PROJECT IGELS

The IGELS Project

A Vision for Change in Introductory Life Science Courses

NSF-DUE #2126154

What is IGELS?

Interactions in
General Education
Life Science Courses

Mission Statement:

The national network for the Improvement in General Education Life Science Courses (IGELS) is a coalition of biologists and biology educators collaborating to support and mentor “non-major biology” instructors.

IGELS Steering Committee

PI

Gordon Uno, David Ross Boyd Professor of Botany, University of Oklahoma

Co-PIs

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Tamar Goulet, Professor of Biology, University of Mississippi
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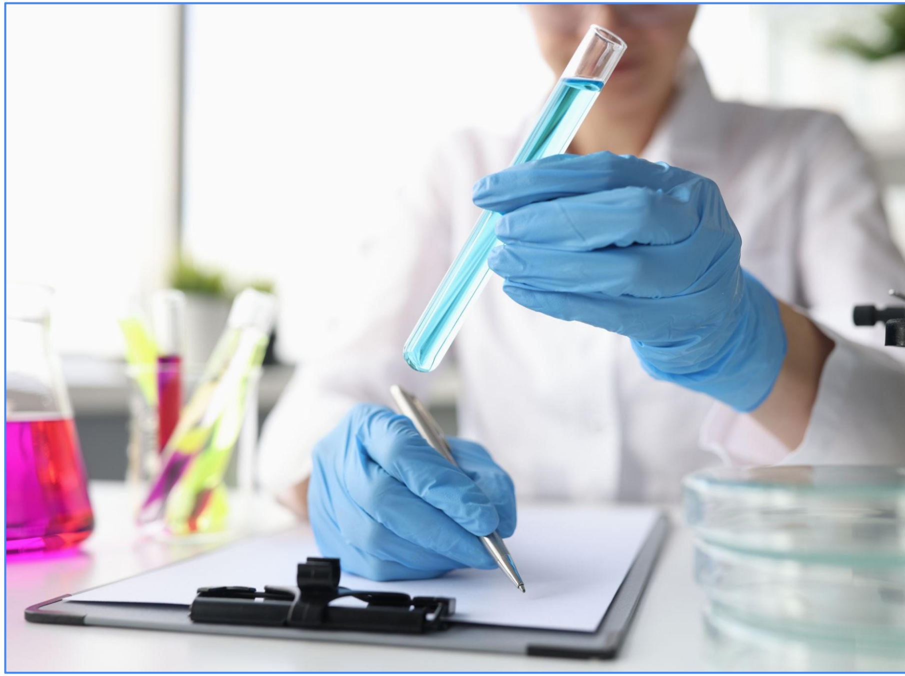
John Moore, Professor Emeritus, Taylor University
Elizabeth Harrison, Kennesaw State University
Gabriela Hamerlinck, University of Georgia

Project Evaluator Dayna DeFeo, University of Alaska

One major goal

- Identify, review, and modify existing educational resources that address V&C principles and facilitate their implementation in GELS courses that promote *science literacy, skills, civic engagement, and application of knowledge*
  - To support educators in GELS courses, a **LifeSkills guide** was developed to help identify relevant learning objectives.



Vision & Change:
Concepts & Competencies

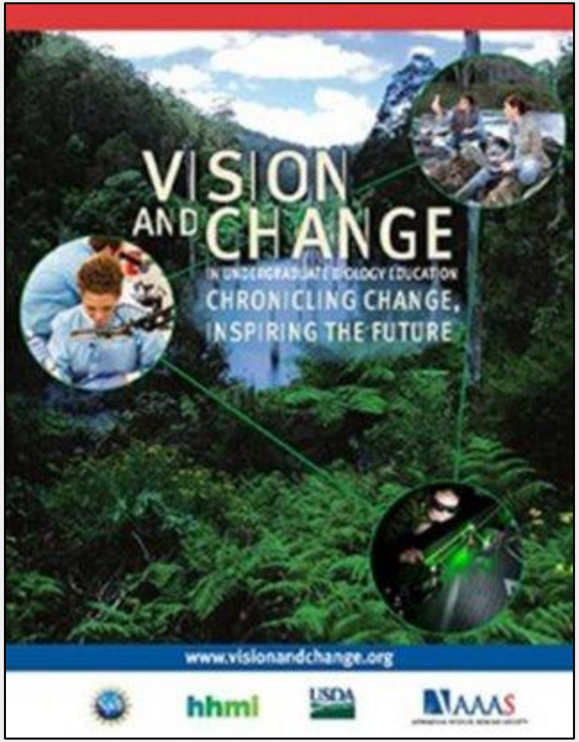
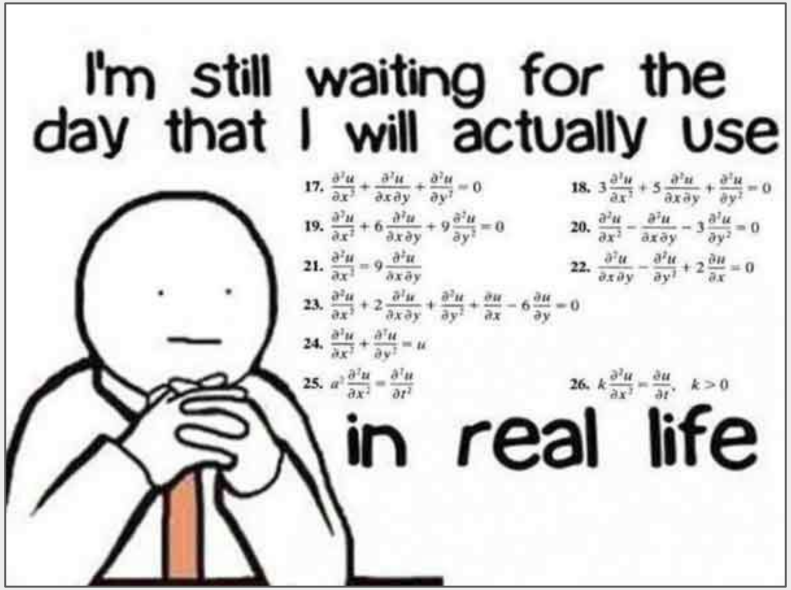


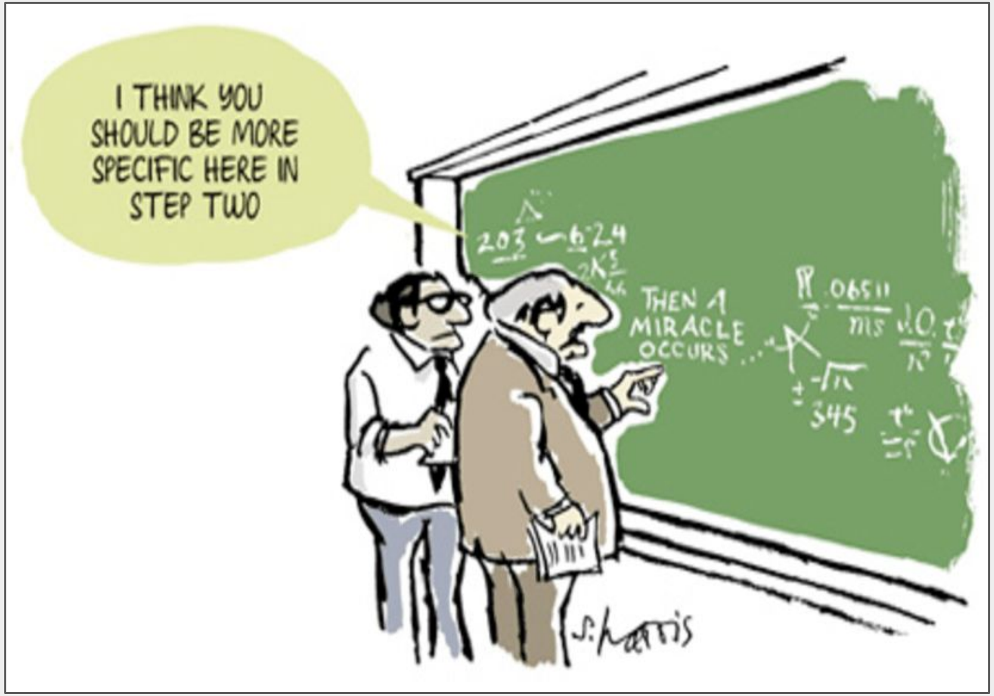
Table 2.1: Core Competencies and Disciplinary Practices. A competency-based approach to undergraduate biology education focuses on demonstrating analytical, experimental, and technical skills as measurable outcomes of student learning. Biology literacy is defined primarily in terms of acquired competencies, demonstrated within the context of fundamental biology concepts.

Core Competency	Ability to apply the process of science	Ability to use quantitative reasoning	Ability to use modeling and simulation	Ability to tap into the interdisciplinary nature of science	Ability to communicate and collaborate with other disciplines	Ability to understand the relationship between science and society
Instantiation of Ability in Disciplinary Practice	Biology is an evidence-based discipline	Biology relies on applications of quantitative analysis and mathematical reasoning	Biology focuses on the study of complex systems	Biology is an interdisciplinary science	Biology is a collaborative scientific discipline	Biology is conducted in a societal context
Demonstration of Competency in Practice	Design scientific process to understand living systems	Apply quantitative analysis to interpret biological data	Use mathematical modeling and simulation tools to describe living systems	Apply concepts from other sciences to interpret biological phenomena	Communicate biological concepts and interpretations to scientists in other disciplines	Identify social and historical dimensions of biology practice
Examples of Core Competencies Applied to Biology Practice	Observational strategies Hypothesis testing Experimental design Evaluation of experimental evidence Developing problem-solving strategies	Developing and interpreting graphs Applying statistical methods to diverse data Mathematical modeling Managing and analyzing large data sets	Computational modeling of dynamic systems Applying informatics tools Managing and analyzing large data sets Incorporating stochasticity into biological models	Applying physical laws to biological dynamics Chemistry of molecules and biological systems Applying imaging technologies	Scientific writing Explaining scientific concepts to different audiences Team participation Collaborating across disciplines Cross-cultural awareness	Evaluating the relevance of social contexts to biological problems Developing biological applications to solve societal problems Evaluating ethical implications of biological research

Why Lifeskills?



Relevance



Reasoning

https://www.opencolleges.edu.au/informed/features/how-to-make-learning-relevant/

https://www.researchgate.net/profile/M-Tarbell/publication/333061528/figure/fig2/AS:787157769801731@1564684445486/Where-AI-stands-today-Then-a-miracle-occurs-C-Sidney-Harris-in-American-Scientist.png

Interpretations of Vision & Change
“BioSkills Guide”

PROCESS OF SCIENCE	
Program-Level Learning Outcomes	**Course-Level Learning Outcomes**
SCIENTIFIC THINKING Explain how science generates knowledge of the natural world.	Explain how scientists use inference and evidence-based reasoning to generate knowledge.
	Describe the iterative nature of science and how new evidence can lead to the revision of scientific knowledge.
INFORMATION LITERACY Locate, interpret, and evaluate scientific information.	Find and evaluate the credibility of a variety of sources of scientific information, including popular science media and scientific journals.
	Interpret, summarize, and evaluate evidence in primary literature.
	Evaluate claims in scientific papers, popular science media, and other sources using evidence-based reasoning.
QUESTION FORMULATION Pose testable questions and hypotheses to address gaps in knowledge.	Recognize gaps in our current understanding of a biological system or process and identify what specific information is missing.
	Develop research questions based on your own or others' observations.
	Formulate testable hypotheses and state their predictions.
STUDY DESIGN Plan, evaluate, and inplement scientific investigations.	Compare the strengths and limitations of various study designs.
	Design controlled experiments, including plans for analyzing the data.
	Execute protocols and accurately record measurements and observations.
	Identify methodological problems and suggest how to troubleshoot them.
	Evaluate and suggest best practices for responsible research conduct (e.g., lab safety, record keeping, proper citation of sources).
DATA INTERPRETATION & EVALUATION Interpret, evaluate, and draw conclusions from data in order to make evidence-based arguments about the natural world.	Analyze data, summarize resulting patterns, and draw appropriate conclusions.
	Describe sources of error and uncertainty in data.
	Make evidence-based arguments using your own and others' findings.
	Relate conclusions to original hypothesis, consider alternative hypotheses, and suggest future research directions based on findings.
DOING RESEARCH Apply science process skills to address a research question in a course-based or independent research experience.	

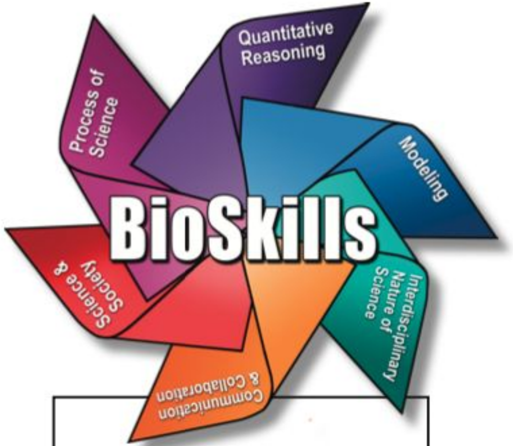
QUANTITATIVE REASONING	
Program-Level Learning Outcomes	**Course-Level Learning Outcomes**
NUMERACY Use basic mathematics (e.g., algebra, probability, unit conversion) in biological contexts.	Perform basic calculations (e.g., percentages, frequencies, rates, means).
	Select and apply appropriate equations (e.g., Hardy-Weinberg, Nernst, Gibbs free energy) to solve problems.
	Interpret and manipulate mathematical relationships (e.g., scale, ratios, units) to make quantitative comparisons.
	Use probability and understanding of biological variability to reason about biological processes and statistical analyses.
	Use rough estimates informed by biological knowledge to check quantitative work.
	Describe how quantitative reasoning helps biologists understand the natural world.
QUANTITATIVE & COMPUTATIONAL DATA ANALYSIS Apply the tools of graphing, statistics, and data science to analyze biological data.	Record, organize, and annotate simple data sets.
	Create and interpret informative graphs and other data visualizations.
	Select, carry out, and interpret statistical analyses.
	Describe how biologists answer research questions using databases, large data sets, and data science tools.
	Interpret the biological meaning of quantitative results.

MODELING	
Program-Level Learning Outcomes	**Course-Level Learning Outcomes**
PURPOSE OF MODELS Recognize the important roles that scientific models, of many different types (conceptual, mathematical, physical, etc.), play in predicting and communicating biological phenomena.	Describe why biologists use simplified representations (models) when solving problems and communicating ideas.
	Given two models of the same biological process or system, compare their strengths, limitations, and assumptions.
MODEL APPLICATION Make inferences and solve problems using models and simulations.	Summarize relationships and trends that can be inferred from a given model or simulation.
	Use models and simulations to make predictions and refine hypotheses.
MODELING Build and evaluate models of biological systems.	Build and revise conceptual models to propose how a biological system or process works.
	Identify important components of a system and describe how they influence each other (e.g., positively or negatively).
	Evaluate conceptual, mathematical, or computational models by comparing their predictions with empirical data.

INTERDISCIPLINARY NATURE OF SCIENCE	
Program-Level Learning Outcomes	**Course-Level Learning Outcomes**
CONNECTING SCIENTIFIC KNOWLEDGE Integrate concepts across other STEM disciplines (e.g., chemistry, physics) and multiple fields of biology (e.g., cell biology, ecology).	Given a biological problem, identify relevant concepts from other STEM disciplines or fields of biology.
	Build models or explanations of simple biological processes that include concepts from other STEM disciplines or multiple fields of biology.
INTERDISCIPLINARY PROBLEM SOLVING Consider interdisciplinary solutions to real-world problems.	Describe examples of real-world problems that are too complex to be solved by applying biological approaches alone.
	Suggest how collaborators in STEM & non-STEM disciplines could contribute to solutions of real-world problems.
	Be able to explain biological concepts, data, and methods, including their limitations, using language understandable by collaborators in other disciplines.

COMMUNICATION & COLLABORATION	
Program-Level Learning Outcomes	**Course-Level Learning Outcomes**
COMMUNICATION Share ideas, data, and findings with others clearly and accurately.	Use appropriate language and style to communicate science effectively to targeted audiences (e.g., general public, biology experts, collaborators in other disciplines).
	Use a variety of modes to communicate science (e.g., oral, written, visual).
COLLABORATION Work productively in teams with people who have diverse backgrounds, skill sets, and perspectives.	Work with teammates to establish and periodically update group plans and expectations (e.g., team goals, project timeline, rules for group interactions, individual and collaborative tasks).
	Elicit, listen to, and incorporate ideas from teammates with different perspectives and backgrounds.
	Work effectively with teammates to complete projects.
COLLEGIAL REVIEW Provide and respond to constructive feedback in order to improve individual and team work.	Evaluate feedback from others and revise work or behavior appropriately.
	Critique others' work and ideas constructively and respectfully.
METACOGNITION Reflect on your own learning, performance, and achievements.	Evaluate your own understanding and skill level.
	Assess personal progress and contributions to your team and generate a plan to change your behavior as needed.

A Tool for Interpreting the Vision and Change
CORE COMPETENCIES



The BioSkills Guide comprises program- and course-level learning outcomes that elaborate what general biology majors should be able to do by the time they graduate. Building on the six core competencies of Vision and Change, the learning outcomes were developed and then nationally validated using input from over 600 college biology educators from a range of biology subdisciplines and institution types.

https://qubeshub.org/publications/1305/5

Process of Science

Scientific Thinking	1. Explain how scientists use inference and evidence-based reasoning to generate knowledge and understanding
	2. Describe the iterative nature of science and how new evidence can lead to the revision of scientific knowledge and explanations
Question Formulation	3. Develop questions to investigate based on observations made by the student or other students
Study Design	4. Engage in study design, such as in the development of simple controlled experiments, and make predictions
	5. Accurately record measurements and observations
Data Interpretation and Evaluation	6. Analyze data, summarize resulting patterns, and draw appropriate conclusions
	7. Make evidence-based claims/arguments using one's own and/or other's research
Model Application	8. Build and use simplified representations (e.g., models/concept maps) to describe a biological system and its components, explore a problem/concept, communicate ideas, and make predictions

Quantitative Reasoning

Numeracy	9. Use simple mathematical calculations, such as percentages and means
	10. Create and interpret simple representations of data such as graphs, tables, and charts
Quantitative & Computational Data Analysis	11. Describe how quantitative reasoning helps us understand and communicate about the natural world

Communication and Collaboration

Communication	12. Be able to communicate scientific concepts, data, and methods effectively using language appropriate to a targeted audience (e.g., the public, fellow students, life science experts, and collaborators in other disciplines)
	13. Use a variety of modes to communicate science (e.g., oral, written, visual)
Collaboration	14. Work with teammates to establish and periodically update group plans and expectations (e.g., team goals, project timeline, rules for group interactions, individual and collaborative tasks)
	15. Elicit, listen to, and incorporate ideas from teammates with different perspectives and backgrounds
Collegial Review	16. Evaluate feedback from others and revise work or behavior appropriately
	17. Critique others' work and ideas constructively and respectfully

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Science and Society

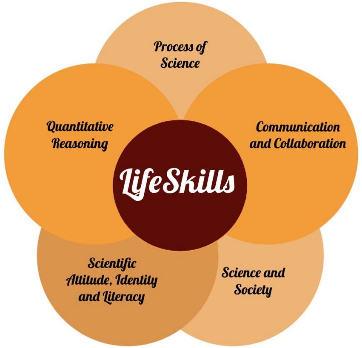
Problem Solving	18. Describe examples of real-world problems that are too complex to be solved by applying life science approaches alone
	19. Suggest how collaborators in STEM & non-STEM disciplines could contribute to solutions of real-world problems
Ethics	20. Identify ethical concerns & considerations of a given research study
	21. Critique how ethical controversies in life science research have been and can continue to be addressed by the scientific community
	22. Evaluate and use best practices for responsible research conduct (e.g., lab safety, record keeping, proper citation of sources)
Societal Influences	23.Describe examples of how scientists' backgrounds & biases can influence science and how science is enhanced through diversity
	24. Identify and describe how systemic factors (e.g., socioeconomic, political) can affect how and by whom science is conducted
Science's Impact on Society	25. Identify how evidence-based reasoning and life science knowledge is useful in daily life (e.g., purchasing products, reading claims from popular media, engaging in the solution of civic issues)
	26. Use examples to describe the relevance of science in everyday experiences of people
	27. Relate science content presented in class to current, real world, local or global issues
	28. Identify and describe the broader societal impacts of biological research on different stakeholders
	29. Describe the roles and responsibilities scientists have in facilitating public understanding of the process and products of science

Students' Scientific Attitude, Identity, and Literacy

Attitude and Identity	30. Recognize the importance of one's own openness to alternative ideas to solve a science problem or answer research questions
	31. Critically assess one's own contributions to a team's scientific work
	32. Identify an area of personal interest in the sciences
	33. Identify possible roles that one could undertake in science or science-related careers
	34. Evaluate one's own personal growth in understanding and ability in science
Scientific Literacy and Critical Thinking	35. Explain how scientific thinking is used daily to resolve personal or societal problems
	36. Evaluate personal understanding of scientific information and concepts by explaining scientific concepts in the student's own words
	37. Find and evaluate credible scientific information from a variety of sources
	38. Evaluate claims in scientific papers and social media and from non-scientists and scientific experts using evidence-based reasoning
	39. Recognize misuse of scientific information, including cherry-picking of data, use of anecdotal information, and/or pseudoscience

Project website
https://projectigels.org/

LifeSkills Resources:
https://docs.google.com/spreadsheets/d/1zq4knt1cxEVYNIHC1txGxetahHov4ETHxw88-26UiKw/edit?usp=sharing



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This project is funded through NSF #2126154

The IGELS LifeSkills Guide

The LifeSkills guide comprises course-level learning outcomes focused on the skills we consider as critical for all students taking an undergraduate general education life science class. Building on the six core competencies of Vision and Change, and inspired by the original BioSkills guide, these outcomes were developed by the Project IGELS team and tested by AP Biology Teachers and college biology educators from a range of biology subdisciplines and institution types.

LifeSkill

Theme

Outcome

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Introduction to the Resources

Case Studies	Computer Based Activity/ Simulation	Click and Learn	YouTube Videos	Click and Learn	Podcasts	Classroom Activity	Class Activity	Model Course	Survey/ Instrument	Reading/ handout/ book	Guide/ Manual/ Handbook	Lab activity	Un-classified Materials

In preparation for finalizing the LifeSkills Guide and making a push to map curriculum resources to the various learning objectives we are very interested in your input.

bit.ly/LSG_NABT_2024

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Introduction to the Resources

RESOURCES								
LifeSkill	**Learning Outcome**	**Item Type**	**Description**	**Time Length**	**Instructor Notes**	**Key Words**	**License**	**Link to resource**
PROCESS OF SCIENCE								
Scientific thinking	1. Explain how scientists use inference and evidence-based reasoning to generate knowledge and understanding	Case study	In this problem-based learning case, students are asked to identify the information needed to evaluate the choice between two lamp types, and then use a published life-cycle analysis to find and evaluate that information. To conclude, they make a decision and argue for it using quantitative evidence and reasoning. The case was developed for an intermediate-level course designed to help environmental studies students understand the role of scientific information and scientific thinking in resolving complex environmental problems.	3 day sess	https://www.nsta.org	Life-cycle analysis; life-cycle assessment; LCA; compact fluorescent lamp; CFL; incandescent lamp; greenhouse gases; energy; mercury; quantitative skills	add	https://www.nsta.org/ncss-case-study/green-light-cfls
		Click and Learn	Interactive module allows students and educators to document, annotate, and reflect upon scientific research processes. Has accompanying "Educator Materials" document that provides additional tips and an example of how to engage students with this Click & Learn	add	add	add	add	https://www.biointeractive.org/classroom-resources/how-s
		Click and Learn	This Click & Learn shows how paleoanthropologists, scientists who study human evolution, use the scientific process to make inferences about prehistoric events. The accompanying "Worksheet" guides students' exploration of the Click & Learn. The "Resource Google Folder" link directs to a Google Drive folder of resource documents in the Google Docs format.	add	add	add	add	https://www.biointeractive.org/classroom-resources/using ocess-study-human-evolution
		You Tube Video	Series of videos covering the Process of Science	add	add	add	add	https://qubeshub.org/publications/4319/1
		Computer based activity	The mystery box puzzle presents students with a relatively straight forward logic problem. The assignment includes teaching notes and suggestions and can be done in 50 min	50 mins	add	add	add	
	2. Describe the iterative nature of science and how new evidence can	Click and Learn	Flowchart representing the process of scientific inquiry, through which we build reliable knowledge of the natural world. Mouse pointer can be	add	add	add	add	https://undsci.berkeley.edu/science-flowchart/

LifeSkill Outcome Theme

RESOURCES								
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		Click and Learn	Interactive module allows students and educators to document, annotate, and reflect upon scientific research processes. Has accompanying "Educator Materials" document that provides additional tips and an example of how to engage students with this Click & Learn	add	add	add	add	https://www.biointeractive.org/classroom-resources/how-s
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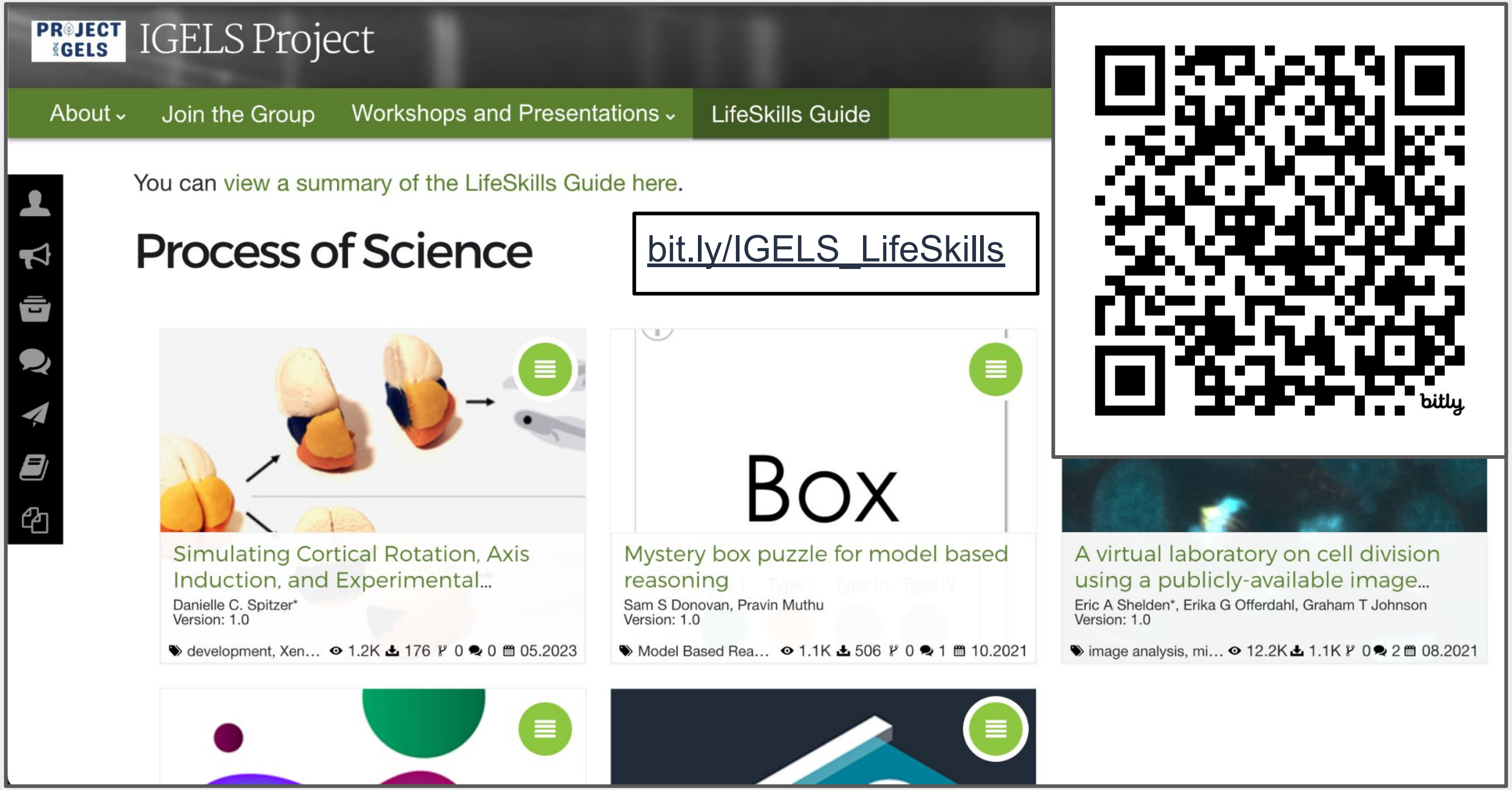
We have also begun to collect resources in the IGELS group on QUBES



Would you like to recommend a resource?

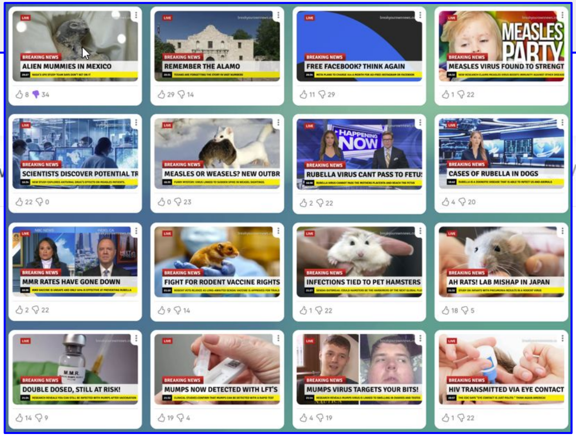
QUBES
A BioQUEST Project

Resources Community Services

About News & Activities Help

Browse Resources Why OER? Submit a Resource Softw

/ Resources / Teaching Materials / Fake News Activity / Description



Fake News Activity

Author(s): Davida Smyth

Texas A&M San Antonio

35 total view(s), 8 download(s)
0 comment(s) (Post a comment)

Download Adapt 0

Summary:
This activity has been used in majors and non-majors courses. In microbiology-themed courses, students research a microbe and generate an ePortfolio project as part of the course activities (https://journals.asm.org/doi/10.1128/jmbe.00055-22). By...

more

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Version **1.0** - published on 26 May 2025 doi:10.25334/V6HT-Q858 - cite this

Keywords

reading comprehension | critical thinking | scientific literacy | team work | Evidence

Alignments

Resource Type | Audience Level | Inclusive Pedagogy for Life Science Education

Contents:

- Example of Padlet.p...
- Example of student ...
- Fake News - Instruct...

view all files

Collect

Watch resource

Share:

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IGELS Project

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Would you like to recommend or contribute a resource?

Recommend a LifeSkills Guide Resources - May 2025

Thank you for taking the time to share a resource with us. This form will collect some basic information and allow us to get back in touch with you to fully integrate your recommendation.

For your reference, this link takes you to a handout about the LifeSkills Guide.

Link: https://bit.ly/4mD08UL

Contact us!

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