. The wider implication is clear: inclusive teaching should embed support from the beginning rather than rely on students to request it.

2.2 Hidden Cognitive Barriers in Learning

Several cognitive barriers are relevant here. Long explanations, crowded slides or loosely organised tasks can make attention harder to hold. When students have to remember instructions, read examples, handle materials and make choices at the same time, working memory may become overloaded. Sweller (1988) argues that learning can be hindered when problem solving places heavy cognitive load on limited processing capacity. From the perspective of inclusive pedagogy, this indicates that challenges may originate as much from how a task is constructed as from the individual characteristics of the learner.Memory, retrieval and executive function also matter, since students need to bring earlier knowledge back into use while planning and monitoring complex work.

These barriers are not limited to students with learning differences, but these students may experience them more sharply. They are also easy to misread. A pause may mean processing, not disengagement. A short answer may show difficulty organising language, not lack of understanding. A simple artwork may suggest that the link between concept, material and outcome has become unclear. Consequently, effective inclusive pedagogy must examine the cognitive architecture underpinning tasks, instead of evaluating learners solely on the basis of their end-product performance.

Cognitive accessibility does not remove difficulty. It separates meaningful challenge from avoidable confusion. Teachers can sequence explanation, reduce split attention, clarify expectations, combine visual and verbal information, build in recall and provide structures for planning and explanation. The goal is not easier learning, but better designed access to demanding learning.

2.3 Why Cognitive Accessibility Matters in Art Education

Art education makes this issue visible because artistic learning combines perception, interpretation, memory, decision-making and expression. In lessons involving cultural forms, students are not simply recognising a pattern or object; they are learning how visual forms carry social, historical and symbolic meaning. Fu (2025) treats arts and crafts appreciation as a matter of interpretation, and Sullivan (1993) similarly frames art education as meaningful, authentic, critical and pluralist rather than mere practical production.

The danger is that making can be mistaken for understanding. Studies of surface-level learning have demonstrated that learners are capable of generating accurate responses yet remain unable to articulate the underlying rationale (Aleven, Koedinger, Sinclair, & Snyder, 1998). Although the subject area is distinct, this observation holds relevance for art education: pupils can replicate a design or finish a project without grasping its cultural significance or conceptual foundation.Completion is therefore not the same as cognitive access.

A more inclusive art lesson makes the movement from seeing to understanding, and from understanding to expression, more visible. It does not impose one interpretation or restrict creativity. It clarifies what students should notice, how form connects with meaning, how prior knowledge can be recalled and how creative decisions can be explained.

3. Cognitive Science as Inclusive Design Principles

Cognitive science is most useful for inclusive teaching when it functions as a design resource, not as a catalogue of techniques. Research on Cognitive Tutors shows how theories of cognition can inform instructional design through knowledge representation, practice, feedback and progression (Anderson et al., 1995). This essay uses that insight in a broader classroom sense: learning processes should shape inclusive design.

Weinstein, Madan and Sumeracki (2018) discuss dual coding, concrete examples, retrieval practice, elaboration and spaced practice. Here these strategies are organised around three design problems: access, memory and interpretation. This structure keeps cognitive science tied to barriers in learning rather than presenting it as a list of study tips.

3.1 Designing Access: Dual Coding and Concrete Examples

The first issue is access, or how students first meet new knowledge. Dual coding can help because it connects what students see with what they hear or read. In an art lesson, for example, a teacher might show an artwork, point out the focal area, mark contrast or rhythm, and briefly explain how these features guide attention. When cultural symbols are introduced, the image can be placed beside a few key words and a short explanation of its meaning. This is useful for students who find long verbal explanation difficult, and also for those who can see the image but need language to make sense of it.

Concrete examples give abstract ideas a visible form. Concepts such as symbolism, cultural identity or creative transformation are difficult if introduced only through general language. Hakka architecture, paper-cut designs, festival objects, traditional colours or local craft materials can become bridges between sensory experience and conceptual understanding when students observe, describe and discuss what they represent.

These strategies support inclusion only when aligned with the learning purpose. More images do not automatically improve access; crowded or decorative visuals may increase load. Examples can also encourage imitation if students are not guided to compare, question and apply them. As research on shallow learning suggests, learners may rely on surface features when teaching does not direct attention to underlying principles (Aleven et al., 1998).

3.2 Designing Memory: Retrieval Practice and Spaced Practice

The next issue is memory. Students cannot use knowledge if they cannot bring it back when they need it. In art education, for example, a cultural symbol introduced in one lesson may return later in a sketch, a discussion, or a final piece of work. Retrieval practice asks students to recall information, rather than simply look over it again (Weinstein et al., 2018). In an inclusive lesson, this does not need to feel like a test. It can be simple and low-pressure: sketching a symbol from memory, recalling the steps of a technique, naming features of an art style, or explaining an idea briefly to a classmate.

Spaced practice supports this process by returning to content over time. Instead of presenting a cultural idea once, the teacher can revisit it through observation, visual analysis, sketching and later transformation. Each return allows students to reconstruct understanding in a different form.

For students with learning differences, retrieval and spacing reduce the expectation that everything must be understood and remembered immediately. They also support transfer. Yet they should not become mechanical repetition; each return should add meaning, moving from recognition to explanation, application and creative transformation.

3.3 Designing Interpretation: Elaboration and Self-Explanation

The third problem is interpretation. Studies of surface-level learning have demonstrated that learners are capable of generating accurate responses yet remain unable to articulate the underlying rationale (Aleven, Koedinger, Sinclair, & Snyder, 1998). Although the subject area is distinct, this observation holds relevance for art education: pupils can replicate a design or finish a project without grasping its cultural significance or conceptual foundation.

Problem-solving research supports this point. Ahlum-Heath and Di Vesta (1986) found that conscious verbalisation can support transfer by making reasoning explicit. Aleven and Koedinger (2002) likewise found that students who explained their problem-solving steps developed stronger understanding and performed better on transfer tasks. Explanation is therefore part of learning, not merely a report after learning.

In art education, students should be supported not only to make an artefact, but to explain their choices. Questions such as why a particular symbol was chosen, how a given form connects to a cultural concept, what modifications have been made relative to the source material, and what significance the final piece conveys can shift learners from mere execution toward genuine comprehension.

Such explanation still requires support. Open questions can invite rich thinking, but may overwhelm students who need linguistic or conceptual scaffolding. Aleven and Koedinger (2000b) show that useful self-explanation often depends on feedback and dialogue. Sentence starters, labelled examples, visual prompts, comparison tables and group discussion can make explanation an accessible practice rather than another barrier.

3.4 From Techniques to Design Logic

The value of cognitive science does not lie in a fixed package of methods. Its stronger contribution is a design logic. Dual coding and concrete examples support access; retrieval and spaced practice support memory; elaboration and self-explanation support interpretation. Together, they form a sequence from noticing to understanding, remembering, explaining and creating.

This design logic connects cognitive science with inclusive education. Weinstein et al. (2018) show that learning depends on how knowledge is encoded, retrieved, elaborated and revisited. Aleven and Koedinger (2002) show that deeper understanding is more likely when learners explain reasoning rather than only complete tasks. Inclusive teachers should therefore ask not only whether students participate, but whether participation builds organised and communicable understanding.

This view also connects with UDL, which emphasises multiple means of engagement, representation, action and expression (Sewell et al., 2022). Cognitive science explains why such flexibility matters: different forms of representation and expression reduce different cognitive barriers. Used in this way, cognitive science does not reduce ambition; it clarifies where a lesson pressures attention, memory, retrieval, interpretation or expression.

4. Applying Cognitive Science to Inclusive Art Education

4.1 From Visual Observation to Guided Noticing

The first application is to make visual observation more guided. Students are often told to “look carefully”, but that instruction can be too open to help. A cognitively accessible lesson needs to show what careful looking involves. The teacher might draw attention to line, colour, texture, proportion or rhythm, and then add a short verbal explanation for each feature. When looking at Hakka architecture or a local craft object, students could first notice repeated forms, then consider how these forms connect with use, belief or community memory. In this way, dual coding gives observation some structure, but it does not replace interpretation. Students are not just shown an image and left to work it out alone. They are helped to notice what matters, and why it may matter.

4.2 From Cultural Symbols to Interpretation

A second application concerns cultural symbols. Students may recognise a motif, a colour or a detail in a building without really understanding its historical meaning. So inclusive art teaching needs to help them move from recognition to interpretation. Concrete examples should not be treated as models to copy. They

work better as materials for comparison, questioning and meaning-making. Students might compare several motifs, notice shared visual qualities, and then discuss how these qualities connect with social context. A second application concerns cultural symbols. Students may recognise a motif, a colour or a detail in a building without really understanding its historical meaning. So inclusive art teaching needs to help them move from recognition to interpretation. Concrete examples should not be treated as models to copy. They work better as materials for comparison, questioning and meaning-making. Students might compare several motifs, notice shared visual qualities, and then discuss how these qualities connect with social context.
Vavrus (2008) reminds us that teaching needs to take culture seriously, rather than assume learners are culturally neutral. In art education, this means cultural examples should open up dialogue, not close it down with one fixed meaning. This matters because cultural knowledge is not simply information handed from teacher to student. It is understood through students' own experiences, language and sense of identity.

4.3 From Memory to Creative Transformation

A third application is to connect memory with creative transformation. Students cannot reshape an idea if they cannot recall it. When a cultural notion is presented only once before being immediately succeeded by an unrestricted creative assignment, certain learners risk severing the connection between the original reference and their personal output. A more supportive sequence might move from observation, to recall, to comparison, then sketching and later adaptation. In this sense, retrieval and spacing are not rote repetition. They give students repeated chances to meet the same cultural idea at different levels of difficulty. Later making can then be guided by remembered meanings, rather than only by isolated visual effects. Cognitive support does not limit creativity; it gives students something firmer to think with when making independent choices.

4.4 From Single Output to Multiple Expression

The fourth application is to broaden expression. If assessment focuses only on a polished final artwork, some students may be unable to show the thinking that occurred during learning. UDL values multiple means of action and expression (Sewell et al., 2022). Learners may evidence their comprehension through labelled drawings, spoken justification, graphic organisers, brief reflective writing, collaborative dialogue, electronic montages, or a concluding artefact accompanied by documentation of the creative process.These are not easier alternatives; they are different routes for showing the relationship between form, meaning and intention. This also makes assessment fairer: the teacher can judge not only aesthetic finish, but the quality of interpretation, decision-making and reflection behind the work.

5. Critical Discussion

5.1 The Contribution of Cognitive Science

Cognitive science helps inclusive teaching by making the learning demands of a task easier to see. It asks what students are being asked to do with attention, working memory, retrieval, interpretation and expression. This matters in art education, where taking part and finishing a piece of work can sometimes look like understanding. But they are not always the same thing. Aleven and Koedinger (2002) are useful here because their study shows that learners often develop stronger understanding when they explain their reasoning, rather than only complete the task. In this sense, cognitive science supports a deeper kind of inclusion: one concerned with understanding and transfer, not just participation. Its role is not to remove difficulty from learning. It helps teachers decide which difficulties are meaningful, and which ones simply block access.

5.2 The Limits of a Cognitive Approach

At the same time, a cognitive account has obvious limits. Inclusion is not just about making information easier to process. It is also shaped by emotion, language, identity, culture, peer relationships and the wider conditions of the institution. Lindsay (2003) warns that inclusive education is too complex to be explained through simple claims about placement or teaching method. Even a meticulously planned lesson can prove exclusionary when it treats cultural knowledge as static, or when learners do not experience a sense of trust and validation within the classroom environment.Vavrus (2008) is useful here because he stresses the need for culturally responsive teaching. Cognitive accessibility, then, has to work alongside cultural responsiveness, care in classroom relationships and a critical awareness of power.

5.3 Cognitive Science and Universal Design for Learning

Cognitive science and UDL are complementary rather than interchangeable. UDL offers a broad framework through engagement, representation, action and expression; cognitive science explains why these forms of flexibility matter for learning processes. Yet UDL should not become a checklist. Kennette and Wilson (2019) found that students and faculty perceived many UDL elements as useful, but also note that perception data do not by themselves prove learning outcomes. A cognitively informed UDL approach should ask which barriers a lesson creates, which forms of representation or expression address them, and how teachers will know that understanding has developed. In this sense, UDL provides the inclusive orientation, while cognitive science helps test the pedagogical logic of particular design decisions.

6. Conclusion

This essay has argued that cognitive science can inform inclusive teaching by shifting attention from physical presence to cognitive accessibility. Students with learning differences may be excluded because the learning pathway is narrow, overloaded or implicit. Cognitive science helps teachers identify these hidden barriers and redesign lessons so that students can access, retain, interpret and express knowledge more effectively.

Even a meticulously planned lesson can prove exclusionary when it treats cultural knowledge as static, or when learners do not experience a sense of trust and validation within the classroom environment. Dual coding, concrete examples, retrieval practice, spaced practice, elaboration and self-explanation can support this movement from noticing, to understanding, to remembering, explaining and creating. When applied thoughtfully in combination with UDL and culturally responsive pedagogy, insights from cognitive science have the potential to render inclusive art teaching both more intentional and more equitable across diverse learner profiles.

REFERENCES

[1] Ahlum-Heath, M. E., & Di Vesta, F. J. (1986). The effect of conscious controlled verbalization of a cognitive strategy on transfer in problem solving. *Memory & Cognition*, 14(3), 281-285.
[2] Aleven, V., & Koedinger, K. R. (2000a). Limitations of student control: Do students know when they need help? In G. Gauthier, C. Frasson, & K. VanLehn (Eds.), *Intelligent Tutoring Systems* (pp. 292-303). Springer.
[3] Aleven, V., & Koedinger, K. R. (2000b). The need for tutorial dialog to support self-explanation. In C. P. Rose & R. Freedman (Eds.), *Building dialogue systems for tutorial applications: Papers from the 2000 AAAI Fall Symposium* (pp. 65-73).
[4] Aleven, V. A. W. M. M., & Koedinger, K. R. (2002). An effective metacognitive strategy: Learning by doing and explaining with a computer-based Cognitive Tutor. *Cognitive Science*, 26(2), 147-179.
[5] Aleven, V., Koedinger, K. R., Colleen Sinclair, H., & Snyder, J. (1998, August). Combatting shallow learning in a tutor for geometry problem solving. In *International Conference on Intelligent Tutoring Systems* (pp. 364-373). Berlin, Heidelberg: Springer Berlin Heidelberg.
[6] Anderson, J. R., Corbett, A. T., Koedinger, K. R., & Pelletier, R. (1995). Cognitive tutors: Lessons learned. *The Journal of the Learning Sciences*, 4(2), 167-207.
[7] Sewell, A., Kennett, A., & Pugh, V. (2022). Universal Design for Learning as a theory of inclusive practice for use by educational psychologists. *Educational Psychology in Practice*, 38(4), 364-378.
[8] Weinstein, Y., Madan, C. R., & Sumeracki, M. A. (2018). Teaching the science of learning. *Cognitive Research: Principles and Implications*, 3(1), 2.

[9] Sullivan, G. (1993). Art-based art education: Learning that is meaningful, authentic, critical and pluralist. *Studies in Art Education*, *35*(1), 5-21.

[10] Lindsay, G. (2003). Inclusive education: a critical perspective. *British journal of special education*, *30*(1), 3-12.

[11] Sweller, J. (1988). Cognitive load during problem solving: Effects on learning. *Cognitive science*, *12*(2), 257-285.

[12] Kennette, L. N., & Wilson, N. A. (2019). Universal design for learning (UDL). *Journal of Effective Teaching in Higher Education*, *2*(1).

[13] Vavrus, M. (2008). Culturally responsive teaching. *21st century education: A reference handbook*, *2*(49-57).

[14] Schmidt, M. W., & Harriman, N. (1998). *Teaching strategies for inclusive classrooms: Schools, students, strategies, and success*. Cengage Learning.

[15] Fu, K. (2025). Application of symbolic interaction theory in arts and crafts appreciation course design. Art Education Research, (5), 128–130.