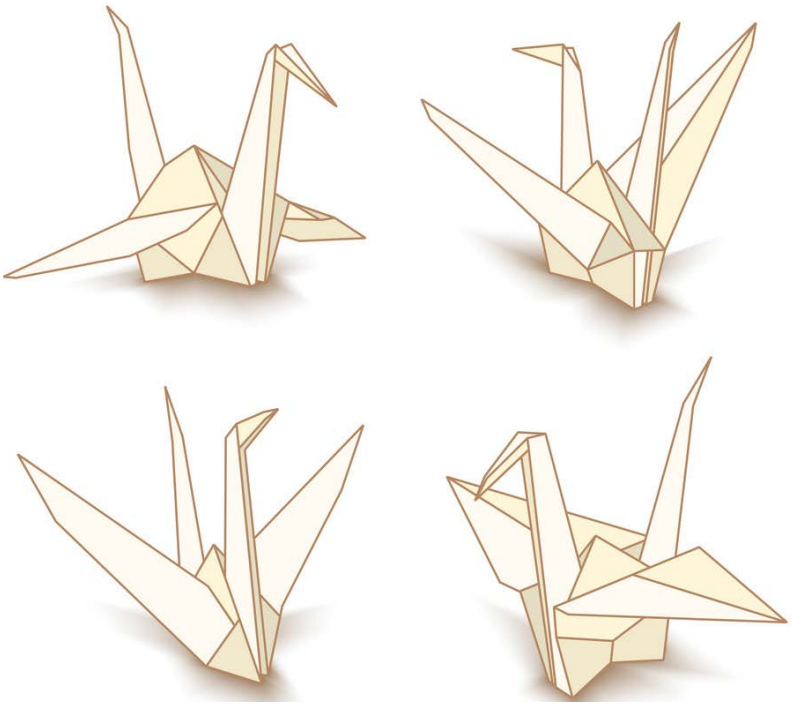
HANNA DEROCHE, MEAGHAN JEREMIC, WALKER KITCHENS, DEANNE WAH

Origami

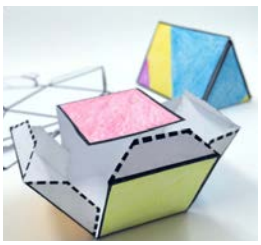
& Its Role in Geometry and Spatial Reasoning



HISTORY OF ORIGAMI

Origami is the Ancient art of paper folding, where one square piece of paper is folded into various shapes. By the 1800s, children in Japan were learning the art of paper folding. With Origami came the popularized legend that folding 1000 paper cranes would grant the folder a wish; cranes were thought of as noble, moral, beautiful, and truthful in Japanese and Chinese cultures. *Sadako and the 1000 Paper Cranes* is a book based on a Japanese girl who developed cancer after the Hiroshima bombing. She then attempted to fold 1000 paper cranes as a wish for world peace.

Ethnomathematics is the study of the relationship between mathematics and culture. The goal of ethnomathematics is to contribute to both the understanding of culture and the understanding of mathematics, and mainly to lead to an appreciation of the two.



CURRICULUM CONNECTIONS

Geometry and Spatial Sense (from the Ontario Ministry of Education):

- Spatial sense is the awareness of one's surroundings and the objects within them, and this can be represented through shapes and geometry
- Spatial sense is necessary for understanding and appreciating the various geometry aspects of our world

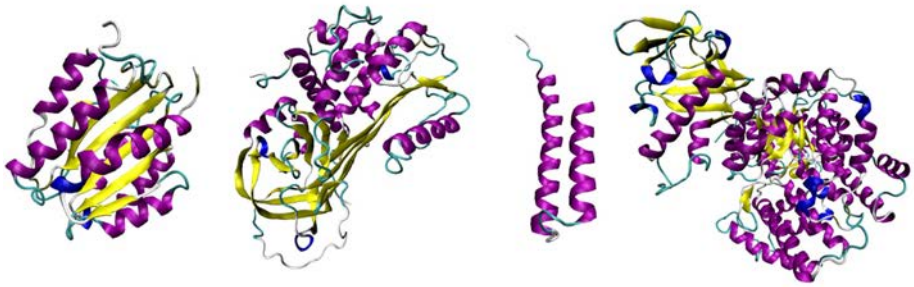
Throughout the grades, children are assessed on whether or not they can;

- Compose and decompose common 2D shapes and 3D figures (grade 1)
- Identify and name shapes according to attributes (grade 1)
- Describe the relative locations of objects on a map (grade 2)
- Identify and describe the locations and movements of shapes and objects (grade 3)
- Construct 3D figures using 2D shapes (grade 4)
- Identify and construct nets of prisms (grade 5)

LESSON IDEAS

Origami Math (Robertson Program)

- Connection between math, history and visual arts through origami
- Students will be able their understanding of two- and three-dimensional geometric properties and relationships in a real-world application
- Allows students to interact with shapes and angles as well as shape composition



REAL WORLD APPLICATIONS OF ORIGAMI

The spatial skills, geometry and patterning used in origami can lead to careers in Science, Technology, Engineering, Arts, and Mathematics (STEAM). There are various real-world examples of origami being used in STEAM.

Protein Folding in Biology:

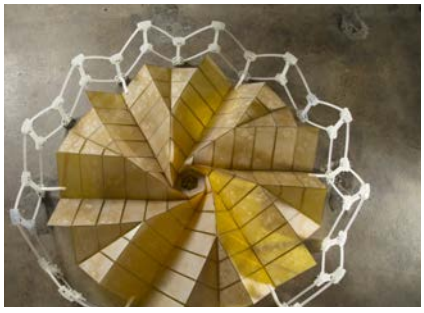
Foldit is a crowdsourcing game for anyone interested in predicting and creating protein structures using the principles of folding, chemical bonds, and interactions between moieties. Players can find the best protein structure fo specific functions (i.e., curing diseases).

DNA Origami for Drug Delivery:

DNA origami is a technique that uses principles of origami to fold DNA into a desired shape. It is useful at the nanoscale to carry drugs to target cells.

Origami-Inspired Solar Array:

Using the principles of origami, specifically the Miura map fold, scientists from Brigham Young University created a deployable solar array. The solar array collapses like a fan and expands in space to capture solar energy.



SPATIAL REASONING TASKS

Foldable Nets

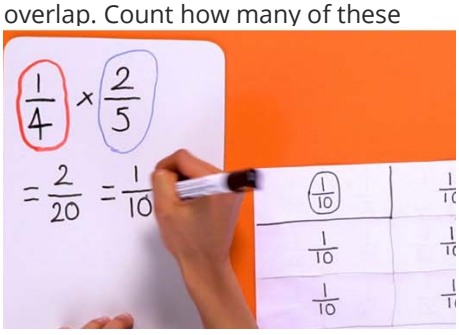
Foldable nets require students to visualize how a 2D net can be folded into a 3D structure. This requires students to mentally manipulate objects using spatial visualization.

Hole Punch Symmetry

Students will visualize how folded paper will look once unfolded. Where will the hole punches be? Can the students describe the designs and pictures of images with a vertical, horizontal, or diagonal line of symmetry?

Folding Fractions

Can be used to visualize multiplication of fractions. The denominator of the first fraction tells us how many rows we need to make by folding our paper. The denominator of the second fraction tells us how many columns we need to fold. The numerator of the first fraction tells us how many rows we should shade. The numerator of the second tells us how many columns we should shade. Colour each section in with different colours, for each numerator. We then need to identify the sections which have both been shaded in, and overlap. Count how many of these



SPATIAL REASONING

Spatial Reasoning involves the location of objects and ourselves, either mentally or physically, within space, and incorporates a number of concepts, tools and processes. Spatial reasoning is critical to mathematical processes as it allows us the ability to understand and modify complex sets of data, and translate concepts into concrete ideas.

CONNECTION TO INDIGENOUS CULUTRE

In 2019, the First Nations Centre at the University of Northern British Columbia began an initiative to have staff and students fold 1000 paper ravens (which are symbolic in indigenous cultures) as a wish for reconciliation.

FURTHER READING

ORIGAMI-BASED INSTRUCTION HAS A POSITIVE EFFECT ON SPATIAL VISUALIZATION, SPATIAL ORIENTATION AND GEOMETRIC KNOWLEDGE.
"Results indicated that origami-based instruction had a positive effect on elementary students' spatial ability scores (pg.65)."

ORIGAMI CAN GROUND GEOMETRY IN REAL-WORLD EXAMPLES.
"Origami helps students see that math emanates from various cultural activities, and that it is not just comprised of formulas and calculations (Pg. 277)."

ORIGAMI ENGAGES STUDENTS IN MATH IN DIFFERENT WAYS.
"Artistic Aspect of origami can help teachers excite students who are more artistically inclined about mathematics (Pg. 277). Participants developed positive opinions about origami-based instruction and its relation to math (Cakmak, Isiksal & Koc, 2014, p. 65)."

References

Akayuure, P. Asiedu-Addo, S.K., & Alebna, V. (2016). Investigating the Effect of Origami Instruction on Preservice Teachers' Spatial Ability and Geometric Knowledge for Teaching. International Journal of Education in Mathematics, Science and Technology 4(3), p. 198-209.

Cakmak, S., Isikal, M., & Koc, Y. (2014). Investigating effect of origami-based instruction on elementary students' spatial skills and perceptions. The Journal of Educational Research, 107(1), p. 59-68.

Coerr, E. (1977). Sadako And the Thousand Paper Cranes. New York City, U.S.A.: G.P. Putnam's Sons.

Hull, T. (2015). Origami: Mathematics in creasing. The Conversation. Retrieved from https://theconversation.com/origami-mathematics-in-creasing-33968.

Hysolli, E. (2018). DNA origami suit up to thwart molecular villains. Wyss Institute. Retrieved from https://wyss.harvard.edu/news/dna-origami-suit-up-to-thwart-their-molecular-villains/.

Kumar, Geeta. (2018). Origami Math. The Robertson Program.

https://www.bbc.co.uk/bitesize/topics/znmtsbk/articles/zd6dqhv.

Ontario Ministry of Education. (2005). The Ontario Curriculum, 1-8: Mathematics. *Government of Ontario*. Retrieved from http://www.edu.gov.on.ca/eng/curriculum/elementary/math18curr.pdf.

Ontario Ministry of Education. (2014). Paying Attention to Spatial Reasoning: K-12. *Government of Ontario*. Retrieved from http://www.edu.gov.on.ca/eng/literacynumeracy/lnspayingattention.pdf.

Wares, A. (2013). "Appreciation of mathematics through origami." International Journal of Mathematical Education in Science and Technology, 44(2), 277-283.