



Self-Reflective Crowds: Surfacing Wisdom through Emergent Scaffolding

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Motivation

Crowdsourcing creative, complex work

a

Make the following change to the text on the left:
*First, there is a typo ("she he") should be "should he". Finish paragraph with:
Perhaps he should take a little gander and see if he can get some help with the balloon.*

When he woke up, he found himself staring at glow of big, beautiful crystal-like glass buildings, shimmering in the brilliant sunshine. One was emerald green, another ruby red,

How would you write this part?

Cancel Submit

b

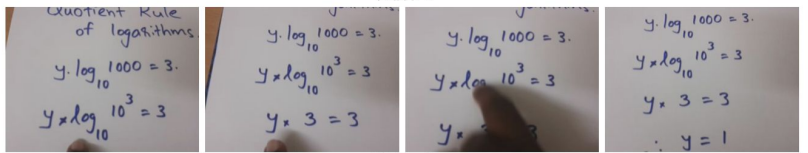
Choose the paragraph that best makes the following change to the text on the left:
*First, there is a typo ("she he") should be "should he". Finish paragraph with:
Perhaps he should take a little gander and see if he can get some help with the balloon.*

When he woke up, he found himself staring at glow of big, beautiful crystal-like glass buildings, shimmering in the brilliant sunshine. One was emerald green, another ruby red

When he woke up, he suddenly found himself staring at glow of big, beautiful crystal-like glass buildings, shimmering in the brilliant sunshine. Oargantuan glass buildings, their exteriors shimmering under the sun's rays. These buildings rose

#1
#2
#3
#4

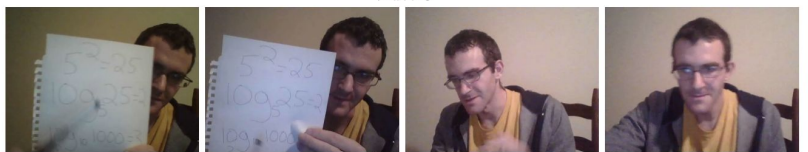
Video 1



Video 2



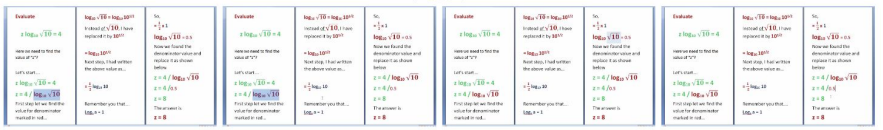
Video 3



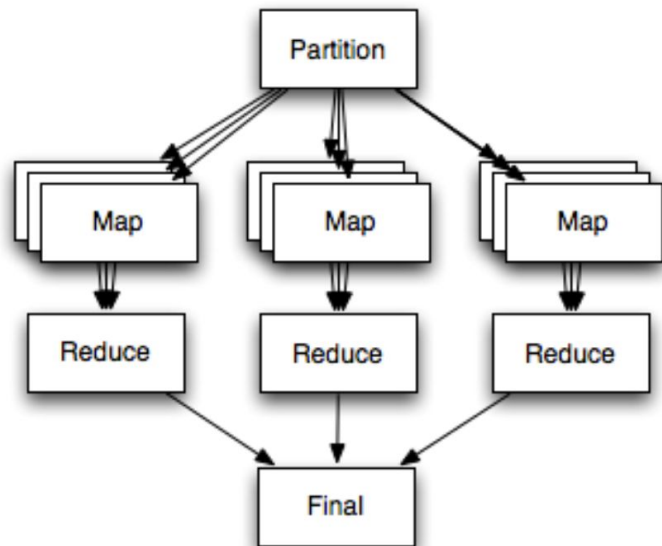
Video 4



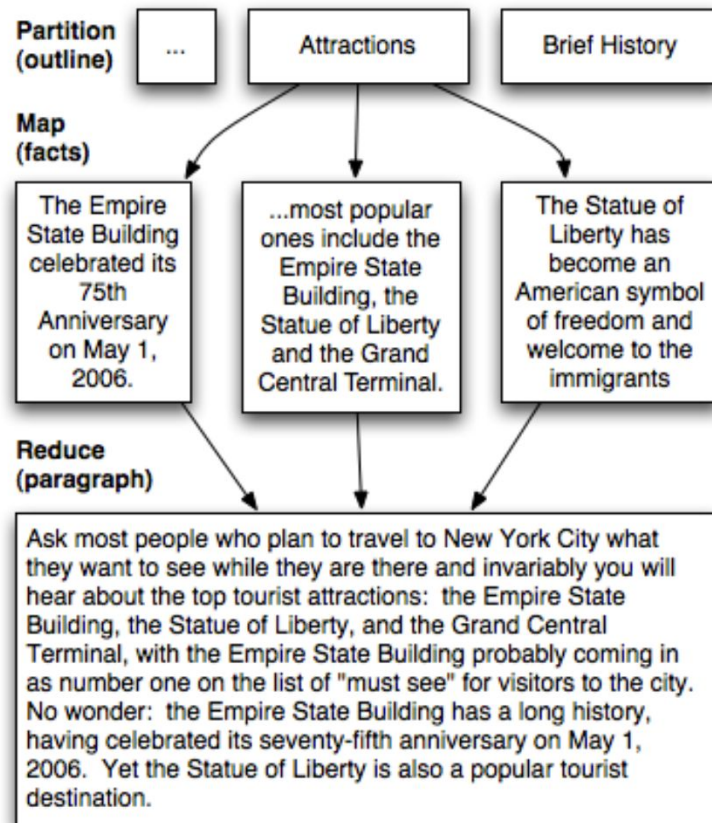
Video 5



Strategies to crowdsource creative work: Decomposition



collaborative
writing



Strategies to crowdsource creative work: Scaffolding



Scaffolding is a temporary learning support that helps novices complete tasks beyond their current ability



Examples



Rubric & Guidelines



Feedback

Dow et al. (2012). Shepherding the crowd yields better work.

Kim et al. (2022). Mixplorer: Scaffolding Design Space Exploration through Genetic Recombination of Multiple Peoples' Designs to Support Novices' Creativity.

Winkler et al. (2020). Sara, the Lecturer: Improving Learning in Online Education with a Scaffolding-Based Conversational Agent.

Nguyen et al. (2020). Where's the Learning in Education Crowdsourcing?

Scaffolding materials are difficult to produce

Difficulties include

- Lack of expert domain knowledge
- Requires ongoing requester input
- Unavailable or unclear standards
- Costly
- Hard to scale

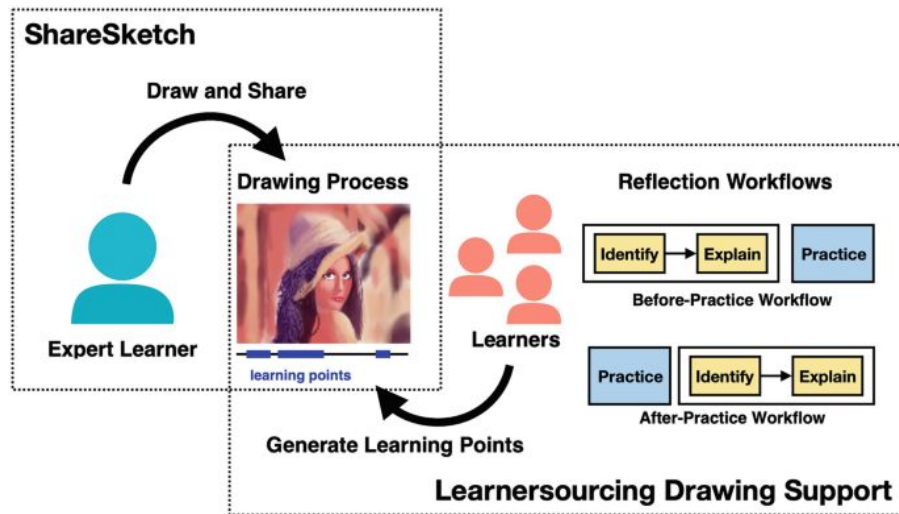
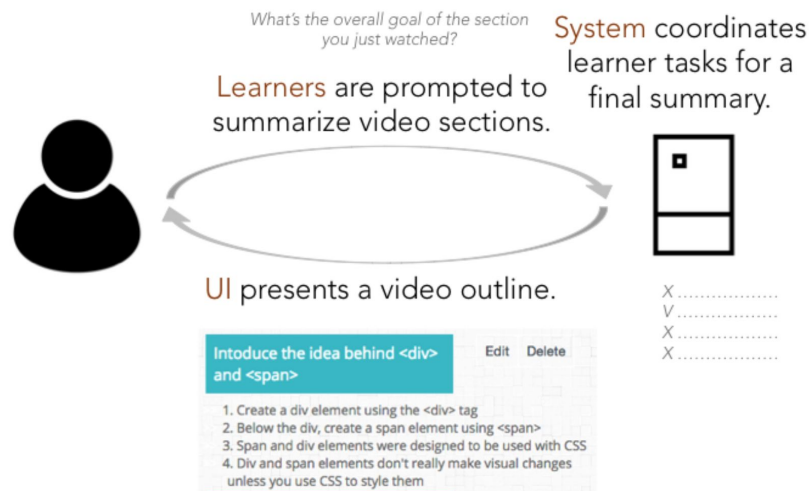
Generic examples or rigid instructions could

- Limit creative freedom
- Introduce conformity effects



Learnersourcing materials

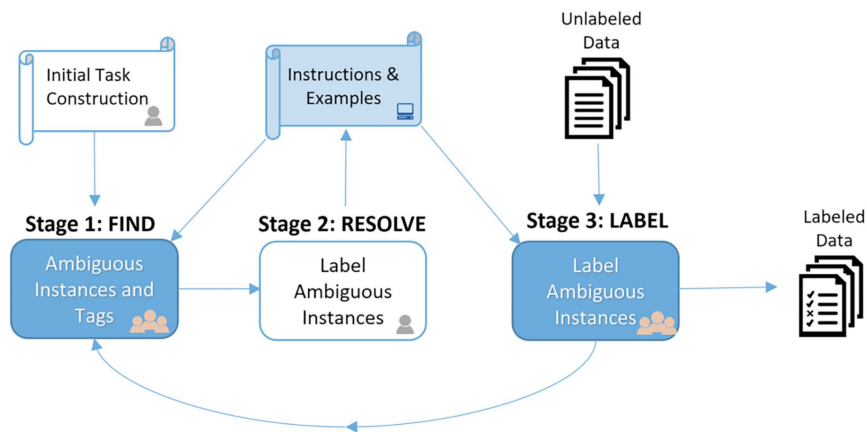
Learnersourcing uses insights from learners/workers to improve tasks and materials



Can scaffolding itself emerge from the crowd?

- Propose a **workflow** to test it
- Analyze the **collected scaffolding materials**
- Investigate if the scaffolding materials (from the crowd) **improves work quality**
- Examine participants' **experiences**

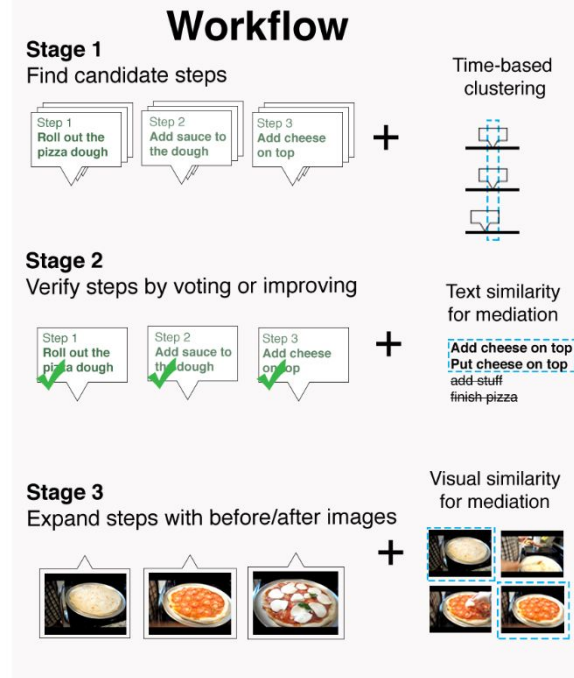
Workflow examples: Find-Resolve-Label, Find-Verify-Expand



Input Video

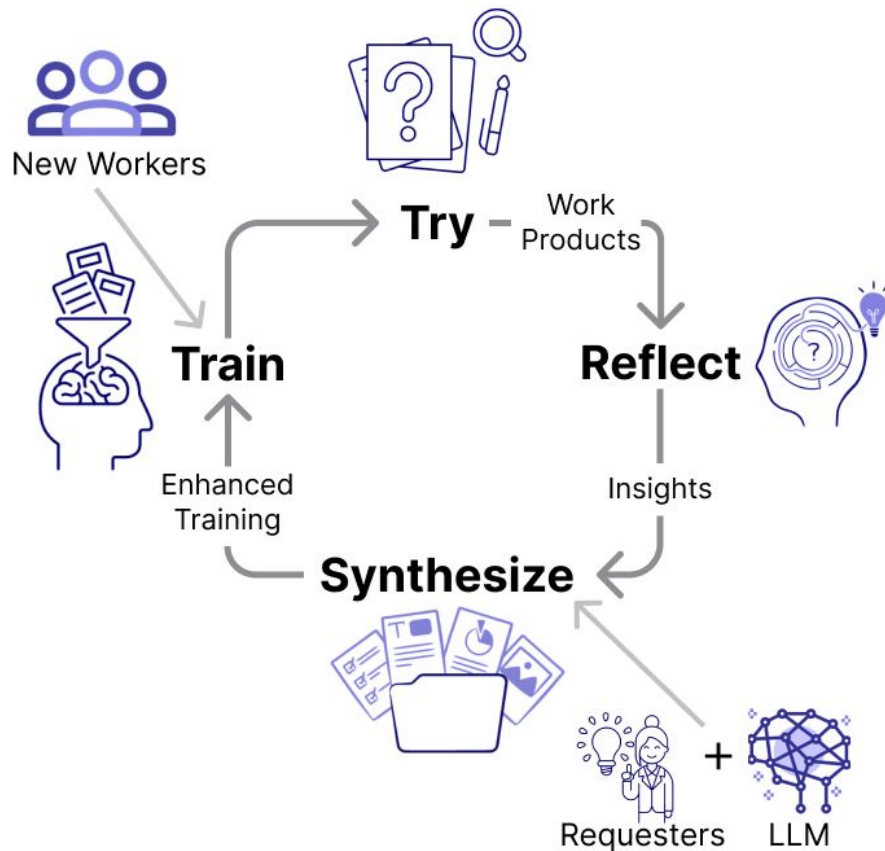


Output Timeline



Propose a Workflow

Emergent Scaffolding workflow



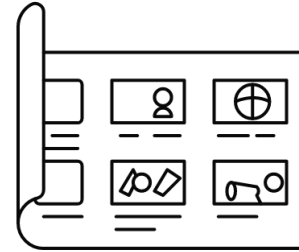
Try Task: Create an illustration for scientific papers

Paper Title + Abstract



Try

Visual Illustration



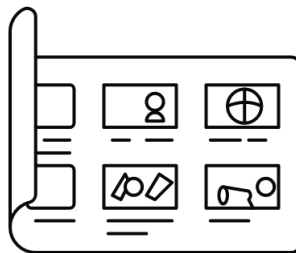
Batch 1: Produce illustrations & 3 hints → rubric

Paper Title + Abstract



Try

Visual Illustration



Reflect

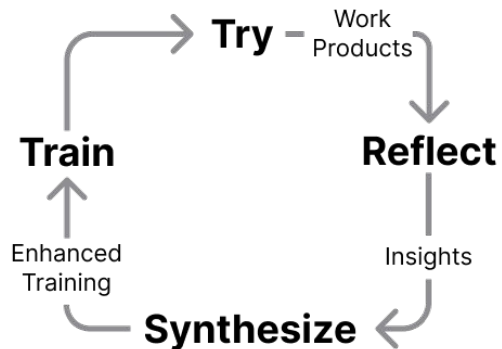


3 Hints







(assisted by LLM)

Synthesize

Rubric



Diverse hints from the crowd

Theme	Example of Raw Hints
 Visual Representation	<ul style="list-style-type: none">• “Turn words into images to bring the reader in.”• “Use a consistent color scheme for easier visualization.”
 Clarity & Simplicity	<ul style="list-style-type: none">• “Make the illustration simple and easy to understand.”• “Use arrows and link things.”
 Creativity & Design	<ul style="list-style-type: none">• “Think about personal experiences with the prompt.”• “Use creative techniques (like rotations) to help your illustration stand out.”
 Content & Understanding	<ul style="list-style-type: none">• “Highlight key elements.”• “Make sure you fully understand the content and topic of your paper before creating an illustration.”
 Audience Focus or Engagement	<ul style="list-style-type: none">• “Keep the target audience in mind.”• “Use catchy phrases or examples to hint/show the potential user what they would be doing.”
 Technical Aspects	<ul style="list-style-type: none">• “Find free images to use with the ‘search the web’ feature on Google Slides.”• “Use Google images and stack images.”

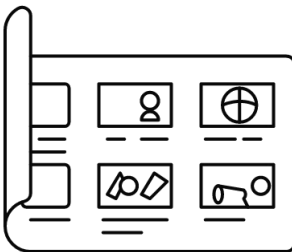
Batch 2: Evaluating illustrations with justifications

Paper Title + Abstract

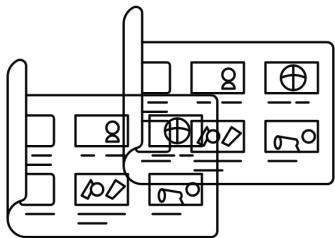


Try

Visual Illustration



Batch 1's illustrations



Reflect

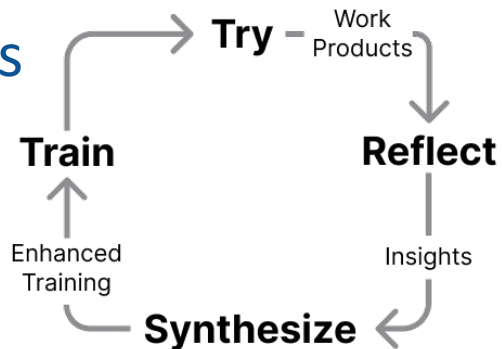
Ratings




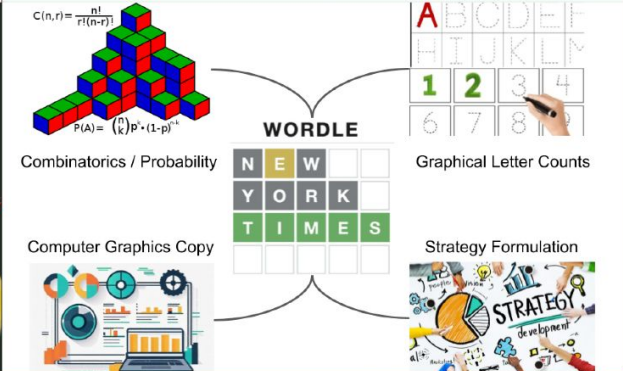
Synthesize

Low Quality

High Quality

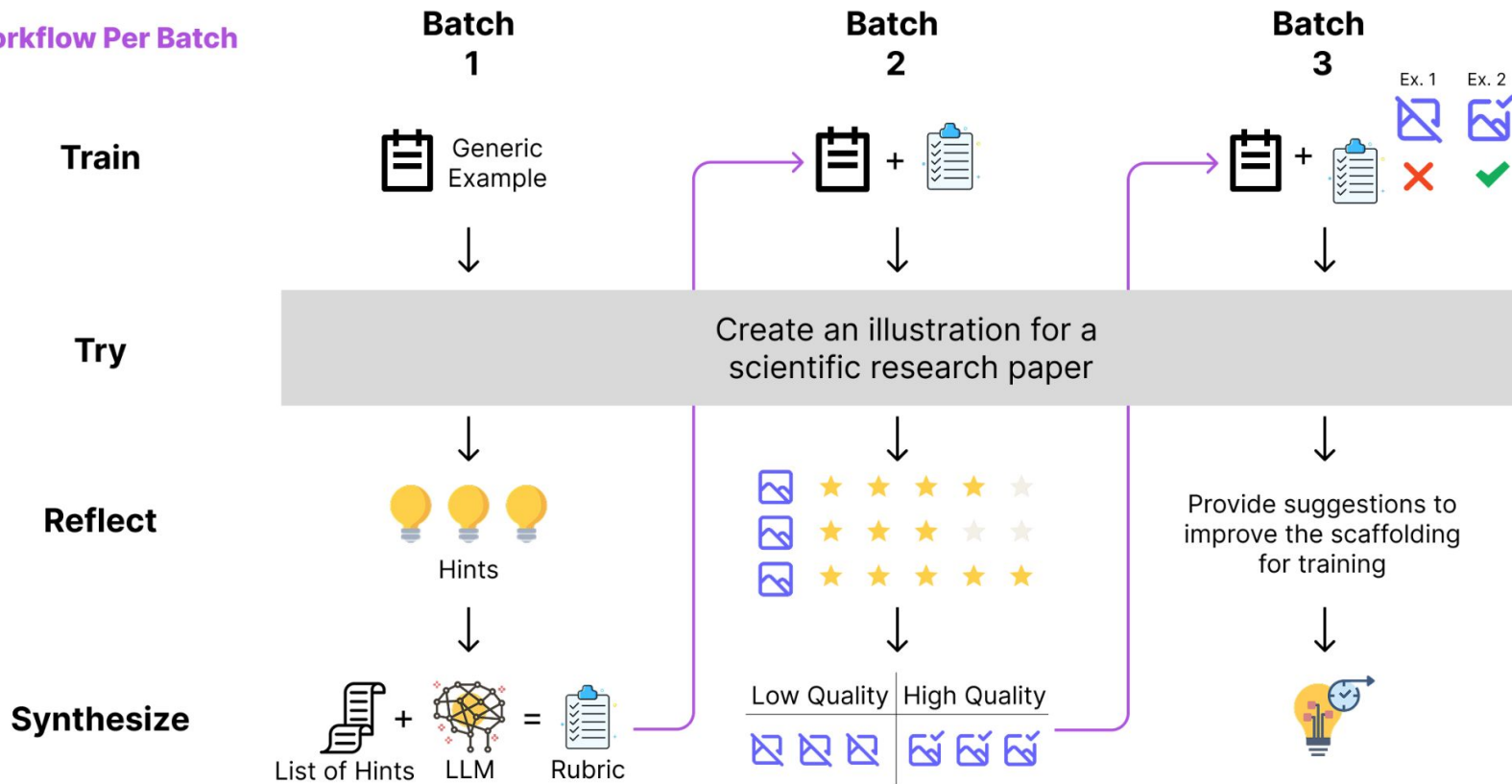


Side-by-side comparison of examples with ratings

<div>B</div> <div>Example 1</div> 	<div>Example 2</div> 
<div>A</div> <ol style="list-style-type: none"> Understanding and Clarity Engagement and Aesthetics Content Relevance & Conciseness Logical Flow and Organization Professionalism and Consistency 	<div>C</div> <div> <div>✗</div> <div>✗</div> <div>✗</div> <div>✗</div> <div>✗</div> </div>
<div>D</div> <div>Reviewer Comments</div>	<div> <div>✓</div> <div>✓</div> <div>✓</div> <div>✓</div> <div>✓</div> </div> <ul style="list-style-type: none"> “Does not look professional and feels jumbled, cannot tell that the paper is about Wordle as a teaching tool” “There’s only one image that goes with the paper and the rest of the images I don’t think are relevant to the paper. It also seems like it’s not organized well.” “I am not too sure what is going on and how wordle being in a different language reflects the scientific paper.”

Summary of batches

Workflow Per Batch



Batch 3/Between-subjects study: 3 conditions

Instructions Only

- A brief instruction

Generic Examples

- 3 examples taken from a journal website

Emergent Scaffolding

- The set of materials collected from Batch 1 + 2
 - Rubric
 - A side-by-side comparison of examples with rating + justifications

Data collection

Participants

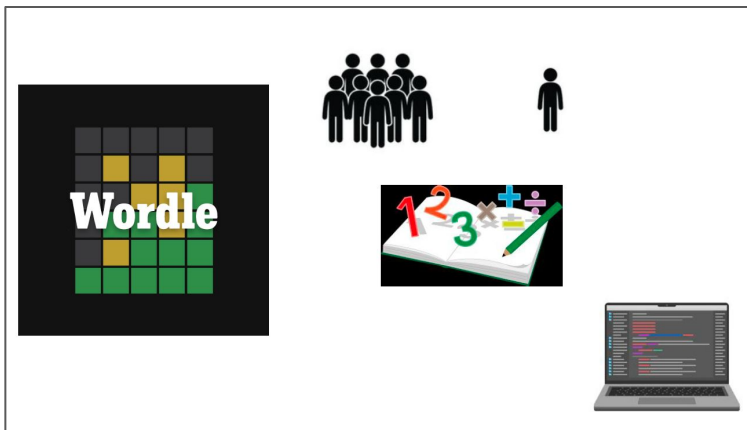
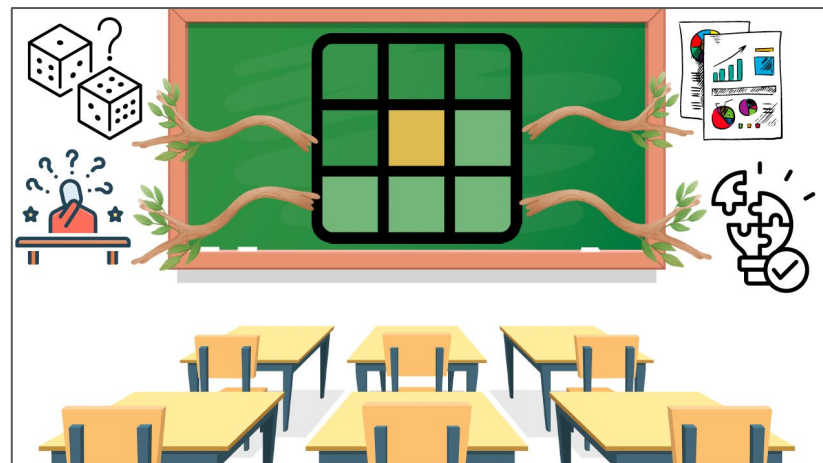
- Recruited on SONA platform, completed Qualtrics surveys
- Batch 1 - 83 illustrations, 300 hints
- Batch 2 - 89 illustrations, multiple ratings (3-6 times) per Batch 1 illustrations
- Batch 3/Between-Subjects Study - 54 illustrations
 - **Instructions Only - 19**
 - **Generic Examples - 16**
 - **Emergent Scaffolding - 19**



Measures

- Self-efficacy - 5-point likert scale & open-end questions
- Work Quality - Raters independently scored illustrations, co-calibrated

Example illustrations



Four Uses of Wordle to Promote Mathematics

1, 2

Combinatorics
&
Probabilities

3

Programming
&
Graphic Presentation

4

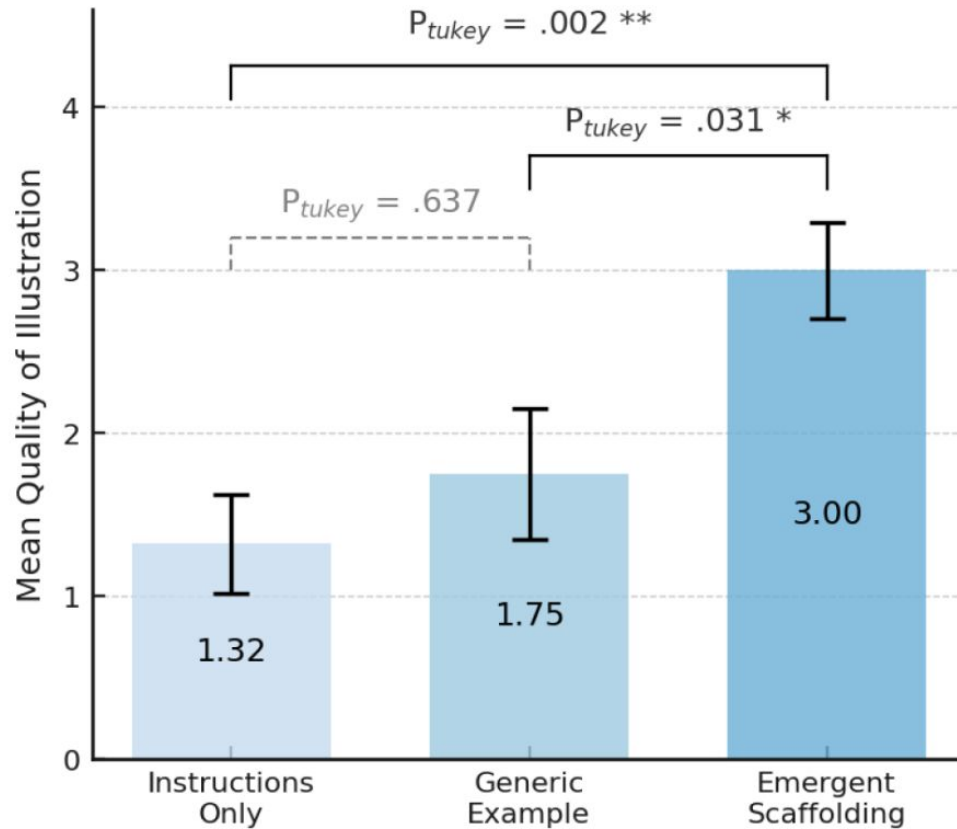
Minimization Strategy

WORDLE

R	E	A	D	Y
C	O	U	N	T
W	H	I	P	S
L	I	M	B	S
S	K	I	L	L

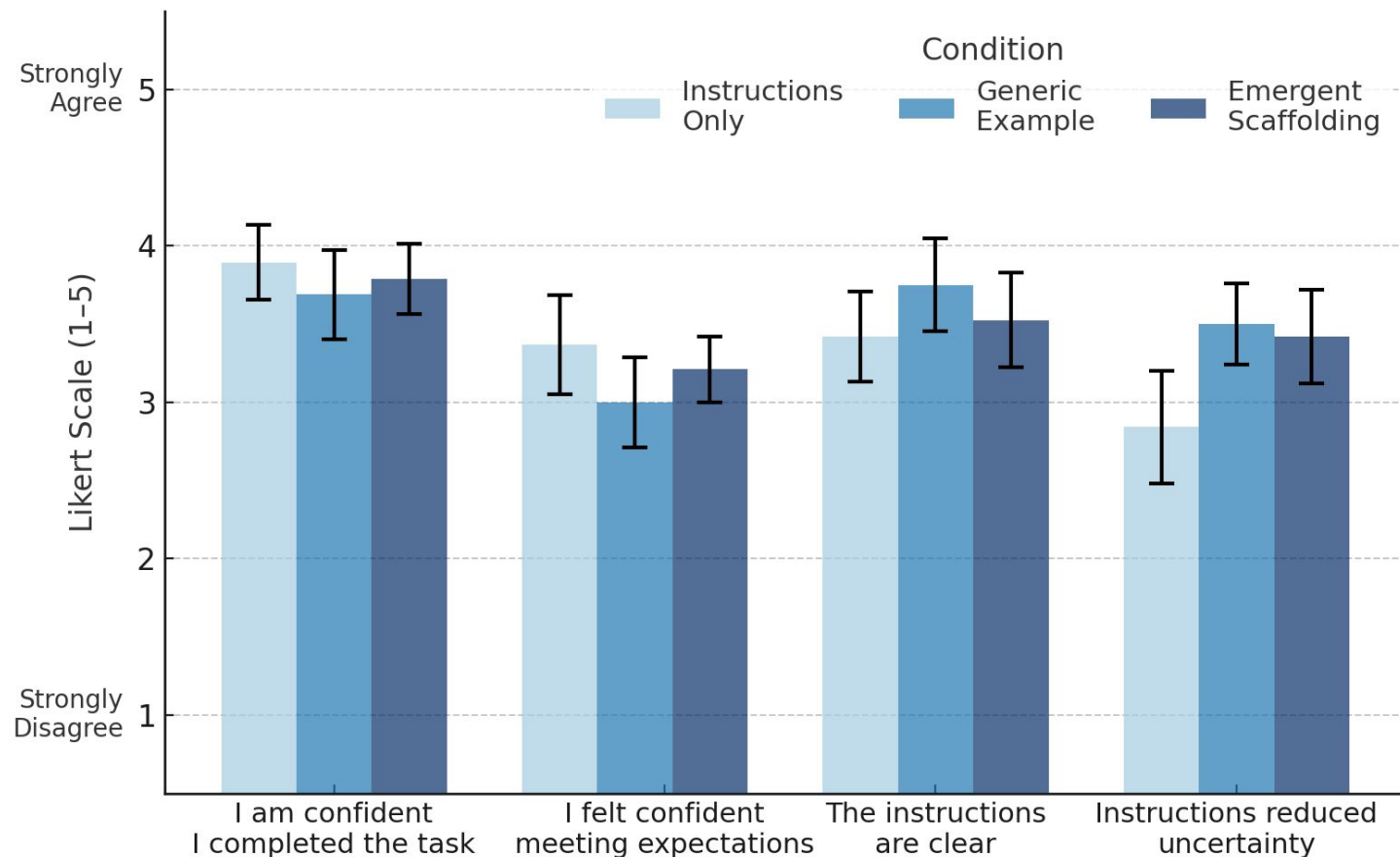
Results: Does emergent scaffolding improve work quality?

Emergent Scaffolding workers outperforms other conditions



Results: How do participants perceive their experience across conditions?

Mixed self-efficacy



Results: How do participants perceive their experience across conditions?

Emergent Scaffolding was seen as more helpful

Generic Example

“It gave me **something** to **base my work off** of.”

“They are very complicated...
beyond my skills, so they made it a bit **stressful**.”

Emergent Scaffolding

“The example and comments gave **clear help** for me to create a good enough illustration that met the guidelines”

“It pretty much gave me a sense of what to do... but it was a bit hard since **math is a very ‘abstract’ concept** where images can be hard to illustrate.”

Generic Example boosted clarity but not necessarily confidence.

Emergent scaffolding sparked **context-sensitive** reflection.

Results: How do participants perceive their experience across conditions?

Richer scaffolding yield more specific challenges & suggestions

Instructions Only

“I found it a little **difficult to understand** the task.”

“I did not have a clear understanding of what was expected.”

“**Give more guidance** on what you want us to display.”

Generic Examples

“**Difficulty finding images** to match my exact thought process.”

“...more details on what you want the drawing to actually encompass.”

“...**more examples** to reference from.”

Emergent Scaffolding

“Knowing **how many words** to put in relation to the images.”

“**How to organize it** so it makes sense.”

“Give **more specifics** on what they were looking for (a lot of images? words?).”

Key takeaways

Useful scaffolding **can emerge** from the crowd and **improve** work quality

Clarity without confidence: knowing what to do is not enough

Trade-offs in the Emergent Scaffolding workflow for **scalability and efficiency**

Implications & next step

LLMs can **accelerate** the process of surfacing crowd's wisdom

Unpack not only ***what*** to do but also ***how*** to do

Generalize the Emergent Scaffolding workflow (*Train-Try-Reflect-Synthesize*) to other tasks

This workflow is also generalizable to other fields to gather wisdoms from a community of {researchers, teachers...}.

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#2009003

PROTOLAB






UC San Diego

THE DESIGN LAB

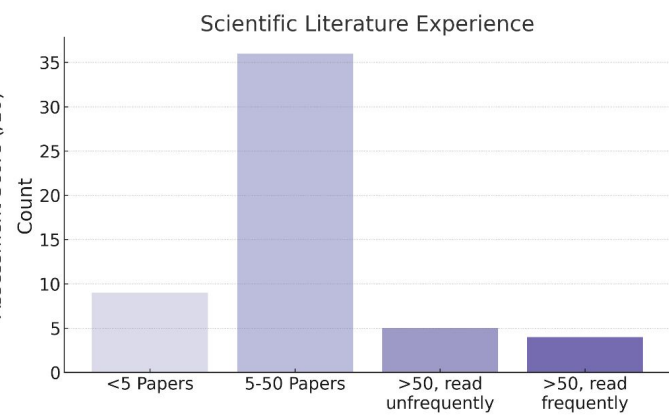
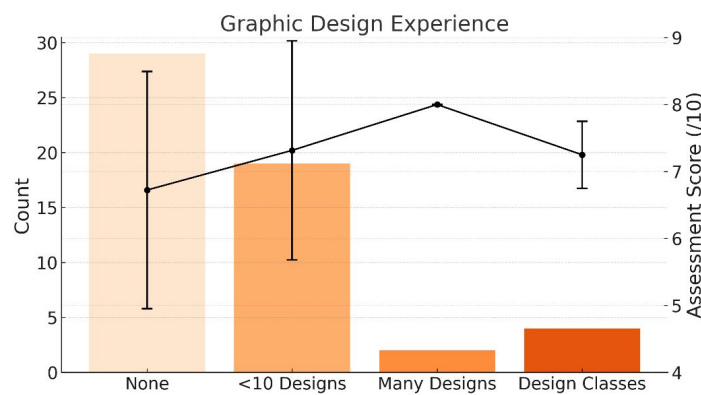
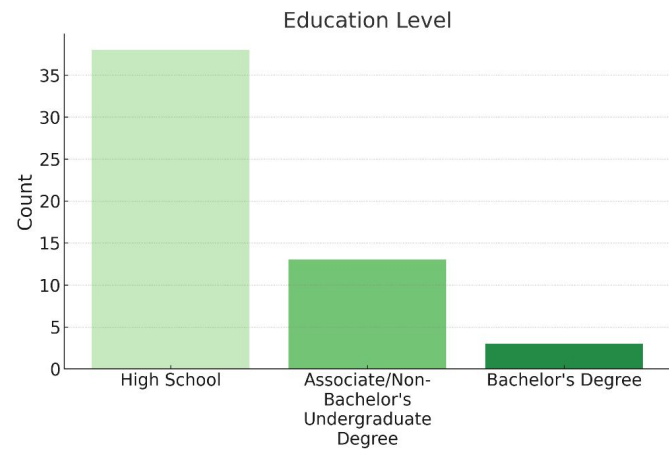
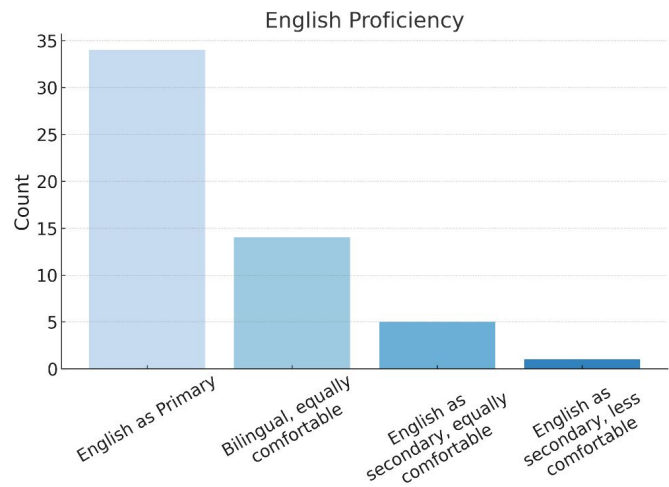
Full Paper



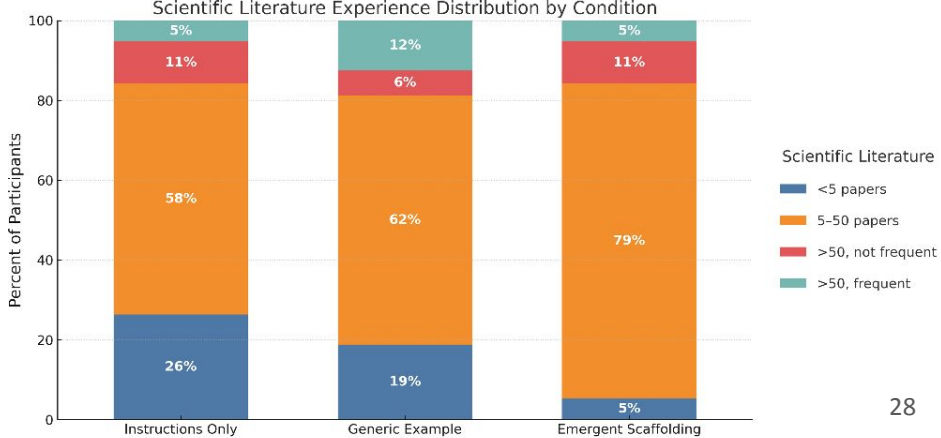
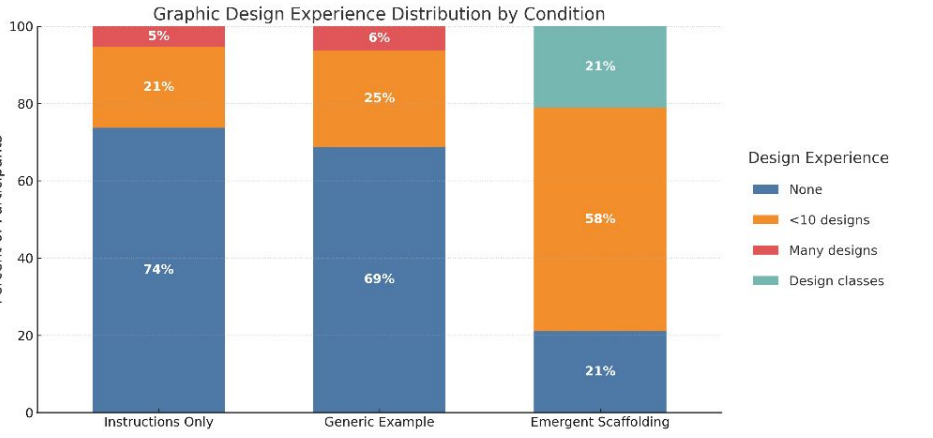
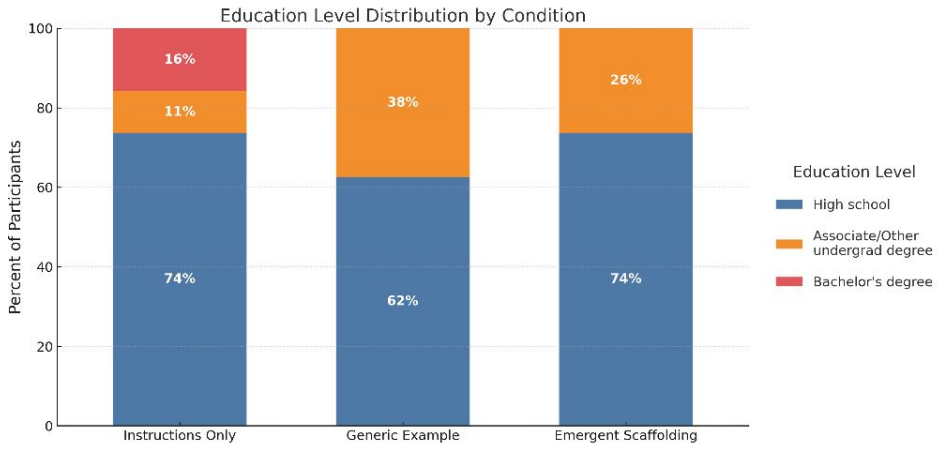
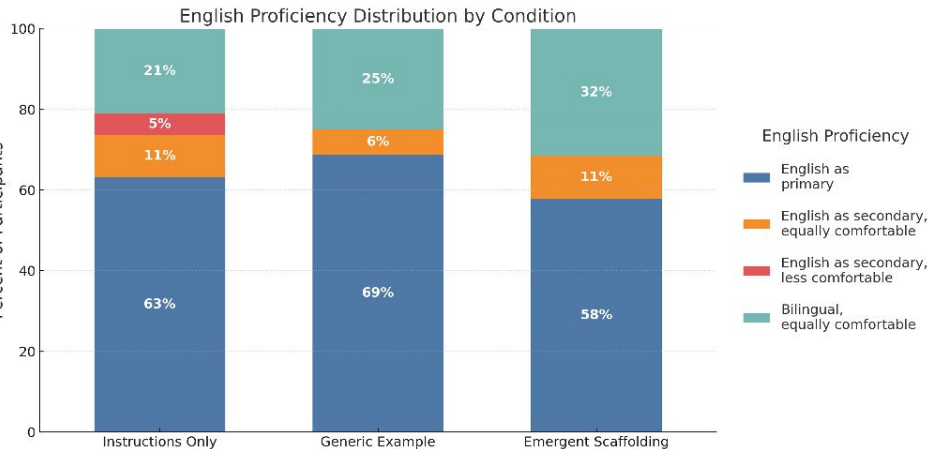
Rubric

Item	Description
 Understanding & Clarity	The designer demonstrates a clear understanding of the scientific paper's framework and core message, ensuring that the representation effectively conveys the significance of the research.
 Engagement & Aesthetics	The visual representation is engaging and visually appealing, using eye-catching colors, varied images, and clear design elements to capture the audience's attention without overwhelming them.
 Content Relevance & Conciseness	All elements used (text and images) are relevant to the assigned topic, clearly presented, and concise, minimizing complexity while highlighting key concepts and findings from the paper.
 Logical Flow & Organization	Information is presented in a logical order that is easy to follow, with a clear structure that ties together the main ideas and facilitates understanding through visual aids and appropriate labeling.
 Professionalism & Consistency	The overall design maintains a professional and consistent theme, ensuring that fonts, colors, and layout are cohesive and conducive to effective communication of the research findings.

Demographic information



Demographic information per condition



Generic Examples

Article


Bioactive Components in Black Currant Fruit, Red Perilla (Shiso) Leaf, and Chinese Sweet Tea That Enhance Testosterone Production in Leydig Cells and Their Combined Effect in Male Mice

Eisuke Kato*, Yosuke Inagaki, Hiromi Kayooka, Yusuke Adachi, Tomoaki Nagase, Naofumi Terada, and Ai Tsuruma

ACS Food Science & Technology 2024, 4, 5, 1209-1215 (Article) [Subscribed](#)

Publication Date (Web): May 6, 2024

DOI: 10.1021/acsfoodscitech.4c00022

 Abstract

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Journal of Chemical Education 2024, 101, 2, 633-639 (Technology Report) [Subscribed](#)

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