Contextualizing Programming with Algorithmic Art Practices Using Computational Thinking Principles for Undergraduate Design Students

De-scription/In-scription Method

Thesis Jury 02 →

Statement

Research indicates that contextualized programming education positively impacts students' learning and enthusiasm for the subject. However, there is a requirement for resources and explicit instructional methods specifically designed for students in design-based undergraduate programs, where visual learners are prominent. To bridge this gap, this study introduces materials (ALAP) and a method (D/I) that can be implemented in programming education within the framework of algorithmic art.

Research Question

How should we contextualize programming fundamentals through algorithmic art practices to improve students' computational thinking skills and engagement in design departments?

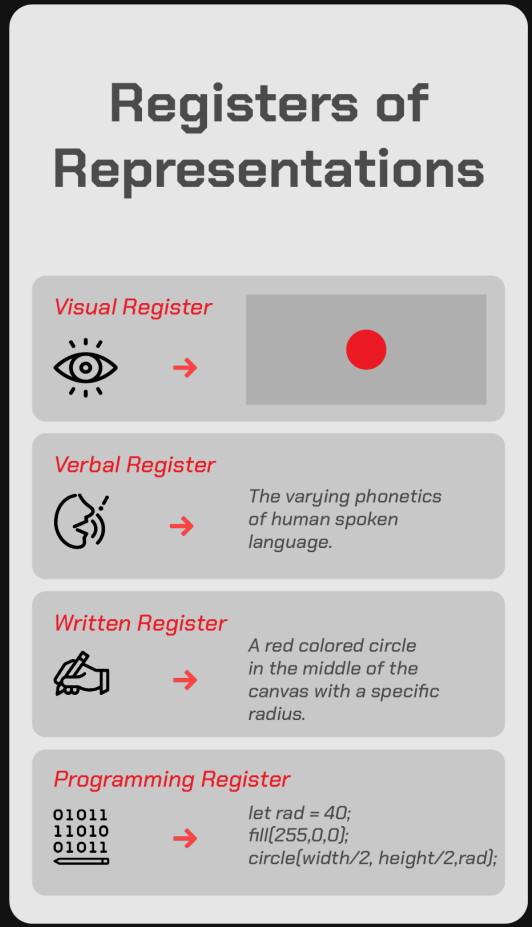
The Framework

- Algorithmic Art Praxis Categories `Contextualization`
- Computational Thinking `Methodological Approach`
- Theory of Semiotic Registers `Register Conversion`

What is register?

A register of representation refers to a specific semiotic system used to express mathematical concepts, such as natural language, symbolic notation, graphical representations, or visual displays. (Duval, 2006)

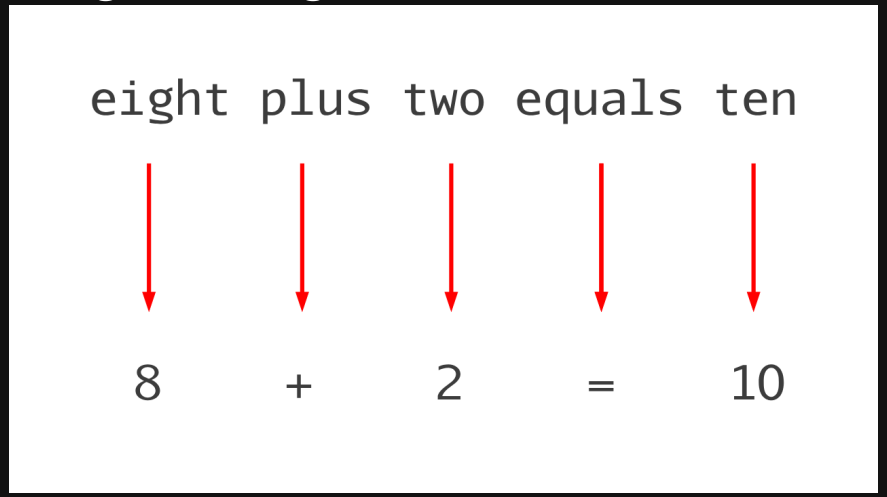
1. Visual Register
2. Verbal Register
3. Written Register
4. Programming register



Register Conversion

Congruent and Non-congruent registers

Congruent Register Conversion

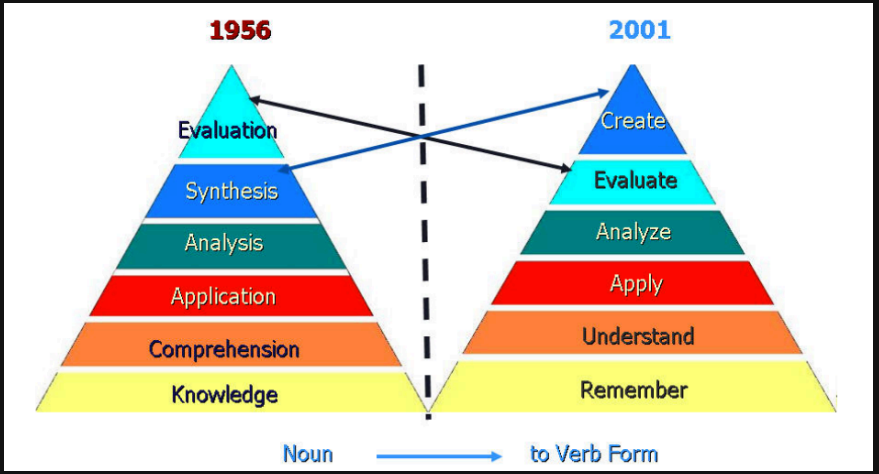


Non-congruent Register Conversion

`Adding eight and half of four gives the sum of ten`, the word "adding" comes before the numbers, two is derived from the half of four and the conversion becomes non-congruent.

How does Duval's theory relate to the programming?

In the context of programming education, non-congruent conversions can arise when students need to translate between natural language descriptions of problems and their corresponding programming code representation - (Bråting & Kilhamn, 2021).



The Methodological Framework

Computational Thinking

Computational Thinking

Decomposition

Pattern Recognition

Abstraction

Algorithm Design

ALAP Categories

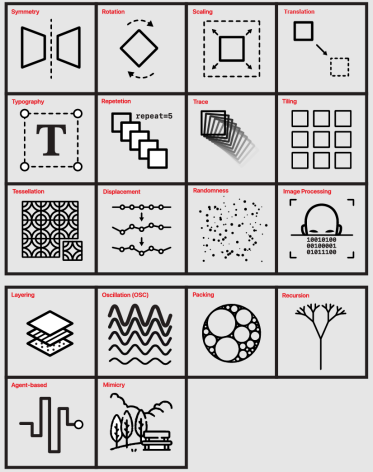
Algorithmic Art Praxis

Categories identified in the previous research;

Symmetry
Rotation
Scaling
Trace
Layering
Tiling
Tessellation
Image Processing
Collage
Typography
Translation
Displacement
Repetetion
Recursion
Packing
Randomness
Agent-based
Oscillation (OSC)

Multiple Registers

Semiotic Representations



Register Conversion

Registers of Representations

Visual Register

Verbal Register

The varying phonetics of human spoken language.

Written Register

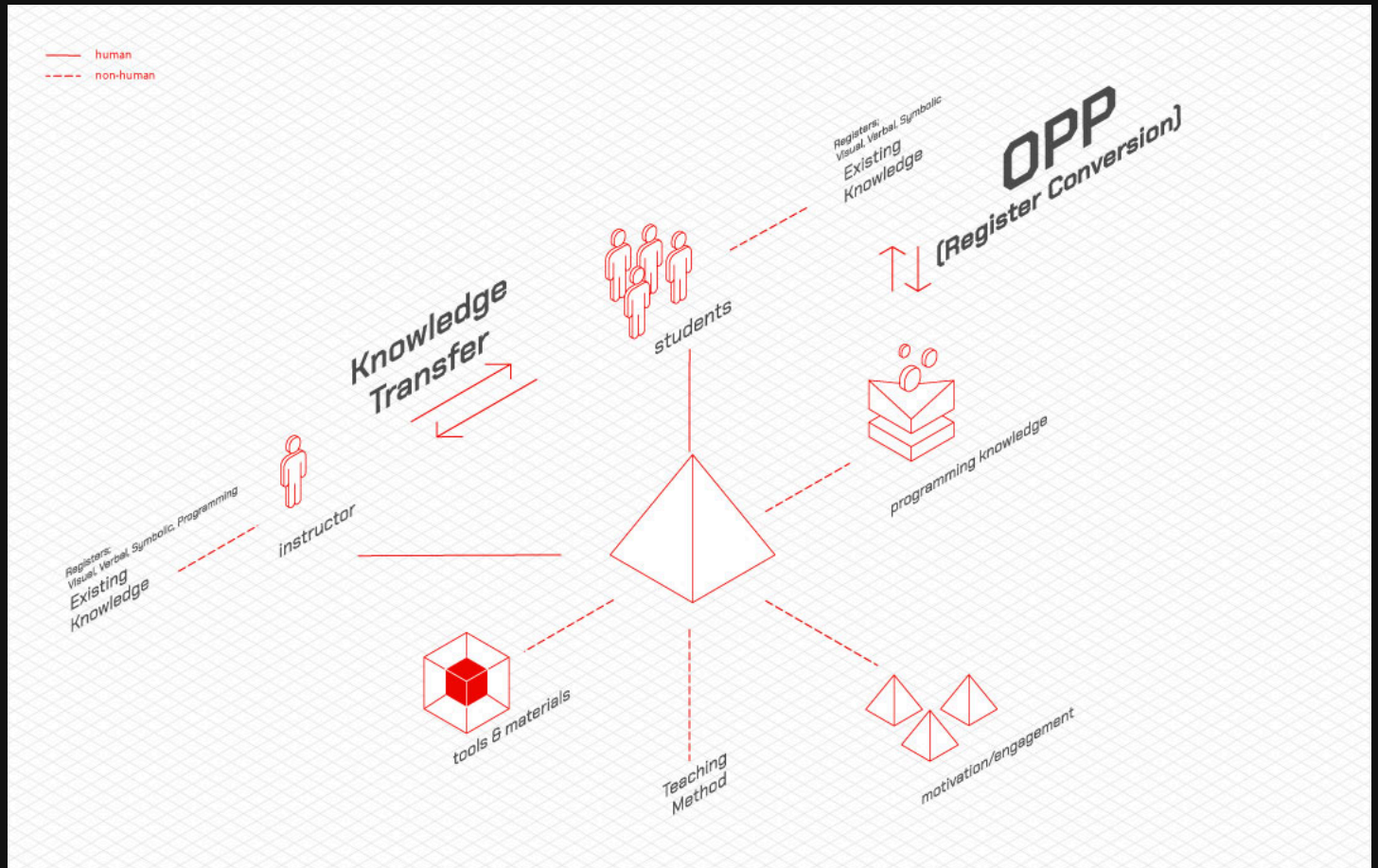
A red colored circle in the middle of the canvas with a specific radius.

Programming Register

```
01011
11010
01011
```

```
let rad = 40;
fill(255,0,0);
circle(width/2, height/2,rad);
```

OPP


human
non-human
Registers:
Visual, Verbal, Symbolic
Existing
Knowledge
OPP
(Register Conversion)
students
Knowledge
Transfer
instructor
Registers:
Visual, Verbal, Symbolic, Programming
Existing
Knowledge
programming knowledge
tools & materials
Teaching
Method
motivation/engagement

Methodology

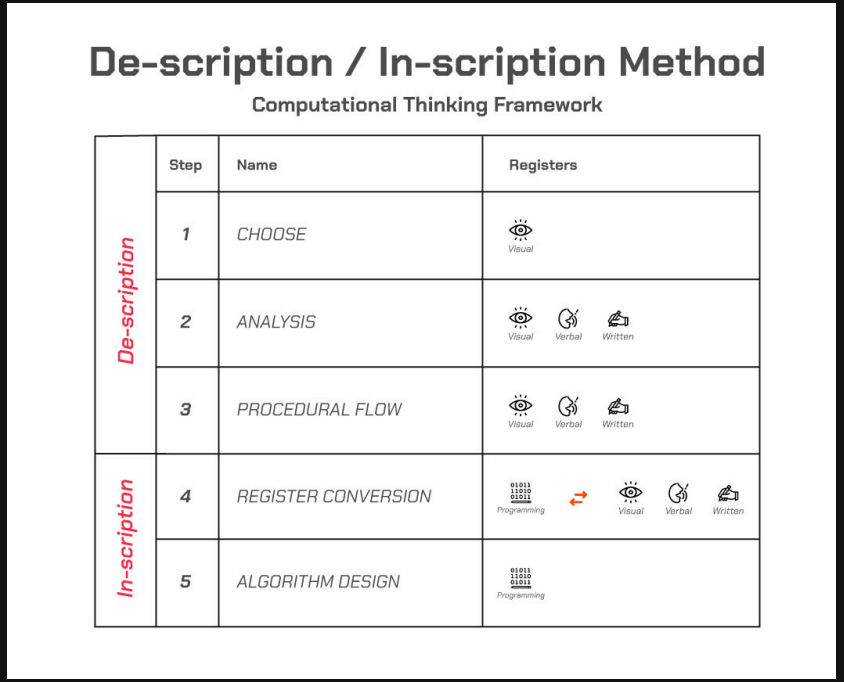
	Step	Name	Registers
De-scription	1	CHOOSE	Visual
	2	ANALYSIS	Visual Verbal Written
	3	PROCEDURAL FLOW	Visual Verbal Written
In-scription	4	REGISTER CONVERSION	Programming ⇄ Visual Verbal Written
	5	ALGORITHM DESIGN	Programming

OPP
(Register Conversion)

p5.Utils

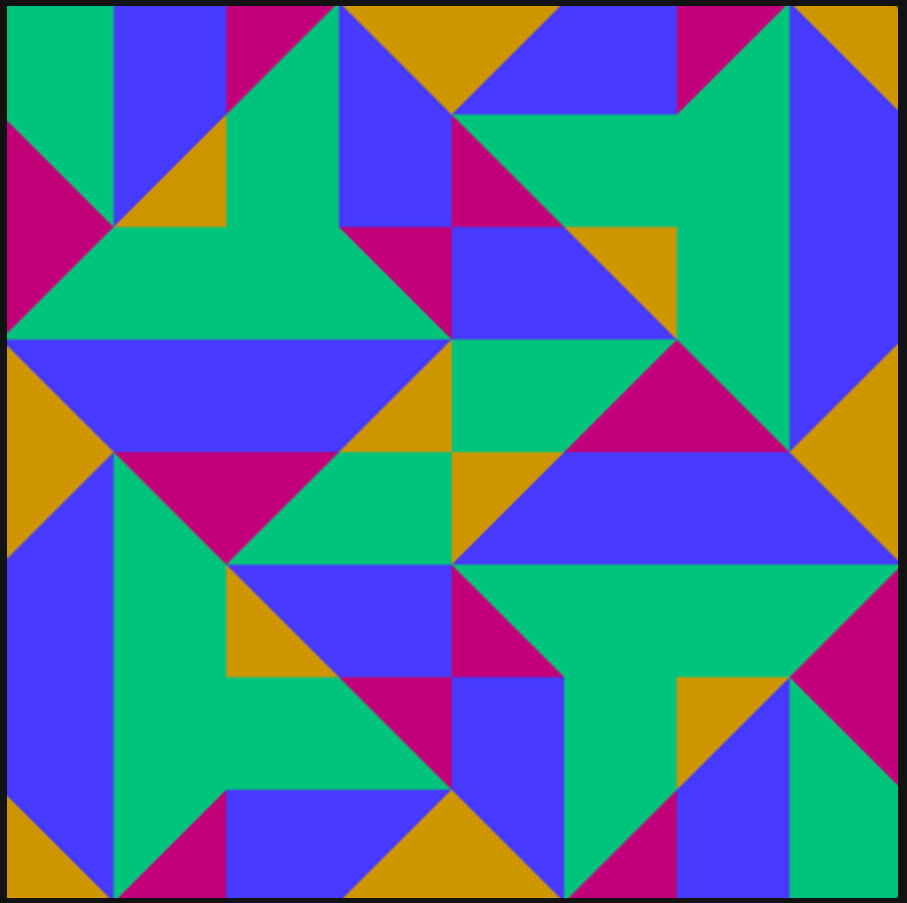
De-scription / In-scription Method

1. Choose an image from the database
2. Analyze it using pen and pencil or any other tool like drawing tablets familiar to the learner.
3. Determine the instruction order.
4. Register Conversion Stage.
   - Use the cheat-sheet.
   - Research using the cheat-sheets (web-sites, previous assignments, ALAP codes).
5. Algorithm Design



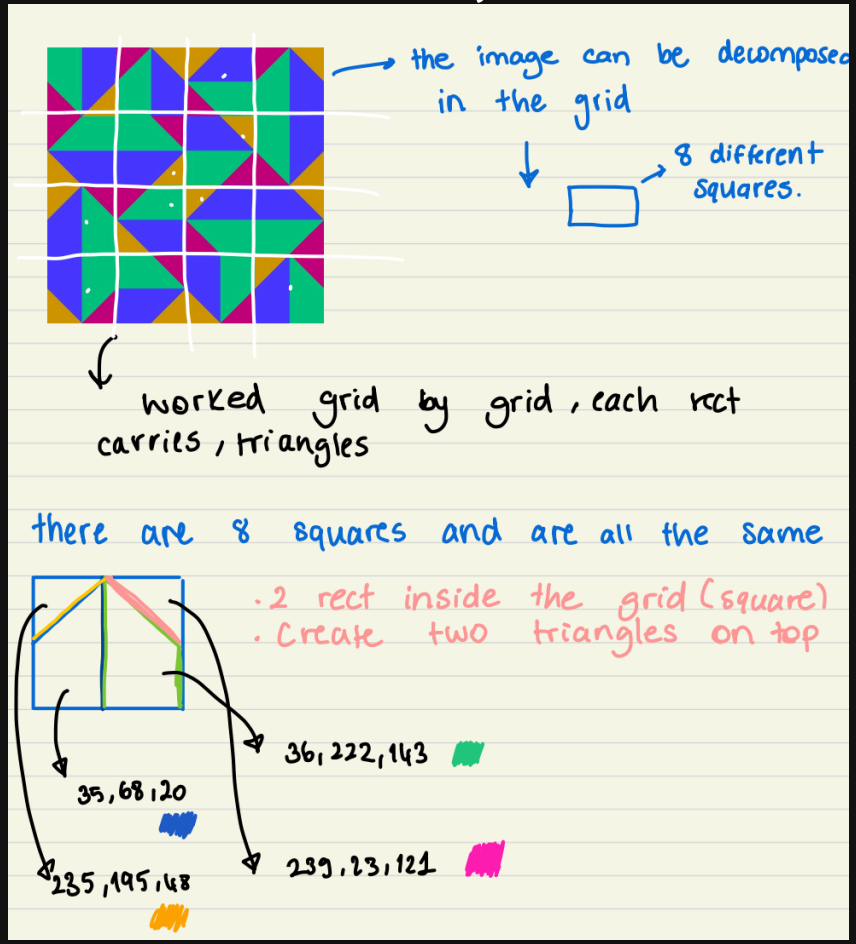
Method Applied

1. Choose: Student selected the image below



Paul Brown, "4^16-2030311203312120", 2005

2. Analysis


the image can be decomposed in the grid
8 different squares.
worked grid by grid, each rect carries, triangles
there are 8 squares and are all the same
. 2 rect inside the grid (square)
. Create two triangles on top
36, 222, 143
35, 68, 20
239, 23, 121
235, 195, 148

3. Procedural Flow

Flow

1) draw the grid

2) draw the shape inside one square

3) rotate it

① draw two rect

② draw triangles on top of each grid as it is in the image

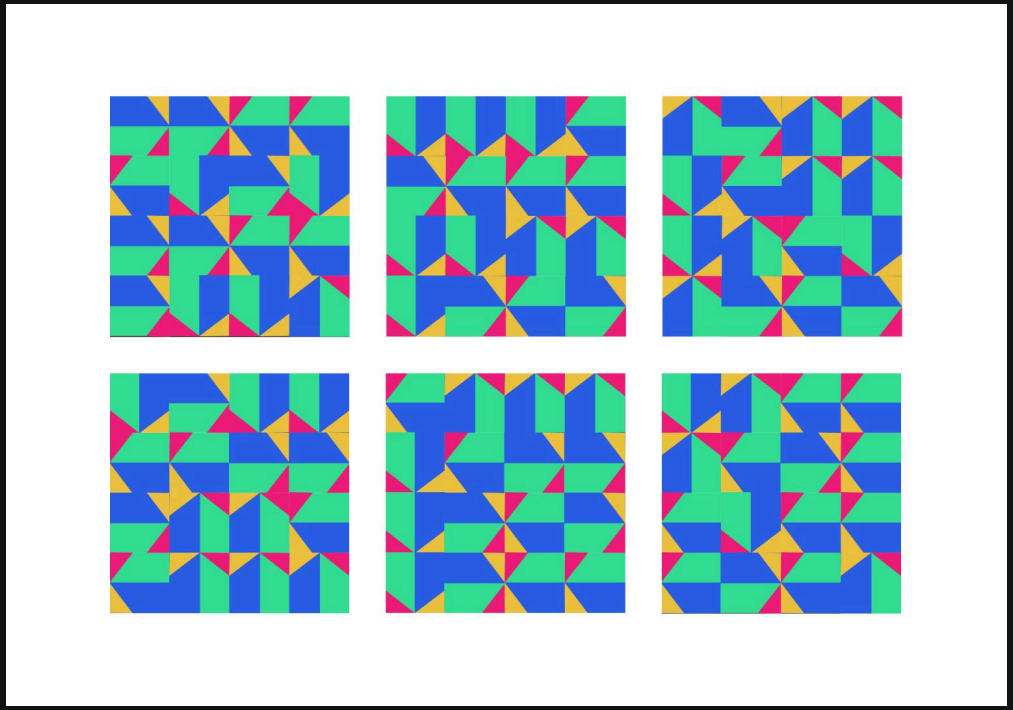
③ Fill the color

④ use rotate, translate

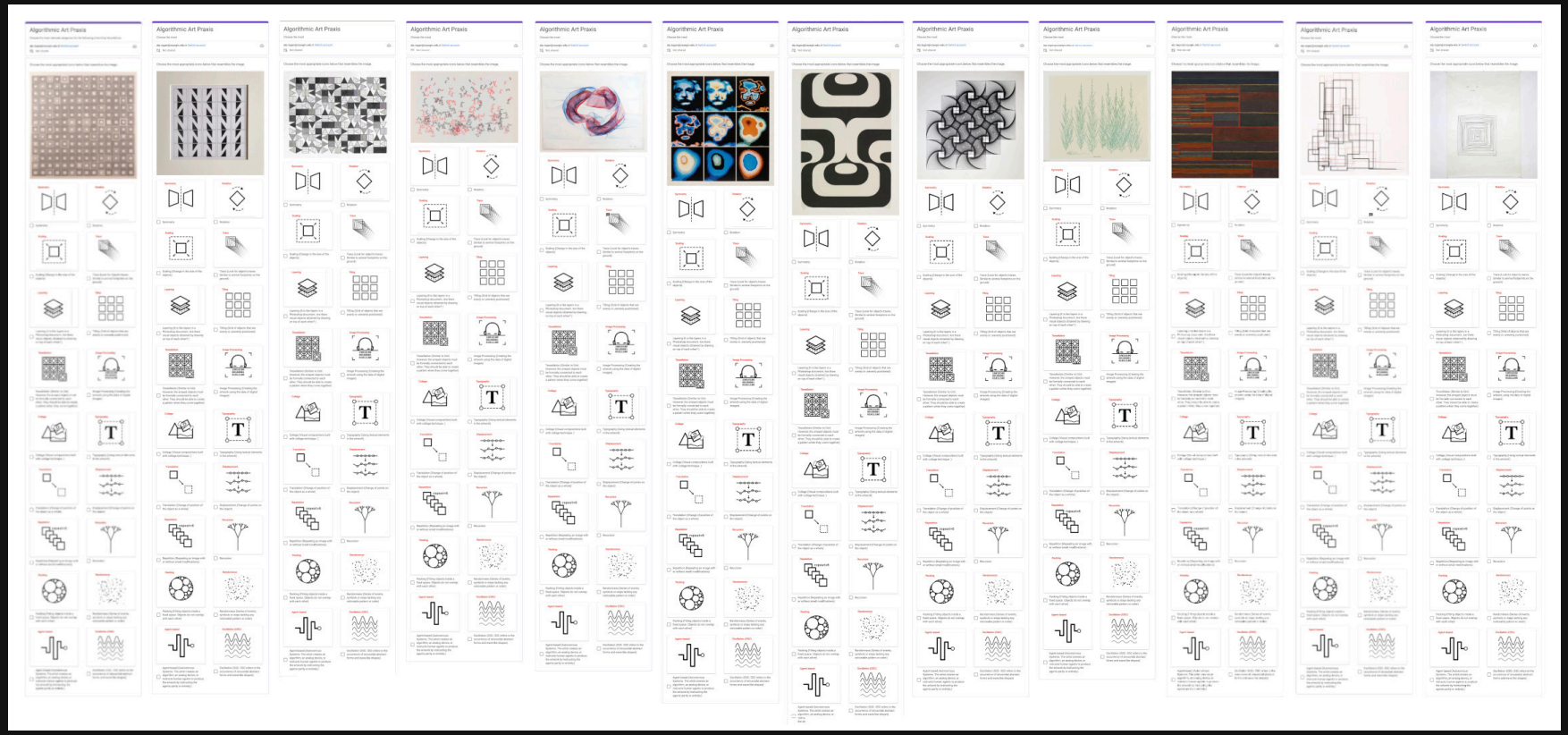
4. Register Conversion

Written Register	Programming Language Register
Green color →	`let green; green = color(36, 343, 143);`
Triangle →	`triangle(x1,y1,x2,y2,x3,y3);`
Square →	`rect(xr1, yr1, sr1, sr1);`
Create canvas 800 by 800 px →	`createCanvas(800, 800)`

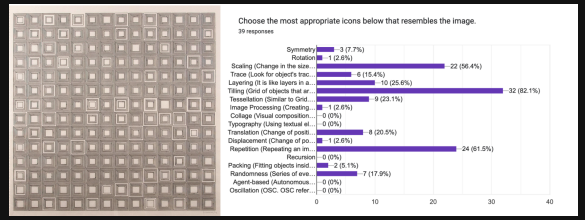
5. Algorithm Design

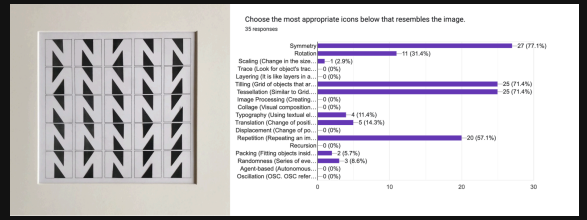


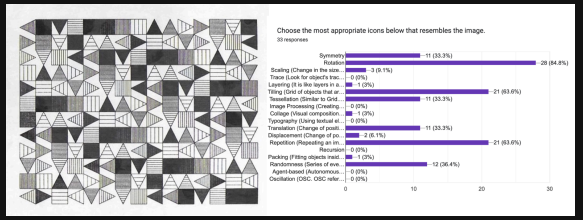
Survey 1 - ALAP Categories

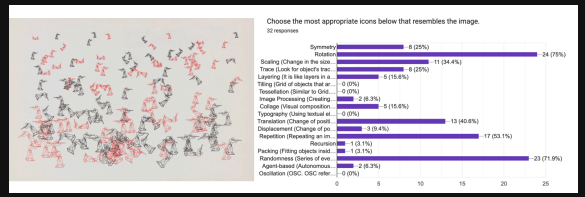


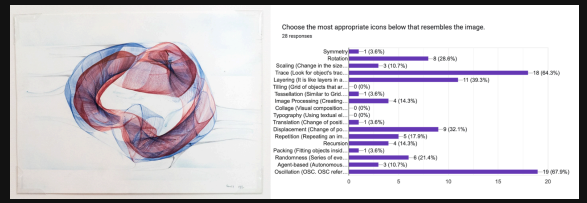
Results (Survey 1)

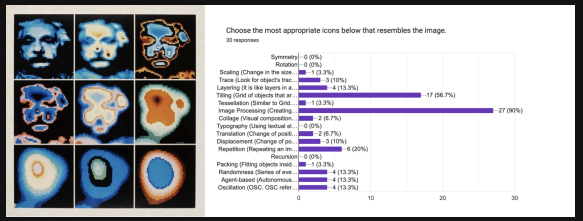


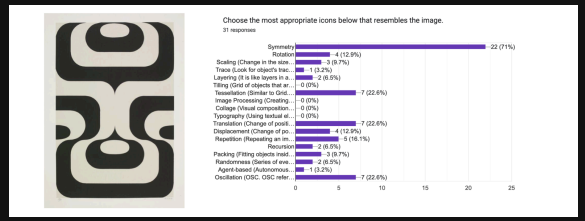


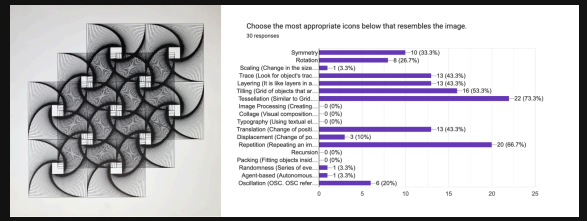


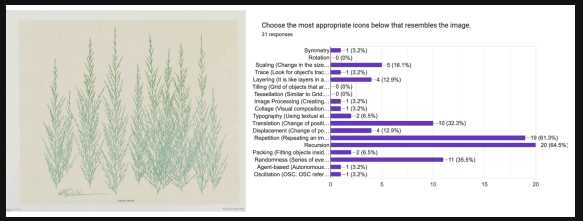


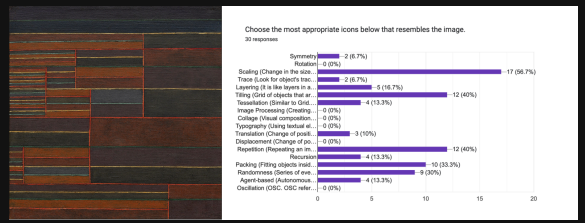


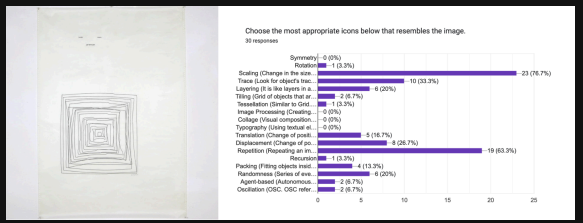




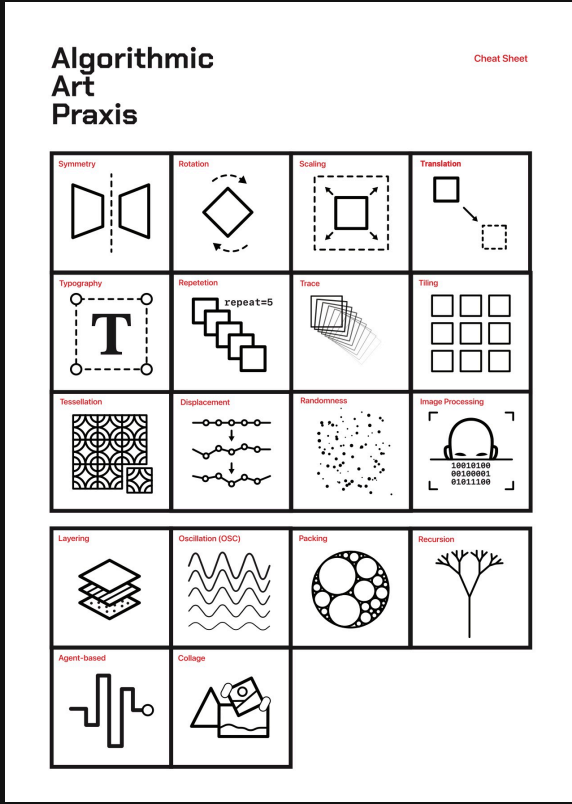








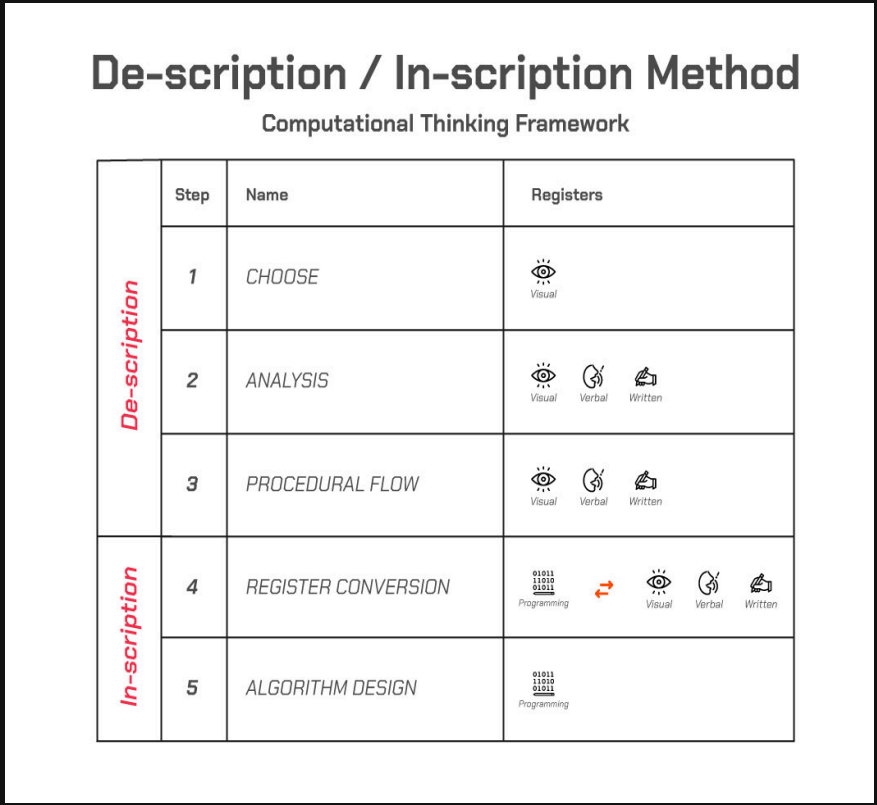
Conclusion: ALAP Survey



Results show that;

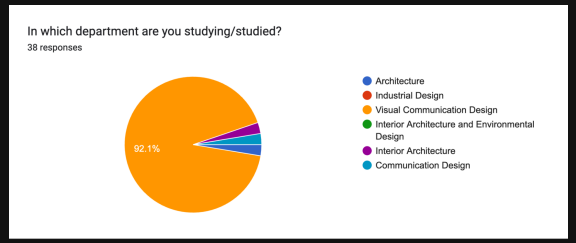
- Participants comprehend categories.
- Some of the selected artworks take time to identify. The artworks, including abstract and natural forms (e.g., Desmond Paul Henry's), become more challenging than those generated with simple shapes, such as Vera Molnar's geometric works.
- Increased engagement.
- Peer assessment.
- In-class discussions increased.
- Participants use cheat-sheets while asking questions.

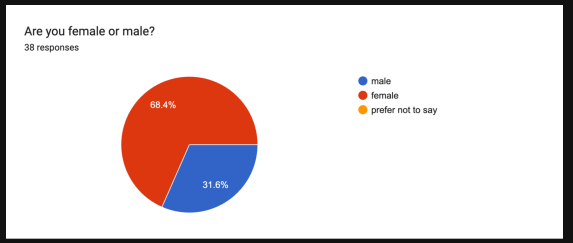
Results (Survey De-scription/In-scription)

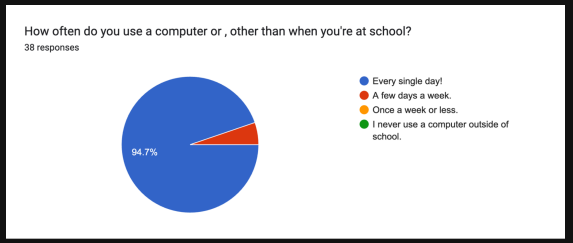


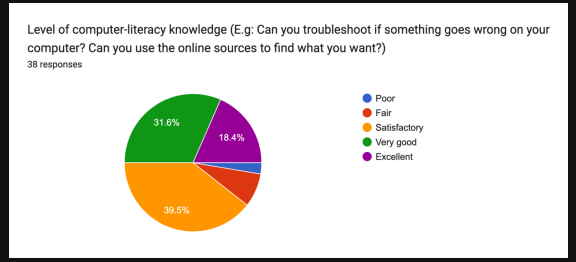
- The survey is divided into two main sections.
- The first section, related to participants' backgrounds, providing essential demographic information.
- The second section, focuses on the efficiency of the De-scription/In-scription method.

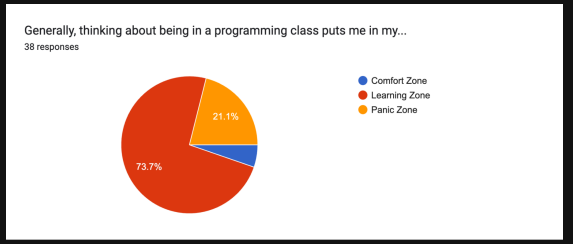
Participants' Background

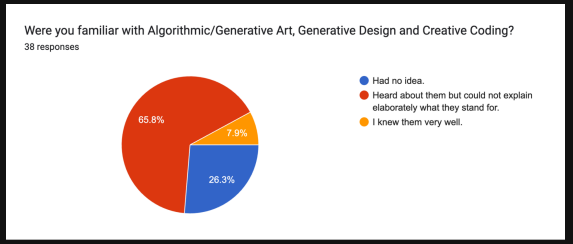


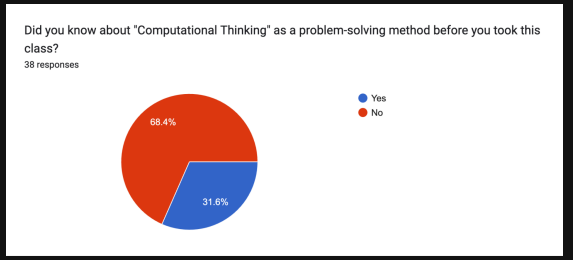




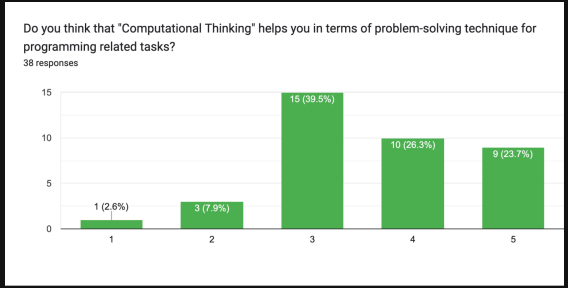


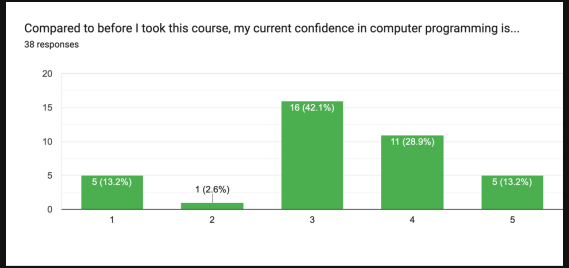


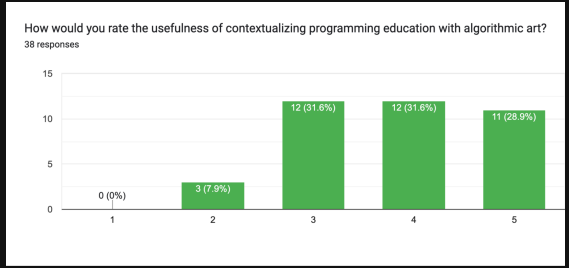


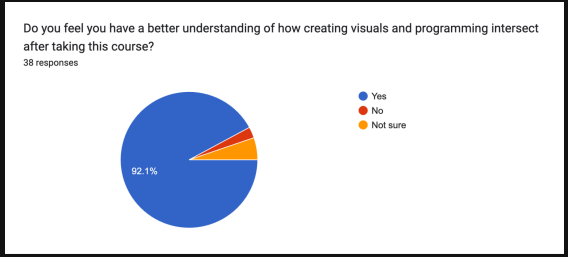


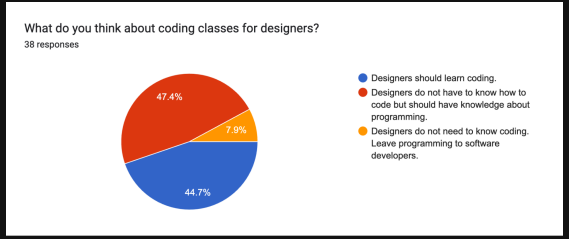
Is The Method Effective?











Interview Observation Section (to be removed??)

Conclusion

Equipping students with opportunities to express themselves through visual aids like the ALAP categories can significantly enhance the learning experience, comprehending cognitive processes, and fostering self-assurance and willingness to articulate views.

- ALAP Database provide source material for contextualization.
- ALAP categories eases the process of register conversion.
- ALAP cheatsheet improves communication between the instructor and the learner.
- D/I Method provides an explicit, step-by-step, problem-solving approach.
- Increased self-confidence results in higher engagement.

Thank you.

The End