

Geologic Maps Foundation, Inc.

(California Secretary of State Entity Number: C3901556)

Ventura, CA 93001 USA, Tel: 818-429-4278

Email: geologicmapsfoundation@gmail.com, Web page: geologicmapsfoundation.org

Subject: ICMAPS (Increasing Cognitive Map Abilities and Participation System)

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Summary: Over the last 5 years, the Geologic Maps Foundation (GMF)¹ has developed ICMAPS which increases the education and experience of science instructors and science communities with maps and field-skills in the earth sciences. ICMAPS (Increasing Cognitive Map Abilities and Participation System) builds on the innate, spatial-cognitive abilities, navigational, and leadership skills of the participants through in-person and virtual field trips, and courses that integrate with several earth science field skills. Research shows that increasing cognitive map use and skills will develop and strengthen portions of the human brain used for learning and success in the STEM subjects^{2,3,4} and, simultaneously, increase personal confidence with the quantitative parts of STEM.² Technology can fail, or information be misunderstood. Being lost covers more than disorientation in the outdoors, implies disconnection from many forms of reference, and can lead to an interconnected cognitive and emotional state that almost always leads to poor judgement.² A key objective of ICMAPS is to lessen these adverse impacts by building and exercising participant's cognitive map abilities. ICMAPS employs map making both real and imaginary, teaching MCR (map and compass reading),⁵ introduction to GIS (Geographical Information System), and teaching several earth-science based field-skills. MCR has had years of STEM educational success in Scandinavia where students are provided an engaging gateway to the STEM subjects and their opportunities, shown math in a useful and less imposing manner, and develop an enthusiasm for the outdoors, the environment, and physical activity.²

The earth sciences component of ICMAPS emphasizes spatial relationships and memory-linked shapes, boundaries, and points of geologic and geomorphic features and structures (natural allocentric-map representations) while holistically tying them to earth systems via their geologic history and processes. Instruction conforms to secondary-education science curricula and post-secondary earth science requirements; for instance, California public school's new Science Framework for the Earth Sciences⁶ while offering instructors and students a new approach, achievements, and opportunities. DNA and neuroscience research show humans are hard-wired for developing advanced cognitive map skills² but during the last several decades, with the increased use of GPS technology and less "free play" at childhood, the natural pathways-or latent learning-to these skills are not fully engaged and the adverse impacts to the nation's spatial abilities and to STEM development are just being recognized.² Our ancestor's survival depended on cognitive map and navigational skills, building their allocentric representations of the natural world, and physical map-making may pre-date the written word.⁷ We should utilize this underappreciated and very human connection to the STEM subjects. ICMAPS does this by providing an effective, inexpensive, and equitable teaching system that increases the spatial-cognitive abilities, navigational expertise, and leadership skills of participants, regardless of personal background or physical abilities. Participants learn through a variety of experiences that include field trips and activities, both in-person and virtual.

GMF's ICMAPS in-person events and publications have occurred in the natural settings of southern California such as the Northern Channel Islands⁸ while the virtual experiences are world-wide.⁹ Participation in ICMAPS has included courses for secondary education science teachers,¹⁰ informal natural science communities, and post-secondary education communities.¹¹ Teachers and university students have transferred their increased knowledge and skills back to their institutions and communities, received positive reviews, and have increased the cognitive map and field skills of their audience.



ICMAPS has been successful but limited in reach as events are all-volunteer efforts and constrained by time and budget.

The GMF is seeking funding to expand its ICMAPS training and outreach secondary and post-secondary instructors and students, and further develop its public school compatible science¹² and social science curricula¹³ (geography). ICMAPS offers a deeply human-intrinsic educational system that will provide STEM-oriented cognitive map pathways and instruction via in-person and virtual field events and courses. ICMAPS' events are focused on California^{8,10,11} and could be modified for other locations and curricula in the USA and serve as a new option for STEM education and outreach.

- ¹ The Geologic Maps Foundation, Inc. (GMF) is a nonprofit, scientific-focused, public-benefit organization. GMF was granted Federal income tax exemption under Internal Revenue Code IRC Section 501 (c) (3) on October 21, 2016 and was incorporated as a Nonprofit Public Benefit Corporation with the State of California on April 28, 2016. For more information, www.geologicmapsfoundation.org
- ² Bond, M., 2020, From Here to There: The Art and Science of Finding and Losing Our Way: the Belknap Press of Harvard University Press, Cambridge, MS, 288 p. ISBN 9780674244573
- ³ Uttal, D. H., Meadow, N.G., Tipton, E., Hand, L.L., Alden, A.R., Warren, C., and Newcombe, N.S., 2012, The Malleability of Spatial Skills: A Meta-Analysis of Training Studies. *Psychological Bulletin*, 2012; DOI: 10.1037/a0028446
- ⁴ Le Doux, J., 2002, *Synaptic Self: How are brains become who we are*: Viking, 226 p.
- ⁵ Watters, R., 1997, The art of teaching map and compass: Instructional techniques, curricular formats, and practical field exercises, in Guthrie S., Macke J. & Watters R. (Eds.), *Proceedings of 1996 International Conference on Outdoor Recreation and Education*. (pp. 177-185). Boulder, CO: Association of Outdoor Recreation and Education.
- ⁶ CA Science Framework chapter detailing high school three course model: <https://www.cde.ca.gov/ci/sc/cf/documents/scifwchapter7.pdf>
- ⁷ Norman, J., 2017, History of information: <http://www.historyofinformation.com/expanded.php?id=6>
- ⁸ Davis, T.L., Behl, R.J., O'Sullivan, K.M., Raskin, S., and Bryne, S., 2020, Santa Cruz Island field trip: Geology, history, and research opportunities, in Heermance, R.V., and Schwartz, J.J., eds., *From the Islands to the Mountains: A 2020 View of Geologic Excursions in Southern California: Geological Society of America Field Guide 59*, p. 115–163, <https://rock.geosociety.org/store/TOC/FLD059.pdf>
- ⁹ Geologic Maps Foundation Online Science Education, <http://geologicmapsfoundation.org/trips.html>, <http://geologicmapsfoundation.org/resources/UsingPinToolInGoogleEarthProTLD08May2020.pdf>
- ¹⁰ Geol 4770 / 5770: Special Topics in Geology, Fundamentals of Field Geology & Geologic Mapping, Santa Cruz Island, CA, <https://extended.csub.edu/santacruz>
- ¹¹ Hwy 33 Structural Transect Plus Petroleum Geology of the Ventura & Cuyama Basins <https://www.meetup.com/Geo-hikes/events/248543358/>
Map and compass reading short course-and it is free! <https://www.meetup.com/Geo-hikes/events/260347570/>
- ¹² Next Generation Science Standards (NGSS), <https://www.nextgenscience.org/get-to-know>
- ¹³ California Department of Education History-Social Science Framework, <https://www.cde.ca.gov/ci/hs/cf/hssframework.asp>

Thomas L. Davis PhD
Professional California Geologist #4171
President Geologic Maps Foundation, Inc.