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NETWORK SCIENCE: Hoop Network. Activity guide for facilitators

Worlds of Connections SEPA

NETWORK SCIENCE

Hoop Network

Activity guide for facilitators

WORLDS OF CONNECTIONS
SCIENCE EDUCATION PARTNERSHIP AWARD
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University of Nebraska Lincoln

HOOP NETWORK

Next Generation Science Standards*

Crosscutting Concept *4. Systems and system models*. A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems.

Objective

Youth will demonstrate how parts of a network are interdependent.

Materials

Per group

- Hula hoop

Per youth

- Paper or whiteboard
- Writing utensil(s)
- Eraser

Anticipatory Set

Begin by leading an open discusion using the guiding questions below. Seek to spark youth curiousity and make them wonder about groups that require coordination to achieve a goal.

- *What is it like to be part of a team that is trying to win a game?*
- *What makes being part of a group that is trying to accomplish something fun?*
- *What makes being part of a group that is trying to accomplish something hard?*
- *What helps people in a group work together well?*
- *What challenges must people in a group overcome to work together well?*

Procedure

Introduction

1. Invite participants to try the hula hoop and take turns.

2. Let them know that today you are going to explore systems and networks using the hula hoops in an unusual way.
3. Let participants know briefly what a system is: *A system is a group of interacting, interrelated, and interdependent components that form a complex and unified whole*.
4. As a group, come up with a few examples of everyday systems. What can youth think of that is made up of interacting, interrelated, and interdependent parts that come together to form a unified whole? Examples:
   a. Muscles, bones, skin, etc. form bodies
   b. Engines and pistons in cars
   c. Gears and hands in clocks
   d. Clouds, rivers, wind, and gravity, and more form weather systems
   e. Roads, cars, bikes, trains, and pedestrians form transportation systems
   f. Students, teachers, administration, and other staff members make up schools
5. Ask, *Is a hula hoop a system?*
   a. Alone, a hula hoop usually does not fit the criteria of a system.
   b. A person playing with a hula hoop might form a system because the person and hoop are interacting, they are interrelated, and depend upon each other for the hoop to stay up and not drop.

Activity 1 — Hoop network challenge

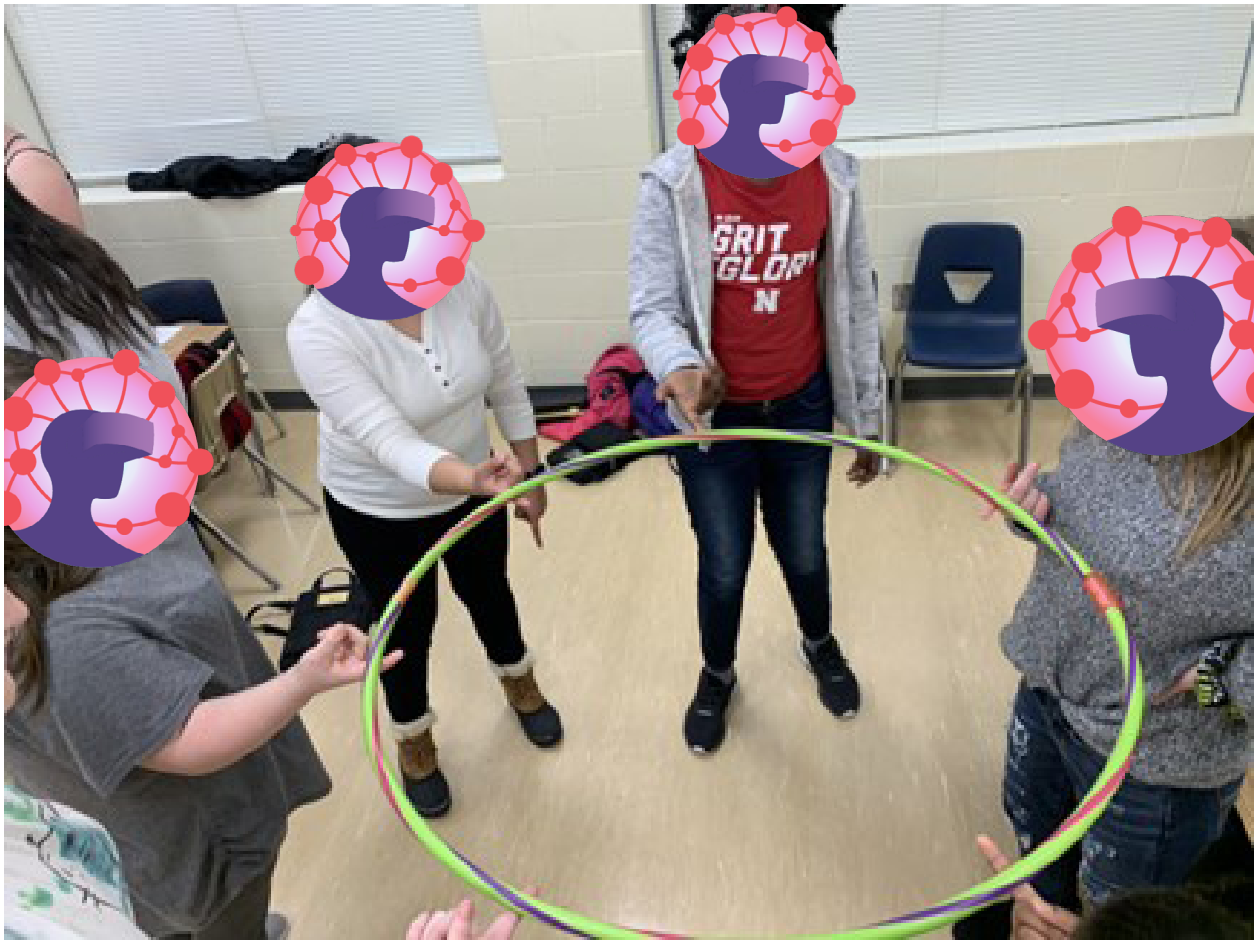
1. Let participants know that you are going to create systems by using the hula hoop together. It can be more fun if you tell youth that the activity is simple (which is true—they are just going to lower a hoop) because they might be surprised how hard it is to keep the hoop level.
2. Tips for facilitators:
   a. If youth struggle to lower the hula hoop, suggest experimenting with focusing on their neighbors vs. focusing on their own section. If participants focus on neighbors, lowering the hoop becomes harder, and the hoop rises. It is easier to lower the hoop when everyone focuses on their own section of the hoop.
   b. Facilitators can watch, guide, or particpate as necessary.
   c. Review **Reflection Questions for Discussion/Debrief** (p. 4) to discuss during the challenge.
3. Split the participants into groups of 3–4. Form circles wide enough for hula hoops in the center. Let participants know that the game requires everyone's cooperation to succeed. The team goal is to lower the hula hoop to the level of the participants' knees without anyone disconnecting from the hoop. Explain the rules:
   a. Rule #1: No one can stop touching the hoop. If they do, start over.
   b. Rule #2: Each person's finger touches only the BOTTOM of the hoop (no curled fingers).

c. Rule #3: Each person's finger must be straight throughout the duration of the activity. It is easiest if they put the hula hoop on top of their fingers with knuckles facing up.
d. Ask each participant to place the tip of one index finger under the hoop and hold it up to the shoulder height of the shortest person in the group. (Fingers point forward – see images below).

4. Instruct youth to lower the hoop to knee level without disconnecting from the hoop. After the first challenge, try the following variations:
   a. 2 people, 1 or 2 fingers
   b. 3 people 1 or 2 fingers
   c. 4 people, 1 or 2 fingers
5. After a few rounds of variations, have youth draw the networks that they created with the hoop. (See **Vocabulary**, pp. 7–8, for example network diagrams.) Ask them to think about which combinations of numbers of people and fingers made the hoop network challenge easier or harder.
6. Discuss:
   a. After doing the activity, how do you feel now? IS a hula hoop a system?
   b. Review the network drawings. *Which variations are easiest/hardest?*

Activity 2 – Hoop network challenge: Advanced mode

1. Increase the number of participants in each group to 5-6 and repeat **Activity 1**. (You can combine groups or include facilitators if needed.)
2. Ask the youth what changed by adding more people to the group. Ideas:
   c. Des the task become easier (more stable) or harder (more to coordinate) when more people (nodes) are added?
3. Have youth review the networks that they drew, try to figure out which ones made the challenge easiest/hardest, and explore why.



Differentiation/Extension

- Try lifting the hula hoop instead of lowering it.
- Have intermediate goals for lowering (see "Colorful Connections" video in **References**, p. 9).
- Change position of the index finger (knuckles face down vs. knuckles face up).

Reflection Questions for Discussion/Debrief

Questions for a debrief discussion to connect the activity to network science and health.

Explore the idea of relationships between individuals in systems, e.g. the hula hoop network challenge, as models for how each club member matters for club success:

- *Was any one person's finger most important on the hoop?*
- *What happened when a finger stopped touching the hoop?*
- *What are possible similarities between collaborating to lower the hoop and collaborating in other groups? What are possible differences?*
- *How much control do you have over the hoop and/or other youth in the group?*

This activity can help with establishing norms of group behavior for the club, for example, facilitators might want to ask:

- *What can we do as club members to help the group (represented by the hoop) have balanced, gentle, and efficient time in club?*

If relevant to the club theme, explore how network models are relevant to health phenomena (see **Background**).

- *What can the hoop represent in our lives and help us explore?*
  - *If the hoop represents a playground, who is responsible for keeping it a place where kids want to play?*
  - *If the hoop represents a community pool, who is responsible for keeping it clean and safe?*
  - *If the hoop represents our collective health, how do all of us contribute to our collective health?* (Possible answers: *getting vaccinated, staying home when we are sick, washing hands, wearing masks.*)
- *How does the hoop network exemplify core concepts in network science?* (Examples below. See also **Quick Reference on VIPS**, p. 10)
  - **Visualizing relationships**: Participants build a network model.
  - **Interdependence**: Participants experience how each participants' actions matter for what happens with the hoop.
  - **Position**: The hoop activity involves forming a hub-and-spoke network in which no person is directly connected, thus people experience how position in the network matters for how the activity unfolds.
  - **Scope**: Participants form a small network in this activity. Connecting to larger networks happens through reflection/discussion about other kinds of interdependent systems with hubs such as bus stations or airports.

Career/Future Application

The basic network ideas and skills in this activity can be used in numerous career paths to study patterns of behavior and reveal hidden connections. **Sociologists**, **computer scientists**, **biologists**, **anthropologists**, **engineers**, **neuroscientists**, and many others can use network science in their work.

Background

So what?

Interdependence in networks is a core concept that can be hard to comprehend in the abstract. Participating in the hoop network helps youth experience networks as models of interdependent systems. Unless all participants are touching the hoop with the same amount of force, the hoop will rise because of interdependence.

There are several health-related phenomena in which network interdependence matters in ways similar to what youth experience when they try to collectively lower the hoop. For example:

- If people get vaccinated against an infectious disease, they protect the people who cannot get vaccinated.
- If most people in a community shop at a local grocery store, they help keep access to nutrition in their community.
- If people eat too much of one food group and not enough of another, unbalanced nutrition can lead to worse health.
- If communities add more walking/biking paths, everyone in the community has more opportunity for exercise and can help reduce air pollution.
- When members of a community are connected in a network of support, they can get help when they need it.

Network details

We adapted an activity focused on leadership and teambuilding to provide a fun way to introduce basic network concepts. Club participants, their fingers, and the hula hoop form a network. Each person touching the hoop is a vertex (node). The arms/fingers are the edges (links/ties). The hula hoop becomes a hub when all the participants are touching it, and the edges become spokes. (Note: this is a *bipartate* network. It contains two types of nodes—people and the hoop—rather than nodes of a single nature, e.g. person to person.)

When holding the hula hoop with one finger, each participant has a degree of 1, and the hoop hub has a degree equal to the number participants. If participants use two fingers each, the degree doubles.

Vocabulary

Note: The vocabulary terms are helpful for the activity facilitator to learn the scientific language used in the activity and within the network science community. You can decide if you want to emphasize vocabulary or not.

Network

1) A set of relationships; 2) can be visualized as models to show how things are connected; 3) when mapped, reveals hidden information.

Vertex (vertices)

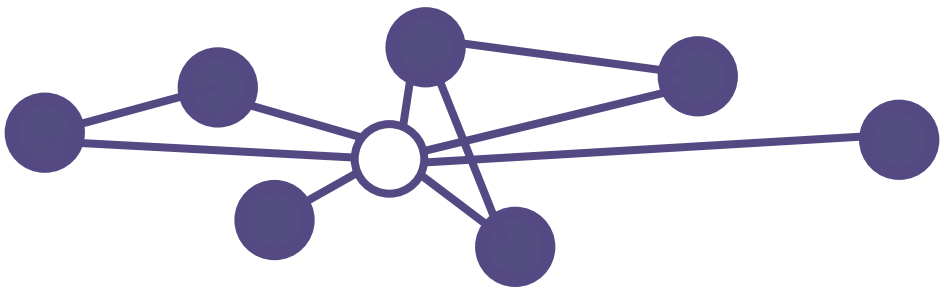
Also called a node, usually drawn as a circle; can represent different things in a network (e.g., people, animals, cells in the body, organizations). For example, vertices or nodes representing an immediate family can include siblings, guardians, and even pets.

Edges

The lines connecting vertices in a network that represent relationships. Arrows can indicate the direction of the relationship. The first example below shows an undirected edge; the second example shows a directed edge; the third example shows a bidirectional edge.

Hub

A node that has a lot more connections than the rest. In other words, it has a much higher **degree** compared to the other vertices. The center (white) node below is a hub.

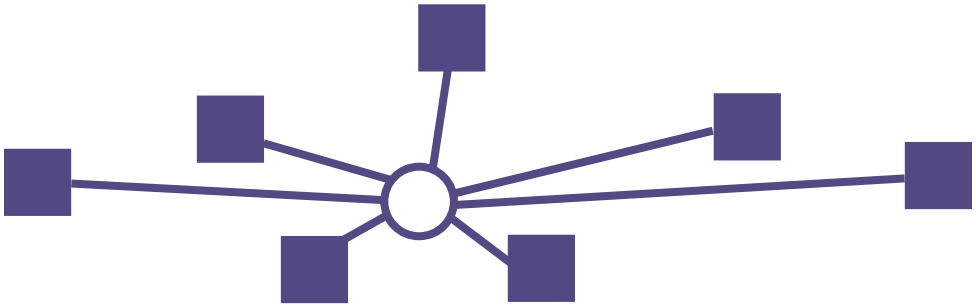


Degree

The number of lines a vertex has connected to it. The center (white) vertex pictured on Page 7 has a degree of six. (Note: In this activity, we count each finger touching the hula hoop as one edge. So, if each participant has one finger touching the hoop, then each participant has a degree of one, and the hub has a degree as high as the number of participants. If each participant uses two fingers, then the degree doubles.)

Bipartate network

A network that has nodes with different natures (e.g. some nodes are students and some nodes are schools), and the edges/links are ONLY between unlike nodes. They are also called "affiliation" or "two-mode" networks. The network below with the circular node in the middle and the square nodes around the edge is an example of a bipartate network.



System

"A system is a group of interacting, interrelated, and interdependent components that form a complex and unified whole. Systems are everywhere—for example… the circulatory system in your body, the predator/prey relationships in nature, the ignition system in your car, and so on" (Benson and Jost 2019). The Next Generation Science Standards crosscutting concepts define systems as "an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems…..Models are limited in that they only represent certain aspects of the system under study" (NGSS Lead States 2013).

References

Next Generation Science Standards crosscutting concepts

NGSS Lead States. (2013). APPENDIX G: Crosscutting concepts in the Next Generation Science Standards. In *Next Generation Science Standards: For States, By States.* Washington, DC: National Academies Press.

Our definition of "system" is from...

Benson, T., and T. Jost. (2019). Introduction to systems thinking for early childhood. Waters Center for Systems Thinking CEELO Leadership Academy, Washington D.C., July 3—Aug 1, 2019. http://ceelo.org/wp-content/uploads/2019/08/CEELO_2019Cohort5Workbook.pdf

Our definition of "Bipartate Network" is from...

Liew, C.Y., Labadin, J., Kok, W.C. et al. (2013). A methodology framework for bipartite network modeling. *Appl Netw Sci 8*, 6 (2023). https://doi.org/10.1007/s41109-023-00533-y

This activity is based upon the leadership activity "Helium Hoop."

Leadership Inspirations. (2018). Helium hoop. *Leadership Inspirations*, https://leadershipinspirations.com/helium-hoop/

Watch a group trying to do the activity in a video about integrity in leadership:

ILI Team. (2012, August 1). Activity 5 - Helium hoop [Video]. *YouTube*, https://www.youtube.com/watch?v=QFm5_4ULy_4

Another leadership version of the activity:

jay3ROI. (2013, May 12). Helium hoop teambuilding ROI [Video]. *YouTube*, https://www.youtube.com/watch?v=Su2JSFsEj5U

Examples of coaching for success:

Hambleton, Rob. (2017, November 10). Colorful connections hula hoop success and debrief [Video]. *YouTube*, https://www.youtube.com/watch?v=pryFNjwdL5U

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Quick Reference on Visualization, Interdependence, Position, and Scope (VIPS)

This guide is designed to give activity leaders the core themes for using network models to analyze systems.

Visualization

- What does the image represent?
- What are the nodes/vertices or what do the nodes represent? (Could be trees, neurons, story characters, friends, family, planets, chemicals, countries, bus stops, airports, etc.)
- What are the edges—what connects nodes? In other words, what are the ties? (Could be friendship, advice-seeking, dendrites, genes, mycelium, gravity, roads, information-sharing, chemical bonds, bytes, touching, territory, trade routes, etc.)

Interdependence

- What flows or moves through the system?
- Does a change in one node/vertex (e.g. remove it, change properties, change resources, drop or add connections) result in a change for other nodes/vertices?
- Do nodes/vertices have ways to gain more or avoid more if they want to by changing themselves only, or do they need other nodes or connections to change to achieve their goals?

Position

- If a node/vertex was removed, would that make a difference for any other nodes/edges?
- If a node/vertex was added, would that make a difference for any other nodes/edges?
- Does it matter which nodes/vertices or which ties/edges are removed or added for flows/distribution from node to node?

Scope

- Compare networks of different phenomena. Do the ideas of nodes/vertices; ties/edges; direction of flow (one-way, two-way, mutual); the position in a network of nodes; the presence or absence of ties; or other characteristics of the networks work in the same way or differently for different phenomena?
- What makes such phenomena systems? Think about what is similar or different among phenomena such as flavor combinations, genes and diseases, genetic inheritance, tree communication, disease spread, and/or support from and conflicts among family members.