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EXPLORING THE HIDDEN POWER OF VISUAL THINKING: DEVELOPMENT OF A WORKSHOP FOR STUDENTS

ABSTRACT

Housing for the elderly has become a pressing issue where the challenges of aging populations and sustainable development collide. These challenges can be met by integrating ecological, social, economic, and cultural perspectives into user-centred design. Such interdisciplinary settings highlight wicked problems: complex, shifting issues that resist clear solutions. Cognitive limitations, including restricted working memory and difficulty grasping hidden interdependencies, further complicate sensemaking. This article presents the development of a workshop within the sUser – Introducing User-driven Design and Agile Development Skills in the Case of Sustainable Service Housing for Elderly – project exploring the potential of visual thinking in practice. Visual thinking uses sketches, diagrams, and other visual forms to offload cognitive demands, reveal patterns, and build shared understanding. The workshop emphasises that visual thinking is a natural human ability, unrelated to drawing skill, and demonstrates simple methods for structuring complexity and fostering collaboration. The findings suggest that visual thinking is a versatile cognitive strategy, valuable not only in interdisciplinary design for sustainable elderly housing but also as a general aid for reasoning across domains.

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1. INTRODUCTION

Designing sustainable housing for an aging population is a key societal challenge of the twenty-first century. As people live longer and seek to remain independent, living environments must support accessibility, safety, ecological responsibility, affordability, and social connection. No single field can address these aims alone. Instead, designers, policymakers, care providers, residents, and families must jointly negotiate priorities—an endeavour characteristic of what Rittel and Webber (1973) defined as a wicked problem. This complexity deepens when ecological goals, cultural expectations of aging, financial constraints, and diverse user needs intersect. Choices about location, materials, governance, and services create ripple effects across domains, requiring ongoing reframing rather than fixed solutions. From a design perspective, this aligns with Buchanan's (1992) view that design practice is well-suited to engage with indeterminate problems.

At the same time, such complexity collides with the limits of human cognition. Modern work demands that individuals manage multiple variables and interdependencies, yet working memory remains tightly constrained. As Logie (2011) notes, interference and distraction further reduce our ability to maintain a systems-level overview, making it difficult to reason through multifaceted challenges. One way to mitigate these limits is through externalisation—placing thoughts into visible form so they can be organised and shared. Humans reason through interaction with notes, diagrams, tools, and colleagues; making ideas visible allows them to be inspected and developed more effectively. This also aligns with Hutchins's (1995) account of cognition as distributed across individuals and artifacts. In collaborative design contexts such as sustainable elderly housing, visualisations also serve crucial social and creative functions. Shared sketches, maps, and diagrams help participants align understanding, question assumptions, and negotiate priorities. Even rough drawings can prompt reinterpretation and iteration, reflecting what Schön (1983) describes as a "conversation with the situation."

The present article builds on these insights to argue that visual thinking should be recognised not merely as a tool for communication but as a practical cognitive strategy that individuals can learn, apply, and refine. Our emphasis is not on artistic skill or graphic design, but on the tangible competencies that emerge through making ideas visible. When participants sketch, diagram, map, or model concepts, they practice skills that help them structure information,

explore alternatives, and reason more effectively about complex situations. In the context of sustainable elderly housing, these skills become especially valuable. Visual externalisations enable practitioners to break down intricate systems into manageable components, compare options side by side, and trace relationships that are difficult to grasp in purely verbal discussion. As participants experiment with simple visual tools—such as quick sketches, causal maps, journey diagrams, or layered overlays—they develop an ability to notice patterns, identify gaps, and articulate assumptions that might otherwise remain implicit. These hands-on practices strengthen situational awareness and support more informed decision-making.

Just as importantly, visual thinking cultivates collaborative abilities. Shared drawings and diagrams provide multidisciplinary teams—designers, policymakers, care professionals, and residents—with a common reference point for negotiation. Working together around a sketch helps participants listen, challenge, and build on each other's ideas more effectively. This practice develops skills in facilitation, co-creation, and boundary-crossing communication, making complex discussions more inclusive and productive. To support the development of these practical competencies, we report on a workshop format designed to introduce visual thinking as an accessible practice for participants with no prior drawing experience. The workshop focuses on simple, repeatable techniques that can be applied in real projects, encouraging participants to use visual tools as part of their everyday problem-solving. We also outline how this format is being expanded into an online MOOC, allowing learners to develop and deepen these skills at their own pace while engaging with examples, exercises, and collaborative tasks that mirror real-world design challenges.

2. THEORETICAL BACKGROUND

Before turning to specific mechanisms, it is important to define what is meant here by visual thinking. The term is used in many ways, ranging from graphic communication and artistic expression to design sketching and modelling. In this article, visual thinking is defined narrowly as the use of visual and spatial representations to support cognition and reasoning. It refers to externalising thought in sketches, diagrams, maps, and other spatial forms to augment human cognitive processes. Visual thinking in this sense is not primarily about communication design or aesthetic quality, but about providing cognitive scaffolds that extend working memory, reveal patterns, and enable individuals and groups to process complex information more effectively.

2.1 Wicked problems and cognitive limits

The concept of wicked problems offers a valuable lens for understanding the design challenges of sustainable elderly housing. Rittel and Webber (1973) describe such problems as resisting definitive formulations, lacking stopping rules, and allowing only better or worse outcomes. Buchanan (1992) later argued that wickedness is inherent to design because it unfolds in open, evolving situations where goals and meanings shift. In elderly housing, ecological targets, regulations, cultural expectations, and user needs interact in unpredictable ways, meaning each intervention reframes the problem space and requires iterative, abductive thinking.

This wickedness intersects with human cognitive limitations. Working memory: the system responsible for maintaining and manipulating information—constitutes a central bottleneck in reasoning (Logie, 2011). Klingberg (2008) shows that it is fragile, easily distracted, and quickly overloaded when many interdependencies must be monitored. As a result, even experienced practitioners can struggle to maintain a coherent systems-level overview in real-world conditions marked by interruptions and competing priorities. The consequence is a tendency toward oversimplification or fixation on only part of the problem.

If wicked problems demand integrative reasoning, then working-memory limits pose a fundamental challenge. Researchers therefore emphasise the importance of external supports (notations, diagrams, and other cognitive scaffolds) to augment mental processing.

2.2 Extended mind and distributed cognition

The extended mind thesis (Clark & Chalmers, 1998) maintains that cognitive processes can extend into the environment when individuals reliably couple with external artifacts. If a notebook, smartphone, or diagram performs the same functional role as internal memory or inference, it becomes part of the cognitive system. From this perspective, external aids are not peripheral add-ons but constitutive elements of thought. Sketching, listing, or arranging sticky notes does not merely document ideas—it shapes the thinking process itself. This principle, that cognition emerges through interactions with the environment, is summarised in Figure 1.

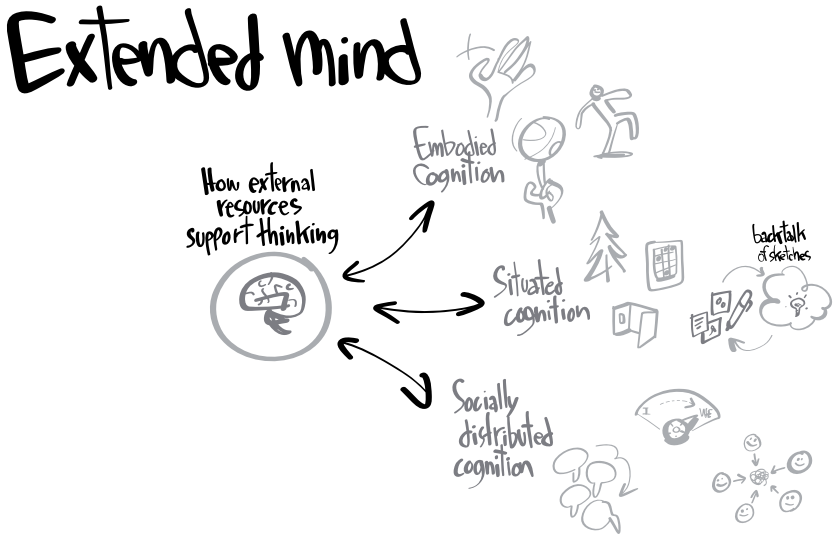

FIGURE 1. Extended mind theory explains how external resources support cognition. This illustration, adapted for the workshop, visualises a commonly used interpretation of the framework, which distinguishes embodied, embedded, and distributed processes (Clark & Chalmers, 1998; Paul, 2021).

This view is reinforced by distributed cognition (Hutchins, 1995), which demonstrates how real-world problem-solving depends on coordination among people, artifacts, and representational media. Hutchins's studies of ship navigation showed that no single individual carried the entire cognitive load; instead, cognition emerged from the system as a whole. In design and innovation, the same principle applies: diagrams, sketches, and models act as "public representations" that synchronise attention, support partial understandings, and enable joint solutions.

Together, extended and distributed cognition underscore that externalisation is fundamental rather than optional. Cognitive artifacts stabilise thoughts, reduce reliance on limited working memory, and enable collective reasoning—justifying visual thinking as a core design method.

2.3 Working memory subsystems and cognitive offloading

Cognitive psychology explains why externalisation is so effective. Working memory consists of specialised subsystems: the phonological loop for verbal material, the visuospatial sketchpad for visual-spatial content, and

a central executive that coordinates them (Logie, 2011). Each subsystem has strengths and limits. The phonological loop excels with sequential information but overloads quickly, while the visuospatial sketchpad processes multiple relations in parallel yet also has finite capacity. Visualisations are powerful because they shift information into the visuospatial system, easing demands on the verbal channel and rendering complex structures more manageable.

Cognitive offloading refers to shifting cognitive demands from internal systems to the external environment (Risko & Gilbert, 2016). Writing a number relieves the phonological loop; sketching a map externalises spatial relations that would otherwise tax the visuospatial sketchpad. Offloading does more than conserve resources: once information is external, perceptual and inferential processes—such as grouping, analogy, or pattern detection—can act on it. Thus, offloading both preserves working memory and expands the operations available to the thinker. This process is illustrated in Figure 2.

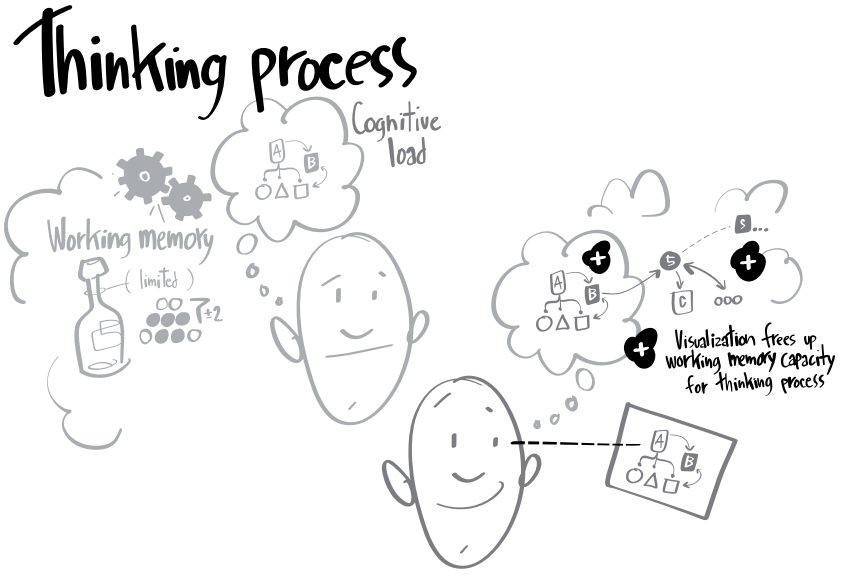

FIGURE 2. Visual thinking relieves the bottleneck of working memory by externalising mental content. This schematic, adapted from workshop materials, illustrates how sketching reduces cognitive load and frees resources for reasoning (Logie, 2011; Klingberg, 2008; Risko & Gilbert, 2016).

Dehn, Kaufman, and Kaufman (2015) further stress that interventions should accommodate subsystem-specific limits. Visual scaffolds can support those with verbal memory difficulties, while verbal structuring can assist those with visuospatial challenges. For design practice, the implication is clear: visualisations provide a versatile means of redistributing cognitive load across modalities.

2.4 Dual coding and grounded cognition

Two theoretical perspectives explain the enduring benefits of visual externalisation. Dual coding theory (Paivio, 2014) posits that verbal and nonverbal representations operate in distinct but interconnected systems. When information is encoded both verbally and visually—as when designers sketch while discussing—each channel reinforces the other, improving memory and comprehension. Research supports this: multimodal learning environments outperform unimodal ones (Moreno & Mayer, 2007).

Grounded cognition (Barsalou, 2008) adds that concepts draw on sensorimotor simulations rather than abstract, amodal codes. Thinking about "balance" recruits motor systems; thinking about "brightness" engages visual areas. Visualisations are effective, therefore, not because they arbitrarily symbolise ideas but because they resonate with perceptual mechanisms that mirror the structure of the concepts. Sketches and diagrams thus enable richer, more embodied cognitive engagement.

Together, dual coding and grounded cognition show how visual thinking enhances memory and understanding by activating complementary perceptual and conceptual systems.

2.5 Visual thinking as cognitive scaffolding

Tversky (2011) highlights how visualisations differ from linear language. While language unfolds sequentially, diagrams exploit spatial properties—proximity, alignment, direction—to encode relations in parallel, thereby reducing cognitive load. Experimental findings support this: visual processing excels when multiple elements must be considered simultaneously (Deryalar, 2022), and visual working memory tends to encode higher-order structure rather than isolated items (Brady & Alvarez, 2011). Effective diagrams leverage these tendencies by organising information into meaningful patterns.

Visualisations also promote active engagement. Bobek and Tversky (2016) found that learners who created their own visual explanations achieved better comprehension than those who only studied the provided materials. The act of sketching forces individuals to externalise, organise, and refine their understanding. In design, Goldschmidt (2003) showed that sketches often yield more information than was intentionally placed in them, as ambiguous marks prompt reinterpretation. Schön (1983) conceptualised this as reflection-in-action, a dialogue between designer and sketch that drives creative discovery.

2.6 Visual thinking in collaborative contexts

Beyond individual cognition, visualisations play a crucial role in collaboration and co-design. Kälviäinen (2025) documents how visual tools such as journey maps, empathy maps, and stakeholder diagrams help diverse participants articulate perspectives, set problems, and explore solutions collectively. Visuals act as boundary objects: flexible enough to accommodate different interpretations yet structured enough to anchor joint work. Gustafsson (2023) adds that artifacts used in strategy work confer neurocognitive advantages by directing attention, eliciting emotion, and supporting memory when groups build meaning together. In workshops, even low-fidelity visuals can transform abstract debates into concrete interactions, enabling participants from diverse backgrounds to co-create shared understanding.

These findings underscore the dual nature of visual thinking: it is both an individual cognitive aid and a social practice. As individuals, we use sketches to offload memory and reveal patterns; as groups, we use them to align mental models, negotiate trade-offs, and foster inclusion. This dual role is particularly salient in wicked problems, where both cognitive and social complexity are high.

2.7 Summary and critical perspectives

The theoretical perspectives reviewed here point to a shared conclusion: visual thinking acts as an extension of the mind. When ideas are externalised into stable, structured forms, individuals can move beyond the limits of working memory, draw on perceptual and embodied systems, and open up forms of inference that are difficult to achieve mentally. At the same time, shared visuals support collective sensemaking, offering groups a way to navigate the shifting, contested landscape of wicked problems. Drawing on extended mind theory, working memory research, dual coding, and grounded cognition, visual thinking emerges not as a stylistic preference but as a central strategy for reasoning and design.

Even so, these approaches have their critics. The extended mind thesis (Clark & Chalmers, 1998) has been challenged for casting too wide a net; if every interaction with artifacts counts as cognition, the concept risks losing its force. Rupert (2010) argues that only tightly integrated processes should qualify as genuinely cognitive, reminding us that for visual thinking, what matters is not simply the presence of diagrams but the ways they are reliably woven into reasoning.

Dual coding theory (Paivio, 2014) also faces questions about its generality. Although the distinction between verbal and visual codes is useful, real cognitive activity often draws on additional affective, motor, and social systems. Research on multiple representations shows that combining visuals and text can sometimes hinder learning when the effort of integrating them exceeds cognitive resources (Schnotz & Bannert, 2003).

Grounded cognition (Barsalou, 2008) expands the picture by highlighting embodied simulations, yet its claims remain contested as well. Mahon and Caramazza (2008) argue that activation of motor or perceptual areas during concept use does not prove that concepts are constituted by embodiment. Instead, they suggest that abstract representations may coexist with sensorimotor activations, complicating stronger interpretations of grounding.

Scholars have also cautioned that cognitive offloading is not without drawbacks. Norman (1993) notes that external artifacts can mislead or oversimplify, while Risko and Gilbert (2016) warn that outsourcing memory may reduce internalisation or foster dependence. In wicked problem contexts, where all visualisations simplify, diagrams can obscure as much as they illuminate.

Taken together, these critiques refine rather than weaken the argument for visual thinking. They remind us that the value of sketches, maps, and diagrams lies not simply in their production but in how they are embedded in cognitive and social activity. This underscores the need for workshops and pedagogical interventions that help students and professionals use visual thinking reflectively and effectively. By situating practice within a nuanced theoretical landscape, we can avoid both uncritical enthusiasm and dismissive scepticism and cultivate visual thinking as a flexible, context-sensitive cognitive strategy.

3. WORKSHOP APPROACH AND ILLUSTRATIVE OBSERVATIONS

In the context of sustainable elderly housing – and, more broadly, university courses dealing with complex systems – a need was identified for practical means to build shared understanding and frame problems productively. As a response, a visual-thinking workshop was developed with the aim to (1) introduce the concept in a non-intimidating way, (2) explain why visual externalisations support cognition, (3) demonstrate that the method is a skill everyone already has, regardless of drawing ability, and (4) offer simple ways to externalise and visualise one's own thinking.

3.1 Initial perceptions and barriers

Introducing visual thinking to students proved paradoxical. On the one hand, it is something almost everyone has already practised informally without naming it; on the other, presenting it under an official-sounding term made some participants assume it was a wholly novel, unfamiliar method. This tension shaped early reactions. To illustrate the core idea, that visual thinking is a form of externalising thought consistent with the extended mind thesis, a simple exercise was used. Students were shown a long word and asked to count its syllables. Many instinctively resorted to using their fingers. This behaviour was then highlighted as an example of cognitive offloading, showing that visual thinking operates on the same principle: making structures explicit outside the head so they can be more easily managed and understood.

3.2 A skill everyone already has – and the myth of drawing skill

Visual thinking is not an exotic or unfamiliar practice but a skill that everyone already uses in everyday life. People routinely externalise thought through lists, notes, reminders, or casual doodles. These simple artifacts are not judged for their appearance but valued for their function: they make mental content visible, stable, and easier to manage.

Against this backdrop, one recurring barrier in the workshop was the persistent belief that visual thinking requires drawing skill. Many participants assumed that to visualise thinking meant to draw well and thus evaluated their output by artistic standards. This misconception required deliberate effort to dispel. The workshop stressed that visualisations are tools for thought, not artworks to be assessed aesthetically. Just as no one evaluates a reminder note for penmanship, sketches should be judged by their cognitive utility rather than by their artistic quality.

It is also worth noting that visualisation is not restricted to drawing. People routinely use physical props and digital tools to externalise thought: Lego bricks, post-it notes, modelling clay, Miro or MURAL boards, whiteboards, or even rearranged objects on a table (Tversky, 2011). Each of these offers tactile or spatial cues that help people perceive and reorganise complexity. However, in our workshop we focused on sketching because it is fast, universally accessible, and flexible: paper and pen are always near at hand. Sketching also uniquely supports the use of metaphor and analogy – for example, drawing arrows to indicate causality or containers to suggest categories – something that other materials make harder to improvise in real time.

3.3 Ways to visualise thinking

Mental content can take many forms: networks of interrelated ideas, hierarchical structures, temporal sequences, spatial arrangements, or qualitative and quantitative values. Externalising these structures visually helps make them tractable. In the workshop, a set of simple tips was compiled to highlight that the aim was not polished diagrams but working artifacts that participants could manipulate as the process unfolded as part of their reasoning.

Perspectives from complexity thinking reinforce this approach. Beeler (2020), writing from a practitioner's perspective, notes that making sense of complexity requires choosing and layering representations that illuminate various aspects of a system, rather than expecting a single view to suffice. Classic frameworks such as Wurman's LATCH (Location, Alphabet, Time, Category, Hierarchy) and Gray's (2012) reflections on organising information provide practical heuristics: they suggest multiple ways to order and map content so that relationships become visible. These approaches align closely with the workshop aim of equipping participants with flexible strategies to make sense of their own complex ideas. Covert (2014) similarly emphasises that clarity is created when relationships are surfaced rather than hidden.

3.4 Workshop dynamics

Many participants initially overestimated the complexity of the practice, which led to hesitation and a stream of "Am I doing it right?" questions. The guiding principle we emphasised was simple: a visualisation is right when it helps you see relationships, options, and next moves more clearly than before. In practice, small constraints (thick markers, limited space, short time boxes, deliberately rough examples) reduced perfectionism and encouraged contribution.

3.5 Multi-level role of visual thinking

Previous research highlights that visual thinking operates at multiple levels. At the individual level, it supports one's own reasoning by externalising and structuring ideas, which in turn makes them easier to revisit, refine, and iterate (Schön, 1983; Goldschmidt, 2003). At the group level, shared visuals function as boundary objects that help align perspectives and build collective sensemaking (Kälviäinen, 2025; Gustafsson, 2023). Finally, visualisations also act as communicative artifacts, conveying insights to wider audiences beyond the immediate design team. This multi-level role of visual thinking is illustrated in Figure 3.

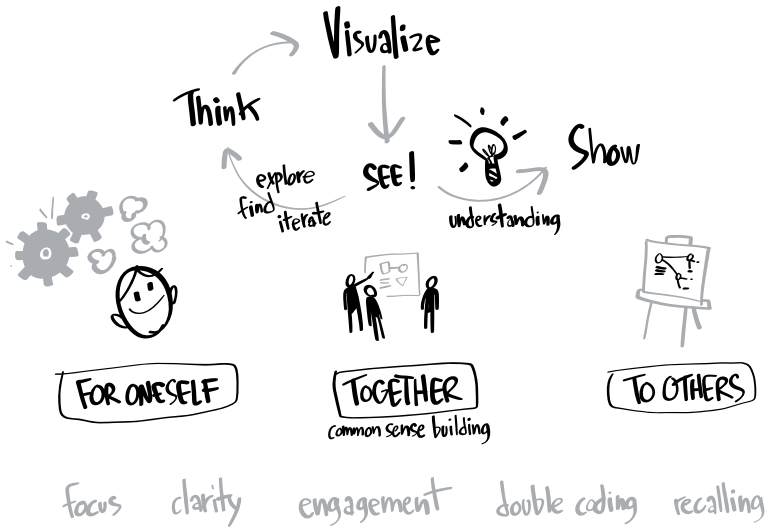

FIGURE 3. Visual thinking operates at multiple levels: supporting individual reflection, enabling collective sensemaking, and facilitating communication to others. This workshop illustration summarises the multi-level role of visualisations as cognitive scaffolds, resonating with research on visual explanations and shared understanding (Tversky, 2011; Kälviäinen, 2025; Gustafsson, 2023).

3.7 Limitations

Findings reflect a particular case within elderly-housing design and rely on facilitation by experienced visual practitioners. Visualisations can oversimplify or privilege certain structures; therefore, they should be combined with verbal and quantitative representations and iterated with stakeholders. Practical constraints (time, materials) must also be managed; however, low-fidelity tools kept costs minimal in our setting.

4. DISCUSSION

The workshop pilots described in this article should be understood as early explorations rather than systematic studies. Their primary aim was to test how the theoretical rationale for visual thinking – particularly its grounding in extended mind theory and cognitive offloading – could be translated into a practical learning format. As such, the observations reported here are anecdotal and facilitation played a significant role. Still, they provide useful indications of how visual externalisation might support both individual reasoning and group sensemaking in complex design contexts.

One recurring suggestion from the pilots was that visualisations can lower barriers to participation. Even when sketches were rough and provisional, they provided a shared canvas that participants could interact with and add to as the process unfolded. This aligns with prior research highlighting how external representations act as boundary objects and scaffolds for collective reasoning (Kälviäinen, 2025; Gustafsson, 2023). Rather than serving as finished products, the sketches functioned as cognitive tools – lists, diagrams, or spatial arrangements – that allowed participants to make their thinking visible and negotiate ideas with others.

Another indication was that visualisations helped participants manage complexity. When issues were discussed verbally, conversation often circled abstractly around competing concerns; when ideas were externalised as diagrams, patterns and relationships became more tractable. This resonates with theoretical accounts of how the visuospatial sketchpad processes multiple elements in parallel, relieving the bottlenecks of linear verbal reasoning (Logie, 2011). Although these impressions are not definitive findings, they suggest that the mechanisms described in cognitive theory are visible in practice, even in short workshop exercises.

At the same time, several limitations became clear. The pilots relied heavily on skilled facilitation, and the outcomes may not generalise without such support. Visualisations inevitably simplify, and there is always a risk that certain perspectives become privileged while others are obscured. Materials and time were limited, which constrained the range of methods that could be tested. Most importantly, no systematic data were collected, so conclusions must remain tentative. These caveats underline the need for further development and structured evaluation.

The workshop is intended as a stepping stone toward a MOOC course on visual thinking. Translating the format into an online environment raises

new challenges: spontaneous sketching is difficult to replicate digitally, and assessment of drawings cannot realistically focus on quality. Nevertheless, digital platforms offer opportunities for self-assessment, peer comparison, and collaborative annotation, which can preserve the core pedagogical principle of making thinking visible. Future iterations should therefore experiment with lightweight digital tools while retaining the focus on visualisations as cognitive scaffolds.

Taken together, these reflections highlight both the promise and the open questions surrounding visual thinking as a pedagogical and design method. The theoretical background provides a strong rationale, and the pilots suggest that practice resonates with theory. Yet the work is only beginning; systematic study, long-term implementation, and adaptation to diverse contexts are needed. For now, the main conclusion is modest but significant – visual thinking is a skill participants' already use in everyday life, and when framed as a cognitive aid rather than an artistic exercise, it can be cultivated to support reasoning and collaboration in complex problem spaces.

5. SUGGESTIONS FOR FUTURE RESEARCH

The promising insights outlined above point to several avenues for further developing visual thinking theory as well as its practices. Although workshops and theoretical arguments suggest that externalisation scaffolds reasoning, these exploratory efforts raise as many questions as they answer. A systematic study is needed to consolidate visual thinking as a cognitive strategy and refine its applications across contexts. Particularly promising directions include design practice, education, and innovation, where targeted studies can clarify how making ideas visible extends cognition and supports social interaction, while also addressing critiques from cognitive theory (Clark & Chalmers, 1998; Rupert, 2010).

In design practice, research should examine how visual thinking functions as part of professional reasoning. While sketching and diagramming are long-standing design tools, empirical evidence is still needed to explain their cognitive contributions. Building on the extended mind thesis, scholars could investigate when sketches become tightly integrated into designers' thinking (Clark & Chalmers, 1998). Cognitive offloading theory predicts benefits in such cases, as diagrams should relieve memory load and enable operations such as pattern recognition or analogical mapping that mental computation alone cannot achieve (Risko & Gilbert, 2016). Controlled studies comparing

design problem-solving with and without sketching could track differences in solution quality or cognitive load. The phenomenon of sketches "talking back" to their creators further warrants study, since ambiguous drawings can trigger novel insights (Goldschmidt, 2003; Schön, 1983). Such research would validate visual thinking as a core design method and offer guidance for maximising the utility of externalisations.

In education, longitudinal and controlled studies are needed to evaluate the effects of teaching visual thinking on learning and problem-solving. Dual coding theory suggests that learning improves when verbal and visual encoding are combined (Paivio, 2014), while prior work confirms that generating diagrams enhances comprehension and recall (Bobek & Tversky, 2016; Moreno & Mayer, 2007). Grounded cognition perspectives further predict benefits from engaging sensorimotor experiences (Barsalou, 2008). Research could compare groups learning complex concepts through visual–spatial methods versus traditional approaches, while applying process-tracing tools such as sketch analysis or eye-tracking. Collaboration across education, psychology, and technology would be valuable in scaling interventions, particularly online. As suggested by the MOOC pilots, digital tools may support collaborative annotation and peer feedback, helping to preserve the principle of making thinking visible.

In innovation and collaboration, research should explore how visual thinking facilitates group cognition in multi-stakeholder contexts. Wicked problems, such as sustainable housing, require shared understanding across diverse participants (Rittel & Webber, 1973; Buchanan, 1992). Visual artifacts are believed to serve as boundary objects, aligning perspectives and externalising tacit knowledge (Kälviäinen, 2025; Gustafsson, 2023). Comparative studies of team tasks with and without structured visual methods could measure outcomes such as idea diversity, consensus speed, and solution quality. Longitudinal work in organisational or community projects could examine how sustained visual practices shape innovation culture. Interdisciplinary collaboration will be essential to link cognitive mechanisms with practical outcomes.

Across these domains, future research must remain critically balanced. While extended cognition, dual coding, and offloading theories highlight clear advantages (Clark & Chalmers, 1998; Paivio, 2014; Risko & Gilbert, 2016), critiques remind us that externalisations can oversimplify or bias reasoning (Norman, 1993; Schnotz & Bannert, 2003). Clarifying when visual thinking genuinely extends cognition – and when it misleads – will be key to refining it into a nuanced theory and a transferable skill that supports individual reasoning, collective sensemaking, and the tackling of contemporary wicked problems.

6. CONCLUSIONS

Making things visible is not a cosmetic step but a cognitive strategy. By offloading thought into space, visual thinking extends capacity, reveals structure, and builds shared understanding – preconditions for progress on wicked problems. The workshop pilots illustrated this vividly: when participants externalised their ideas, hesitation often gave way to engagement, and shared canvases enabled connections that verbal discussion alone tended to obscure. These observations align with theories of extended cognition and dual coding, showing how externalisation taps into complementary cognitive systems.

The implications extend beyond the classroom. In collaborative and participatory contexts, visual artifacts serve as boundary objects that align perspectives and foster inclusion, echoing Gustafsson's (2023) emphasis on artifacts in strategy work and Kälviäinen's (2025) findings on co-design. Thus, visual thinking should be recognised not only as an individual aid but also as a social practice that supports joint sensemaking and ownership of outcomes.

In the future, the trajectory is toward scaling. A MOOC course will translate these ideas into a curriculum that combines theoretical grounding with structured exercises for making thinking visible. While the digital environment cannot fully replicate the immediacy of in-person workshops, it offers learners opportunities to practice visual thinking in accessible ways and to reflect on its role in their reasoning.

In sum, visual thinking is both an ancient and a contemporary practice: from tallies and cave paintings to post-its and digital canvases, humans have long externalised thought to extend their minds. What is new is the recognition that this is not peripheral but central to learning, design, and collaboration. The challenge ahead is to cultivate visual thinking more deliberately – as a transferable skill for individuals, as a facilitative practice in groups, and as a method for tackling the wicked problems that define our age.

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