IDC School of Design अभिकल्प विद्यालय

IIT Bombay

Project 3

VisioCraft: Designing Activities to Boost Visual Thinking Skills in Students

Guided by Prof. Ravi Poovaiah

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Project Approval

The Project Titled "**VisioCraft**: Enhancing Visual Thinking through visual thinking strategies and constructivism approach." by Pooja Kumari is approved for partial fulfillment of the requirement for the degree of 'Master of Design' in Interaction Design at Industrial Design Centre, Indian Institute of Technology, Bombay.

Guide:
Ravi Poovaiah

Chairperson:

Internal Examiner:

External Examiner:

Declaration

I declare that this written document represents my ideas in my own words and where others' ideas or phrases have been included, I have adequately cited and referenced the original sources. I also declare that I have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea, data, fact, or source in my submission. I understand that any violation of the above will be cause for disciplinary action by the institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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Acknowledgment

I want to use this chance to convey my sincere gratitude to everyone who helped this project be completed successfully. First and foremost, I would like to express my sincere gratitude to Prof. Ravi Poovaiah , who served as my adviser, for their excellent advice, unshakable support, and encouragement during this process. Their knowledge and perceptions have significantly influenced the course of my work.
I appreciate the IDC digital library for giving me the tools and resources I needed to carry out my research. The easy access to relevant literature has significantly improved the quality of this project.
I want to express my gratitude to my friends and day school members, parents, especially Rupali ma'am, Niranjana ma'am, Veena ma'am, Jyoti ma'am for their participation, help, and enlightening conversations. Their suggestions have been really helpful in honing my concepts and enhancing my research.
Last but not least, I want to thank my family from the bottom of my heart for their unwavering support, patience, and love throughout this project. I've been inspired and given strength by their unwavering support.
In closing, I want to express my gratitude to everyone who has contributed—no matter how small—to the accomplishment of this project. I genuinely appreciate all of your help, advice, and encouragement, and I want to thank you all for it.

Content:

Abstract:

Visual thinking is an essential skill that can help children become more creative and resourceful in navigating the challenges they encounter throughout their lives efficiently. Fostering visual thinking from a young age is important as it lays down the foundation for skills and habits that are essential for success in various aspects of life. Evidence from earlier studies suggests that using a visual method to solve problems creates a positive mental model in our subconscious, which raises the likelihood of having insights, or "aha" moments. This implies that applying visual thinking strategies can improve one's capacity for creative problem-solving and speed up the process of coming up with novel ideas. In India, there hasn't been much emphasis placed on teaching visual thinking to students, despite the many advantages of including it into the curriculum. This project aims to address this gap by implementing an intervention designed to introduce visual thinking through engaging activities that utilize a variety of visual thinking strategies. This intervention aims to improve students' cognitive capacities, creativity, and problem-solving abilities by introducing visual thinking into the classroom. This will ultimately enrich their learning experience and prepare them for success in an increasingly visual world.

Introduction:

In his 1972 book, Robert H. Mckim highlights the pervasive nature of thinking, suggesting that it occupies a significant portion of our time and existence. He further notes that neurologists emphasize the involvement of our entire nervous system, not just the brain, in the process of thinking. Additionally, Mckim points out that our emotions and motivations play a crucial role in shaping the character of our thoughts.
Visual thinking is integral to all facets of human engagement and interaction, shaping our perceptions, interpretations, and interactions with the world. This phenomenon manifests across various professions; for instance, a dancer may devise new choreography, an artist may explore novel concepts or mediums, and a driver may strategize the most efficient route to a destination.

What is Visual thinking?

Visual thinking is a cognitive process in which people utilize mental images and visual representations to organize information, solve problems, and express ideas. It is the ability to mentally visualize concepts, relationships, and patterns, which are frequently represented by mental images, diagrams, or spatial arrangements.

Why do we need Visual thinking?

A wide range of professions, daily activities, and tasks where mental images and visual aids are crucial are impacted by the application of visual thinking. For architects, graphic designers, and visual artists, visual thinking is extremely helpful in the development and conceptualization of work. They employ diagrams, sketches, and mental imagery to compose, develop concepts, and solve design problems. Engineers and architects can conceptualize and design machines, systems, and structures using visual thinking. They envision complex components, spatial relationships, and structural configurations in order to develop feasible solutions. Students that use visual thinking in the classroom are better able to comprehend and remember the material. Teachers use illustrations, flowcharts, and other visual aids to help students grasp concepts more quickly and actively participate in class. Visual thinking is necessary for both navigation and spatial orientation. It makes it easier for users to plan routes, analyze maps, and navigate through physical environments. One way that visual thinking enhances communication is through the use of visual aids and representations that assist make complex ideas and concepts easier to understand. Encoding knowledge in a visual representation makes it easier to recall later on, which is how visual thinking enhances memory retention. Methods that use visual thinking to improve memory recall include mnemonic devices and visualization exercises. Notes that neurologists emphasize the involvement of our entire nervous system, not just the brain, in the process of thinking. Additionally, Robert H. Mckim (a retired mechanical engineering professor and creator of the "visual thinking" design approach) points out that our emotions and

motivations play a crucial role in shaping the character of our thoughts.
Visual thinking is integral to all facets of human engagement and interaction, shaping our perceptions, interpretations, and interactions with the world. This phenomenon manifests across various professions; for instance, a dancer may devise new choreography, an artist may explore novel concepts or mediums, and a driver may strategize the most efficient route to a destination.

Secondary Research

During my research I came across Robert H. Mckim, an emeritus professor of mechanical engineering, who developed the design methodology known as "visual thinking." He was also a pioneer and significant participant in Stanford's Product Design Programme in the late 1950s. He states that visual thinking consists of three parts in his book "Experiences in Visual Thinking": seeing, imagining, and drawing. Each of these parts is self-reinforcing and offers a unique path for development.

Figure 1

The book also provides us with a flow diagram of strategic choices and some visual thinking strategies which can help enhance visual thinking.
Flow diagram of strategic choices:

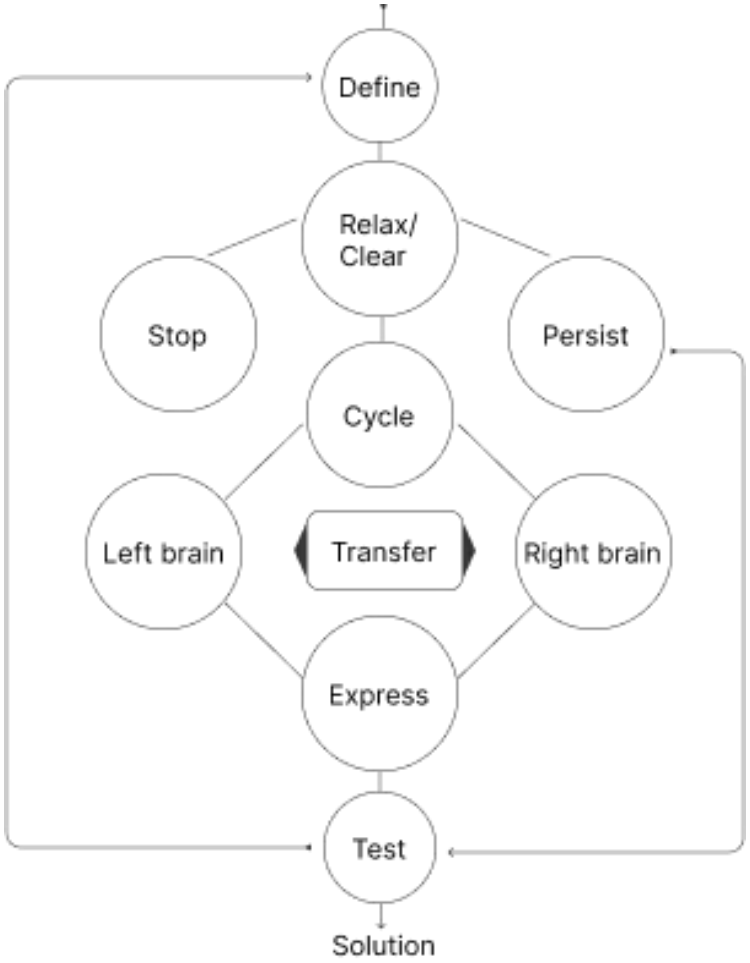


Figure 2

Visual thinking strategies:

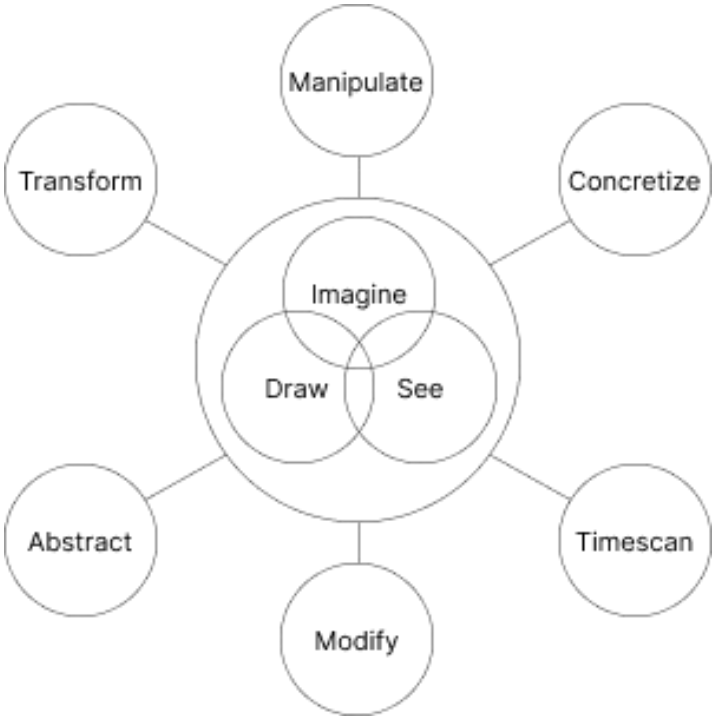


Figure 3

As stated in the book, in order to fully employ visual thinking processes, we must follow the following actions as required:

Abstract

- Defocus/withdraw from details/generalize
- Look at the big picture/seek overall pattern
- Induce principles from particulars
- Think with broad brush
- Group/classify/symbolize
- Diagram/chart/schematize

- Analyze/reshape
- Expand viewpoint/think divergently
- View problem as part of a system/see problem's context

Manipulate

- Rearrange elements of problem or solution
- Disassemble/separate/reassemble
- Randomize/play with
- Eliminate/add on
- Substitute/combine
- Transpose/superimpose
- Reverse/rotate/unfold
- Cross-section/transparentize
- Organize/systematize

Modify

- Reform elements of problem or solution
- Exaggerate/embolden/distort
- Modify slightly/understate/refine
- Reproportion — e.g., heighten, thicken, deepen
- Clarify
- Modify nonvisual quality — e.g., soften/lighten
- Unify/standardize

Transform

- Transform identity of problem or solution
- Abandon labels, conventions, stereotypes
- Think metaphorically/seek analogies
- Empathize/role play

Concretize

- Converge thinking/focus in on one solution
- Clarify/realize/actualize/exemplify
- Develop details
- Use concrete graphic languages
- Embody concept in 3-D

Timescan

- Retrieve/What from the past can help you now?
- Observe/What from now can help you now?
- Envision goals/plan
- Foresee consequences/predict
-
- Next, to get a better understanding of play theories and design I came across:

Play Theories and Design

Caillois's Attitudes in Play Experience

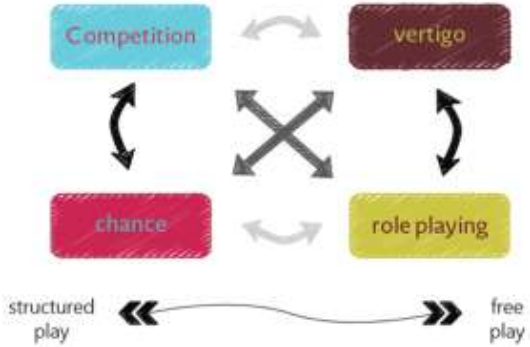


Figure 4

Csiksgentmihalyi's Flow Theory

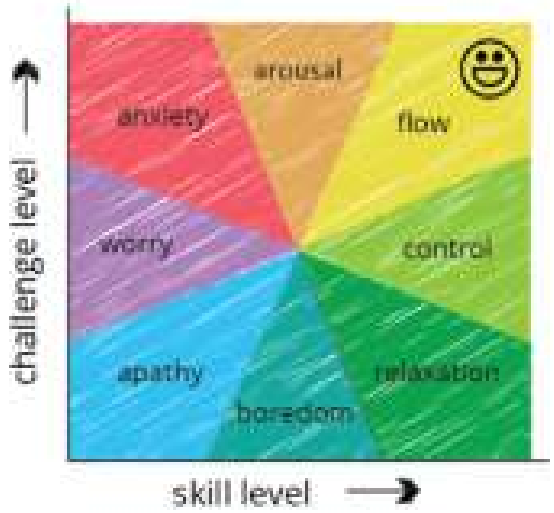


Figure 5

Apter's Reversal Theory

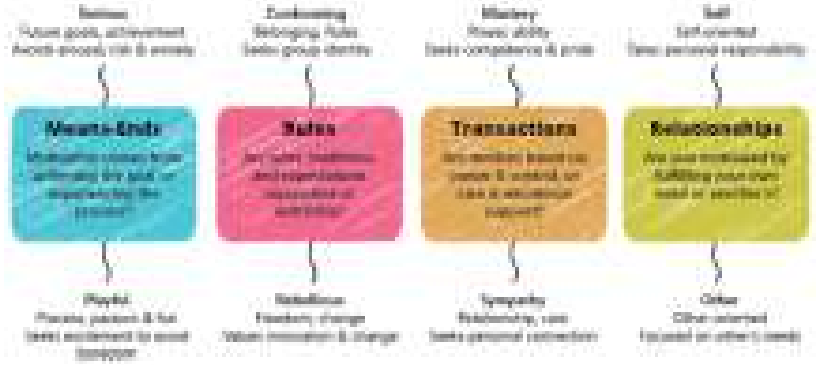


Figure 6

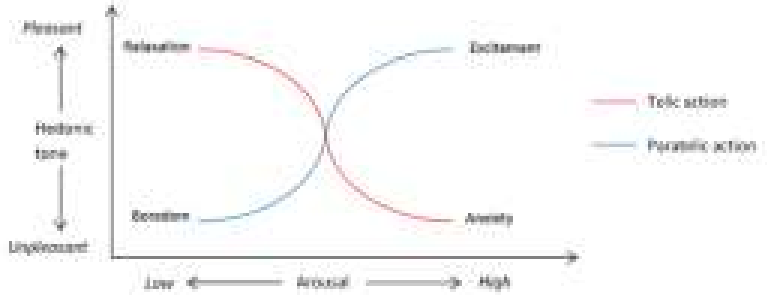


Figure 7

Play Pyramid by Kudrowitz and Wallace

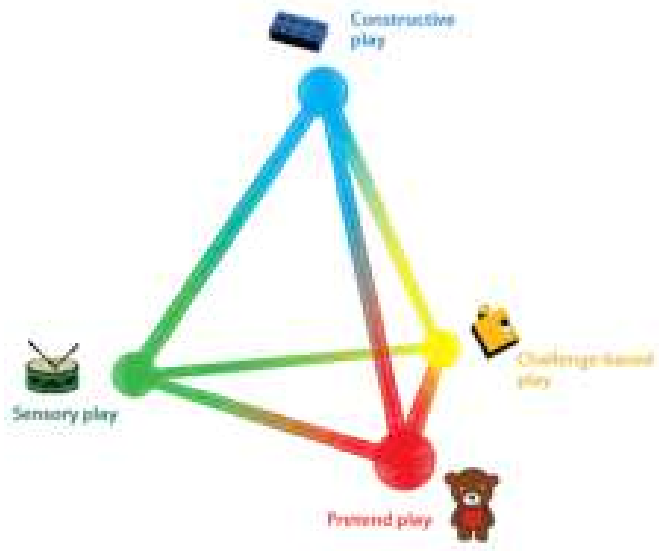


Figure 8

Learning Theories and Design

- Piaget's Theory of Cognitive Development
- Gardner's Theory of Multiple Intelligences
- Vygotsky's Socio-cultural Theory of Development
- Developmental Milestones for Design

At this stage, I aimed to understand the existing measures taken by schools or organizations to enhance visual thinking among students. There are limited initiatives in this area, particularly within the Indian education context. However, I found some research papers that examined various strategies and techniques for understanding and enhancing visual thinking. I will discuss these studies later in the report. Following this, I attempted to brainstorm new ideas but found myself at an impasse. To gain a better understanding, I revisited the book [1] "Experiences in Visual Thinking," which led me to discover the following insights:

Enhance Visual Thinking

According to the book "Experiences in Visual Thinking", the process of visual thinking starts when we face a problem/situation which needs to be solved. First task at hand is to define the problem which is done by recognizing it, assessing the requirements and identifying constraints. This process can be simplified by writing it down or by graphical representation and then listing the objectives. Secondly, one should let the problem sit and think about it with an open and relaxed mind. From here either one proceeds to stay on the problem or dismiss it.
If the problem persists, then one starts to think at it strategically and either decreases or increases effort. If the problem requires more creative thinking then more of the right brain is involved along with information transfer between left and right brain. The outcome is expressed through research of strategies and then put to test.
This test is then fed in the right brain which does most of the creative work. There are multiple ways to work on the solution here, an overlap of seeing, imagining and drawing is seeked out as visual thinking. The mechanisms that facilitate this process are several. Some of the involved methods are discussed as follows:

One can abstract-ize the idea, defocus/withdraw, look at the big picture, symbolize, schematize, analyze patterns and see the problem's context.
Transforming the problem is another approach where labels, conventions and stereotypes are abandoned. In its place one seeks analogy and thinks metaphorically through empathizing or role play.
Third approach is to manipulate the problem/solution for a fresh perspective. Disassemble/reassemble, randomize, eliminate/add-on, substitute, transpose or systemize are a few ways that can be used to manipulate.

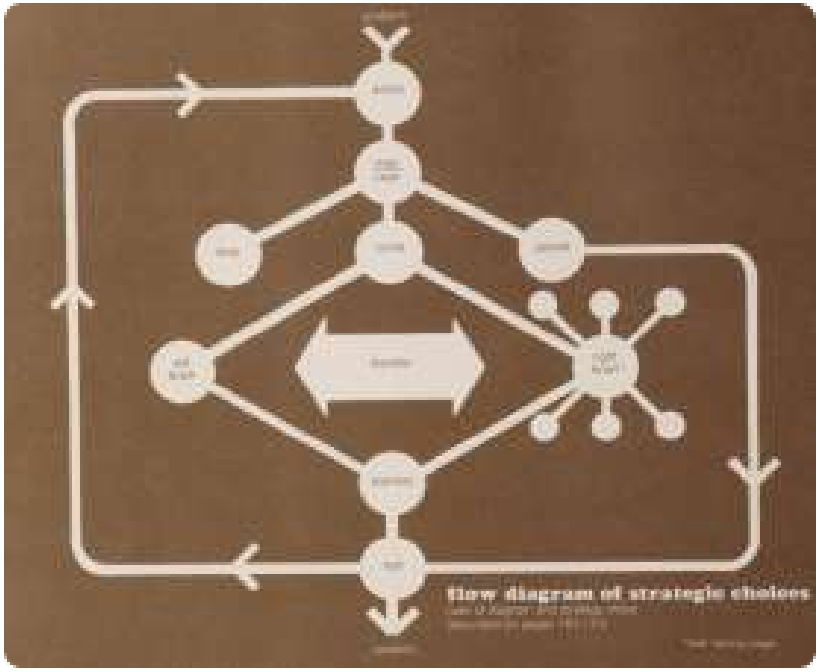


Figure 9

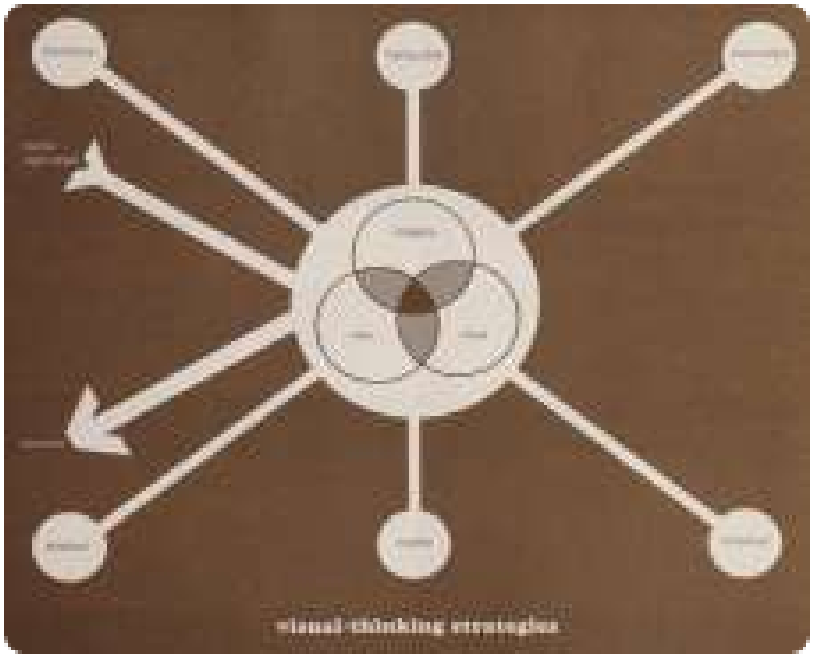


Figure 10

Modifying is another approach where one exaggerates elements, modifying or re-proportion slightly. Sometimes modifying non-visual qualities also help, e.g. soften/brighten or standardizing/modularizing.
Next comes developing the details using converge thinking, clarifying , concrete graphics and embodying concepts in 3-D. Re-evaluate things that can help from the past and things that we have at hand. Envision goals and foresee possible consequences and their troubleshooting.
All this information is then fed back in original thinking sequences where the problem/solution is expressed,

alternatives generated, its flexibility is checked and alternative strategies are explored.
After having all above data, the model is put to test from a critical viewpoint. It is displayed/ compared, evaluated according to set criteria, discriminated using pros and cons and evaluation is recorded. *(Fig. 9, 10)*

Thinking by visual imaging:
The ways by which visual thinking strategies function were explored in the last section. In this section I would discuss in more detail about the visual thinking itself and its three major hands at work, i.e. imagining, seeing and drawing. These three major functions mostly/always work in tandem to give visual thinking an interactive aspect. It is a feedback system where seeing facilitates drawing and drawing invigorates seeing. At the overlap of drawing and imagining, drawing stimulates and expresses imagining, at the same time imagining gives stimulus and material for drawing. The third overlap of seeing and imagining functions similarly where seeing provides raw material for imagining while imagining directs and filters seeing. The three overlapping circles as shown in the previous image (Fig. x) symbolizes that visual thinking is experienced in fullest when all three aspects interact with each other either completely or partially.
Visual thinking is central to design, architecture and visual arts, however their importance in science and technology is still largely unexplored. I will explore the possibilities in following through the overlap of three aspects of visual thinking.

1. Seeing and thinking: Seeing and thinking mostly go hand in hand. One of the classical examples of such an overlap is discovery of penicillin by Sir Alexander Fleming who observed that one particular kind of colony and not all were responsible to kill the bacteria. Another simple example, In the row of 5 cards below, there is only one card correctly printed, there is a mistake in the other four. How quickly can you find the mistakes? *(Fig. 11)*

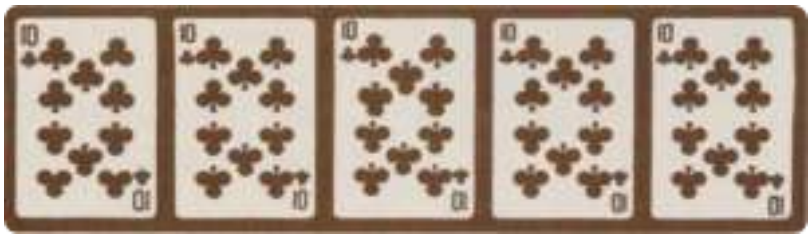


Figure 11

2. Imagining and thinking: Scientists again and again had claimed to imagine things in their head before putting it into action. The technological genius Nikola Tesla is said to have an imagination where he finished drawing circuits in his head and even ran them for some time in his head to find faults in them. Another simple example can be of a painted cube, ‘ Imagine a wooden cube such as a child's block which is painted. Now imagine you did two parallel and vertical cuts through the cube, dividing it into equal thirds. Now make two more vertical cuts perpendicular to the first ones, dividing the cube into equal ninths. At last, make two parallel and horizontal cuts through the cube, dividing it into 27 cubes. Now, the question is how many of these cubes are painted on three side) On two side? On one side? How many of them are unpainted?

3. Drawing and thinking: Firstly drawing brings vague ideas into focus and helps advancing thought stream. It also provides a way to compare several scenarios side by side which is not possible in only memory. Watson's discovery of the DNA structure is preceded by his drawing of fused rings of adenine on paper that eventually gave him one of the ideas that later went into the discovery. Another simple exercise can be,

'With one continuous line that does not retract itself, draw the following pattern' in *Fig. 12*.

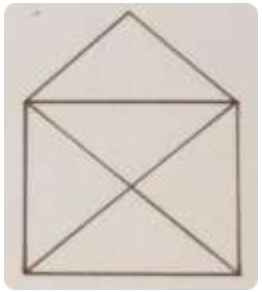


Figure 12

Operations of visual thinking:

There are several ways of pattern seeking, I will discuss a few of them with examples as follows.

1. Pattern seeking: Seeing or 'taking-in' process not only consist of perception but we actively look for a pattern in the things that we observe. The following ways are actively utilized by users to do so:

a. Filling in: Active pattern-seeking nature of perception is used in this context where one tries to build the complete picture with fragments of information. As shown in the picture below *(Fig. 13)* that almost instantly one draws to the conclusion that the picture is of a violin and camel.

Figure 13

b. Finding: Another pattern-seeking behavior is finding similar patterns in a given space. For example, *(Fig. 14)* Choosing the figure on the right side as to which one contains the one on the left.

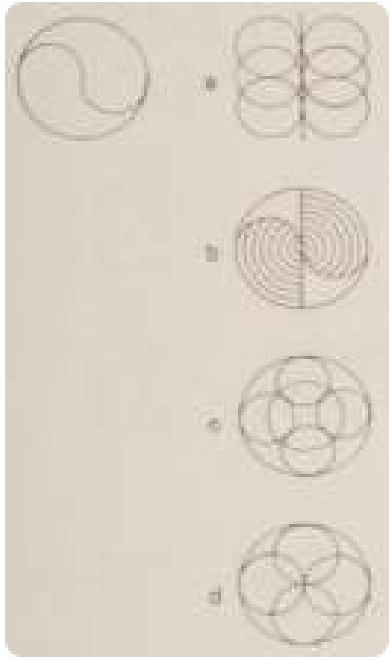


Figure 14

c. Matching: It is an act of matching two representative figures or sketches to one another. As in the figure below *(Fig. 15)* one has to match the figure on the left to the five different options on the right side.

Figure 15

d. Categorizing: The act of trying to group two things together is categorizing, e.g. Figuring out the two exactly same figures in the following image *(Fig. 16)*.

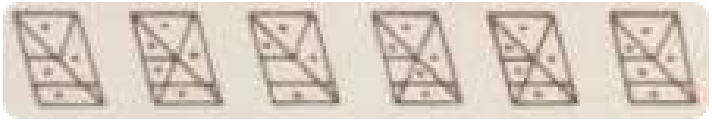


Figure 16

e. Pattern completion: The act of completing a figure or sequence from available information as in figure below *(Fig. 17)*.

Figure 17

2. Visual memory: It is measured as the ability to retain visual imagery. The following ways one can test it is by memory for designs where one looks at the picture (for example see *(Fig. 18)* and then close the book and reproduce what you saw in a separate paper.

Figure 18

3. Rotations: Another exercise is to mentally rotate images. This can be achieved by 2 different methods.
a. Inverse drawing: Drawing inverse of the drawing on the right side *(Fig. 19)*.

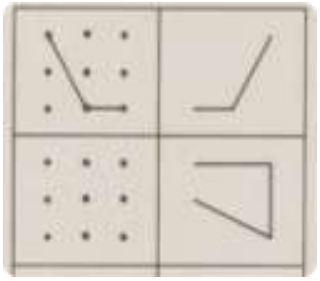


Figure 19

b. Rotating disc: For example, rotating the following disc *(Fig. 20)* and select the pair from the left one that can be rotated to the one on the right.

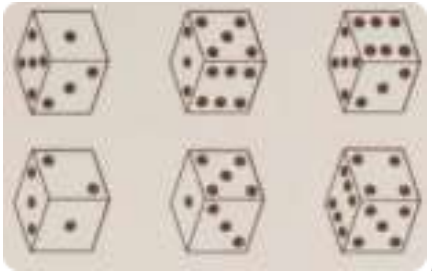


Figure 20

4. Orthographic imagination: This is an exercise where one has to imagine how an object looks from different directions and also when the solid object is cut through. It is an exercise of observing a solid object from a different view-point. For example *(Fig. 21)* the object on the left after being rotated a certain number of times, which one on the right does it resemble to.

Figure 21

5. Dynamic structures: This exercise deals with manipulation of an object to attain certain end results.

a. Folded patterns (*Fig. 22*): The pattern on the left can be folded to get a 3-D object with the gray facing outside, which will be that object?

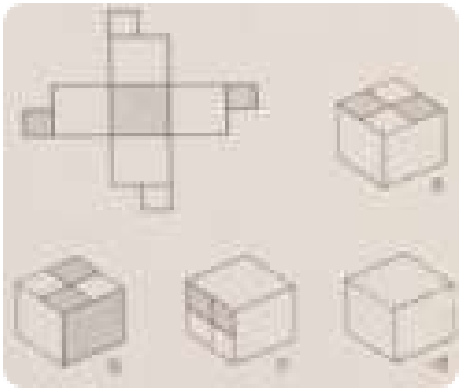


Figure 22

b. Knots: *(Fig. 23)* Among the following figures which one will form a knot after being pulled tight?

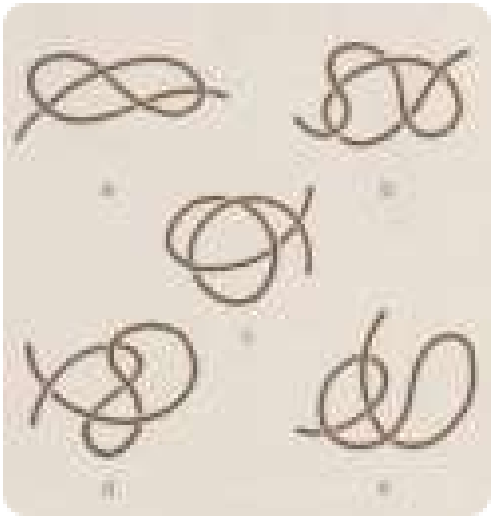


Figure 23

c. Pulleys: More complex form of the above two exercises is to move several objects in relation to each other. For example, in *(Fig. 24)* figuring out which way the pulley will turn in a 2 pulley system as shown below.

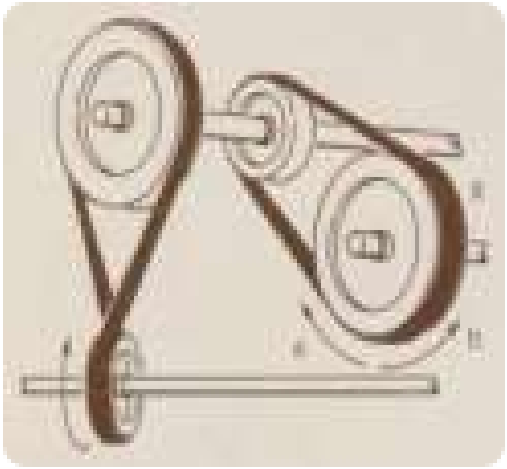


Figure 24

6. Visual reasoning: It works on simplifying the exercise in question. For example, for the previous case of pulleys one logically thinks if one pulley turns to left and other to right, what will be the resultant motion? This can be attempted using following ways:

a. Spatial analogy: Here the attempt is to generate a concrete idea from an abstract idea as tried in the following image *(Fig. 25).*

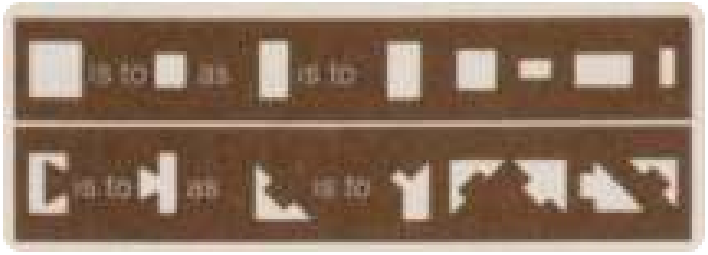


Figure 25

b. Visual induction I : In this case the idea starts as concrete and develops in a more abstract or deductive understanding. For example *(Fig. 26)*, On top is the problem figure and one of the 5 possibilities from the bottom is the fifth image of the sequence, which one is it?

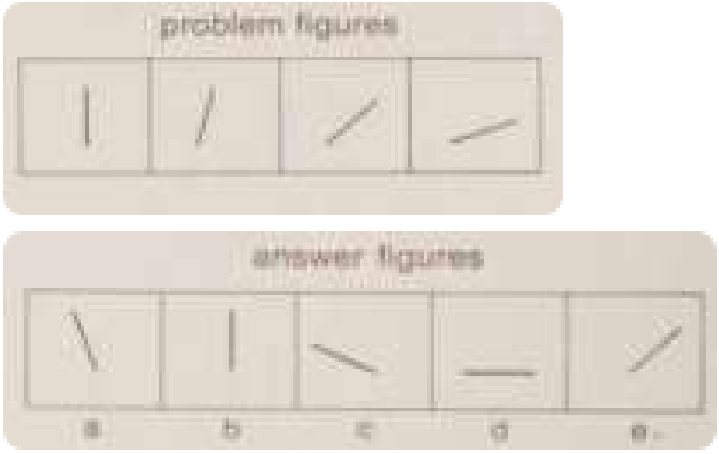


Figure 26

c. Visual induction II : Here as well the idea starts as concrete, however, rather than having one variable, it has multiple variable going spatial transformation. For

example *(Fig. 27)*, the top two figures below are related to each other. Which of the four options in the lower panel fits the top sequence?

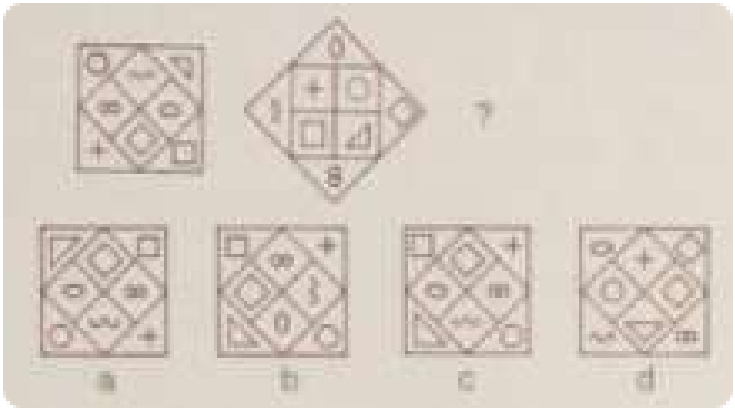


Figure 27

7. Visual synthesis: The visual-spatial operations that come closer to dreams, i.e. creating a new identity which is more than the sum total of its individual parts.

Next I will elaborate on the three parts of visual thinking individually. I will focus on the first two parts, seeing and imagining and some outlook over drawing/ sketching since my project mostly utilizes the first two aspects of visual thinking.

Seeing

Seeing or observing is the first step towards visual thinking. Seeing in itself can span several different aspects depending on which other activity one is pairing it up with.

Externalised thinking, where one sees and thinks simultaneously. Different ways by which one can utilize this is by linking perception, thinking and action as close as possible. Few such practices that can help with the process are described below.

1. Tower of pulp: It's an exercise based on seeing and thinking. For example, one tries to build the tallest tower with two sheets of newsprint and 24 inches of scotch tape.
2. Tangrams: This is a two-dimensional experience in externalized thinking discovered by a Chinese puzzle-maker, where one builds a form of a given silhouette using all provided pieces (*Figure 28*).
3. Soma cube: Invented by Danish poet-scientist Piet Hein, soma cube was used to visualize thinking by building things from bottom-up. 3/4 cubes of the same size are put together (by joining their faces) to form irregular shapes and then these combined cubes are used to create configuration of things that one can envision (*Fig. 29*).

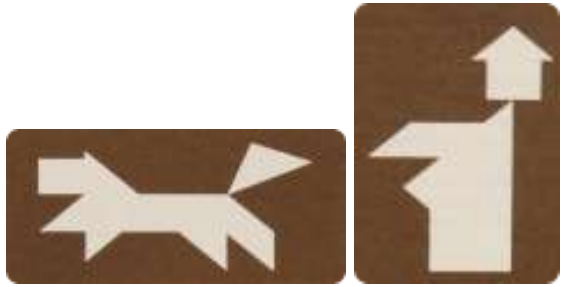


Figure 28

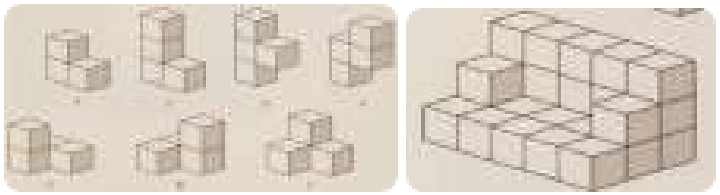


Figure 29

Re-centering imagination and seeing is another approach one can use to enhance visual thinking understanding. As illustrated In the figure below (*Fig. 30*) different ratios of imagination and sensation can result in different outcomes. On one hand, complete imagination can be stated as hallucination and complete sensation result in only seeing an object for what it is. A healthy mixture of imagination and sensation is where one can always re-center and find various meaning/understanding while looking at the same image.

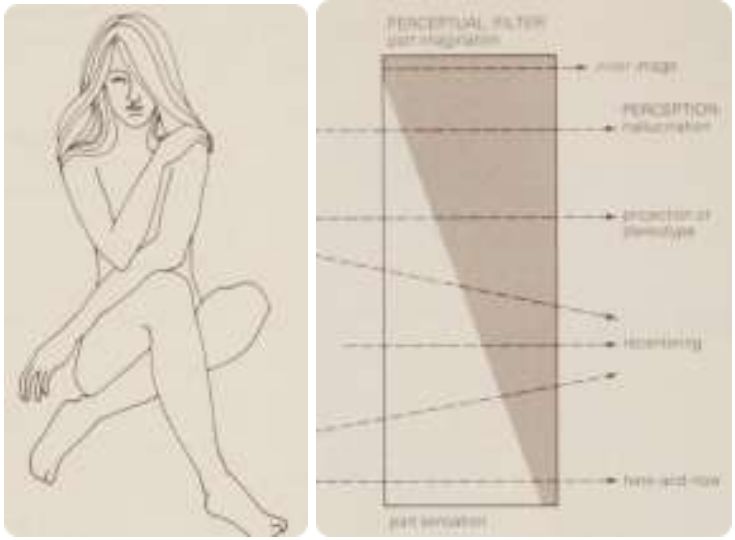


Figure 30

For example, the picture on the right, can be observed from the eye of a sculptor, an advocate of women liberation or the women herself. Having said that, all perception involves some degree of imagination, however that does not have a direct correlation to creativity. The key thing to remember in this exercise is flexibility, people who can flexibly use their imagination to re-center their viewpoints creatively.

Additional aspect of seeing is pattern seeking. Take an example of the picture below *(Fig. 31)*, once you look, you notice that the squares seem to 'group themselves' into swirling patterns. However, this is printed paper/ stationary figure, which brings us to conclusion that we are generating the patterning ourselves.

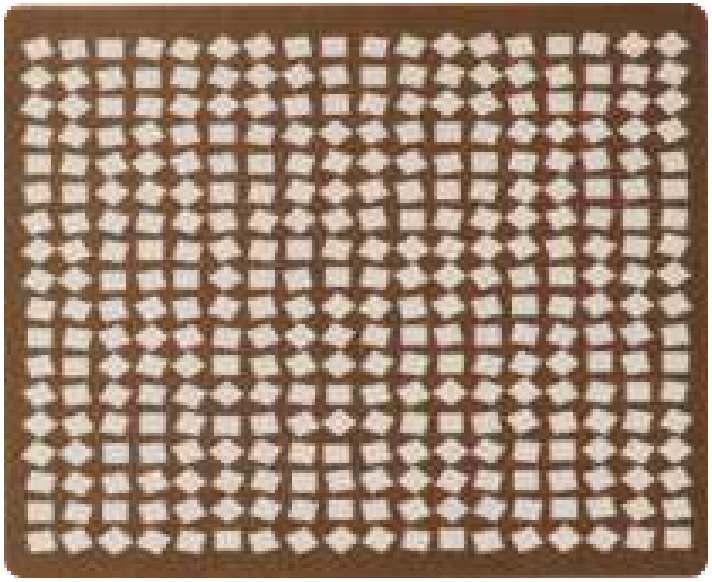


Figure 31

The different ways in which you can seek patterns in things are as described below.

Gestalt: According to Gestalt psychologists (from Austria and Germany), perception acts as an active force that draws sensory imagery together into holistic patterns, or 'gestalten'. The theory believes that each perceptual image is more than the sum of its parts. Finger-painting provides an excellent medium to experience 'gestalt' or melody of visual imagery. Working with finger paint gives a direct feel of the model that you are making/viewing, and bringing that feeling directly into the finger-paint image.

Grouping:
It is a way our brain perceives information and tries to simplify the input that we are getting. For example, in figure below (*Fig. 32*) we group the images according to proximity, similarity and line direction.

Figure 32

Alternatively, we can consciously group them with different set of rules using our own imagination/requirements. Grouping is creative, there are more than one way to do it.

Tachistoscopic seeing:
Another way to exercise our capacity to see visual wholes is by using the principle of tachistoscope where images are flashed on a projector. A tachistoscopic image can be prepared by using a highly contrasted picture, avoiding ambiguous subject matter of viewpoints and avoiding strong shadows that obscure form.
We learn from tachistoscopic seeing, as observed by psychiatrist Lawrence Kubie ``tachistoscopic experiments show how nearly instantaneous and without participation of conscious process we can record visual...experiences...and represent them later in such behavioral responses as 'doodling' ". For example, 'thumbnail sketch' is one way to capture visual essence of an image, where smallness of object in question gives the illusion of distance in which details merge into overall relationships, as in figure below *(Fig. 33)*.

Figure 33

Meaningful patterns:
Our brain seeks to find patterns in things we see in order to simplify it. Furthermore, it is not only any random pattern but a meaningful pattern of some significance to the viewer. For example, in the following pictures *(Fig. 34)*, a. a single-figure ground relationship is seeked and hence you either see a vase

or human faces, b. a spatial meaning is seeked either viewing from up or down, c. a tendency to fill in the missing pattern in quest to seek pattern.

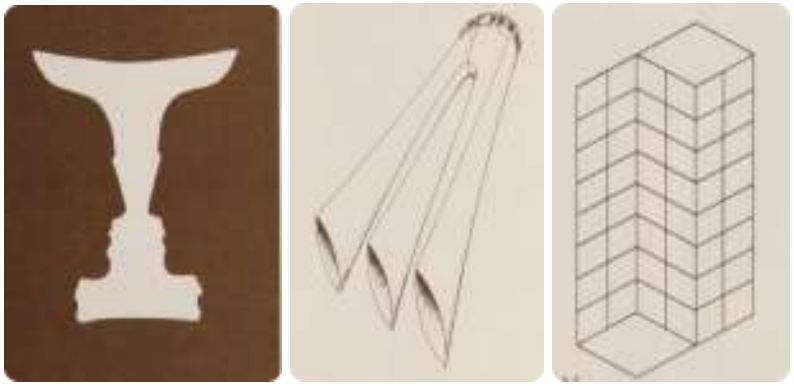


Figure 34

Focus:
Visual perception of the same image in different levels of focus can have variable imprints on our memory. For example, the unfocused pattern of an object can be strikingly beautiful until the focused image shows a decidedly ugly object.

Projection:
Projection is a perceptual phenomenon similar to closure.

Figure 35

It states as to how a simple inkblot *(Fig. 35)* can represent or appear as different items to different people based on individual interests. For example, one of Bartlett's psychological subjects viewed the inkblot as ' a lanky boy and a jester watching the antics of an inebriated abbot'. One way to reinforce perceptive thinking, one can practice the Da Vinci's device. In this exercise one scribbles on a piece of paper with closed eyes and tries to interpret the scribble after opening the eyes again.

Pattern-seeking and problem solving:
The patterning principles of grouping, projection, and closure are important for visual problem-solving. All people invariably start with the conventional pattern when we see a new image, this is called 'vertical thinking'. However, a creative thinker after recognizing the first one immediately delves into other possibilities or ways to see the image before working on the solution, this is referred to as 'lateral thinking'. For example, *(Fig. 36)* problem-solving through grouping in the image below, the objective is to describe the image with minimum number of words and maximum clarity. A layman person will only try to minimize the word or say will do word play, however, a creative thinker will seek other possibilities through which the image can be observed (as in *fig. 36* shown 2-6) before actually working on the solution.

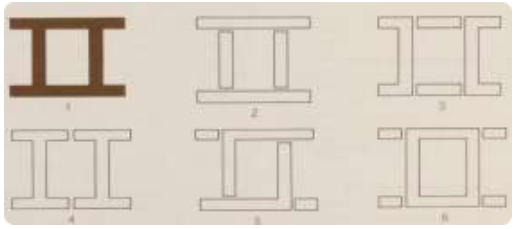


Figure 36

The pattern-seeking effect of projection can also aid problem-solving by bringing inner-thoughts into the act of seeing (externalized thinking). For example, a sculptor may look at the grain pattern in the wood as a materialized form of a sculptor that she will try to realize later.
Problem-solving is also aided by seeking closure in an incomplete pattern.

Analytical seeing:
A tremendous amount of information is gathered through the act of seeing. However, most of the time 'we only look, but we do not see'. To develop our analytical thinking one can use the same principle as used in color matching. Instead of seeing white for different shades of white, try to see the color afresh and through color-matching. One way to practice is with paint chip hunt, where you obtain several different paint-chips from a local paint store and try to match it as exactly as possible to the things from your surroundings while always keeping in mind the analytical nature of the task (defining the shades as accurately as possible).

The tactile, kinesthetic eye:
Seeing is polysensory, combining the visual, tactile and kinesthetic senses. The tactile eye, Rudolf Arnheim writes, In looking at an object we reach out for it. With an invisible finger we move through the space around us, go out to the distant places where things are found, touch them, catch them, scan their surfaces, trace their borders, explore their texture.' These individuals are called 'haptics' who see mostly through their sense of touch.

The other group of individuals are the ones who see an object through a kinesthetic eye. As stated by William James ' The muscular sense has much to do with defining the order of position of things seen, felt, or heard. We look at a point; another point upon the retina's margin catches our attention, and in an instant we turn our attention upon it...'. Such visual scanning involves our eye muscles, which is similar to scanning an object with our hands. There are some exercises one can do to improve our tactile-kinesthetic eye:
a. Feelies: In this exercise one tries to identify objects in a bag without looking and only by feeling them around and then drawing them on a piece of paper. As said by Kimon Nicolaides in The Natural Way to Draw that "learning to draw is really a matter of learning to see-to see correctly-and that means a good deal more than merely looking with the eye.The sort of 'seeing' that I mean is an observation that utilizes as many of the five senses as can reach through the eye at one time'.
b. Contour drawing: This is another way one can use to train our analytical thinking. In this exercise one places an object in the front. Have a sheet of paper prepared with a marker in hand. The essence of exercise is to place the marker on the paper and feel that it is actually touching the object in the front. Now without seeing what we are drawing, trace the contours of the object as if you are touching them. Move in speed with our drawing, do not let your eye wander.

Seeing and knowing: Another aspect of analytical thinking is experienced when the person is also knowledgeable about the object in observation. For example, a pendulum as observed

by a teenager and a physicist are two entirely different things. As Parmenter says, " Don't chip away at the things to make them fit words, but instead conscientiously use words to try to make them fit things." The quest for such verbal description does three things, (1) it enhances visual memory by relating visual imagery to exiting verbal knowledge, (2) it disciplines seeing by joining verbal and visual searching together, and (3) it educates ambidextrous thinking. This can be practiced by following techniques:
Verbal seeing: This exercise is to describe what you see in addition to drawing, with words in great detail as if you are dictating to a person who has to draw what you see.

Analyze, then re-pattern: Generally, we think that pattern-seeking should precede analytical seeing, similarly, visual analysis should be followed by a reformation of the overall pattern. To say that pattern-seeking and analytical seeing are the basic two phases of seeing (and of visual thinking generally).

Proportions
Interactions between pattern-seeking and analytical seeing are involved in the perception of proportional relationships. As Jay Doblin observes, "The most important and difficult mental control is the judgment of proportion". Seeing things in proportion, involving both pattern-seeking and analytical modes of perception, is vital in visual thinking. For example a simple exercise to draw objects on tracing paper and then over-lapping it on the original picture can help improve our perception of proportions. There are several ways to judge proportions:

1. Superimposition: There are several ways by which superimposition can help assess proportions of an object. For example, an artist uses a pencil held at arm's length to gauge proportions, or a square in a paper. Also, superimposed square grids to the image also help to gauge proportions. Several ways to exercise this is practice using (a) multiple squares, (b) superimposed grid, (c) everyday proportion and (d) subtle changes.
2. Distortion: Changing proportional relationships can be used to re-center the way you see things. A caricaturist for example can exaggerate the proportions of the nose or chin to highlight certain aspects of features/expressions more with respect to others.
3. Perceptual and optical reality: Optical reality is governed by geometry, however perceptual reality is governed by what you know, i.e. combining what you know with what you see. A circle seen from an angle is elliptical in shape considering optical reality, however we still see it as a circle because we know of its identity.
4. Perceptual reality and orthographic projection: Orthographic projection is the graphic equivalent of seeing things head-on (perceptual reality), a method commonly used by designers. By doing this one can generate images of an object from different views/sides to explore perceptual reality of three-dimensional form.

5. Optical reality and perspective: Perspective is the graphic equivalent of optical reality. Learning to see and draw perspective's spatial cues can make you aware of space in much more detail.
6. Convergence: Seeing and recording the perspective of convergence exercises your ability to distinguish optical reality from perceptual reality. This can be practiced by exercises developed for, (a) convergence, (b) two-point perspective or (c) convergence errors.
7. Foreshortening: The foreshortening cue is important to the perception of the three-dimensionality of form. The exercises of foreshortening can enhance this ability in drawing.
8. Translation: Our brain resolves the dissonance between perceptual and optical reality and hence we recognize a stable spatial world. Using drawing as a catalyst and making this dissonance more aware, by translating orthographic views into perspective will heighten our awareness of the structure of spatial configuration.
9. Ways to detect errors: This is a sure way to perfect your drawing by understanding if you are seeing or drawing inaccurately. You can either look at your image from various angles or ask someone else to look at it.
10. Color and shading: Shading or coloring is required to depict compound surfaces, the effect of light and shadow, the spatial drama of figure-ground relationships, or delicate nuances of mood and feeling. However, a visual thinker should seek a shading that is quick and impressionistic, not photographically realistic so as to not lose the purpose of shading in the first place.

Seeing is a precious gift, however it is also very limited with respect to what we know and it cannot be completely separated from imagination.

Imagining

Second part of visual thinking as written by Dugald Stewart, "The faculty of imagination is the principle source of human improvement."

Contemporary education neglects the inner imagination, by ignoring them upfront and also providing little opportunity to actually practice them. However, through practice mental imagination/imagery can be revived. First step that one can start in the direction is seeing 'after image' an object in observation. There are well known exercises that one can practice, for example, luminous dust, phosphene projections, etc.

Conditions for fostering inner imagery

For many, it could be a frustrating journey till they can redevelop/develop mental imagery. Some ways to grow inner imagery can be:

(a) A quiet environment to focus on inner stimuli and not be distracted by external stimuli. (b)Encourage or motivate individuals to foster inner imagery, they will be more inclined to see mental pictures. (c) A state of relaxed attention so that imagery is not suppressed due to stress or is wandering due to lack of attention. A medium ground of 'optimal tonus' is

required. (d) Finding the ‘locus’ of your imagery is one crucial step to figure out where/how to see mental imagery is better. For some can be with open/closed eyes, in front of vision, more located near the fore-head, etc.

Clarity and completeness
Mental imagery is not an exact representation of the physical world. As said by Writes Osgood, “Images are generally less clear, stable and saturated than perception”. So one must not get disheartened at initial tries to generate mental imagery. There are ways to test to judge the state of your mental imagery and frequently practicing these can lead to improvement as well.
a. Clarity of mental imagery: It grades our mental image using the scale, C=Clear, V= Vague, but recognizable, N=No image at all. You can use this test for all of our senses, for example (1) Visual imagery: can you see a familiar face, horse, rosebud, etc. (2) Hearing: can you hear the sound of rain on the roof-top, children laughing,etc. (3) Touch:

A cold shower, an itch, etc. (4)Taste: the taste of salt, toothpaste, etc. (5) Smell: the smell of gasoline, burning leaves, etc.

Controllability
Ability to control imagery is more important than the imagery itself. We can grade our control of the image according to the following scale, C= Controlled the image well , U=Unsure, N=Not able to control the image. Then you can try and imagine several scenarios starting with a simple one, for example, a rosebud blooming very slowly, a gray kitten that turn blue then green, then purple, the table slowly floating towards the ceiling, or the reverse of any of these acts, etc.
the key is not to get discouraged if you don't succeed the first couple of times. Practicing will bring results eventually.

Foresight and insight
We are limited by the limit of our senses. Taste, touch and kinesthesia enable you to sense only what is in reach, hearing and sound extend our domain to several kilometers, but by far vision is our most effective distance sense simply by the fact that we can see stars. There are exercises one can try to use visual sense predictively, i.e. to look ahead in time as well as space. Virtually everyone exercises foresight (anxiety could not exist without it), however to utilize it to our benefit when we envision our future or the consequences to our present plans and hence can prepare for it. This goes to say that foresight and creative insight are related.

Idea Sketching
The third and last part of visual thinking is idea sketching which gives birth to ideas. I will give a brief overview here, since I do not use many ideas from here.

Graphic ideation
An idea is an object of mind, they are internal constructs of perception, imagination and thinking, e.g. I look at my hand, my hand is. not an idea but my perception of my hand is.

Idea-sketching is a way to express visual ideas. Graphic ideation more specifically means idea-generation and expression by means of drawing. Graphic ideation has two basic modes, exploratory and developmental. Idea-sketching generally has a combination of both stages where it starts as exploratory and then becomes more developmental when the designer has decided on an idea. It is an idea in evolution in the form of continuously changing sketches.
Graphic ideation precedes graphic communication in the sense that ideation is to discover and develop an idea worth communicating.

A feedback loop (ETC: express/test/cycle) *(Fig. 37)*.
ETC is primarily concerned with processing , not with collecting or communicating information. The basic process of graphic ideation is Express, then Test, then cycle, ETCetera, until the desired idea is fully conceivable, at which point it can be expressed/communicated. It is crucial to treat these as sequential steps in a developmental process and not to be carried out simultaneously.

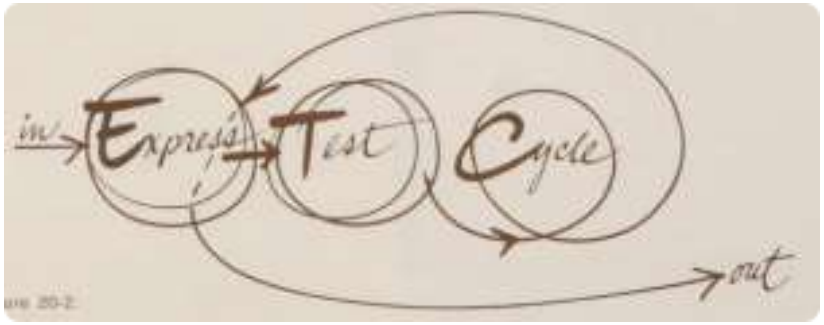


Figure 37

Expression of ideas
The first step of graphic ideation can be the most daunting one. Four basic principles intended to help open the flow of ideas onto paper, (1) fluency and flexibility of ideation, (2) deferred judgment, (3) unhesitating response, (4) skill in drawing.
Few exercises that can help in the expression part of this cycle are, thirty circle, visual brain-storming and idea log.

Time for testing
After having expressed ideas in a number of sketches, it is turn to evaluate them (Test). Testing involves (1) seeing the sketches fully and imaginatively, (2) comparing sketches, (3) evaluating each idea in relation to present criteria and (4) developing new criteria. Testing phase can be improved by practicing several exercises, e.g. displaying your graphic memory, recenter, compare, color notations, criteria formulation, etc.

Cycle
It is an important part of the idea because most of the time the first round of idea-sketching rarely produces an idea that fully meets your test. After the first round of evaluation, one can delve deeper in the concept, decide to develop one concept, generate more ideas before delving more in detail, etc. and then go back to expression of ideas with re-evaluated strategies.

These steps might seem mechanical, but it is like any other skilled behavior which needs to be practiced for a period of

time and in time one can develop their own style of graphic ideation that is distinctly their own.

Visual thinking provides an individual with the flexibility to think or approach a problem using various tools. Where verbal thinkers are limited by only one language, visual thinkers can acquire a variety of graphic languages, some ancient (cave painting), some modern, some abstract, some concrete. This helps visual thinkers to avoid 'language rut' that holds thinking to a fixed viewpoint and a limited set of mental operations.

Visual thinking and graphic language intersect to give rise to graphic ideation *(Fig. 38)*.

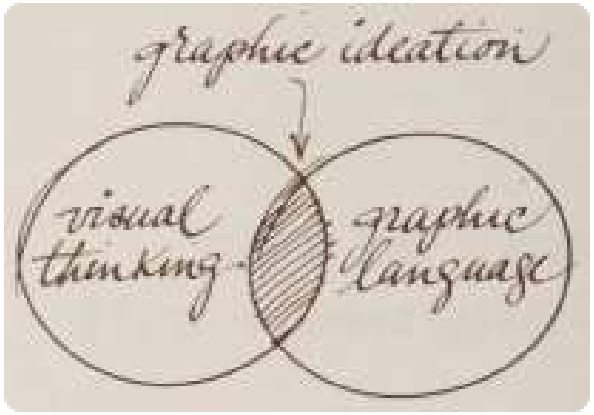


Figure 38

Interaction of thinking and language give rise to two important observation, (a) not all visual thinking is language thinking, e.g. visual can utilize operations such as representation by imagery(perceptual and metal imagery), outside the realm of language thinking (b) not all graphic language involves thinking, i.e. a major use of graphic language is to communicate the result of thinking.

Market study

To gain a better understanding of the methods and strategies implemented in schools and organizations, I began with a market study. I discovered several initiatives in this area that I found both interesting and effective. Here are some notable examples:

1. 'Perspective on teaching' [3]. In the late 1980s, cognitive psychologist Abigail Housen and museum educator Philip Yenawine created the student-centered Visual Thinking Strategies (VTS) curriculum. It makes use of art to help primary school pupils develop their communication, critical thinking, and visual literacy skills. The paper states that VTS facilitates polite, cooperative problem-solving and improves verbal language abilities through discussions that flow naturally from spoken to written language. The programme encourages students to visit art museums in order to interact with local resources, while also integrating technology to help them become more independent and proficient with computers. Measurable improvements in visual literacy, linguistic and cognitive capabilities, and observational abilities are produced by VTS, which also meets state requirements and raises test scores in a number of areas, including writing and reading.

2. Why integrate games into learning?
   Games bring out an intrinsic nature in children to learn, have fun and a motivation to win. Several research has been done in this direction to speculate that game based learning can be used to attract users while simultaneously achieving teaching goals [2] (Garris and Driskell (2002). Yien, Hung, Hwang and Lin (2011) suggested a cooperative system to engage both teachers and students in the games for better results. According to Hwang and Wu (2012) this can help to obtain meaningful learning with integration of proper course and game-based learning. This approach will encourage children to learn with the help game setup which will incorporate challenge, competition or collaboration, opportunity or joyfulness and education. This will facilitate learning while developing knowledge through game content and skills through game experiences (McFarlane, Sparrowhawk & Heald, 2002). Below are a few examples and their learning aspects:

   - Ubongo: This game trains and develops spatial concepts by testing user ability to identify and observe shapes, as well freely moving them, rotating,comparing and manipulating. *(Figure : 39)*

Figure 39

   - Board game: Board games is another very valuable game that can be used in teaching curriculums. Gamlath (2007) pointed out that board games are characterized by group participation, easy and vivid game rules, unlikely formation of attack and opposition, luck, strategies and choices and emphasis on creativity. This fortifies the findings of Liu and Liu (2010), that indicated that players can acquire abilities like social learning and skills, skill assessment and community sharing. Gee (2003) also suggested that it can also help expand student's vision and abilities once they get used to the content and rules.

3. Implementation and Effectiveness of Visual Thinking Strategies (VTS) in the Classroom [4].

4. Implementation of VTS:

Peggy Marconi, an experienced teacher, collaborated with University of Oregon researchers and local museum educators to improve students' critical thinking and writing skills through Project STELLAR. They implemented Visual Thinking Strategies (VTS) by:

- Art Selection: Choosing appropriate art pieces that are connected with students' interests or curriculum content.
- Guided Observation: Asking students to silently observe the artwork and then discuss it using three key questions:
  "What's going on in this picture?"
  "What do you see that makes you say that?"
  "What more can we find?"
- Inclusive Participation: Ensuring all students, including struggling learners and non-native English speakers, felt comfortable participating without fear of wrong answers.
- Writing Integration: Encouraging students to write about their observations and discussions, using the guiding questions to structure their writing.

The implementation of VTS led to:

- Increased Engagement: Students were more engaged during lessons with visual elements.
- Enhanced Critical Thinking: Improved skills in making claims, supporting them with evidence, and summarizing.
- Improved Writing Skills: Better articulation of thoughts and evidence in written work.
- Inclusive Participation: All students could participate meaningfully, regardless of their academic level or language proficiency.
- Overall, VTS effectively enhanced students' critical thinking, engagement, and writing skills.

5. Implementation and Effectiveness of Visual Thinking Curriculum (VTC) [5].

Implementation of VTC

The Museum of Modern Art (MoMA) created the Visual Thinking Curriculum (VTC) to teach students how to think critically via art discussions. The programme has been improved over the last ten years and is now implemented in numerous New York schools in addition to being modified for use abroad. Researchers at Project Zero started a year-long study in October 1998 to learn more about the social and cognitive advantages of the VTC.

Methods of Research:Qualitative research: comprised student and teacher questionnaires, classroom observations, one-on-one interviews with teachers, and interviews with groups of students.Quantitative Research: This involved evaluating student performance using an experimental design that followed a standard control group/treatment group layout.

The study produced a number of noteworthy conclusions:

- Enhanced Evidential Reasoning: Students' capacity to use evidence to construct interpretations of art improved somewhat but statistically significantly as a result of VTC. This ability translated to the interpretation of scientific visuals as well as non-art ones.
- Knowledge of Subjective Interpretation: Pupils demonstrated a greater understanding of the subjectivity of interpretation in both artistic and scientific contexts.
- Wide Benefits Across Abilities: Most students, irrespective of their starting ability levels, saw improvements in evidential reasoning. However, the teachers' comprehension of the methodology had a significant impact on the VTC's efficacy.
- Effective Teaching Strategies: Instructors whose pupils made the biggest progress encouraged their pupils to conduct in-depth observations and provide evidence to support their conclusions. Additionally, they promoted a dialogue-based and cooperative learning environment in the classroom.
- Less Effective Teaching Methods: On the other hand, educators whose pupils made the least progress concentrated more on making a list of observations and prevented students from considering images' deeper meanings and delving into conflicts.
- Student Engagement and Transferability: Students acknowledged the cognitive merit of the VTC and found it to be both challenging and enjoyable. They also mentioned using VTC questions outside of the classroom in a variety of settings.
- In 2000, MoMA worked with Project Zero to update the VTC in light of these discoveries. To further increase the curriculum's efficacy, an updated version was released.

For this next part I went ahead to look for existing activities, games, exercises.

1. Tsuro (board game) *(Fig. 40)*: Originally patented as Squiggle Game by McMurchie in 1979 but not published at that time. Similar to Metro and Spaghetti Junction.

Gameplay:

- Components: Tiles with twisting lines, a 6x6 grid, and tokens for each player.
- Turn Actions: Players place a tile next to their token and move the token along the line until it stops at an empty space, the board edge, or another token.
- Elimination: If a token reaches the board edge or collides with another token, that player is out.
- Objective: Be the last player with a token on the board.

Strategy:

- Drive opponents' tokens off the board or into each other while extending your own route to make it difficult for opponents to eliminate you.

The game enhances visual thinking by requiring players to:

- Recognize and predict patterns (pattern recognition and prediction).
- Develop spatial awareness to navigate the board effectively.
- Continuously solve problems and adapt strategies (problem-solving and adaptability).
- Utilize visual-spatial memory to track the evolving game state.

These strategies help players improve their ability to visualize potential outcomes, plan ahead, and make strategic decisions based on visual information.

Figure 40

2. Activities to practice Visual spatial ability:
    a. In *(fig. 41)* the squares will be filled with red in a certain pattern and we hv to remember the sequence of each square turning red in an ascending order with reference to the numbers in the image below.

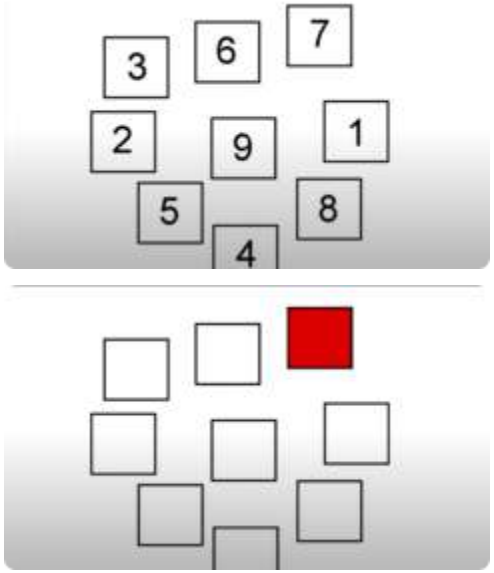


Figure 41

b. In this next activity *(Fig. 42)* one main square is given with a different pattern in a certain sequence.
One has to fill all the squares of the same pattern in the same sequence as that of the centre square.
All the other squares are rotated/mirrored differently.

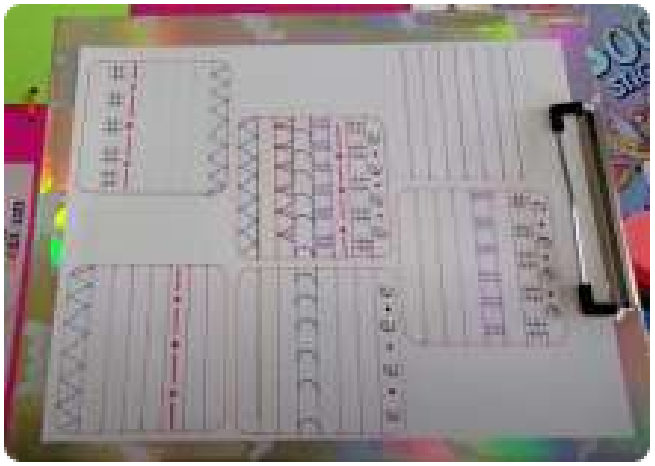


Figure 42

c. Count the number of colors *(Fig 43)* in each image and then multiply them with the number of times each color is repeated.

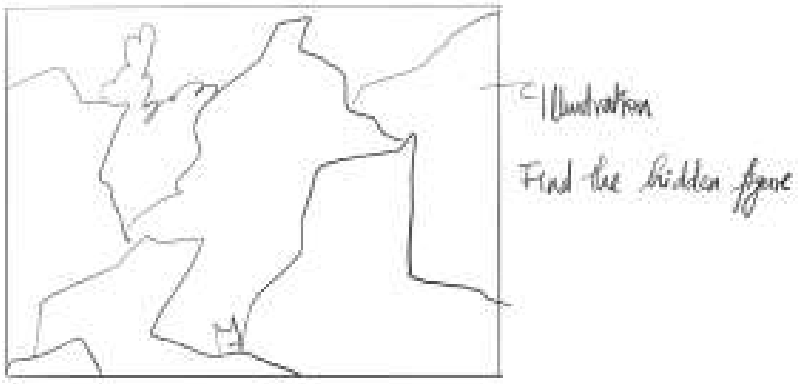
Figure 43

Ideation

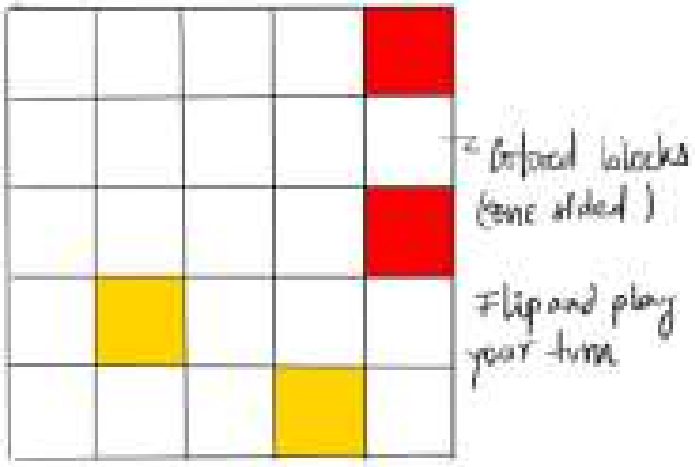
Initial Ideations

1.

2. Cards with Illustrations. Player has to find the hidden object as prompted.

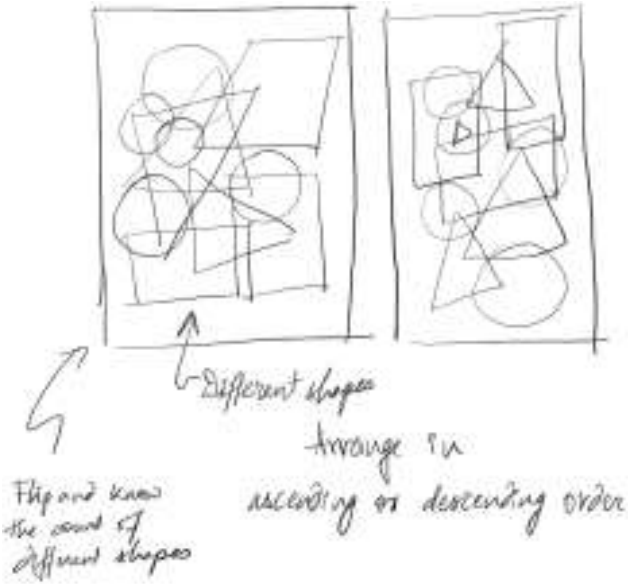


3. Cubes with two colors red and yellow on on one side. To play each player flips and moves. The player with most number of their colored cubes flipped wins.

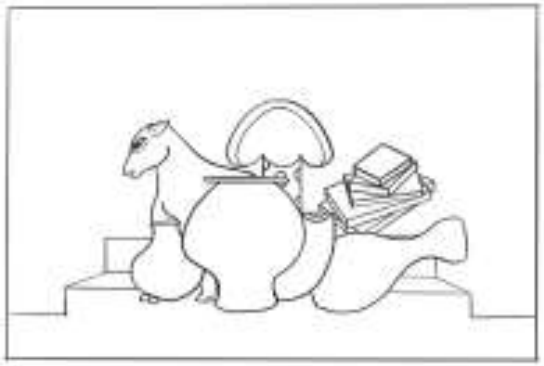


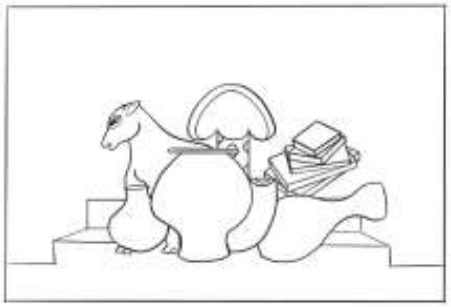
4. A set of cards with composition of different shapes with varying numbers. Another set of cards with illustrations of just one shape. These shape cards are the prompts. First the 4 composition cards are played on the floor in front of players.

Afterwards one shape card is flipped. Next player has to arrange the composition cards in ascending order based on the shape on the prompt card.



5. Still image





Board with still image

- Target cards will be shuffled and distributed 3-3 each

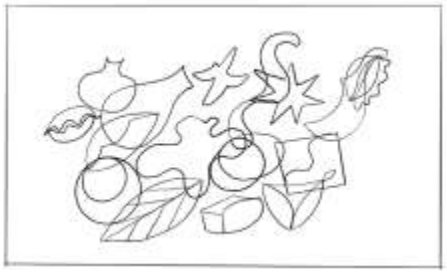
- Target cards with different views of objects from board
- Player can discard 1 card or keep all the 3 target cards

- Cards with slices of objects to be assembled forming object

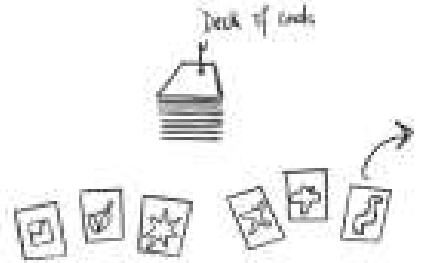
Objects in the front – less points
Objects in the back – More points

Light play on the still image –
Behind images – less visibility – More points
Middle images – Comparatively more visibility – Good points
Front images – More visibility – More points

6. Find the shape



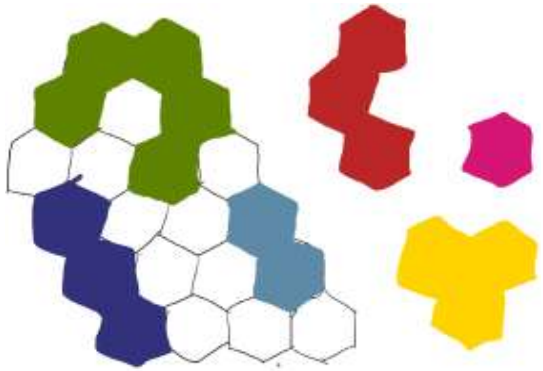
- Age 7+ years
- 2 to 4 players



- Target shapes to make to win the game

- One can keep two target cards or three

7. To finish the large hexagon board, different shaped tiles composed of a combination of hexagonal tiles must be placed on the board.

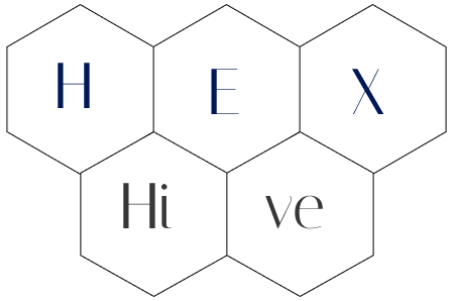


Developing ideas for pilot study

1. HexHive

Age group: 16+ year

Students in higher secondary schools and up can play this.



Gameplay:

Hexagonal board with tiles made from combining single-single hexagons.

Ten pieces in a single color are given to each player.

choosing at random from a box and placing each tile on the board in turn.

The goal is to fit all the pieces and fill their side of the board.

The player who completes the board first wins the game.

Conflict:

Skip your chance tile.

Block a tile space in your opponent's board.

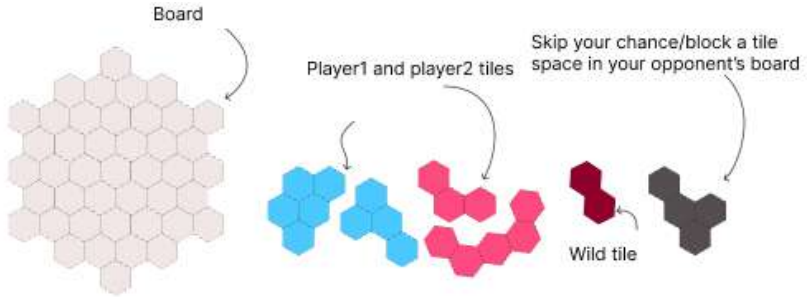
Wild tile (one can take a tile from the opponent's board and can make it theirs)

Winning:

The player who places the most of their pieces on the center board wins.

How does this help with visual thinking?

Helps with spatial ability like, to understand, reason the spatial and visual relations.

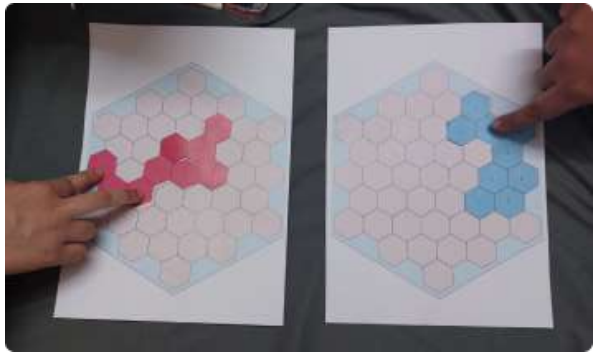


Pilot

How does this help with visual thinking?

Mental operations of visual thinking used:

Pattern seeking



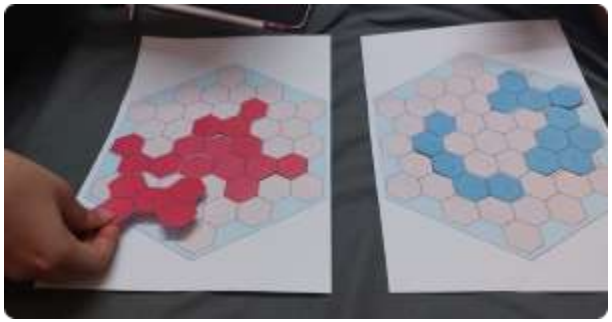
Findings

Positive:

Strategising from start, starts to fill the board from center so that less tile space is left.
Visualizing where it fits, constructivism approach utilized.

Area of improvement:

What happens when a tile doesn't fit?
Make multiple sets of 2 tiles?
How to strategize better rearranging of tiles?



Afterwards, I realized that this is an existing puzzle activity. I decided not to pursue it further and brainstormed additional ideas.

2. Shape Seekers

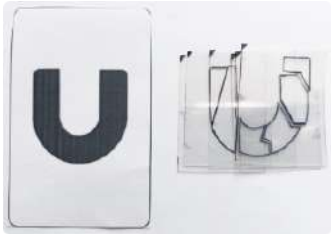
Age group: 16+ year
Students in higher secondary schools and up can play this.

Game play:
Target cards to be shuffled and distributed 3-3 each.
Players can discard one card or keep all 3 target cards.
Cards with slices need to be assembled forming the shape on the target card.

Winning:
Whoever completes the form first wins.

How does this help with visual thinking?
Mental operations of visual thinking used here:

a. Pattern seeking
   Filling in, Matching, Finding, Pattern completion, Categorising

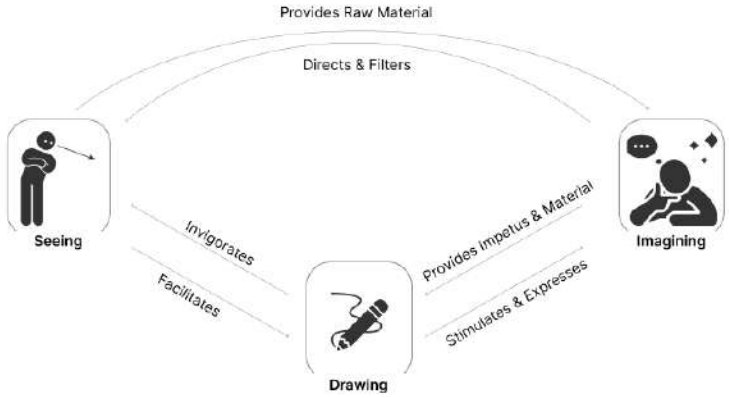


Target cards

Slice cards

Exploring More Ideations

Finding myself not satisfied with the ideations and the output I wanted to get from my ideas I went ahead with exploring more. To gain a better understanding, I revisited the book "Experiences in Visual Thinking" by Robert H. McKim. I reviewed all the strategies and methods that enhance visual thinking.



1. Match me

   Objective

   The primary objective of Match Me is to enhance individuals' awareness of their surroundings and challenge their memory. Players must accurately match texture cards with their corresponding edited versions, promoting visual thinking, attention to detail, and memory skills.

   Content

   - Texture Cards: A set of cards featuring various textures found in the environment (e.g., wood grain, fabric, leaves).
   - Edited Texture Cards: A set of cards showcasing edited versions of the textures, with some images zoomed in and others zoomed out.
   - Instruction Manual: Detailed rules and setup instructions for players.

Activity Setup

1. Shuffle the Cards:
    - Shuffle the set of texture cards thoroughly.
    - Shuffle the set of edited texture cards separately.
2. Arrange the Cards:
    - Place four texture cards face up in a row in front of the players.
    - Place four edited texture cards face up in a row beneath the texture cards.
3. Decide Play Order:
    - Determine the play order using a coin toss or any preferred method.

How to Play

Initial Placement

1. Set Up:

- Ensure that four texture cards and four edited texture cards are face up on the table.
- Each player starts with no cards in their collection.

Matching Phase

1. Player Turn:
    - Players take turns attempting to match a texture card with an edited texture card.
    - On a player's turn, they select one texture card and one edited texture card they believe correspond to each other.
2. Making a Match:
    - The player places the selected texture card next to the chosen edited texture card and announces their match.
3. Verifying the Match:
    - Other players verify if the match is correct:
4. Correct Match:
    - The player keeps both cards and places them in their collection, earning one point.
5. Incorrect Match:
    - The player must return one card from their collection (if they have any).

Refilling Cards

1. Replace Cards:

- After each turn, whether the match was correct or incorrect, draw new cards from the respective decks to replace the used cards so that there are always four texture cards and four edited texture cards in play.

Winning the Game

1. End of the Game:

- The game continues until all cards from both decks have been used.
- The player with the most correct matches in their collection at the end of the game wins.
- In the case of a tie, players can opt for a tie-breaker round where each player attempts to make one final match, or they can choose to share the victory.

Game Tips

- Focus on Details: Carefully examine the details in each texture and its edited version. Subtle differences can be crucial.

- Memory and Observation: Remember which textures and edited versions have been previously matched to avoid incorrect matches.
- Analyze Patterns: Pay attention to patterns, shapes, and other characteristics of the textures that might help in matching.

Guide for Solo Play

- Objective: Try to match all textures with their corresponding edited versions.
- Scoring: Keep track of your correct matches and aim to beat your own record in subsequent games.

Guide for Multiple Players

- Objective: Compete to make the most correct matches.
- Interaction: Engage with other players by discussing and verifying matches, making the game more interactive and fun.
- By following these guidelines, players can enjoy Match Me while improving their visual and cognitive skills. Whether playing solo or with friends, the game offers an engaging and educational experience for all edited versions.
- Scoring: Keep track of your correct matches and aim to beat your own record in subsequent games.

Guide for Multiple Players

- Objective: Compete to make the most correct matches.
- Interaction: Engage with other players by discussing and verifying matches, making the game more interactive and fun.
- By following these guidelines, players can enjoy Match Me while improving their visual and cognitive skills. Whether playing solo or with friends, the game offers an engaging and educational experience for all.

How is this activity helping with enhancing visual thinking ?

For this activity following operations of visual thinking are being utilized:

- Matching
- Categorizing

Through these processes, participants identify patterns and characters within the images presented to them. Often, we glance at our surroundings without truly engaging with them. This activity encourages us to slow down, pause, and observe the finer details, fostering a deeper level of awareness that is crucial for analytical thinking.

The game "Match Me" aligns with the strategies of visual thinking as outlined by Robert H. McKim in several ways:

1. Matching and Categorizing:
   Matching: The primary task of the game involves matching texture cards with their edited versions. This exercise helps participants develop their ability to identify and compare visual elements, enhancing their matching skills.
   Categorizing: By grouping textures and their variations, players practice categorizing visual information, a fundamental aspect of visual thinking that McKim emphasizes.

2. Pattern Recognition:
   Players must identify patterns, shapes, and other characteristics of textures to make accurate matches. Recognizing and understanding these patterns is crucial for visual thinking, as highlighted by McKim. This process helps players improve their ability to detect subtle visual differences and similarities.
3. Attention to Detail:
   The game encourages players to carefully examine details in each texture and its edited version. This focus on detail helps players develop a habit of thorough observation, which is essential for effective visual thinking. McKim stresses the importance of paying attention to fine details in visual tasks.
4. Memory and Cognitive Skills:
   Memory: Remembering which textures and edited versions have been previously matched is vital for success in the game. This aspect of the game enhances players' visual memory, a key component of visual thinking according to McKim.
   Cognitive Skills: The process of matching textures also engages cognitive skills, such as logical reasoning and problem-solving, which are integral to McKim's visual thinking framework.
5. Seeing and Thinking:
   McKim posits that visual thinking involves both seeing and thinking. In "Match Me," players use their visual perception to identify textures and their cognitive abilities to match them correctly. This integration of seeing and thinking helps players improve their overall visual thinking capabilities.
6. Imagining and Visualizing:
   The game requires players to imagine how a zoomed-in or zoomed-out texture relates to its original form. This mental visualization aligns with McKim's concept of imagining as a critical part of visual thinking. By practicing this skill, players enhance their ability to visualize changes and transformations in their minds.
7. Analytical Thinking:
   By slowing down and observing the finer details of each texture, players engage in analytical thinking. McKim emphasizes the importance of analytical thinking in visual tasks, and "Match Me" fosters this by encouraging players to analyze and compare visual information critically.
8. Multisensory Engagement:
   While primarily a visual game, "Match Me" also involves tactile elements as players handle the cards. McKim supports the idea that engaging multiple senses can enhance visual thinking. The tactile interaction with cards complements the visual analysis, providing a richer cognitive experience.
9. Interactive and Collaborative Learning:
   The game's design encourages interaction and discussion among players, fostering collaborative learning. McKim advocates for social interaction as a means to enhance visual thinking skills. By discussing and verifying matches, players learn from each other

and improve their visual thinking through shared experiences.

User Testing

1 Student of 9 year
2 Students of 10 year
2 Students of 7 year

Insights from User Testing:

- Some were able to find patterns quickly.
- For some it was confusing.
- Once finding, participants eagerly explained how and why that is the correct pair.

2. Pallet Connect

This next idea is inspired by the concept of color chips. Players must match color palettes with their corresponding illustration cards. The gameplay is similar to the game "Set." There are two sets of cards: one with illustrations and another with color palettes. Each set is shuffled separately. Then, four illustration cards and four palette cards are placed in front of the players. The goal is to match the illustration cards with the correct palette cards. This game can be played solo or with two or more players. The player who makes the most correct matches wins. If a player makes an incorrect match, they must return one card from their collection.

Objective:

The primary objective of Pallet Connect is to enhance players' color perception, visual discrimination, and matching skills. Players must accurately match color palettes with their corresponding illustration cards, promoting visual thinking and pattern recognition.

Content

- Illustration Cards: A set of cards featuring various illustrations, each with a unique color scheme.
- Palette Cards: A set of cards displaying different color palettes that correspond to the illustrations.
- Instruction Manual: Detailed rules and setup instructions for players.

Activity Setup

1. Shuffle the Cards:
    - Shuffle the set of illustration cards thoroughly.
    - Shuffle the set of palette cards separately.
2. Arrange the Cards:
    - Place four illustration cards face up in front of the players.
    - Place four palette cards face up in front of the players.
3. Decide Play Order:
    - Determine the play order, which can be decided by a coin toss or any other method preferred by the players.

How to Play

1. Initial Setup:
    - Each player starts with no cards in their collection.
    - Players take turns in the order decided.
2. Matching Phase:
    - On their turn, a player attempts to match one illustration card with one palette card.
    - The player makes a match by selecting one illustration card and one palette card they believe correspond to each other.
3. Checking the Match:
    - After making a match, the player shows the cards to the other players.
    - If the match is correct (the color palette matches the illustration), the player keeps both cards and earns a point.
    - If the match is incorrect, the player must return one card from their collection (if they have any).
4. Refilling Cards:
    - After each match attempt, whether correct or incorrect, replace the used cards with new ones from the respective decks so that there are always four illustration cards and four palette cards in play.
5. Winning the Game:
    - The game continues until all cards from both decks have been used.
    - The player with the most correct matches at the end of the game wins.
    - In case of a tie, the players can choose to have a tie-breaker round or share the victory.

How is this activity helping with enhancing visual thinking ?

Similar to previous activity, for this activity also following operations of visual thinking are being utilized:

- Matching

- Categorizing

Through these processes, participants identify colors within the images presented to them. Many people find using colors daunting. In his book “Experiences in Visual Thinking,” Robert H. McKim mentions that one of the best ways to overcome the stereotyping effect of color constancy and color labeling, and to see color afresh, is through color matching. One helpful exercise he describes is the 'paint chip hunt,' where participants visit a paint store to collect paint chips and then try to find those colors in their surroundings.

The game "Pallet Connect" aligns with the strategies of visual thinking as outlined by Robert H. McKim in several ways:

1. Matching and Categorizing:
- Matching: The core task of the game involves matching illustration cards with their corresponding color palette cards. This exercise enhances participants' ability to identify and compare visual elements, improving their matching skills.
- Categorizing: Players group illustrations and their color palettes, practicing the categorization of visual information, which is a fundamental aspect of visual thinking according to McKim.
2. Color Perception and Visual Discrimination:
- Color Perception: McKim emphasizes the importance of seeing colors accurately and afresh. "Pallet Connect" challenges players to match colors precisely, improving their ability to perceive and differentiate between various hues and shades.
- Visual Discrimination: The game requires players to distinguish subtle differences in color palettes, enhancing their visual discrimination skills. This aligns with McKim's principles of recognizing and understanding visual nuances.
3. Pattern Recognition:
- Players must identify patterns and color schemes within the illustrations to make correct matches. Recognizing and understanding these patterns is crucial for visual thinking, as highlighted by McKim. This process helps players improve their ability to detect visual patterns and relationships.
4. Attention to Detail:
- The game encourages players to carefully examine the details in each illustration and its corresponding palette. This focus on detail helps players develop a habit of thorough observation, essential for effective visual thinking. McKim stresses the importance of paying attention to fine details in visual tasks.
5. Seeing and Thinking:
- McKim posits that visual thinking involves both seeing and thinking. In "Pallet Connect," players use their visual perception to identify colors and their cognitive abilities to match them correctly. This integration of seeing and thinking helps players improve their overall visual thinking capabilities.
6. Overcoming Color Constancy and Labeling:
- In his book “Experiences in Visual Thinking,” McKim discusses overcoming the stereotyping effects of color constancy and labeling by engaging in color matching

activities. "Pallet Connect" directly addresses this by challenging players to see colors anew, free from preconceived labels and stereotypes.

7. Analytical Thinking:

- By analyzing the relationship between the color palettes and the illustrations, players engage in analytical thinking. McKim emphasizes the importance of analytical thinking in visual tasks, and "Pallet Connect" fosters this by encouraging players to analyze and compare visual information critically.

8. Memory and Cognitive Skills:

- Memory: Remembering which color palettes have been previously matched with illustrations is vital for success in the game. This aspect enhances players' visual memory, a key component of visual thinking according to McKim.
- Cognitive Skills: The process of matching colors also engages cognitive skills such as logical reasoning and problem-solving, which are integral to McKim's visual thinking framework.

9. Interactive and Collaborative Learning:

- The game's design encourages interaction and discussion among players, fostering collaborative learning. McKim advocates for social interaction as a means to enhance visual thinking skills. By discussing and verifying matches, players learn from each other and improve their visual thinking through shared experiences.

10. Multisensory Engagement:

- While primarily a visual game, handling the cards involves tactile interaction. McKim supports the idea that engaging multiple senses can enhance visual thinking. The tactile interaction with cards complements the visual analysis, providing a richer cognitive experience.

User Testing

- 1 Student of 9 year
- 2 Students of 10 year
- 2 Students of 7 year

User Testing Photos

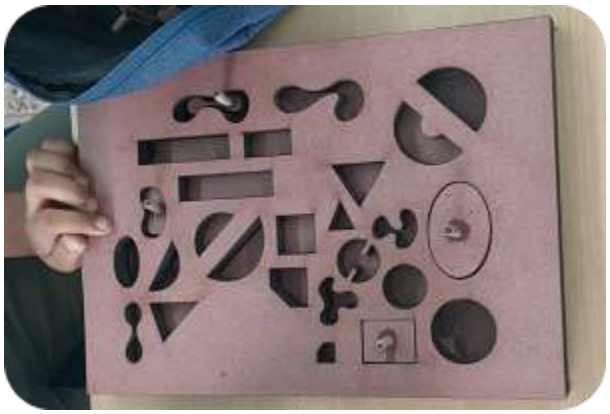
Insights:

- Some were able to find patterns quickly.
- For some it was confusing.
- Once finding, participants eagerly explained how and why that is the correct pair.

3. ShapeSense

The Tactile Kinaesthetic Eye

Inspired from the Pierced Block but we will be incorporating seeing with kinaesthetic parts.



How to?
A board is pierced with various shapes at different heights. While blindfolded, a person must feel the solid blocks with their hands and visualize the shapes in their mind. The next step is to find the corresponding hole on the board where each solid block fits. The user must fill all the pierced blocks on the board, one by one.

Objective
The objective of this activity is to enhance tactile perception, spatial visualization, and fine motor skills. It aims to help participants develop their ability to recognize and match shapes without relying on their sight, thereby improving their sensory integration and cognitive mapping abilities.

Content

- Board: A wooden or plastic board with various shaped holes pierced at different heights and positions.
- Solid Blocks: A set of solid blocks corresponding to the shapes and sizes of the holes on the board.
- Blindfolds: To ensure participants rely on their tactile senses rather than their vision.
- Timer (optional): To add a time challenge element to the activity.
- Instructions Card: A card explaining the rules and steps of the activity.

Activity Setup

1. Prepare the Board: Ensure the board is securely positioned on a stable surface, with all the holes pierced in various shapes (e.g., circles, squares, triangles, stars) and placed at different heights.
2. Arrange the Blocks: Place the solid blocks in a container or spread them out on a table near the board.
3. Blindfolds: Have blindfolds ready for participants.
4. Clear the Area: Ensure the area around the board is clear of obstacles to provide a safe environment for participants.blocks with their hands and visualize the shapes in their mind. The next step is to find the corresponding hole on the board where each solid block fits. The user must fill all the pierced blocks on the board, one by one.

How to Play

1. Preparation:

- Each participant is blindfolded before starting the activity.
- The facilitator explains the rules and objectives of the game.

Starting the Activity:

- The participant picks up a solid block from the container or table.
- While blindfolded, the participant feels the shape of the block and visualizes it in their mind.

Matching the Shapes:

- The participant moves towards the board, using their tactile sense to find the corresponding hole for the block.
- The participant attempts to fit the block into the correct hole. If it doesn't fit, they must try again with a different hole until they find the right one.

Completing the Task:

- The participant repeats the process for all the blocks, one by one, until all the shapes are correctly matched and placed in the corresponding holes on the board.

Optional Challenge:

- To add an element of competition or personal challenge, participants can be timed to see how quickly they can complete the task. This can be done individually or in teams.

How is this activity helping with enhancing visual thinking ?

One of the best ways to exercise our visual thinking is through our mind's eye rather than just our eyes. Seeing involves more than just vision; it encompasses all our senses—touch, smell, hearing, feeling, and taste.
In this exercise, we limit our vision by using a blindfold, allowing us to 'see' the activity with our tactile and kinesthetic senses. Participants explore the product through touch, experiencing it without the use of sight.

1. Visualization and Mental Imagery
   McKim's Strategy: Visualization involves creating mental images to represent objects or scenarios. It is a key aspect of visual thinking, helping to improve understanding and memory.

   Alignment with Activity:

- In the activity, participants are blindfolded and must rely on their sense of touch to visualize the shapes of the blocks. They create mental images of the shapes and use these images to find the corresponding holes on the board. This process directly engages and enhances their ability to form and manipulate mental images, a core component of visual thinking.

2. Sensory Experiences

McKim's Strategy: Sensory experiences are crucial for developing visual thinking skills. Engaging multiple senses can enhance perception and cognitive processing.

Alignment with Activity:

- The activity involves tactile exploration, requiring participants to feel the shapes of the blocks and the holes on the board. By relying on touch rather than sight, participants develop a deeper sensory understanding of the shapes, which helps improve their overall sensory integration and cognitive mapping abilities.

3. Spatial Relationships and Perception
   McKim's Strategy: Understanding spatial relationships is essential for visual thinking. This includes recognizing how different shapes and objects relate to each other in space.

   Alignment with Activity:

   - Participants must understand and interpret the spatial relationships between the blocks and the holes on the board. This involves perceiving the size, shape, and orientation of each block and matching it to the correct hole, which enhances their spatial reasoning skills.

4. Problem-Solving and Critical Thinking
   McKim's Strategy: Visual thinking supports problem-solving by allowing individuals to visualize possible solutions and explore different scenarios mentally.

   Alignment with Activity:

   - The activity requires participants to solve the problem of matching each block to its corresponding hole without visual cues. They must think critically and use their visualization skills to determine where each block fits. This process encourages innovative thinking and problem-solving.

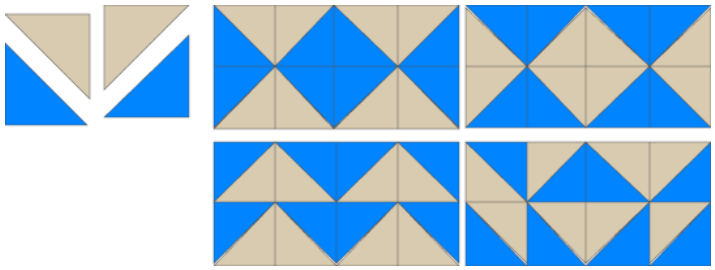
Here are some images from user testing:

Insights:

- Initially it was difficult for some users.
- Found difficulty with more curvier shapes.
- With time and practice, users started figuring out tactics to perform the activity. the
- When played in a group, other participants also tried to give verbal cues, for which the player was able to perform more actively.

4. Form a Form

Players are provided with two equal sets of triangles, a set of cards with different compositions made from triangles and a frame. Each set is kept a different color. One has to arrange the triangles the same as the composition in the card.



After the first user testing, I observed this was a little tricky for the user group I am targeting. So, I went ahead and made it a little simpler for the beginners level. Converting triangles to squares.

Players are provided with two equal sets of squares, a set of cards with different compositions made from squares and a frame. Each set is kept a different color. One has to arrange the squares the same as the composition in the card.

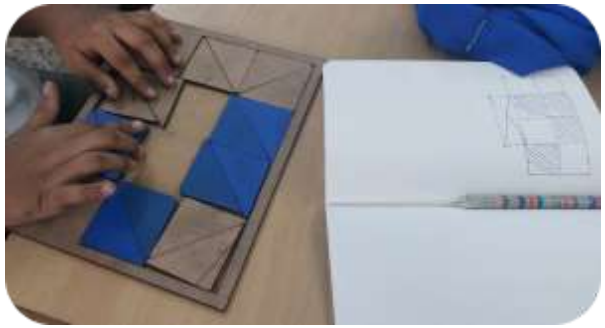
Objective

The primary objective of Form a Form is to enhance players' spatial reasoning, geometric understanding, and problem-solving skills. Players must replicate the square compositions depicted on the cards using provided sets of squares.

Content

- Square Sets: Two equal sets of squares, each set in a different color.
- Composition Cards: A set of cards depicting different

Image from user testing



- compositions made from squares.
- Frame: A frame to help players arrange the squares accurately according to the card compositions.

Activity Setup

1. Shuffle the Composition Cards:
2. Shuffle the set of composition cards thoroughly.

Initial Setup:

1. Place the shuffled composition cards in a stack, face down, within easy reach of all players.

2. Ensure the frame is placed on a stable surface where players can arrange their squares.

How to Play

Arranging the squares

- Setting the Composition:
- The player must use their set of squares to replicate the composition shown on the card within the frame.
- Players can only use the squares set in the frame to match the composition.
- Verification:
- Once the player believes they have accurately replicated the composition, they show their arrangement to the other players for verification.

Refilling Cards

1. Replace Cards:
   After each turn, draw a new composition card so that the stack is always available for the next round.

Game Tips

- Focus on Details: Pay close attention to the exact arrangement of squares on the composition cards to ensure accurate matching.
- Strategic Placement: Plan your arrangement strategically to minimize errors and achieve the correct composition efficiently.
- Memory and Observation: Remember the positions and shapes of the triangles to make quicker and more accurate arrangements.

Guide for Solo Play

- Objective: Try to match all compositions with your set of triangles.
- Scoring: Keep track of your correct matches and aim to beat your own record in subsequent games.

Guide for Multiple Players

- Objective: Compete to make the most correct matches.
- Interaction: Engage with other players by discussing and verifying matches, making the game more interactive and fun.

How is this activity helping with enhancing visual thinking ?

- Similar to that of ‘ShapeSense’ this also leverages the benefits of our sensory and helps us practice seeing from our minds eye.

The activity "Form a Form" aligns with the strategies of visual thinking as outlined by Robert H. McKim in several ways:

1. Engagement of Multiple Senses:

- As emphasized by McKim, visual thinking is not limited to the sense of sight but involves all senses. "Form a Form" enhances visual thinking by engaging players in tactile and kinesthetic activities. By using touch to arrange the squares within the frame, players stimulate their mind's eye, reinforcing McKim's concept of multisensory involvement in visual perception.

2. Spatial Reasoning and Geometric Understanding:

- McKim highlights the importance of spatial reasoning in visual thinking. This activity directly targets spatial reasoning skills by requiring players to accurately replicate geometric compositions. The hands-on manipulation of squares within a defined frame helps

players develop a deeper understanding of spatial relationships and geometric concepts.

3. Pattern Recognition and Matching:

- The task of matching the compositions on the cards with the physical arrangement of squares promotes pattern recognition, a key element of visual thinking. According to McKim, the ability to recognize and replicate patterns is crucial for visual problem-solving. This activity challenges players to identify patterns and recreate them accurately, enhancing their pattern recognition abilities.

4. Attention to Detail:

- McKim asserts that careful observation is a fundamental aspect of visual thinking. "Form a Form" encourages players to focus on the details of each composition card to ensure precise matching. This attention to detail cultivates a habit of thorough observation, which is essential for effective visual thinking.

5. Strategic and Analytical Thinking:

- The activity requires players to plan and strategize their arrangements, aligning with McKim's idea that visual thinking involves analytical and strategic thought processes. Players must consider the placement of each square carefully to replicate the composition accurately, fostering strategic thinking and problem-solving skills.

6. Memory and Cognitive Flexibility:

- By remembering the positions and arrangements of squares, players enhance their visual memory, another aspect McKim deems important for visual thinking. The repetitive nature of matching compositions helps reinforce memory and cognitive flexibility, allowing players to adapt and improve their arrangements over time.

7. Interactive Learning and Verification:

- Involving other players in the verification process fosters interactive learning and collaborative visual thinking. Discussing and verifying matches with peers aligns with McKim's view that visual thinking can be enhanced through social interaction and shared learning experiences.

User Testing

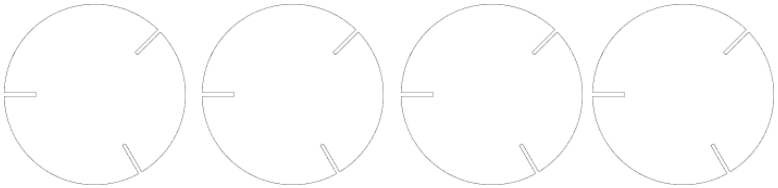
- 1 Student of 9 year
- 2 Students of 10 year
- 2 Students of 7 year

Testing photos:

Insights:

- Initially with triangle, participants found it tricky and confusing in moving
- Problem with composition
- Difficulty due material friction

5. Circle Tower Challenge



Participants are provided with a circle with grooves in them such that two or more circles can be attached to it. one has to build a tower as tall as it goes or make abstract figures from their imagination.

Objective
The primary objective of the Circle Tower Challenge is to enhance participants' spatial reasoning, engineering skills, and creativity. Participants must build the tallest possible tower using interlocking circles or construct a 3D object resembling living or nonliving things.
Content

- Interlocking Circles: Sets of circles with grooves, allowing them to be attached to other circles in various configurations.

Activity Setup

1. Prepare the Interlocking Circles:

- Ensure that each participant or team has an equal set of interlocking circles.
- Each set should contain enough circles to allow for varied and complex constructions.

2. Designate a Building Area:

- Ensure there is a stable, flat surface where participants can build their structures.
- Provide ample space for each participant or team to work without interfering with others.

How to Play

Initial Setup

1. Set Up:

- Distribute the sets of interlocking circles to each participant or team.
- Ensure the building area is clear and accessible.

Building Phase

1. Objective:

- Participants can choose between two challenges: Build the Tallest Tower: Using the interlocking circles, build a tower as tall as possible without it toppling over.

Construct a 3D Object: Create a 3D object that resembles a living or nonliving thing (e.g., a tree, a house, an animal).

2. Starting the Build:

- Participants start with their set of circles and begin attaching them using the grooves to form their structures.
-

Rules:

- Circles must be interlocked using the grooves; no other materials or adhesives are allowed.
- For the tower challenge, the tower must be free-standing and stable.
- For the 3D object challenge, the object should be recognizable and stable.
-

Winning the Game:

Evaluation:

- Tallest Tower: Measure the height of each participant's tower. The tallest stable tower wins.
- 3D Object: Evaluate the 3D objects based on creativity, stability, and resemblance to the chosen living or nonliving thing. Participants can vote, or a designated judge can choose the most impressive
- creation.

Game Tips

- Stability First: Focus on building a stable base for your tower or 3D object to ensure it can support additional circles.
- Creative Connections: Think creatively about how to use the grooves to attach circles in unconventional ways to achieve interesting shapes and structures.
- Plan Ahead: Before starting to build, visualize the structure you want to create and plan how to use the circles effectively.

Guide for Solo Play

- Objective: Challenge yourself to build the tallest tower or the most creative 3D object you can with your set of circles.
- Scoring: Measure your achievements and try to beat your own records in subsequent attempts.

Guide for Multiple Players

- Objective: Compete against others to build the tallest tower or the most creative and stable 3D object.
- Interaction: Engage with other participants by discussing building techniques and creative ideas, making the activity more interactive and fun.

How is this activity helping with enhancing visual thinking ?

The "Circle Tower Challenge" activity aligns with the strategies of visual thinking as outlined by Robert H. McKim in several significant ways:

1. Engagement of Spatial Reasoning:
- McKim emphasizes the importance of spatial reasoning in visual thinking. This activity requires participants to visualize and construct three-dimensional structures, enhancing their ability to understand and manipulate spatial relationships. Building towers or abstract figures with interlocking circles directly engages and develops these spatial reasoning skills.
2. Integration of Engineering Skills:
- Visual thinking often involves problem-solving and engineering principles. The challenge of creating stable, free-standing structures using only interlocking circles requires participants to apply basic engineering concepts. This alignment with McKim's strategies helps participants develop a practical understanding of balance, stability, and structural integrity.
3. Creativity and Imagination:
- McKim underscores the role of creativity in visual thinking. By encouraging participants to build not only the tallest towers but also imaginative 3D objects resembling living or nonliving things, the activity fosters creativity. Participants must envision their creations and experiment with different configurations, which enhances their creative thinking abilities.
4. Pattern Recognition and Matching:
- Identifying and creating patterns is a key component of visual thinking according to McKim. Participants engage in pattern recognition as they decide how to interlock circles to achieve desired shapes and stability. This process of recognizing and replicating patterns improves their ability to see and understand complex structures.
5. Attention to Detail:
- Successful construction in this activity requires careful attention to detail, a crucial aspect of visual thinking highlighted by McKim. Participants must precisely interlock circles and ensure each connection is stable. This meticulous approach helps enhance their observational skills and attention to detail.
6. Multisensory Engagement:
- McKim's strategies for visual thinking include the integration of multiple senses. In the "Circle Tower Challenge," participants use tactile feedback to interlock circles and assess stability, engaging their sense of touch along with their visual perception. This multisensory approach enriches the visual thinking process.
7. Strategic and Analytical Thinking:
- The activity necessitates strategic planning and analytical thinking. Participants must plan their structures to ensure they are both tall and stable or creatively representative of their chosen objects. This requirement aligns with McKim's view that visual

thinking involves analytical processes and strategic foresight.

8. Interactive and Collaborative Learning:

- Interaction with other participants through discussion and verification fosters collaborative visual thinking. McKim advocates for social learning as a way to enhance visual thinking skills. By sharing building techniques and creative ideas, participants learn from each other and improve their own visual thinking abilities.

9. Memory and Cognitive Flexibility:

- Building complex structures from interlocking circles involves remembering previous successful configurations and adapting them to new challenges. This enhances visual memory and cognitive flexibility, aligning with McKim's principles of effective visual thinking.

User Testing

1 Student of 9 year

- 2 Students of 10 year
- 2 Students of 7 year

Photos from Testing:

Insights:

- Material grip problem
- Excited to make things
- Figured out things and shapes on the way while making

6. SpinSpan

Inspired from the Nine Men's Morris board game, but with a little turn.

Objective
The primary objective of this game is to develop and enhance players' visual thinking, spatial reasoning, and strategic planning skills. Players must navigate a rotating, segmented circular board to form mills (rows of three) and outmaneuver their opponent.

Content

- Game Board: A circular board divided into three concentric segments, each capable of rotating independently. Each segment is divided into six equal parts where pawns can be placed.

- Pawns: 14 pawns (7 for each player), distinguishable by color or design.
- Instruction Manual: Detailed rules and setup instructions for players.

Activity Setup

- Assemble the Board: Place the three circular segments on a flat surface, ensuring they can rotate smoothly.
- Distribute Pawns: Each player receives 7 pawns of their chosen color.
- Starting Position: Decide which player will go first (e.g., coin toss).

How to Play

1. Initial Placement Phase:
   Players take turns placing one of their pawns on any available space on the board.
   The objective during this phase is to create mills (three connected pawns) while preventing the opponent from doing the same.
2. Forming Mills:
   A mill can be formed by aligning three pawns in a row on any segment.
   When a mill is formed, the player can remove one of the opponent's pawns from the board, provided it is not part of a mill.
3. Movement Phase:
   Once all pawns are placed, players take turns either moving one of their pawns to an adjacent space or

rotating one of the segments one position clockwise or counterclockwise.
Players can form new mills by moving or rotating pawns. If a mill is formed, they can remove an opponent's pawn as before.

4. Winning the Game:
A player wins by reducing the opponent to fewer than three pawns or leaving them with no legal moves.

Rules:

- Movement: Pawns can only move to adjacent spaces within the same segment or to the same relative position in an adjacent segment.
- Rotation: Each segment can be rotated one position per turn, either clockwise or counterclockwise.
- Forming Mills: Only horizontal and vertical mills are valid. No diagonal mills are allowed.
- Pawns in Mills: If all of the opponent's remaining pawns are in mills, they are immune from removal until they move out of a mill.

How is this activity helping with enhancing visual thinking ?

Here the two aspects of visual thinking is being utilized:

- Seeing and thinking
- Imagining and thinking

Operations of visual thinking applied here are:

- Visual induction II as rotation of the board and movement of the pawns in mind to form mills.
- Rotations keep in mind what pawns will be moved and what will be your opponent's position keeping in mind your own winning strategy.

The game "SpinSpan" aligns with the strategies of visual thinking as outlined by Robert H. McKim in several ways:

Visual Induction and Spatial Reasoning:

- Visual Induction: McKim highlights the importance of visual induction, where individuals visualize changes and transformations in their minds. In "SpinSpan," players must mentally rotate the board and anticipate the movement of pawns to form mills. This process enhances their ability to visualize dynamic changes and their outcomes.
- Spatial Reasoning: The game board's rotating segments require players to understand and manipulate spatial relationships. Players must predict the effects of rotations on pawn positions, honing their spatial reasoning skills.

Seeing and Thinking:

- McKim emphasizes that visual thinking involves seeing with the mind's eye. In "SpinSpan," players must visualize potential moves and outcomes before taking action. This aspect of seeing and thinking encourages players to form mental images of possible board configurations, enhancing their strategic planning and foresight.

Imagining and Thinking:

- The game's requirement to anticipate an opponent's moves and counter them involves a high degree of imaginative thinking. Players must envision various scenarios and develop strategies to outmaneuver their opponents. This aligns with McKim's idea that visual thinking involves imagining different possibilities and thinking through their implications.

Strategic Planning and Problem-Solving:

- McKim highlights the importance of strategic planning and problem-solving in visual thinking. "SpinSpan" requires players to plan several moves ahead, considering both their strategy and potential opponent responses. This fosters analytical thinking and the ability to solve complex problems through visual and logical analysis.

Pattern Recognition and Formation:

- Recognizing and forming patterns is a core component of visual thinking according to McKim. In "SpinSpan," players must identify opportunities to create mills (rows of three pawns). This pattern recognition skill is crucial for success in the game and enhances players' ability to detect and create visual patterns.

Attention to Detail:

- McKim asserts that careful observation is fundamental to visual thinking. "SpinSpan" requires players to pay close attention to the placement of each pawn and the rotation of each segment. This attention to detail helps players avoid mistakes and seize opportunities, sharpening their observational skills.

Multisensory Engagement:

- Although primarily visual, the game also involves tactile interaction with the rotating board and pawns. This multisensory engagement supports McKim's view that visual thinking can be enhanced through the integration of multiple senses, providing a richer and more comprehensive cognitive experience.

Interactive and Collaborative Learning:

- McKim advocates for learning through interaction and collaboration. "SpinSpan" encourages players to engage with each other, discuss strategies, and verify moves. This social aspect of the game promotes collaborative learning and helps players refine their visual thinking skills through shared experiences.

User Testing

- 1 Student of 9 year
- 2 Students of 10 year
- 2 Students of 7 year

Observations:

Insights:

- Exploring strategies and rules
- Initially, the game rule was to play till either of the players has less than three pawns of their own on the board. Which seemed a bit lengthy.
- The Participants wanted to play again.

All User Testing Videos:
https://drive.google.com/drive/folders/1NlMbSxh11haWLG2i-MFiWVyxl1v8n4l3?usp=sharing

Reiteration of Ideas as per User Testing

Branding: imlee (Imagine, learn, Explore, Engage)

1. **SpinSpan**

Since the user testing for this idea was highly successful, not many changes were needed. For the final prototype, I focused on enhancing the aesthetic aspects of the product.

2. **ShapeSense**

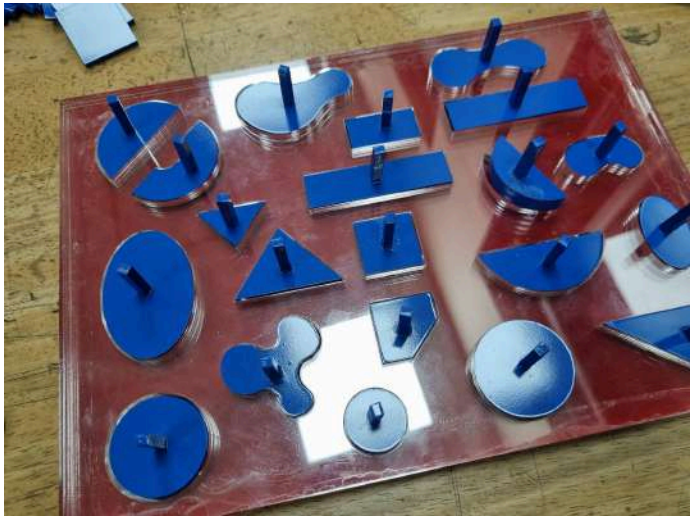


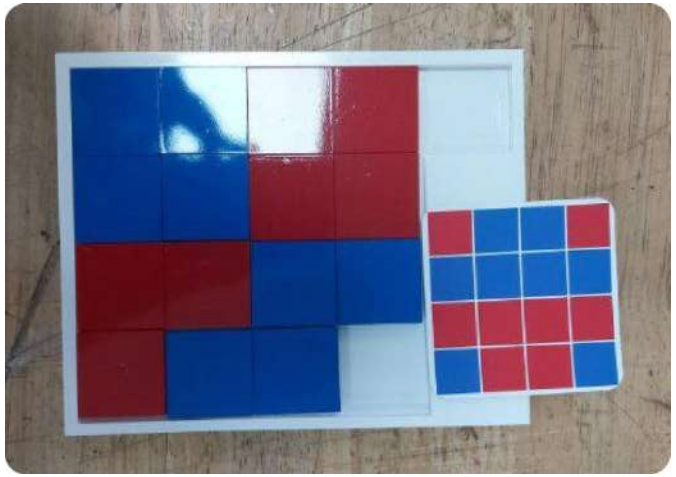
Fig 44

ShapeSense received a highly positive response during user testing, indicating great success. For the final prototype, I aimed to enhance engagement and interest by introducing variations in the depth of the shapes, as shown in Fig 44.

3. **PalletConnect and MatchMe**

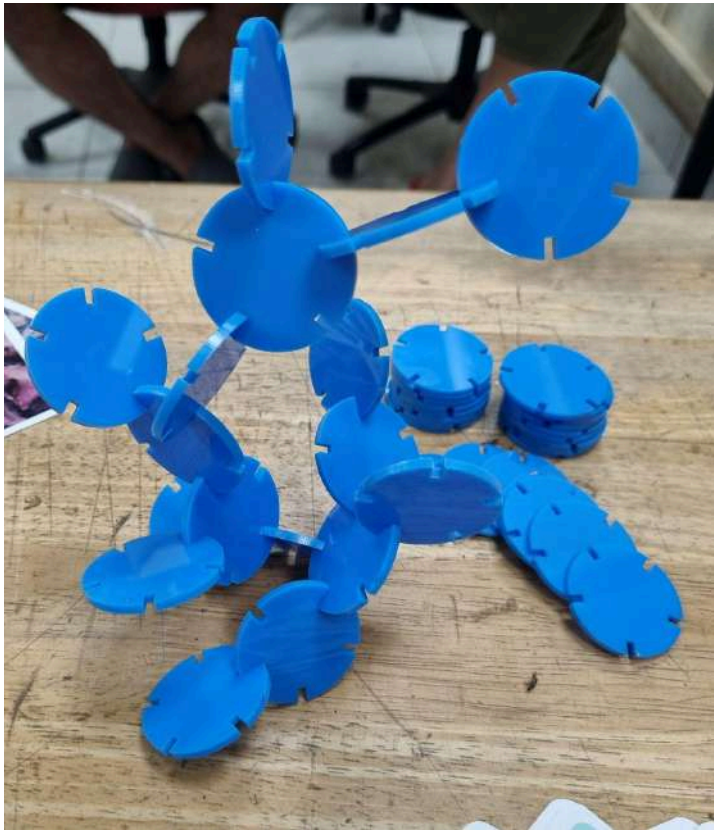
PalletConnect and MatchMe also received positive feedback as it achieved the required goal. The final prototype was designed by carefully considering the optimal shape and size of the cards.

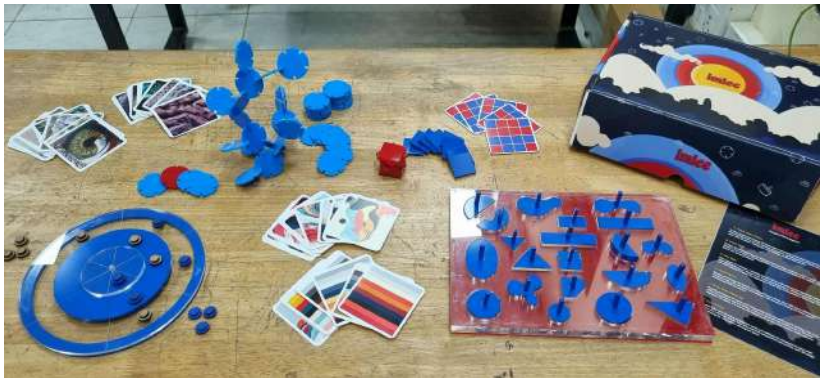
4. **FormAForm**



From user testing, I discovered that triangles can be challenging and require more ideation and planning before designing. Due to time constraints, I proceeded with square pieces for the puzzle, including clue cards to form the desired shape using the movable square puzzle pieces.

5. **Circle Tower Challenge**





Initially, the activity was designed to help users develop a sense of visual weight and balance. However, during user testing, another aspect of the activity was discovered: the ability to form 3D abstract representations of everyday objects.

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