Community Data Science Collective

HUMAN CENTERED DESIGN & ENGINEERING
UNIVERSITY of WASHINGTON

Understanding & Designing for Data Literacies in Online Communities

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Roadmap

- Motivation & Background
  - Dissertation Overview & Anticipated Contributions
- Existing and Ongoing Work: Formative case studies
  - Study 1 - 3
- Proposed Work: Design-based Research
  - Study 4 & 5
  - Timeline & Anticipated Chapters

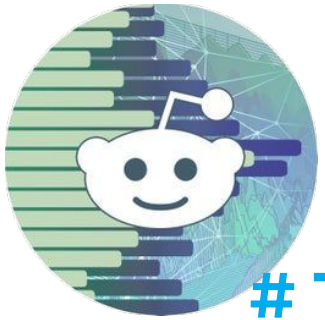
Motivation & Background

The abilities to understand and work with data are important for everyone.

Only a small proportion of people have access to formal training.

Working with data requires a range of skills, yet only a small part is taught in formal education.

Can we find an accessible context for the learning of multi-faceted skills to work with data?



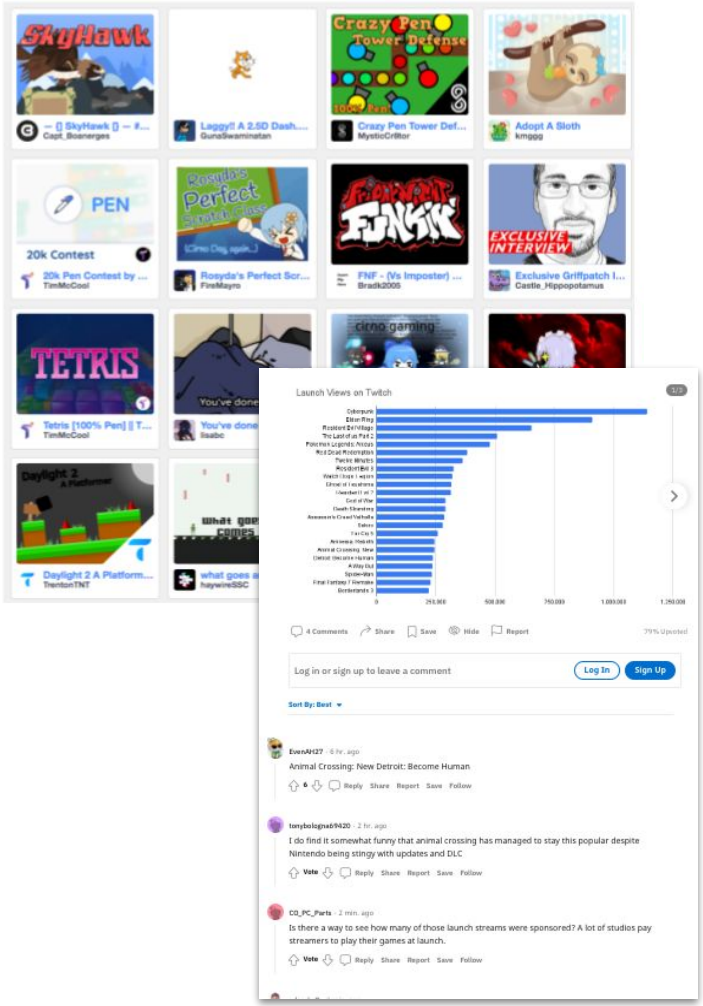
Communities of Practice

Community of Practice (CoP):

- A group that "share a concern or a passion for something they do and learn how to do it better as they interact regularly" (Wenger-Trayner 2015)
- Learning through Legitimate Peripheral Participation (Lave & Wenger 1991)

Online CoPs:

- Affinity spaces (Gee 2005)
- Distributed mentoring (Campbell et al. 2016)
- Plural learning pathways (Cheng & Hill 2022)



Computational participation

- Computational learning via making and sharing projects in socially supported context (Kafai 2016)
- Online communities for computational participation (e.g., Bruckman 1998, Resnick et al. 2009, Fiesler et al. 2017)

Online communities can potentially be a good learning context, but how well does it support data literacies?

“Data Literacies”

Data literacy -> Data literacies

My initial attempt to define data literacies:

- Technical: choose and apply relevant programming and statistical tools to work with data
- Discursive: recognize, reflect and properly communicate the process of working with data
- Critical: interpret and argue for the impact of data in a larger social context

My dissertation will add:

Empirical knowledge of how people develop data literacies in online communities & the challenges they face

Theoretical frameworks that describe:
- Different kinds of data literacies
- How features of online communities impact each type

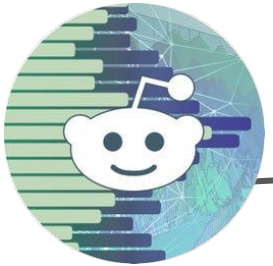
Design knowledge & prototype examples of how to promote data literacies in online communities

Dissertation Overview

RQ1: How do online communities support learners to develop a range of skills related to data literacies?

Formative case studies

kaggle



RQ2: What can we learn from online communities in order to design for data literacies?

RQ3: How might we design to promote data literacies and what do we learn from the design process?

Design-based Research

Theoretical Synthesis

Design & Evaluation

Existing & Ongoing Work:

Formative Case Studies of 3 Communities

Study 1

How Scratch users learn data structures in the community?

Published in CHI 2022

Cheng, R., Dasgupta, S., Hill, B. How Interest-Driven Content Creation Shapes Opportunities for Informal Learning in Scratch: A Case Study on Novices' Use of Data Structures. 2022. Proceedings of the ACM Conference on Human Factors in Computing Systems (CHI 2022).

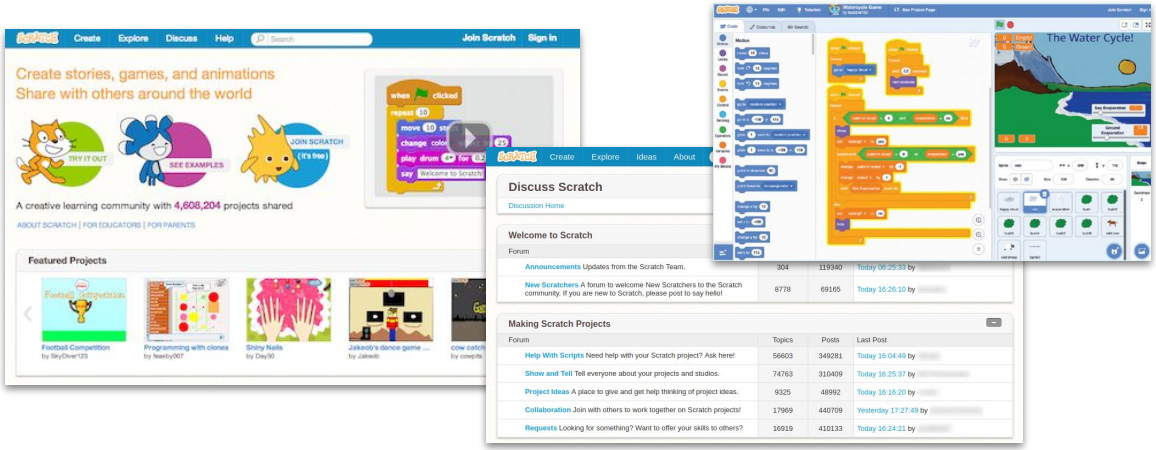
Community: Scratch

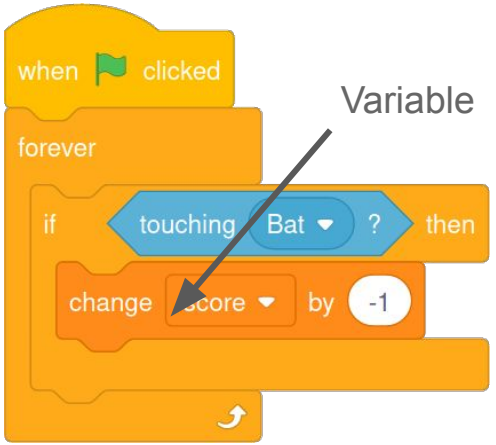
Scratch Online community

- Scratch: block-based programming language for novices
- Largest interest-driven computational learning community

Scratch Data structures

- Scalar variables and lists
- < 15% users have ever used data structures





Method: Mixed-method analysis

Study 1: Qualitative analysis of Scratch forum discussions on data structures

- Sampled 400 threads
- Grounded theory analysis

Proposed Theory

Study 2: Quantitative analysis using large-scale data on Scratch projects and user activities

Hypothesis testing analyses on 5 years of Scratch data: (241,634 projects created by 75,911 users)

Key Findings

Novices use specific use cases to teach each others about variables and list

- Many are game specific

User generated tutorials are often framed in game-making scenarios

"Create a Variable with the name **lives** so that every time the main character touches a ghost, it would lose one life."

Key Findings

Certain examples of how to use data structures become archetypes, which can constrain innovative usage

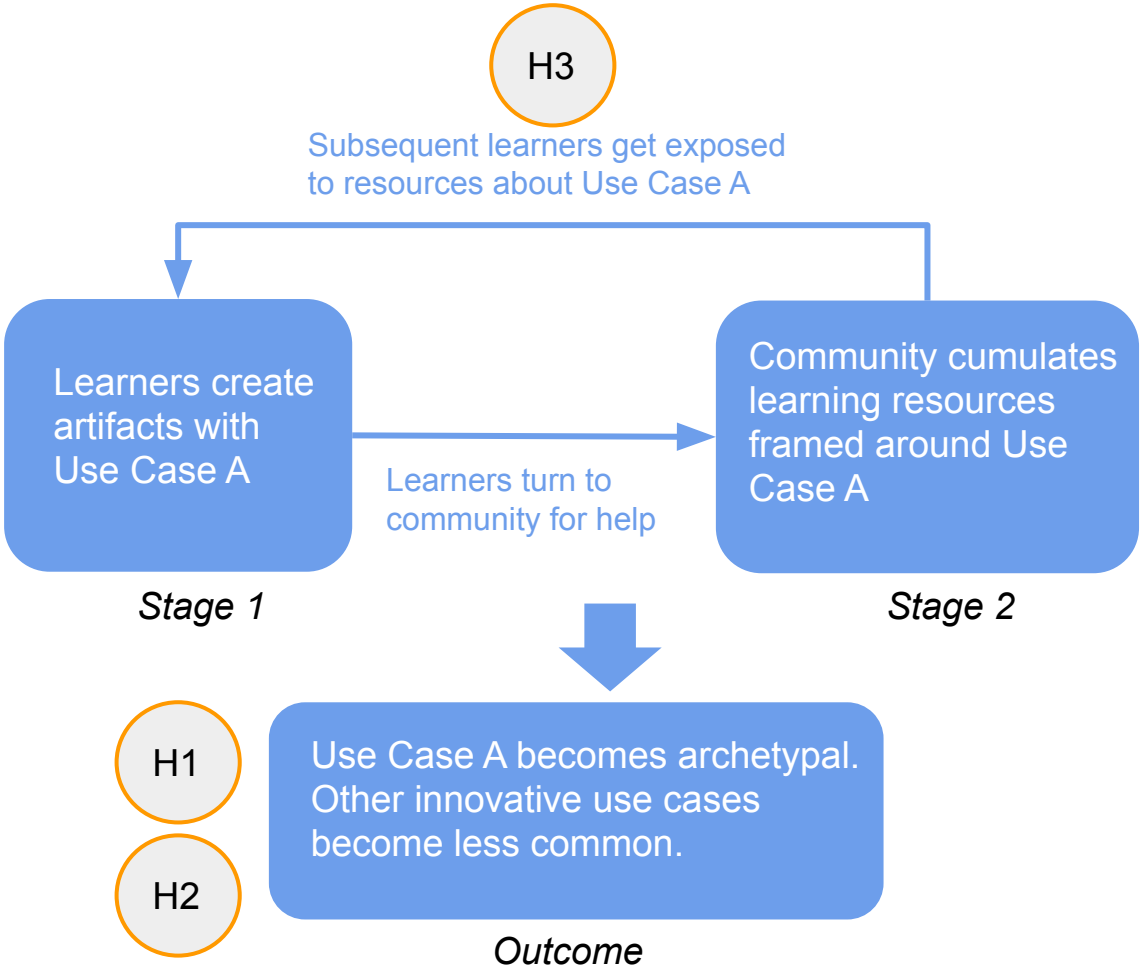
Q: "I want to use variables in my project but I don't know how?"

A: "Here is an example of how to make a **score counter** in your game!"

Q: "But my project is not a game. I am making a storytelling project…"

Key Findings

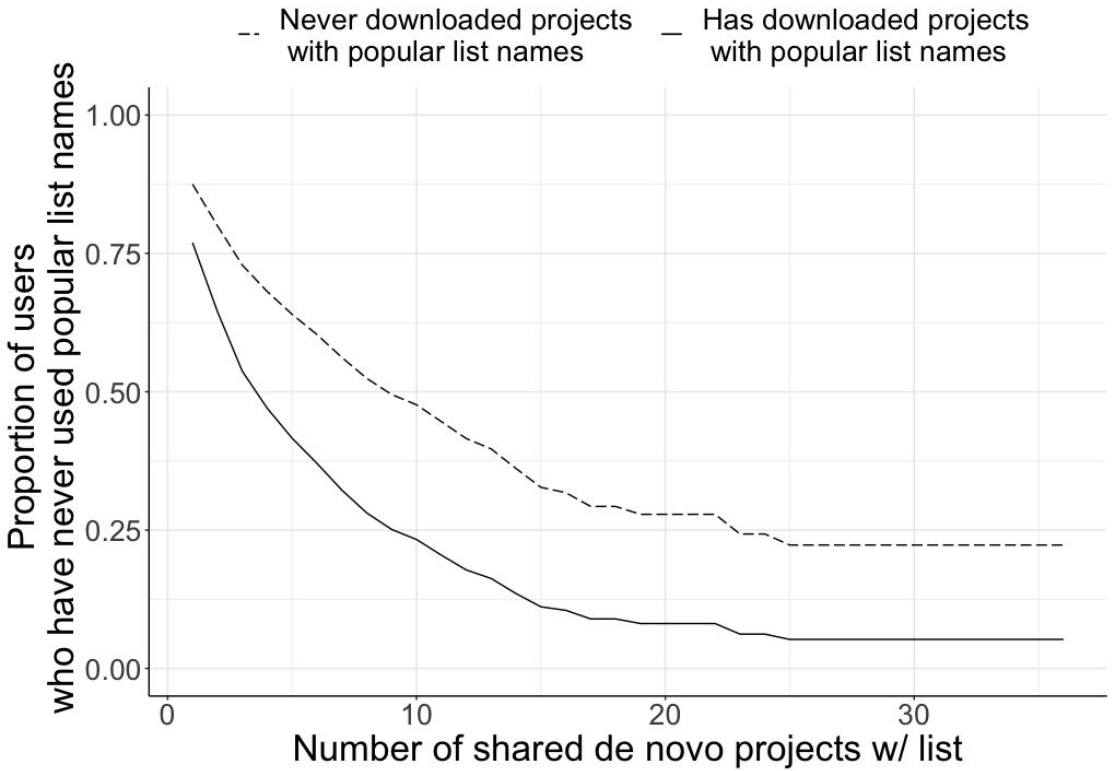
A social feedback loop of how community-generated resources may constrain innovative computational participation



Key Findings

H3: Users who have been exposed to popular variable and list names will be more likely to use those names in their own projects

(Partially supported by Projects with List)



Main Takeaway

Trade-off of online community for learning of technical concepts:

- User-generated explanation and understanding that fit common interests
- Risk of superficial, restricted learning resources

Study 2

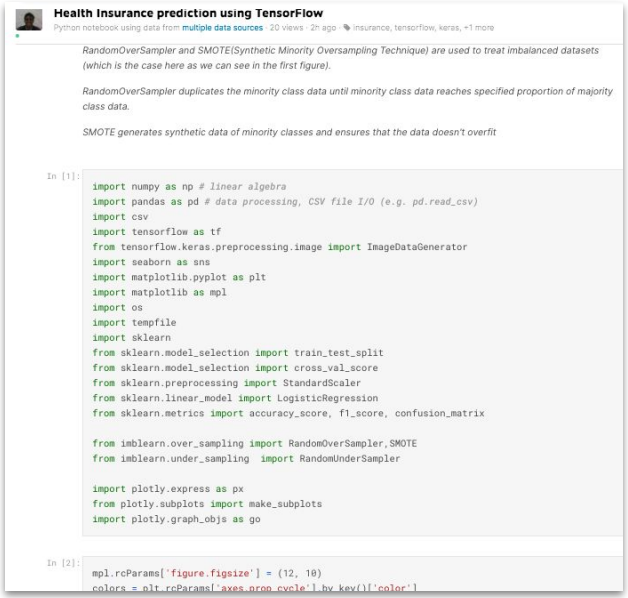
How and why Kaggle users share procedures and rationales of data analysis in the community?

Published in CSCW 2020

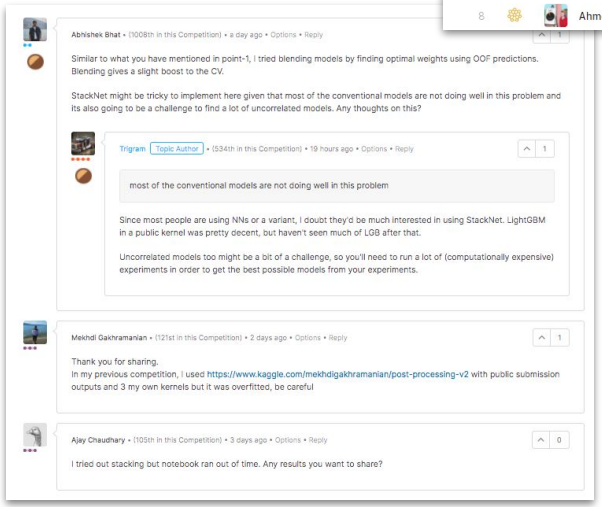
Cheng, R., Zachry, M. Building Community Knowledge in Online Data Science Competitions: Motivation, Practices and Challenges. 2020. Proceedings of the ACM Human Computer Interaction, Computer Supported Cooperative Work and Social Computing (CSCW 2020).

Community: Kaggle

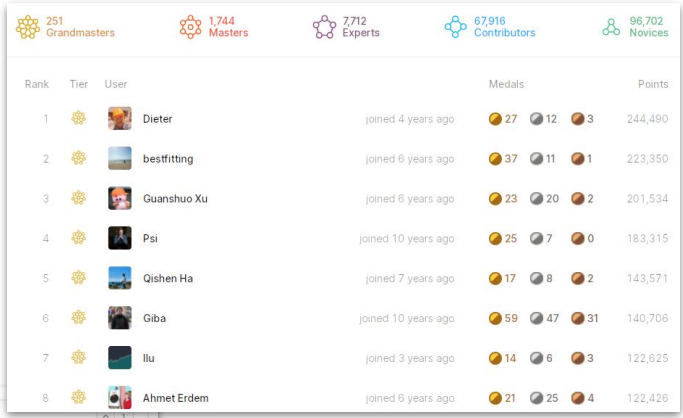
Largest data science competition platform



Notebook (publicly shared executable code)



Discussion



Public user ranking

Method:
Interview with 14 Kaggle users of a various experiences in data science

Key Findings

Experts share procedures and rationales that will be used and appreciated by other experts.

Experts' "niches": partial procedures and convoluted discussions.

"The snippets are better because they are focused into one topic. . . I don't want end-to-end solutions because it's kind of a copy paste." (E4)

"Use notebooks to communicate ideas on an inspiration level, but not submittable solutions." (E2)

Key Findings

Beginners are left out - challenge understanding and participating in experts' niche.

They also get little attention and encouragement for sharing their procedure and rationales.

"Some people only put a snippet, then sometimes I don't exactly understand what they did after that… and When I want to so the same thing, it just doesn't work." (B8)

"Here's always some anxiety that everyone else is more experienced at this, and they're gonna think my post is stupid." (B2)

Main Takeaways

Community recognition can potentially encourage members to share procedures and rationales in data analysis.

However, experts and beginners have very different experience and practices in sharing about analysis in the community.

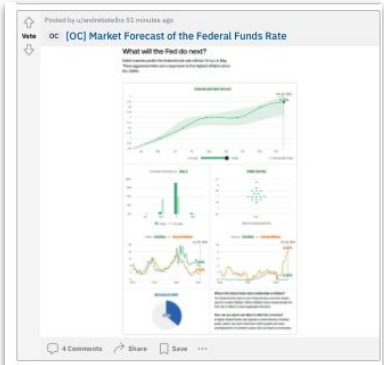
Study 3

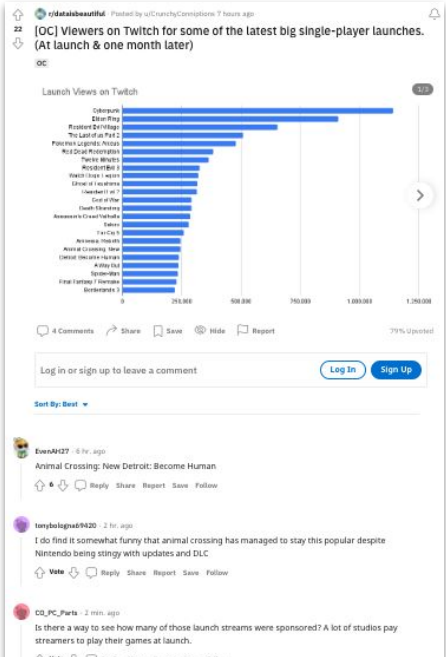
How interaction with community members shapes how people present, interpret, and argue with data.

Ongoing

Community: r/dataisbeautiful

Largest community dedicated to data visualizations on Reddit





Method: Interview with 22 members

- How and why users share their insights with data
- How and why they engage with other members
- What they learn about data science, domain topics and the community in the process.

Finished data collection and initial grounded theory analysis

Key Findings (tentative)

How to make visualizations & how to make visualizations *in and for* the community.

- Make sense of the community and social impact.
- Tailoring for audience's needs and interests.

Emerging trade-offs:

Information consumption experience vs critical exchanges and learning.

Awareness of audiences can constrain how learners work with and present data.

Proposed Work:

Design-based Research

Dissertation Overview

RQ1: How do online communities support learners to develop a range of skills related to data literacies?

Formative case studies

RQ2: What can we learn from online communities in order to design for data literacies?

RQ3: How might we design to promote data literacies and what do we learn from the design process?

Design-based Research

Theoretical Synthesis

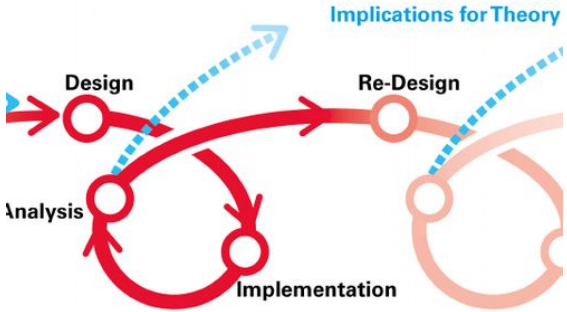
Design & Evaluation

Study 4

Theorizing Data Literacies in Online Communities

Design-based Research (DBR)

- A methodology in learning science
- Relationships b/w theories, design, and empirical evidences of learning
- Iteration



Conjecture maps

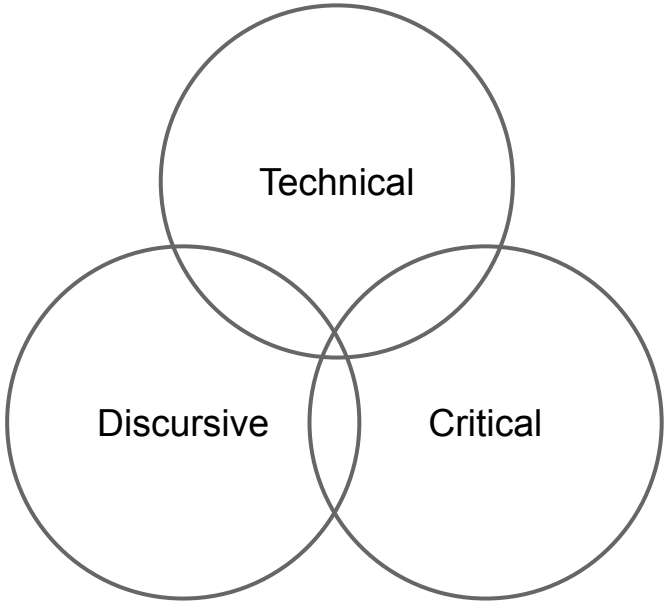
- An analysis instrument of DBR
- Developing theoretical conjectures:

Theorizing Data Literacies in Online Communities

Step 1: Build a framework of data literacies in online communities:

- Extend the three types of data literacies
- Add empirical evidence from formative studies
- Grounded with literature on data science education and workplace

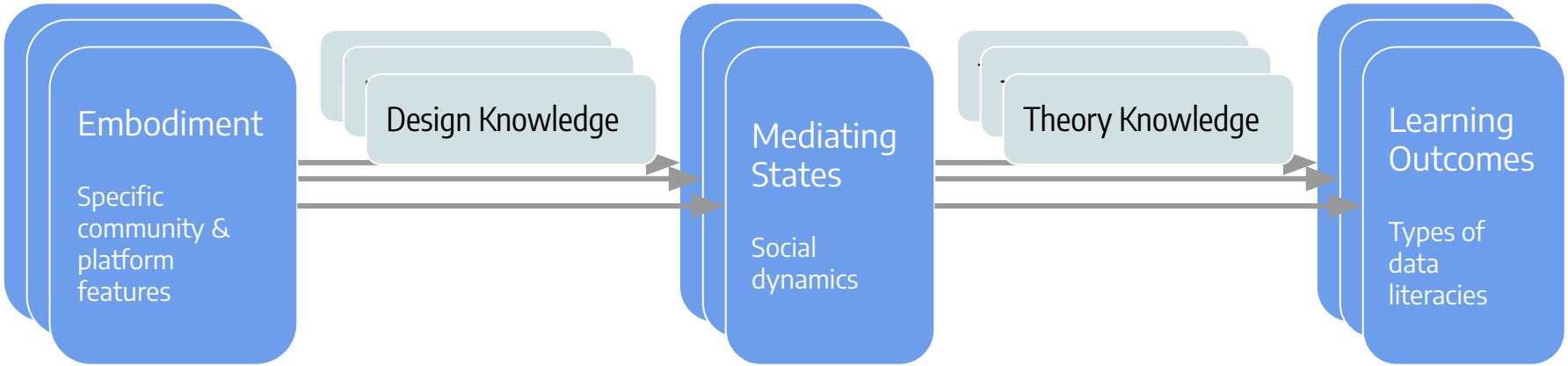
Desired framework: definition, skills and competencies, theoretical grounding, and connection to online communities.



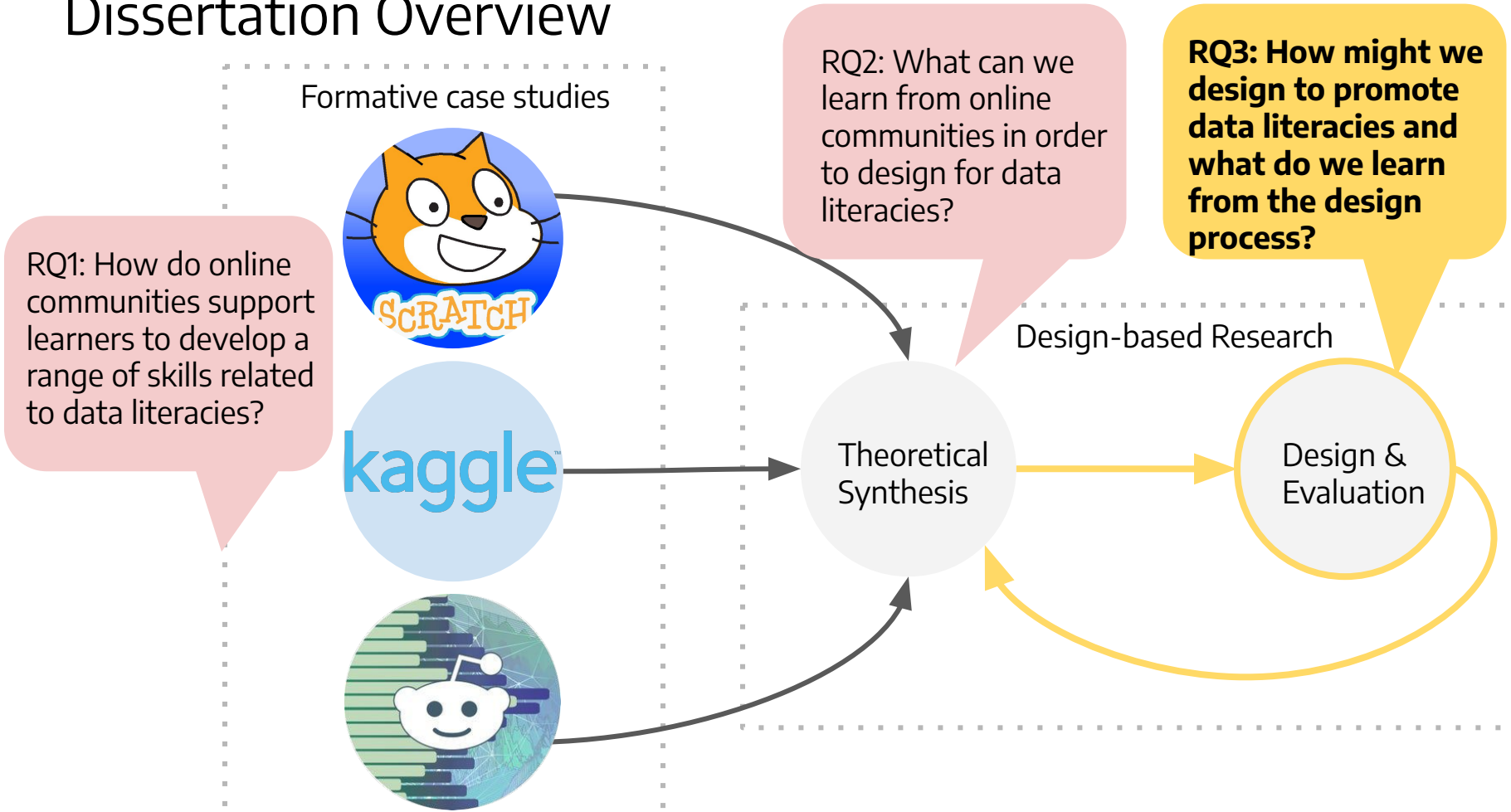
Theorizing Data Literacies in Online Communities

Step 2: Conjecture Maps

- Mechanisms of how features of online communities support or not support the different types of data literacies.
- Output: design directions



Dissertation Overview



Study 5

Design, evaluation, and iteration on theories

- Design and build 3-5 prototypes
- Use the prototypes as elicitations to conduct interview-based user studies.

Design

- Specific design directions will be based on the results of theoretical synthesis.
- Designs can range in fidelity and forms.
- Some examples of design directions:

Extension to Jupyter notebooks that prompts users to enter their rationales and decisions in data analysis and automatically forms a story that users can edit and share in online communities.

Online discussion interface with multiple parallel comment sections tailored for different purposes under a single post of data visualization.

A bot that identifies and explains underlining programming and statistical concepts that appear in posts about data exploration.

User studies

Recruitment:

- 20 - 30 participants
- Must have experience sharing or data analysis projects online and/or learning from others' projects.
    - A balanced mix of skill levels.
- Recruitment from multiple channels:
    - Online data hobbyist communities
      e.g., Kaggle, Tableau Public, and r/dataisbeautiful.
    - Classes such as HCDE 410, HCDE 530, and DATA 512.
    - Previous participants of formative research.

User studies

Procedures:

Pre-interview survey

- Share a most memorable project that they posted or learned from in online communities

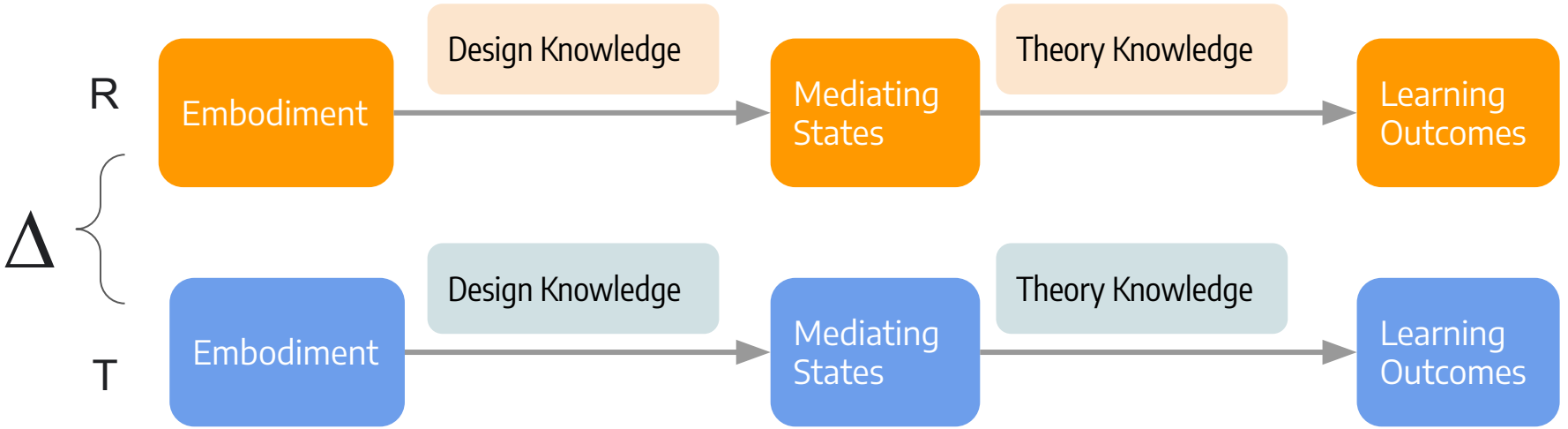
- Questions about the experience and challenges

Semi-structured interviews

- Online, 90 mins long, video audio-recorded
- Interact and think-out-loud with each of the prototypes.
- Imagine a scenario where they could use the prototypes for the project shared in survey.

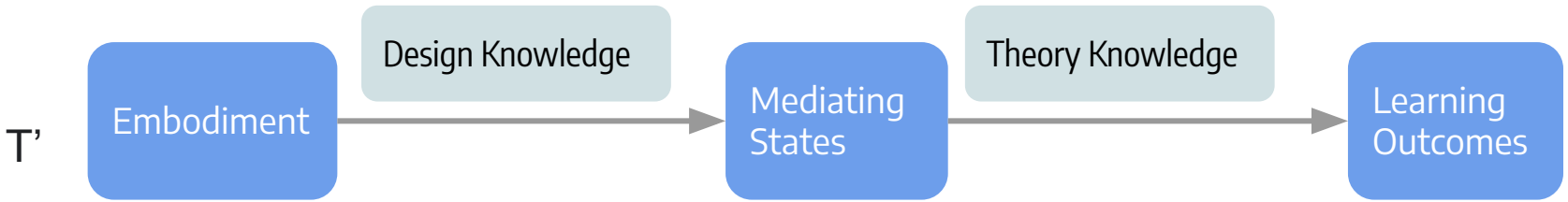
Analysis and Iteration on theories

- Grounded Theory analysis on interview transcripts
- New “real” conjecture maps (R), compared to the theoretical maps (T)



Analysis and Iteration on theories

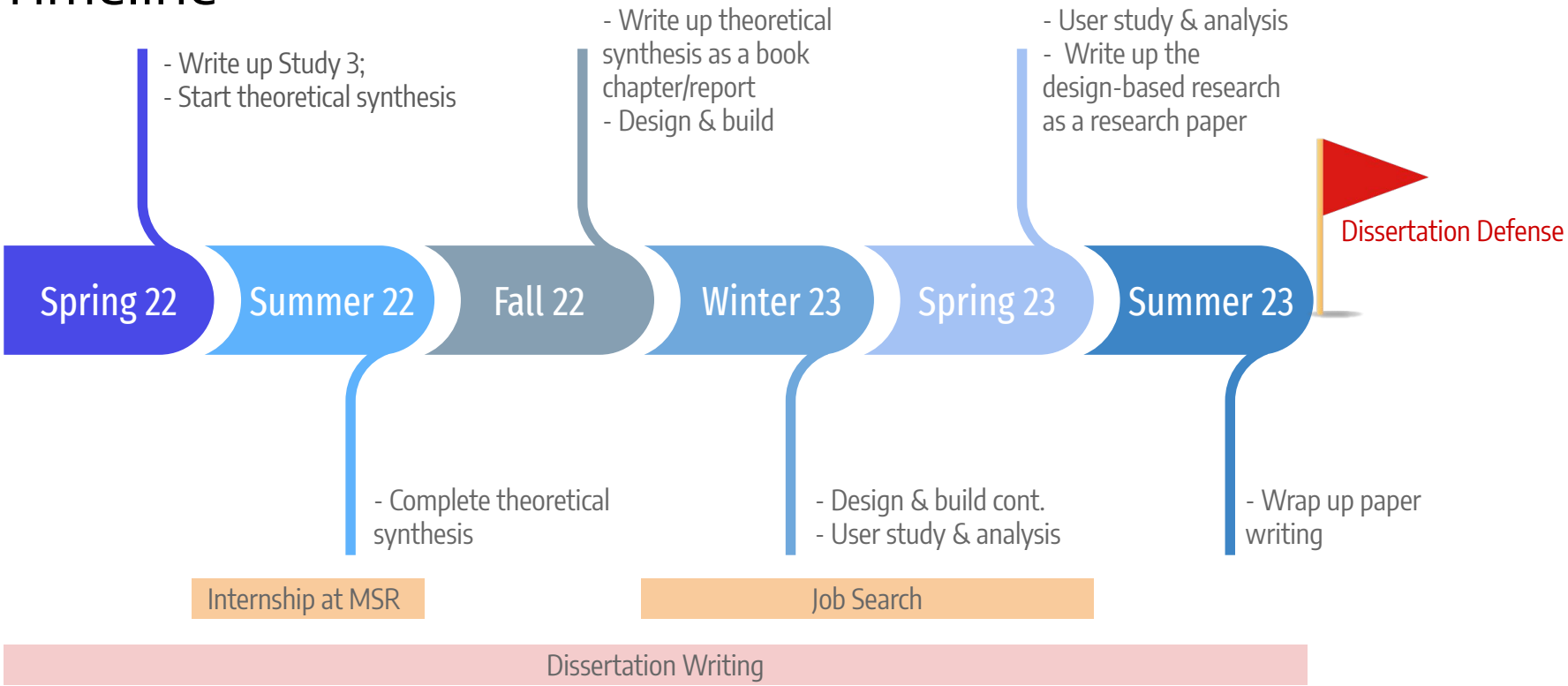
- Grounded Theory analysis on interview transcripts
- New “real” conjecture maps (R), compared to the theoretical maps (T)
- Refine the theory (T’)



Anticipated Chapters

- Chapter 1: Introduction.
- Chapter 2: Case Study 1 - Learning about Data Structures in Scratch.
- Chapter 3: Case Study 2 - Sharing Analysis Procedures in Kaggle.
- Chapter 4: Case Study 3 - Representing and Arguing with Data in r/dataisbeautiful
- Chapter 5 - Theorizing Data Literacies in Online Communities.
- Chapter 6 - Design, Evaluation, and Iteration on the Theories.
- Chapter 7 - Implications and Conclusion.

Timeline


- Write up Study 3;
- Start theoretical synthesis
- Write up theoretical synthesis as a book chapter/report
- Design & build
- User study & analysis
- Write up the design-based research as a research paper
Dissertation Defense
Spring 22
Summer 22
Fall 22
Winter 23
Spring 23
Summer 23
- Complete theoretical synthesis
- Design & build cont.
- User study & analysis
- Wrap up paper writing
Internship at MSR
Job Search
Dissertation Writing

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My advisors, committee members & mentors, my co-authors, humans of CDSC & HCDE, DRG students, my friends, my partner, and my parents - thank you all!