Galileo: Citizen-led Experimentation using a Social Computing System

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american gut

CRI

Key social computing insight

Support complex activities—like experimentation—
by providing procedural support (**how** to)
alongside conceptual knowledge (what)

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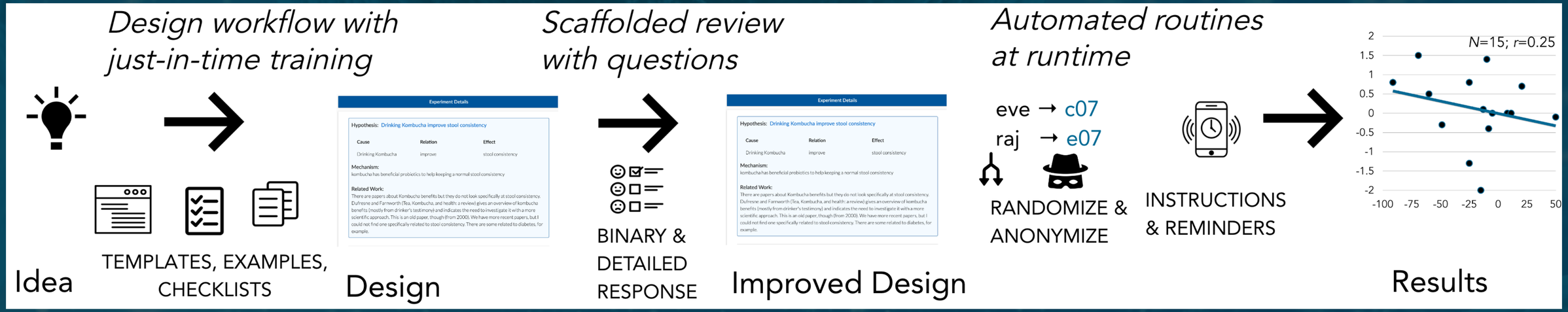
The Galileo system instantiates this insight



Key social computing insight

Support complex activities—like experimentation—
by providing procedural support (**how** to)
alongside conceptual knowledge (what)

In field studies, people used Galileo to

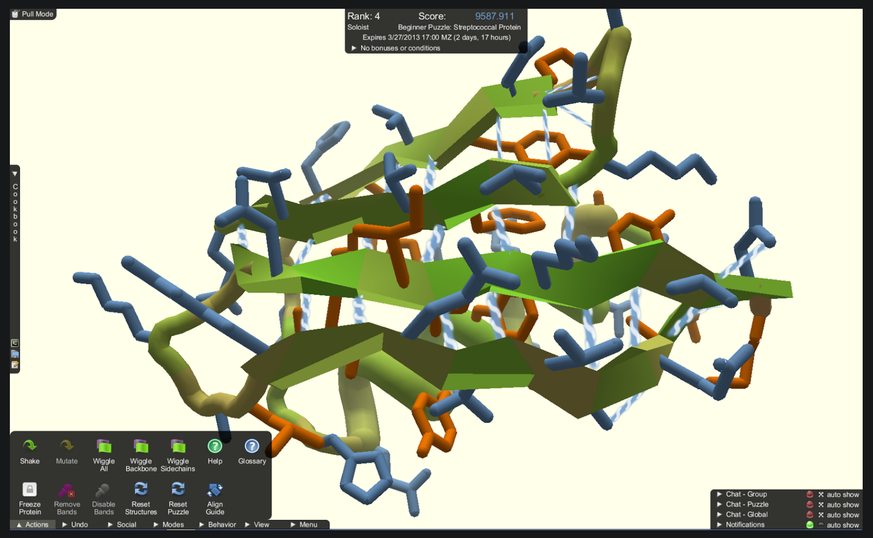
1 Design structurally-sound experiments
2 Review experiments to provide useful suggestions
3 Successfully run experiments with online communities

Motivation

Citizen scientists successfully solve expert-defined problems as *sensors* or *algorithms*

Tracking bird migration using eBird

eBird: A citizen-based bird observation network in the biological sciences. Biological Conservation 2009.



Folding proteins using Foldit

Predicting protein structures with a multiplayer online game. Nature 2010.

Motivation

Previous systems support some aspects of novice-led scientific enquiry on pre-existing datasets

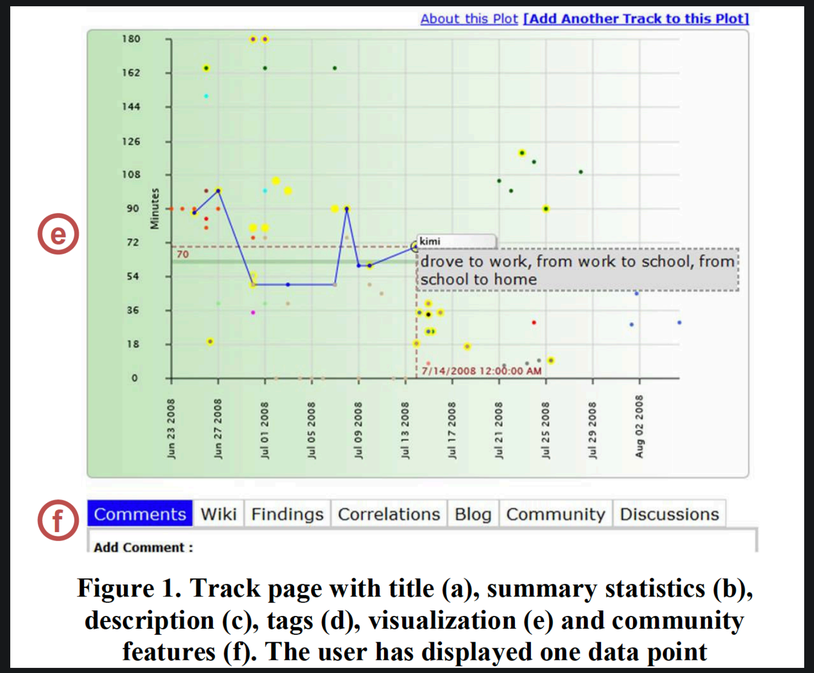


Figure 1. Track page with title (a), summary statistics (b), description (c), tags (d), visualization (e) and community features (f). The user has displayed one data point

Collaboratively discuss and analyze data. *Pathfinder. CHI 2009.*

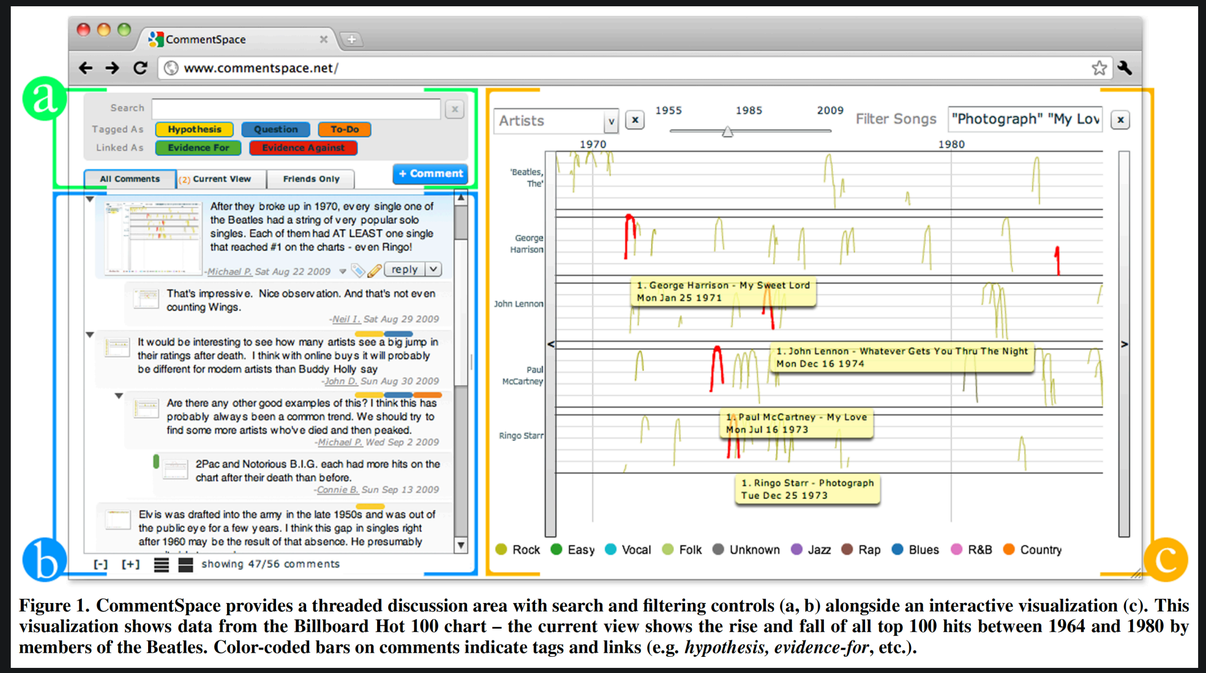


Figure 1. CommentSpace provides a threaded discussion area with search and filtering controls (a, b) alongside an interactive visualization (c). This visualization shows data from the Billboard Hot 100 chart – the current view shows the rise and fall of all top 100 hits between 1964 and 1980 by members of the Beatles. Color-coded bars on comments indicate tags and links (e.g. *hypothesis, evidence-for*, etc.).

Collaborative annotation and synthesis. *Commentspace. CHI 2011.*

Needs, Research Question

People might have intuitions and folk theories that could be useful for science.

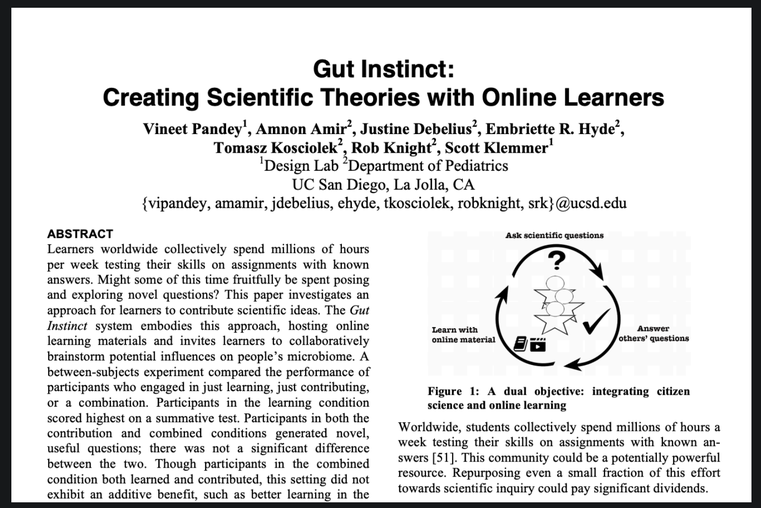
How might people design and run experiments w/others?

Kombucha bacteria: a gut probiotic?

Adriana: Kombucha producer from Rio

Research Contribution

A demonstration that people can collaboratively design and run experiments **without experts' involvement**



Gut Instinct:
Creating Scientific Theories with Online Learners

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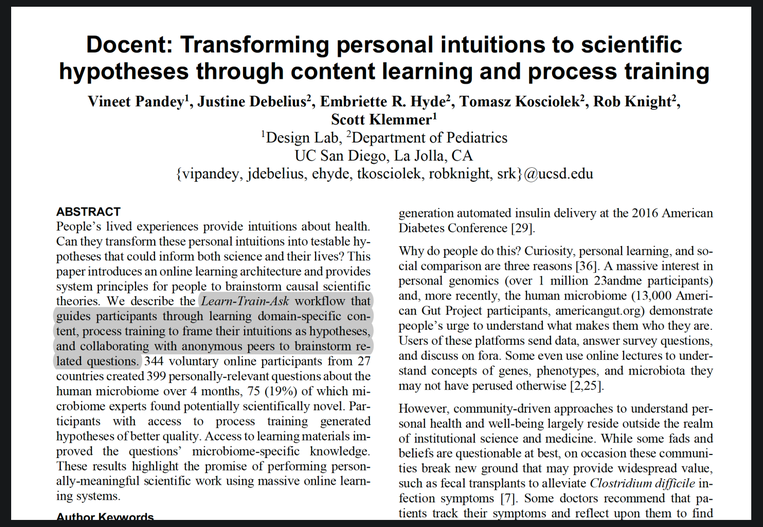
ABSTRACT
Learners worldwide collectively spend millions of hours per week testing their skills on assignments with known answers. Might some of this time fruitfully be spent posing and exploring novel questions? This paper investigates an approach for learners to contribute scientific ideas. The *Gut Instinct* system embodies this approach, hosting online learning materials and invites learners to collaboratively brainstorm potential influences on people's microbiome. A between-subjects experiment compared the performance of participants who engaged in just learning, just contributing, or a combination. Participants in the learning condition scored highest on a summative test. Participants in both the contribution and combined conditions generated novel, useful questions; there was not a significant difference between the two. Though participants in the combined condition both learned and contributed, this setting did not exhibit an additive benefit, such as better learning in the

Figure 1: A dual objective: integrating citizen science and online learning

Worldwide, students collectively spend millions of hours a week testing their skills on assignments with known answers [51]. This community could be a potentially powerful resource. Repurposing even a small fraction of this effort towards scientific inquiry could pay significant dividends.

Collaborative idea creation. *Gut Instinct. CHI 2017.*



Docent: Transforming personal intuitions to scientific hypotheses through content learning and process training

Vineet Pandey[1], Justine Debelius[2], Embriette R. Hyde[2], Tomasz Kosciolek[2], Rob Knight[2], Scott Klemmer[1]
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ABSTRACT
People's lived experiences provide intuitions about health. Can they transform these personal intuitions into testable hypotheses that could inform both science and their lives? This paper introduces an online learning architecture and provides system principles for people to brainstorm causal scientific theories. We describe the *Learn-Train-Ask* workflow that guides participants through learning domain-specific content, process training to frame their intuitions as hypotheses, and collaborating with anonymous peers to brainstorm related questions. 344 voluntary online participants from 27 countries created 399 personally-relevant questions about the human microbiome over 4 months, 75 (19%) of which microbiome experts found potentially scientifically novel. Participants with access to process training generated hypotheses of better quality. Access to learning materials improved the questions' microbiome-specific knowledge. These results highlight the promise of performing personally-meaningful scientific work using massive online learning systems.

Author Keywords

generation automated insulin delivery at the 2016 American Diabetes Conference [29].

Why do people do this? Curiosity, personal learning, and social comparison are three reasons [36]. A massive interest in personal genomics (over 1 million 23andme participants) and, more recently, the human microbiome (13,000 American Gut Project participants, americangut.org) demonstrate people's urge to understand what makes them who they are. Users of these platforms send data, answer survey questions, and discuss on fora. Some even use online lectures to understand concepts of genes, phenotypes, and microbiota they may not have perused otherwise [2,25].

However, community-driven approaches to understand personal health and well-being largely reside outside the realm of institutional science and medicine. While some fads and beliefs are questionable at best, on occasion these communities break new ground that may provide widespread value, such as fecal transplants to alleviate *Clostridium difficile* infection symptoms [7]. Some doctors recommend that patients track their symptoms and reflect upon them to find

Collaborative hypotheses generation. *Docent. LatS 2018.*

Citizen-led experimentation. Galileo. CHI 21.

Key concern: People don’t know what is an experiment design and how to create one

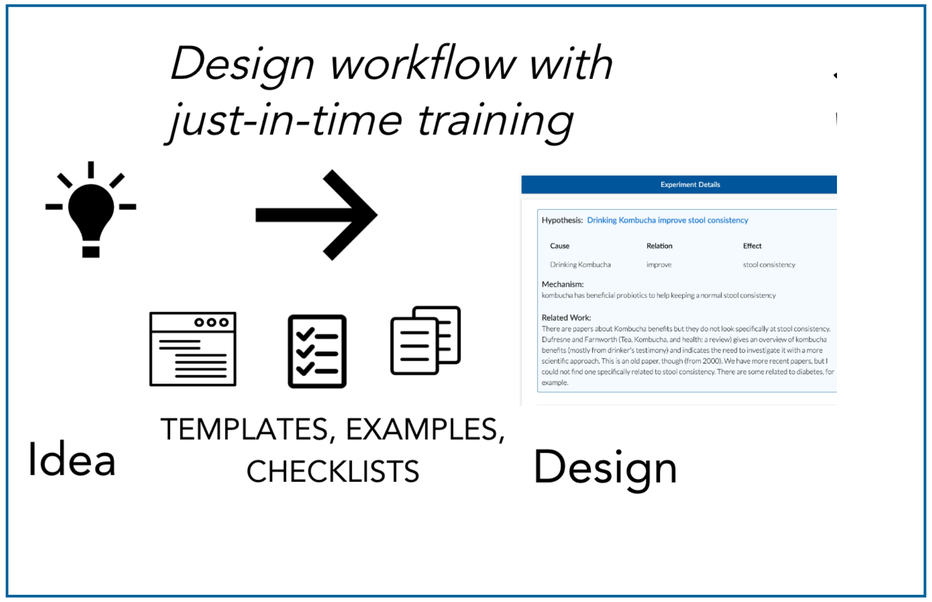
“Kombucha helps the gut” -
what does this mean?

How do I know that participants can understand my instructions?

Which group of participants would be most appropriate? Can I place my friend in the experimental condition I want to?

Step 1: Design

A participant creates an experiment using procedural support



Step 1: Design

A participant creates an experiment using procedural support

PRE-POPULATED TEXT

1 Start with an intuition

Drinking kombucha makes me less bloated

EXAMPLES

These examples might help :

Drinking coffee	*increases*	*alertness*
Eating raisins every day	*decreases*	*number of bowel movements*
Not brushing teeth	*results in*	*bad breath*

Cause	Relation	Effect
Drinking kombucha	improves	stool consistency

2 Measure the cause

Drinking kombucha improves stool consistency

To conduct an experiment, you need to

1. change the cause (called manipulation) and then
2. record the effect.

How will you manipulate **Drinking kombucha** in your experiment?
(To keep your experiment simple, choose **one** option)

- Absence or Presence
  - E.g. Milk in your diet could be present or absent
  - E.g. Exercise in your day could be present or absent

TEMPLATE

3 Set up data collection messages

Send all participants a reminder to provide **Bristol Scale Value** 8:00 pm
of **stool consistency** at

edit the content for the reminder text message to track stool consistency at 8:00 pm

Hello from Galileo! This is your 8:00 pm reminder to measure "stool consistency" today.

How would you classify stool consistency on the Bristol Stool Chart? Please refer to the chart (https://en.wikipedia.org/wiki/Bristol_stool_scale) and reply with a value between 1 to 7.

4 Set up exp/control conditions

Your **Hypothesis**: Drinking kombucha improves stool consistency

Your **Experimental Group:**

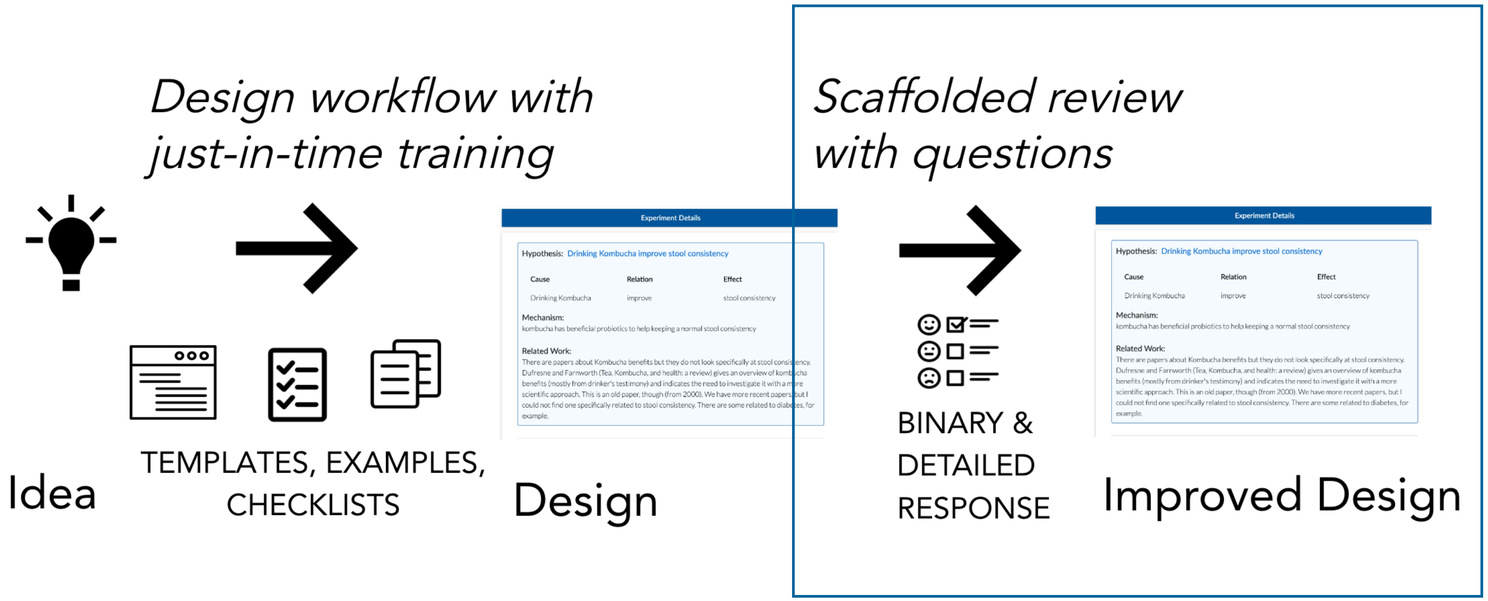
Drinks Kombucha

Your **Control Group:**

Does not drink Kombucha

Step 2: Review

Community members review the experiment using scaffolded questions



Type 7		Liquid consistency with no solid pieces	Inflammation

- Reminder sent every day at 8 pm with the following message:

  "This is your 8:00 pm reminder to measure "stool consistency" 💩 today. How would you classify stool consistency on the Bristol Stool Chart? Please refer to the chart here (https://en.wikipedia.org/wiki/Bristol_stool_scale) and reply with a value between 1 to 7." If you had more than one stool today, please classify each one with a value between 1 to 7 separated by commas. On the other hand, if you did not have a stool today, the value should be 0. Don't worry if you receive a data_invalid message; your response is tracked and saved!"

Control Condition

Does not drink kombucha

Preparation steps

Control steps

1. Do NOT consume kombucha or other fermented foods of any flavor or brand (anytime during the entire day/night)
2. Write down if you consume alcohol or very different food or drink from your usual diet
3. Continue performing your daily activities as usual
4. Measure effect: write down your stool consistency, for each of your daily stool, on a scale of 1 to 7. If no stool that day record 0.
5. Send your measurements to Galileo

Inclusion Criteria

(Every participant must meet EACH of the following criteria)

1. feel comfortable drinking kombucha
2. feel comfortable glancing at your stool for science

Review

Feedback request from the creator of the experiment:
none

People's review of the control condition

Is the control condition appropriate compared to the experimental condition? E.g. If comparing the effect of eating cabbage on bloatedness, control condition participants can eat lettuce/broccoli rather than not eating food at all.

Yes 1 | No 0

Do the control and experimental conditions differ in ONLY one step that manipulates the cause?

Yes 0 | No 0

Are all the steps clear enough so all the participants interpret them consistently?

Yes 0 | No 0

Is every step safe for participants? Please point out any step that asks participants to abstain from food, water, medication, or suggests extreme increase in physical activity!

Yes 0 | No 0

People's daily activities can influence the cause measure. Do the steps account for this issue (called confounds)? For example, if an experiment studies the effect of coffee on sleep, participants should not drink soda (since soda has caffeine too).

Yes 0 | No 0

Can participants perform all the steps in either condition in a reasonable time?

Yes 0 | No 0

Step 3: Run

Automated routines and just-in-time prompts nudge participation and data reporting

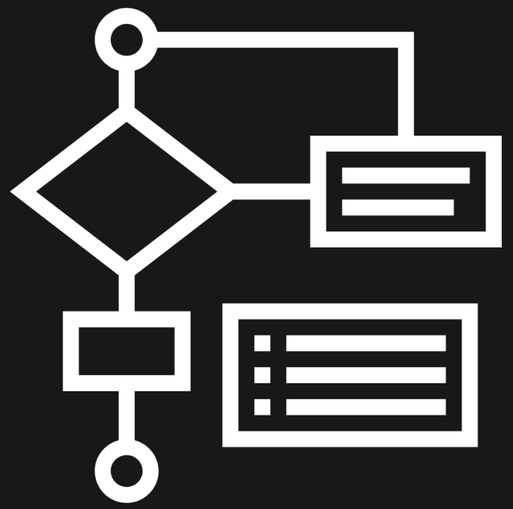
Design workflow with just-in-time training

Scaffolded review with questions

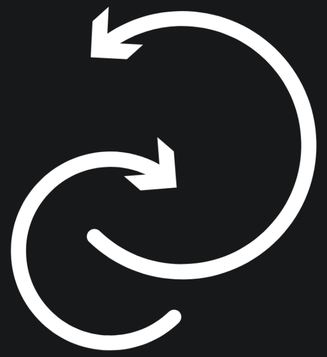
Automated routines at runtime

Takeaway

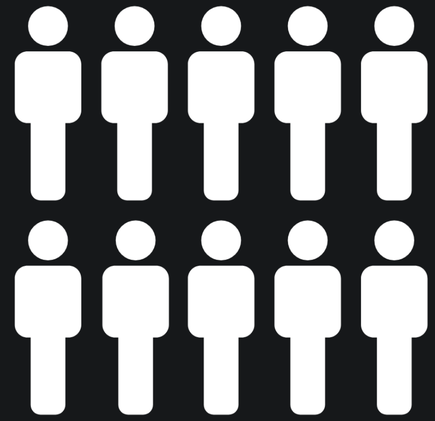
Complex work–like experimentation with people –requires multiple kinds of knowledge and skills



Self-source the first design using Procedural Guidance



Crowdsource technical + pragmatic feedback



Support participation with j-i-t data prompts

Study1

Design and Review Experiments Online

Participants

Study1

Design and Review Experiments Online

Participants

coursera

54 users

16 countries

66 designs

205 comments

Median design time = 27 mins

Study1

People Designed Structurally-Sound Experiments and Drew from Personal Intuitions

10/13
average
design score

38%
drawing on lived
experience

Study1

People Designed Structurally-Sound Experiments and Drew from Personal Intuitions

“Avoiding foods high in lectins cures long-term post-infectious diarrhea” (P31)
“Drinking kombucha regularly reduces joint inflammation/ arthritis symptoms” (P35)

Popular themes: Diet, Technology use, Alternate Treatments

Study1

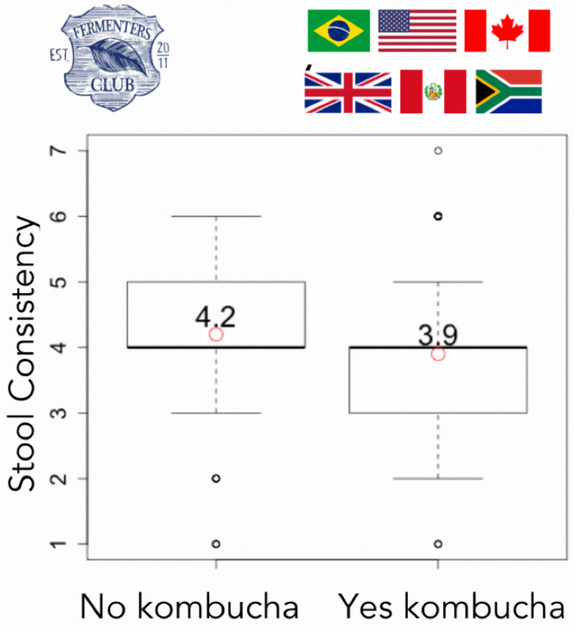
People Designed Structurally-Sound Experiments and Drew from Personal Intuitions

More details in the paper!

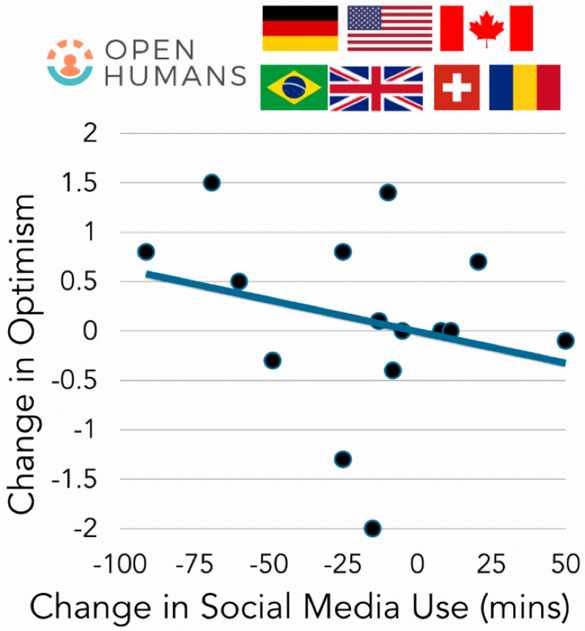
bit.ly/galileo-chi21

Study2

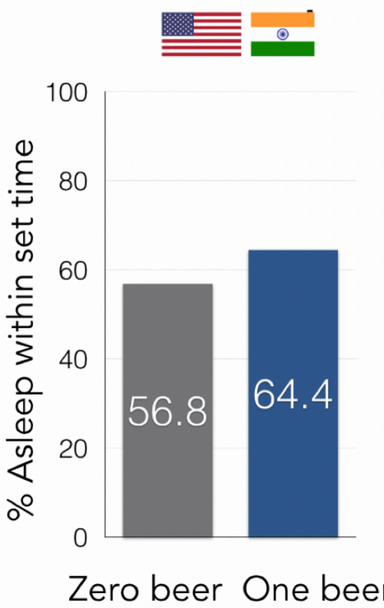
Three communities–Kombucha, Open Humans, Beer–designed and ran experiments



Drinking kombucha improves stool consistency
N=36; *p<0.03*



Reducing social media use was positively correlated with improving optimism
N=15; *r=0.25*



No trend was observed between drinking beer in the evening and time to fall asleep N=17; *p=0.56*

Study2

Three communities–Kombucha, Open Humans, Beer–designed and ran experiments

Multiple challenges

Finding participants, running pilots, and tracking adherence.

Read the paper for more details!

bit.ly/galileo-chi21

Key social computing insight

Support complex activities—like experimentation—by providing procedural support (**how** to) alongside conceptual knowledge (what)

The **Galileo** system instantiates this insight into guidance for experiment designers, reviewers, and participants

People used Galileo to design and run structurally-sound experiments

Galileo:Citizen-led Experimentation using a Social Computing System

We thank the following for their support, work, and ideas

1 

Award #1735234

2 **Dingmei Gu, Liby Lee, Kaung Yang, Orr Toledano, and Aliyah Clayton**
for help developing the website and running pilot studies

3 **Adriana Daudt Grativol** and **Austin Durant (Fermenter's Club, San Diego)**
for inputs on the experiment review and participant gathering phases

4 **Anonymous reviewers** for their thoughtful critiques

5 **Voluntary participants** who used Galileo

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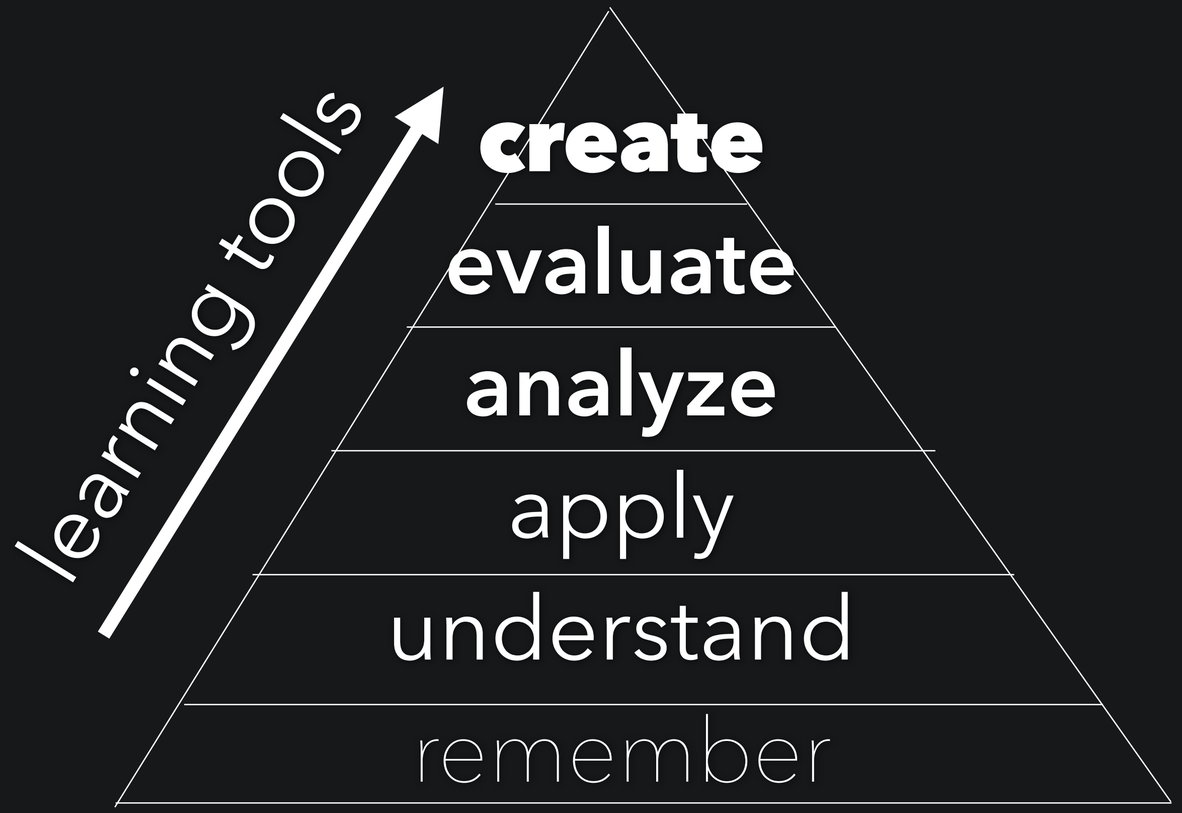
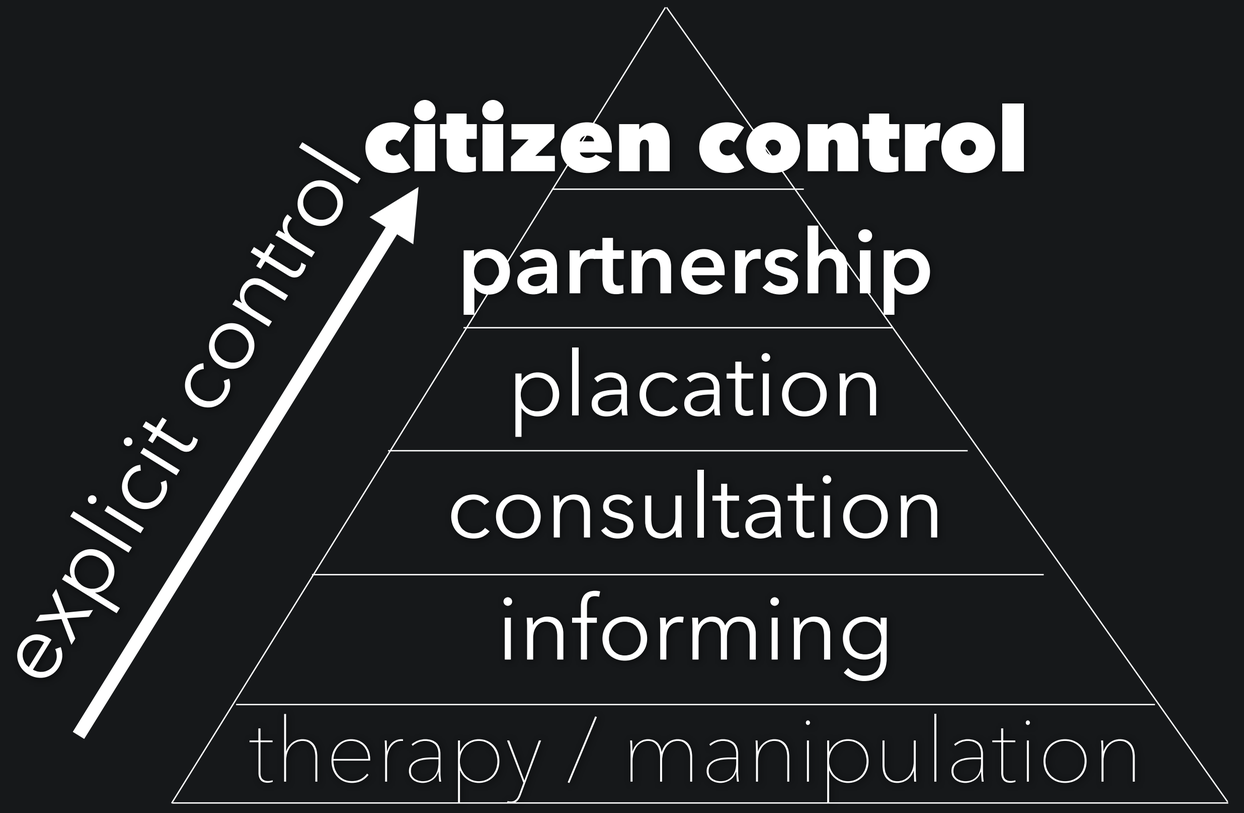
Complex work: learning & collaboration



Learning hierarchy (Bloom)



Participation ladder (Arnstein)