Julia Robinson Mathematics Festival

Magic Flowers Teaching Guide

Objective

Arrange five numbers into a magic flower.

Rule:

1. Every group of three numbers in a line must have the same sum, which is called the **Magic Flower Number**.

Introduction

Have ready to go cards numbered 1 through 5 and the Magic-5 number mat.

Two different ways to begin:

Method 1	Method 2
1. Without stating the goal, ask for suggestions for placing the numbers on the mat. 2. Ask a student to find the sum of each line of three numbers. 3. Explain that the challenge is to have both sums the same. 4. Ask for suggestions to rearrange the numbers so that every group of three numbers in a line has the same sum - the Magic Flower Number. 5. Follow their suggestions until together you find one solution.	1. Show a number mat that already has a solution in place. 2. Ask a student to discuss with a partner what they notice and wonder. 3. Share whole-group. 4. If they haven't noticed that the sum of each line is the same, point that out. 5. If they haven't wondered if there are any other solutions, tell them that there are two more ways to make a Magic-5 flower.

Common misconceptions

Students might think that:

a. The middle number can't be moved.

Exploration

In pairs, have the students try to make two more Magic-5 flowers. Encourage them to explore other strings of 5 numbers before trying Magic 7-Flowers. For example, 2 through 6 or the first 5 even numbers.

Circulate and ask questions to encourage deeper thinking:

a. Which number(s) do you try to place first?
b. Is there anything special about numbers that are in certain places? Is there anything special about the number in the middle, the pairs of numbers that surround the middle number?
c. Can you predict what the magic number is going to be before you make the magic flower?
d. Is there any way you can use what you learned from previous magic flowers to help you build new ones?
e. Do you think you will always be able to build a magic flower for any 9 *consecutive* numbers? If so, how? If not, why not?
f. Do you think you will always be able to build a magic flower for any 9 numbers? If so, how? If not, why not?
g. When a student is stuck, ask:
    i. What numbers have you tried in the middle?
    ii. What are you thinking about trying?
    iii. Encourage them to clear numbers and restart.
h. "Tell me more." is a great basic prompt for getting a student to explain their thinking.

Extend

Have the student pairs try the Magic Triangles task.
A difficult challenge to follow would be the Magic Squares task.

Discussion

As a whole group, have students share something about their experience with Magic Flowers. Try to have at least 3 students share out. Variations of the questions asked earlier are great for generating discussion, such as:

a. Was there anything special about the number in the middle?
b. Was there a strategy you used to place the rest of the numbers?
c. Can you predict the Magic Number before filling in the Magic Flower?

Materials

Large number mats for Magic-5, Magic-7, and Magic-9 Flowers
Set of number cards (1-20) - playing cards work well

or

Small number mats for Magic-5, Magic-7, and Magic-9 Flowers
Dry erase sleeves
Dry erase markers

Optional: Magic Flowers instructions and tasks
Magic Triangles extensions
Magic Triangles large number mats pp. 17-18 and small number mats
Magic Squares instructions and extensions
Magic Squares large number mats and small number mats

Assessment

Evidence of student learning during problem-solving activities can be obtained from three sources: observations, conversations, and products.

Observation involves actually observing students while they perform tasks and demonstrate skills and may take the form of a checklist or quick note.

Conversation involves engaging students in discussion that encourages them to articulate what they are thinking and then capturing that with a quick note.

Products are student-created records that capture not only their answer, but some of the process that led them to the answer.

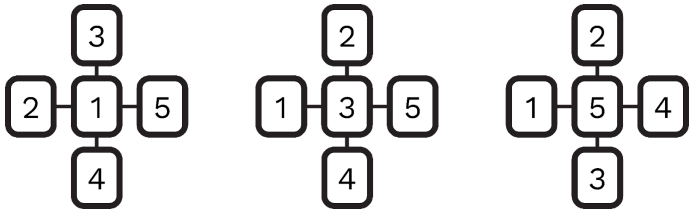
Standards

1. Make sense of problems and persevere in solving them.
   CCSS.MP1
2. Construct viable arguments and critique the reasoning of others.
   CCSS.MP3
3. Model with mathematics.
   CCSS.MP4
4. Attend to precision.
   CCSS.MP6

Answers

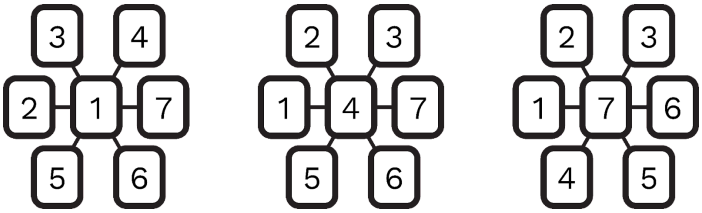
Answers to Magic Flowers Tasks:

1. Magic 5-Flowers
   a. Numbers 1 through 5: sums are 8, 9, and 10



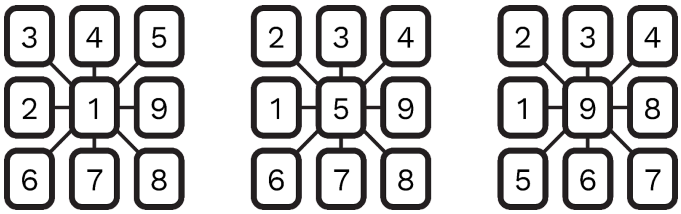
   b. Numbers 2 through 6: sums are 11, 12, and 13

2. Magic 7-Flowers
   a. Numbers 1 through 7: sums are 10, 12, and 14



   b. Numbers 2 through 8: sums are 13, 15, and 17

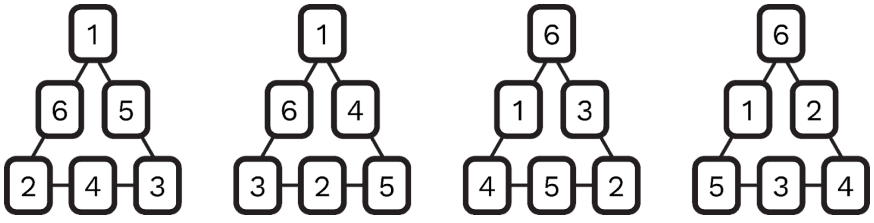
3. Magic 9-Flowers
   a. Numbers 1 through 9: sums are 12, 15, and 18



   b. Numbers 2 through 10: sums are 15, 18, and 21

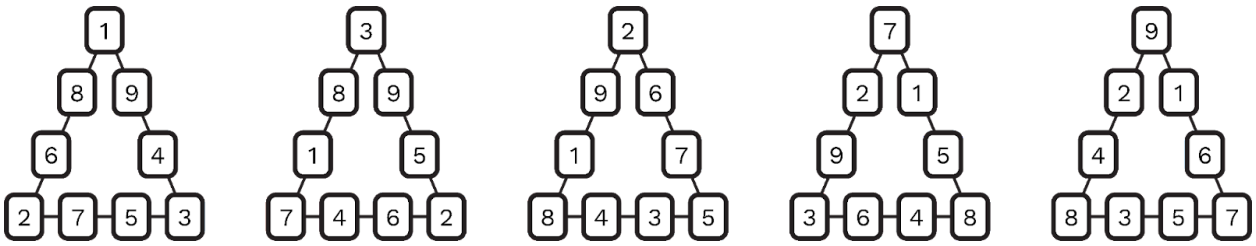
Answers to Magic Triangles Tasks:

1. Magic 6-Triangle
   - Possible side length sums are 9, 10, 11, and 12. See examples of each below:



2. Magic 6-Triangle
   - Solutions for numbers 2 through 7 (not shown) but their sums are 12, 13, 14, & 15.

3. Magic 9-Triangle
   - Possible side length sums are 17, 19, 20, 21, and 23. See examples of each below:



Answers to Magic Squares Tasks:

Students might come up with the following mathematical explanation but this is not an expectation for the activity:

To calculate the sum you need to find for each row, column, and diagonal, add all the available numbers and divide by the number of rows in the grid. For example,

1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9 = 45

45 ÷ 3 = 15 (Magic Number)

To find the middle number of the grid, divide the sum of all the numbers by 9.

45 ÷ 9 = 5 (middle number of grid)

Ruling out reflections and rotations there's really only one solution for each of the questions. Including reflections and rotations there are 8.

Possible Student Answers to Magic Squares Tasks:

Questions 1 to 6

All of these questions are related: to get from 1 to 9 to 2 to 10 (or any other consecutive set of numbers) you add 1 to each entry.

Similarly, to get from 1 to 9 to evens, you multiply by 2, and to get from 1 to 9 to odds, you can apply the formula 2n - 1 to each number.

4	9	2
3	5	7
8	1	6

1 to 9

5	10	3
4	6	8
9	2	7

2 to 10

6	11	4
5	7	9
10	3	8

3 to 11

8	18	4
6	10	14
16	2	12

Even

7	17	3
5	9	13
15	1	11

Odd

Question 7 Number Sets

6	13	2
3	7	11
12	1	8

1, 2, 3, 6, 7, 8, 11, 12, 13

5	11	2
3	6	9
10	1	7

1, 2, 3, 5, 6, 7, 9, 10, 11

no solution

1, 2, 3, 4, 5, 6, 7, 8, 10

4	11	3
5	6	7
9	1	8

1, 3, 4, 5, 6, 7, 8, 9, 11

6	15	3
5	8	11
13	1	10

1, 3, 5, 6, 8, 10, 11, 13, 15

no solution

1, 2, 4, 5, 7, 8, 10, 11, 13

6	12	3
4	7	10
11	2	8

2, 3, 4, 6, 7, 8, 10, 11, 12

7	16	4
6	9	12
14	2	11

2, 4, 6, 7, 9, 11, 12, 14, 16

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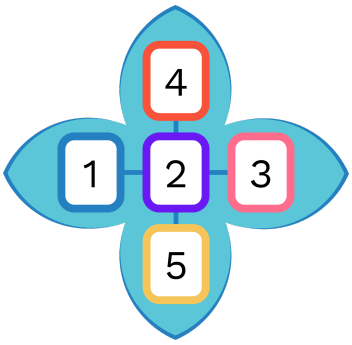
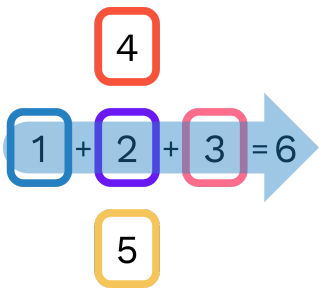
Magic Flowers Instructions

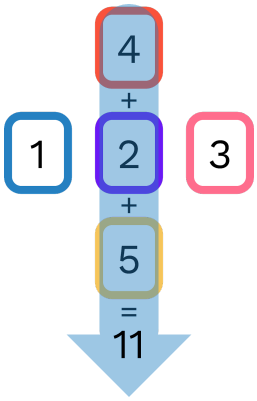
Can you rearrange the numbers to make a Magic Flower?



Rule:

A flower is a Magic Flower if the row and column add up to the same number.

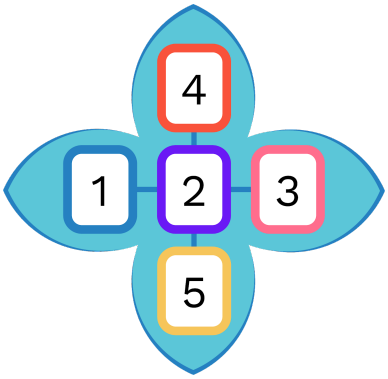




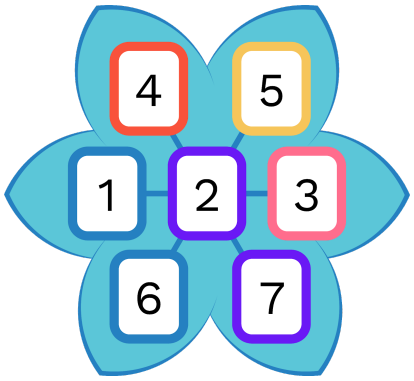
The example above is not a Magic Flower, because the row and column do not add up to the same number.

Magic Flowers Tasks

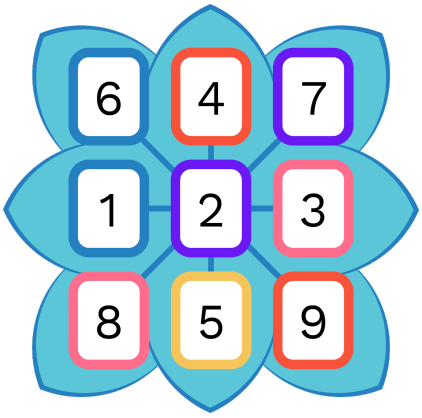
1. There are 3 different Magic 5-Flowers. Can you find them all? What if you use five different numbers such as 2 through 6?



2. There are 3 different Magic 7-Flowers? Can you find them all? Try exploring using 7 different numbers.

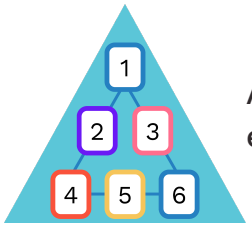


3. How many different Magic 9-Flowers are there?



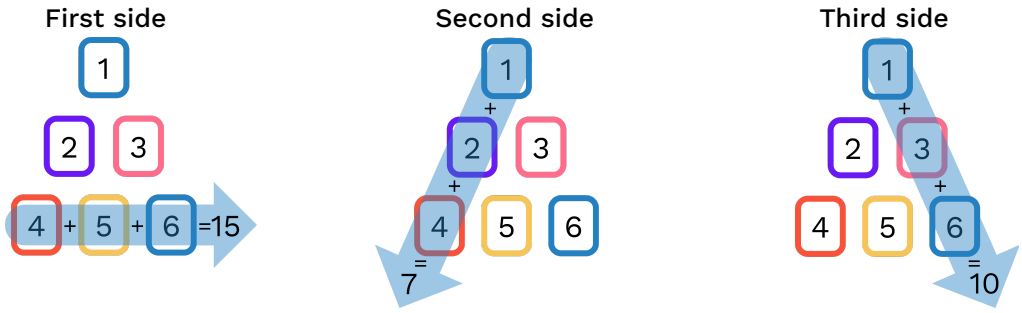
Magic Triangles Challenge Tasks

Turn your Magic Flower into a Magic Triangle!

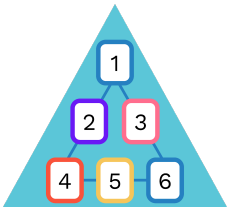


Arrange six numbers in a triangle so that the sum of numbers on each side is equal to the sum of numbers on every other side.

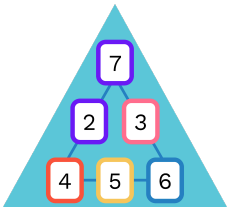
For example, below is not a Magic Triangle because the three sides do not add to the same number.



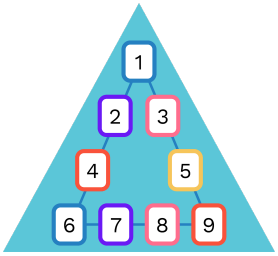
1. Can you make a Magic Triangle using the numbers 1-6?



2. Now try making a Magic Triangle using the numbers 2-7 or other sets of six numbers.



3. Can you build a Magic Triangle using the numbers 1-9?



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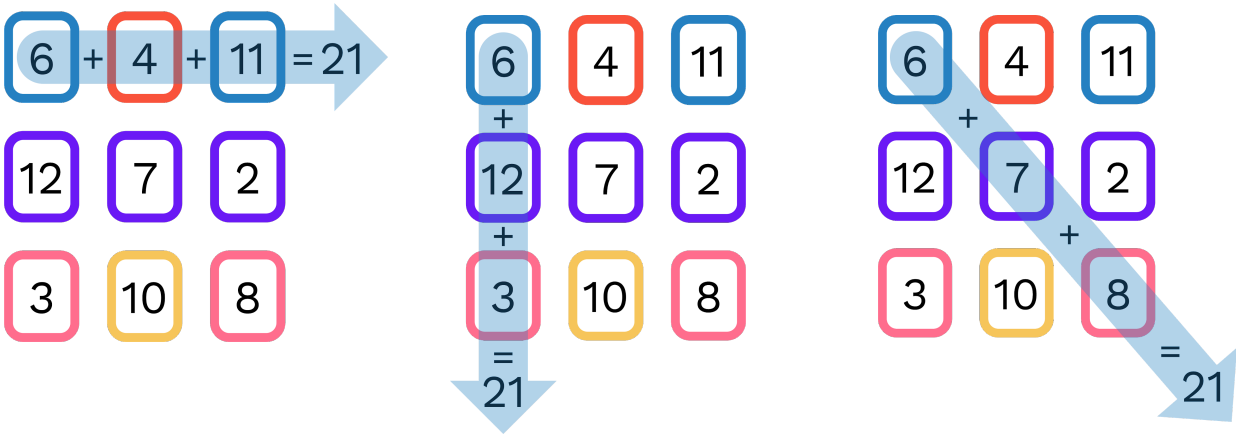
Magic Squares Instructions

Can you arrange nine numbers into a 3 x 3 magic square?

Rules:

- You may only use each number once.
- Every row, column, and diagonal must have the same sum, which is called the **Magic Number**.



Different sets of numbers will have different Magic Numbers.
The Magic Square above uses the numbers 2, 3, 4, 6, 7, 8, 10, 11, and 12,
and its Magic Number is 21.

Magic Squares Challenge Tasks

1. Using the cards labeled 1 to 9:

   a. First try making each row add to the same sum.

   b. Next try making each column add to the same sum as the rows.

   c. Now try making the diagonals add to that same sum.

   d. What's your magic number?

2. Now try making a magic square using the numbers 2-10. What is its magic number?

3. Can you make a magic square using the numbers 3-11? What is its magic number?

4. What if you use the numbers 4-12? 5-13? 6-14? Other sets of 9 consecutive numbers?

Magic Squares Challenge Tasks

5. Can you make a magic square using only consecutive even numbers?

6. Can you make a magic square using only consecutive odd numbers?

7. Can you make a magic square with the number sets below?

   a. 1, 2, 3, 6, 7, 8, 11, 12, 13

   b. 1, 2, 3, 5, 6, 7, 9, 10, 11

   c. 1, 2, 3, 4, 5, 6, 7, 8, 10

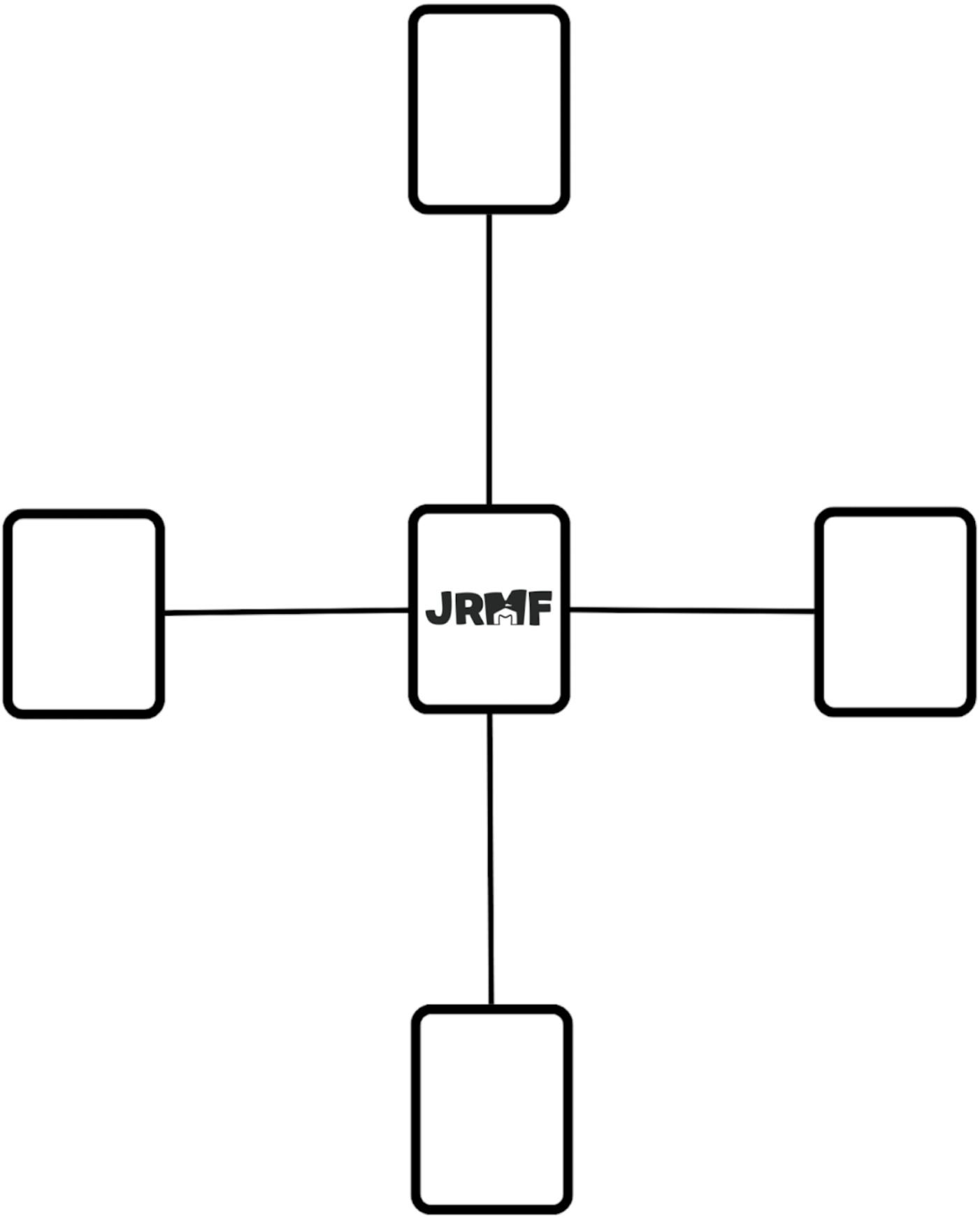
   d. 1, 3, 4, 5, 6, 7, 8, 9, 11

   e. 1, 3, 5, 6, 8, 10, 11, 13, 15

   f. 1, 2, 4, 5, 7, 8, 10, 11, 13

   g. 2, 3, 4, 6, 7, 8, 10, 11, 12

   h. 2, 4, 6, 7, 9, 11, 12, 14, 16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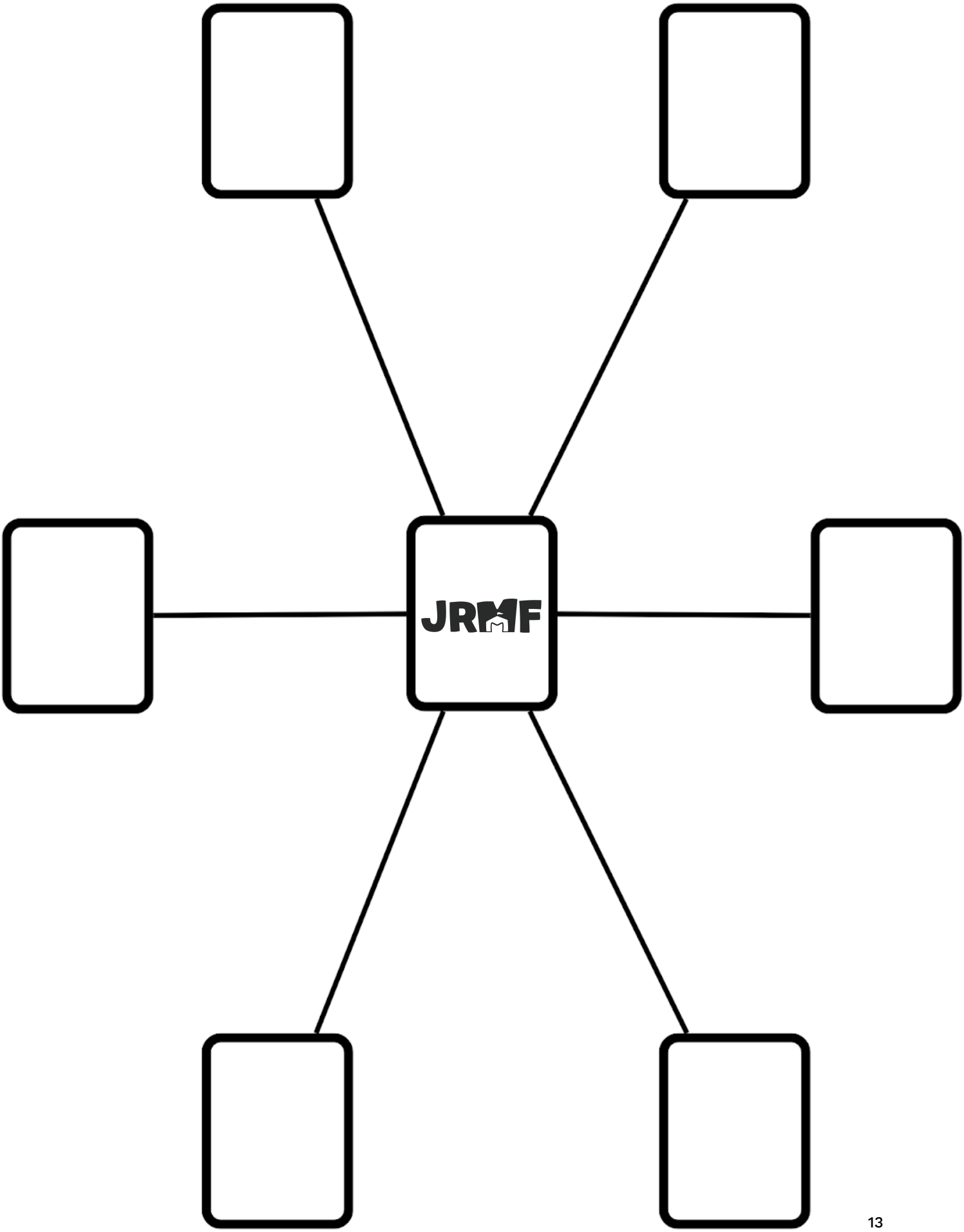
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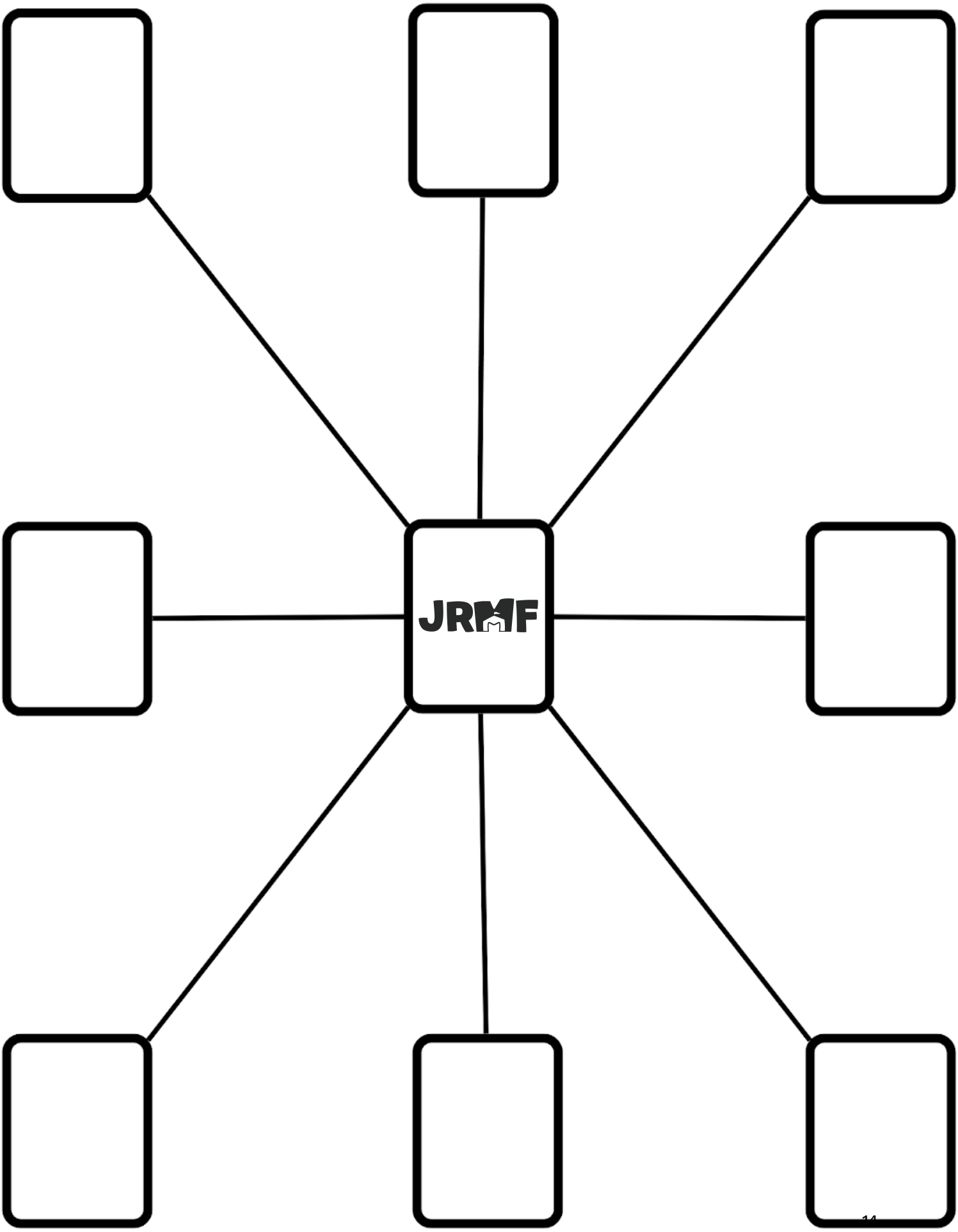
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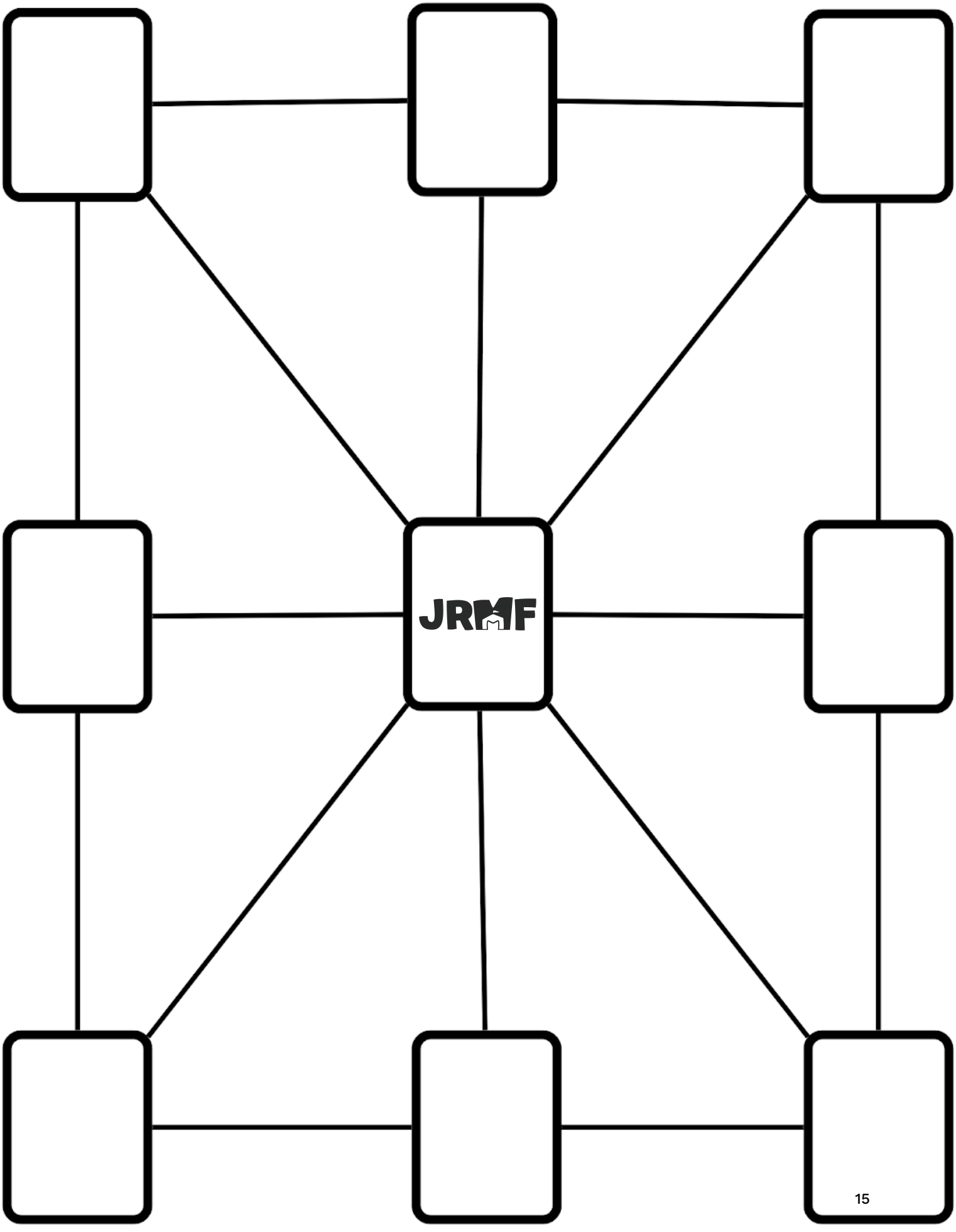
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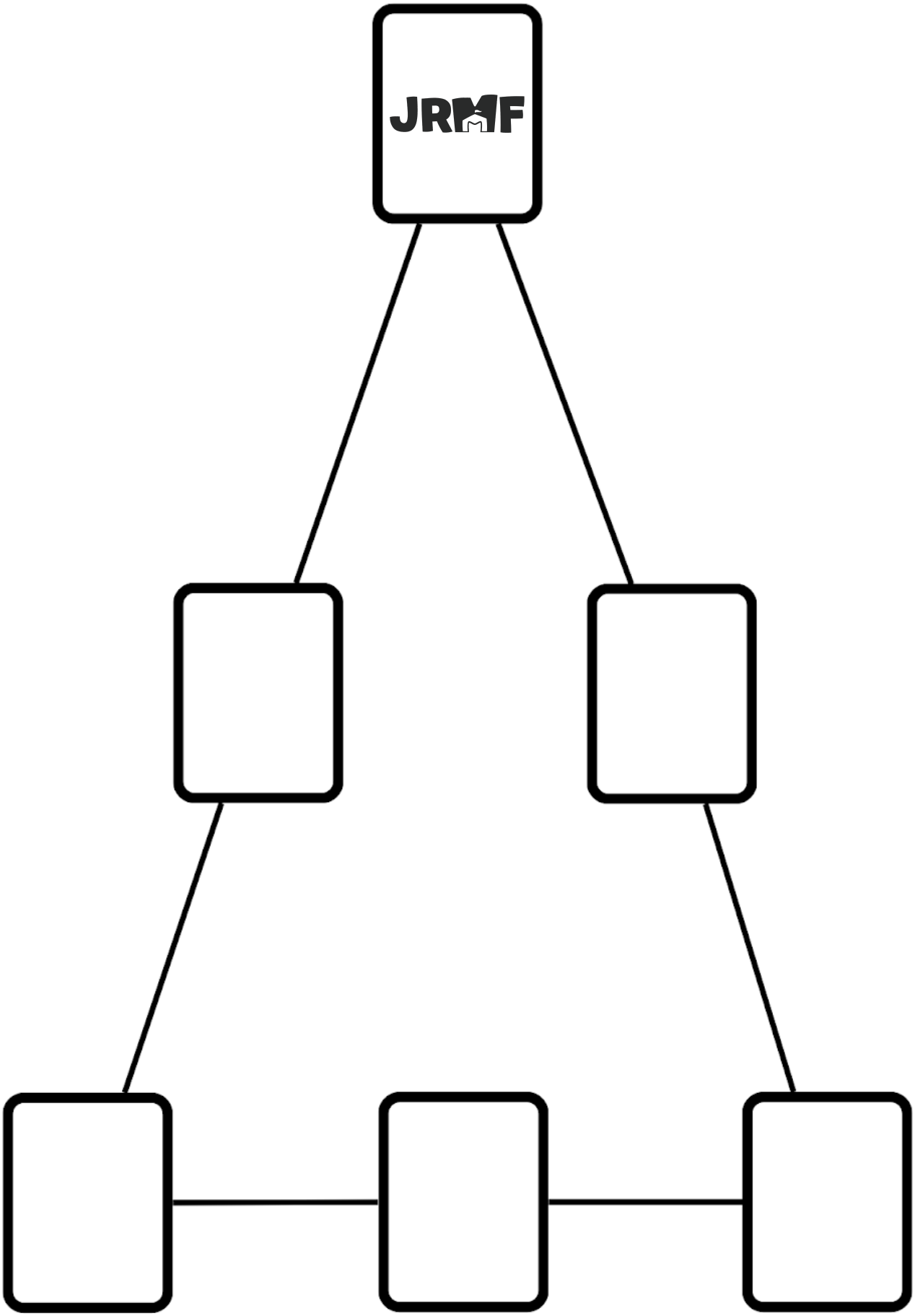
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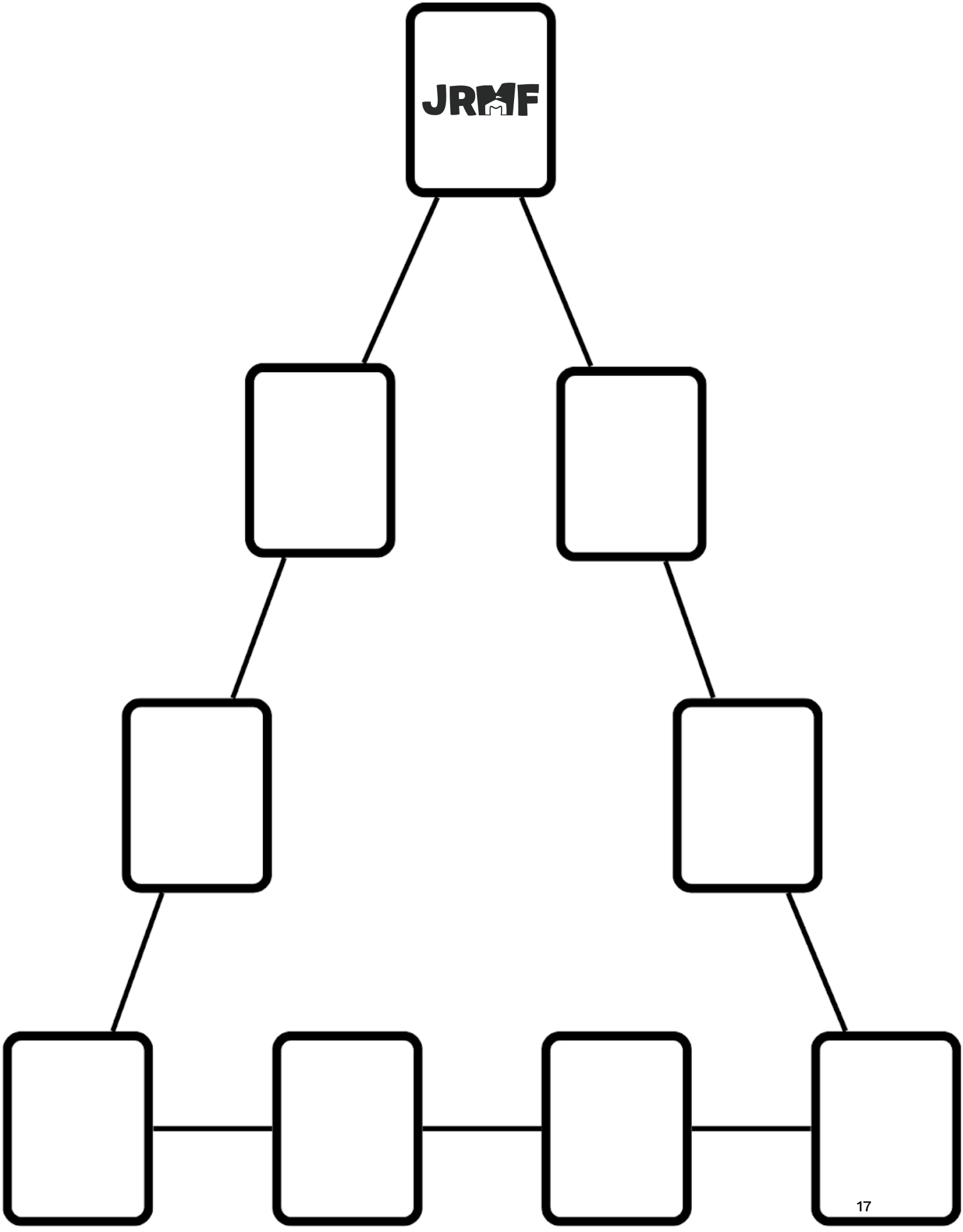
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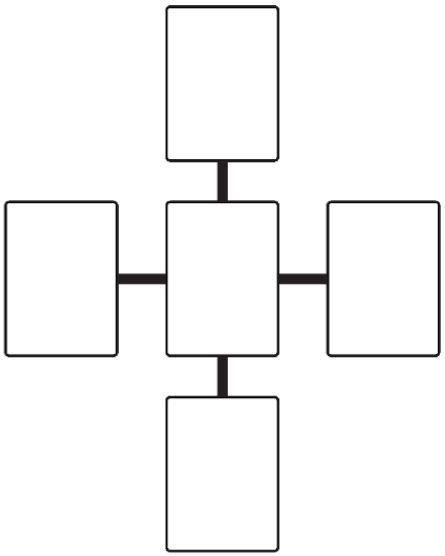
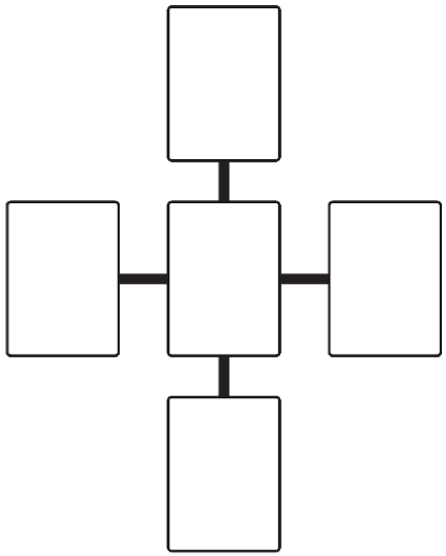
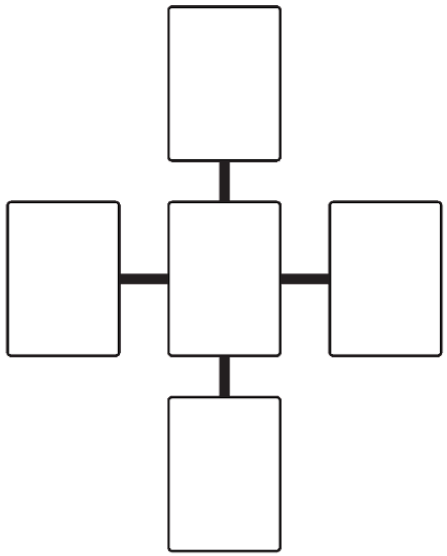
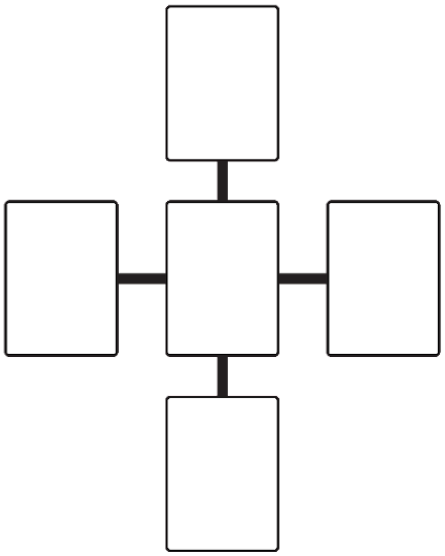
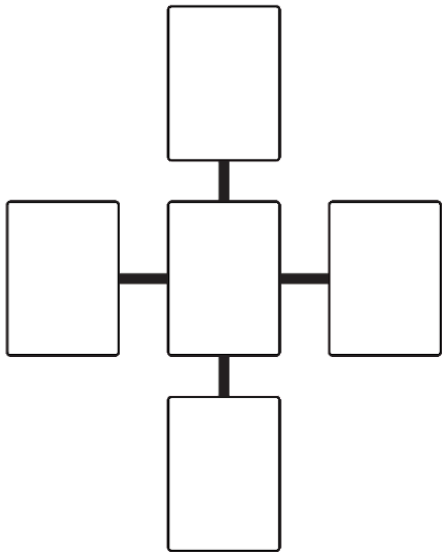
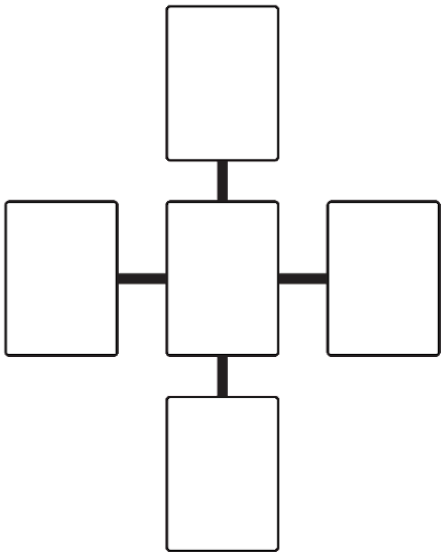
Magic Flowers
5-Flowers

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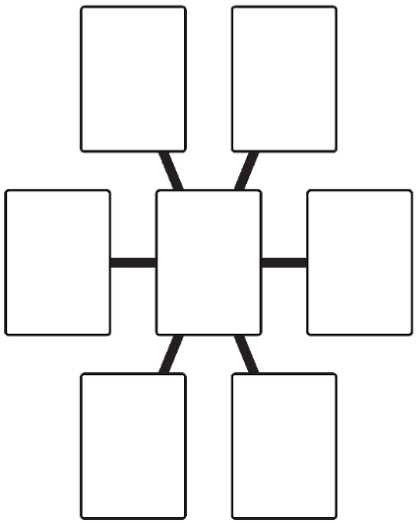
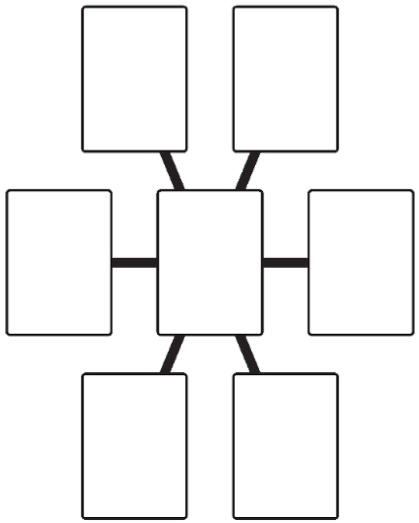
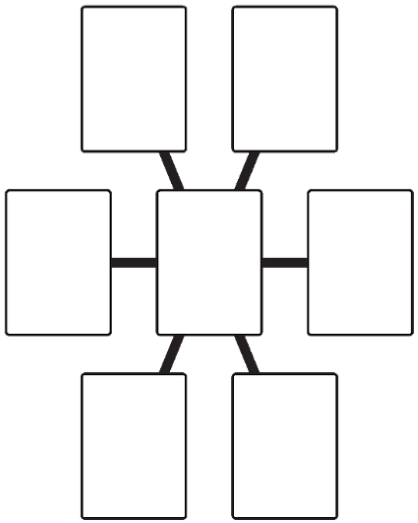
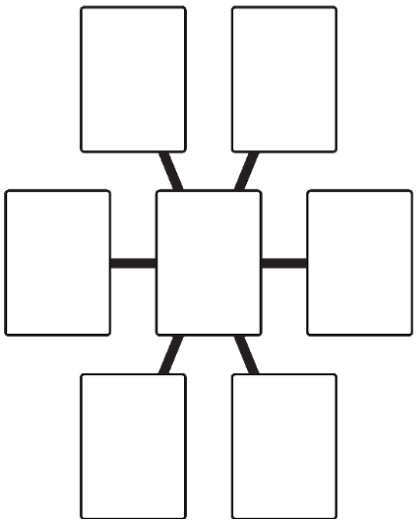
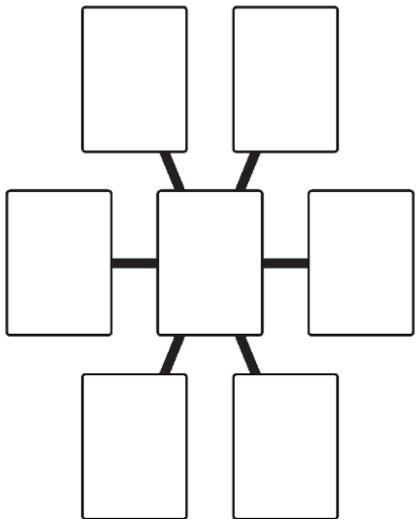
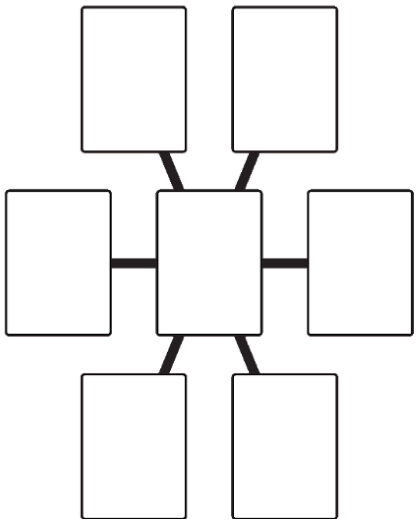
Magic Flowers
7-Flowers

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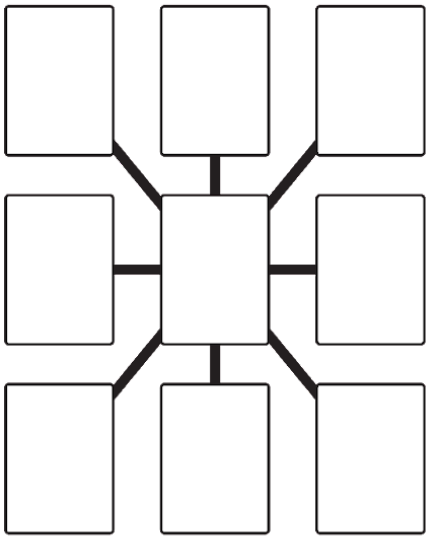
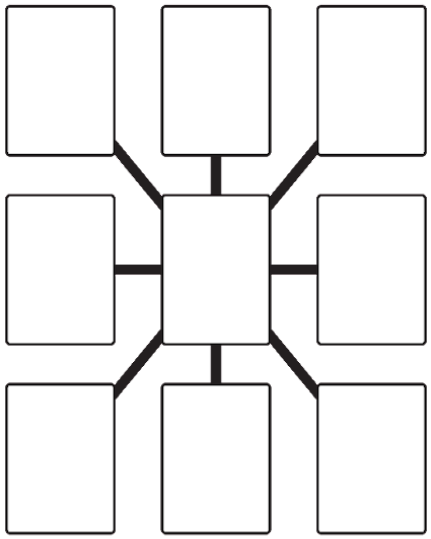
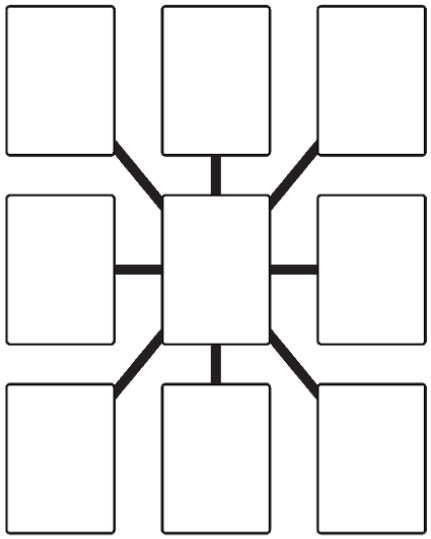
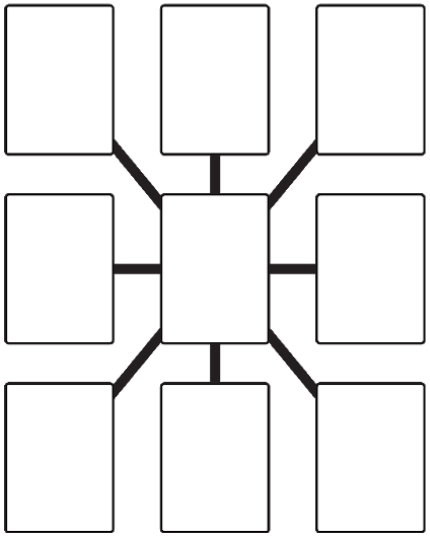
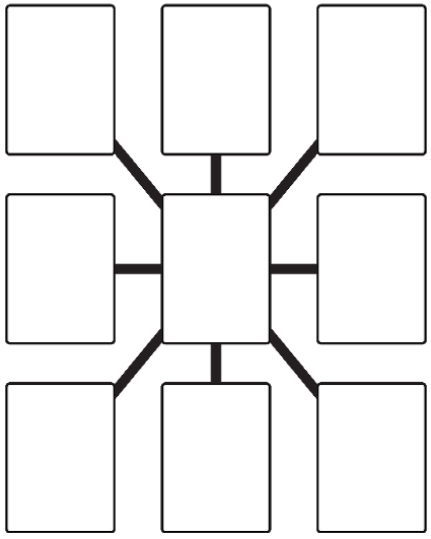
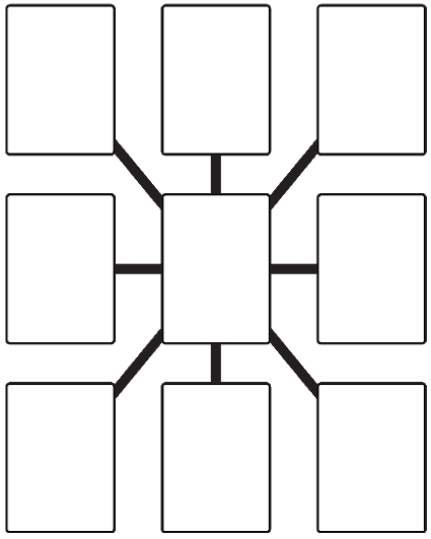
Magic Flowers
9-Flowers

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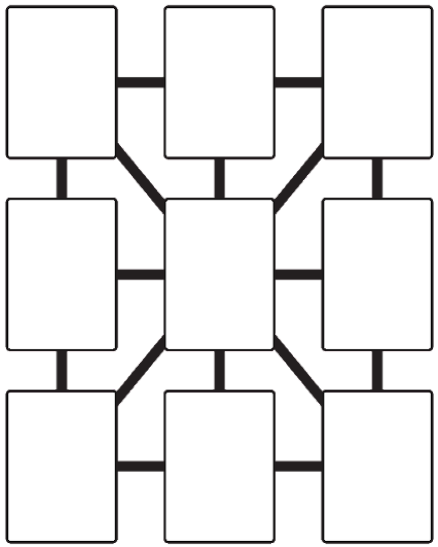
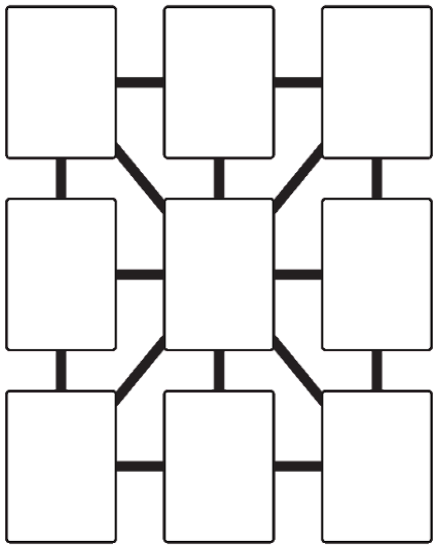
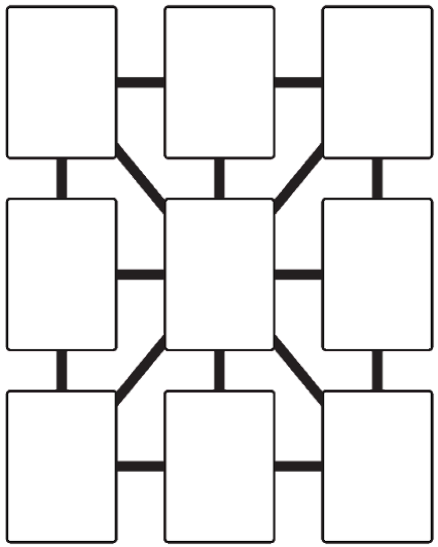
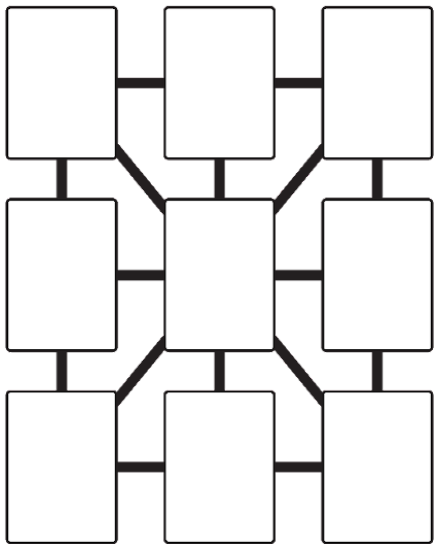
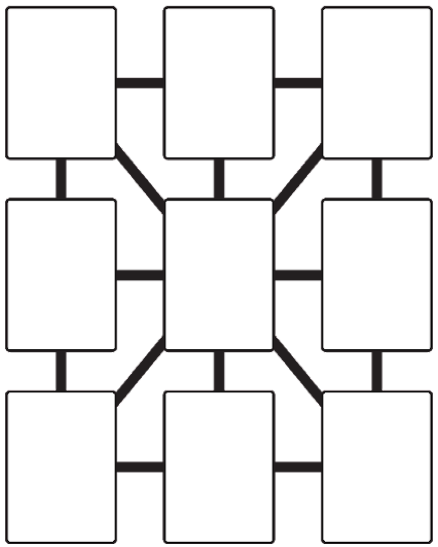
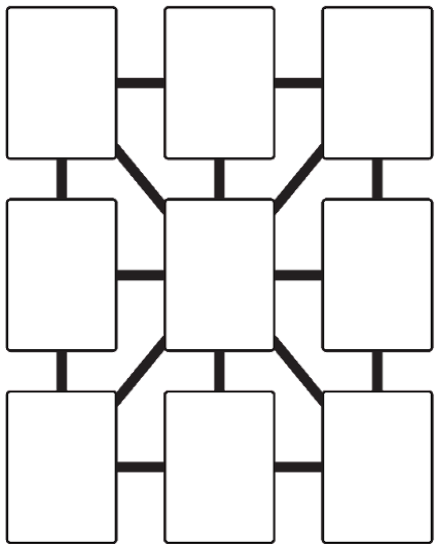
Magic Squares

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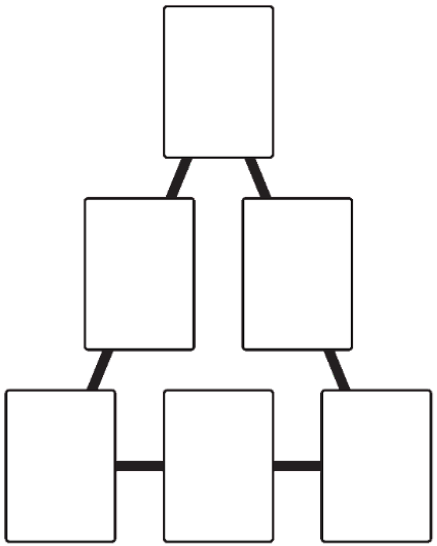
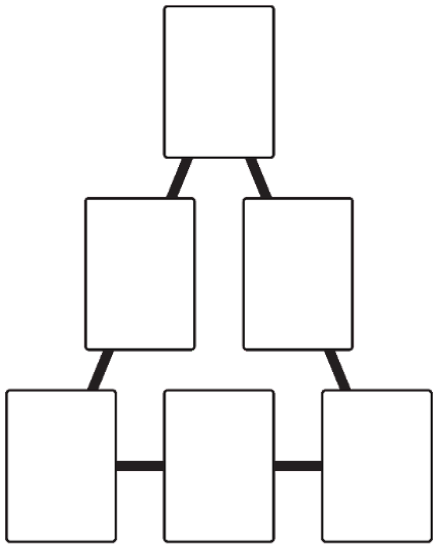
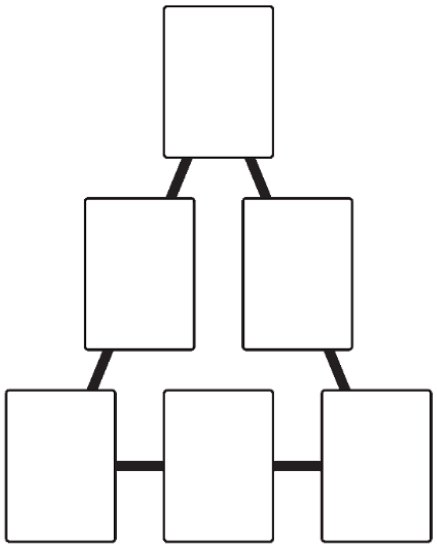
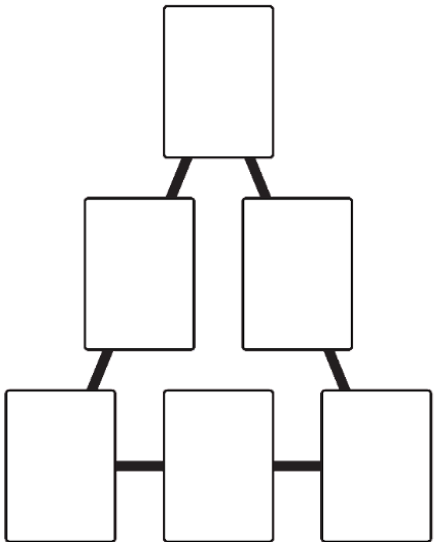
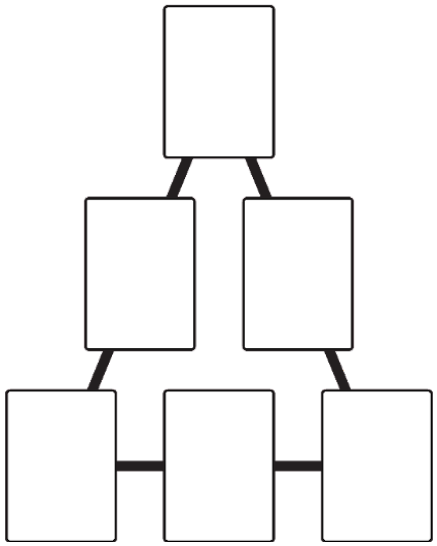
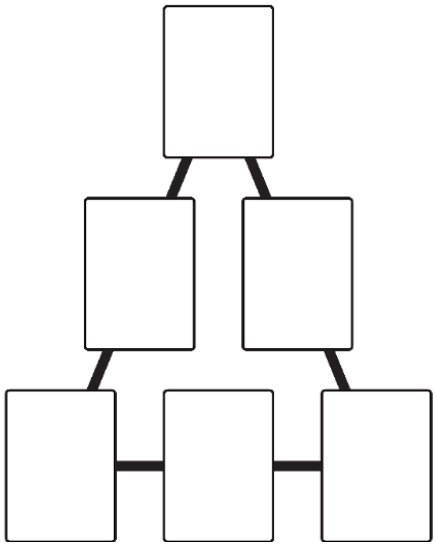
Magic Triangles

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Magic Flowers
Large Magic Triangles