Designing Support for Productive Social Interaction and Knowledge Co-construction in Collaborative Annotation

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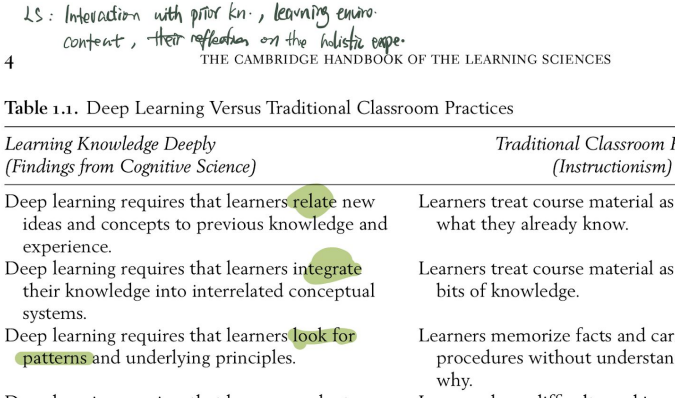
Collaborative Annotation?

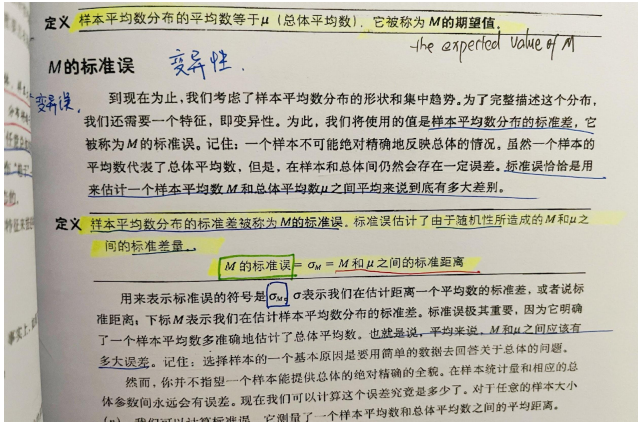
- Annotation: an important part of human cognition



LS: Interaction with prior kn., learning enviro. content, their reflection on the holistic expe.

Table 1.1. Deep Learning Versus Traditional Classroom Practices

Learning Knowledge Deeply (Findings from Cognitive Science)	*Traditional Classroom L (Instructionism)*
Deep learning requires that learners relate new ideas and concepts to previous knowledge and experience.	Learners treat course material as what they already know.
Deep learning requires that learners integrate their knowledge into interrelated conceptual systems.	Learners treat course material as bits of knowledge.
Deep learning requires that learners look for patterns and underlying principles.	Learners memorize facts and car procedures without understan why.



定义 样本平均数分布的平均数等于μ（总体平均数），它被称为M的期望值。

the expected value of M

M的标准误 变异性

变异性

到现在为止，我们考虑了样本平均数分布的形状和集中趋势。为了完整描述这个分布，我们还需要一个特征，即变异性。为此，我们将使用的值是样本平均数分布的标准差，它被称为M的标准误。记住：一个样本不可能绝对精确地反映总体的情况。虽然一个样本的平均数代表了总体平均数，但是，在样本和总体间仍然会存在一定误差。标准误恰恰是用来估计一个样本平均数M和总体平均数μ之间平均来说到底有多大差别。

定义 样本平均数分布的标准差被称为M的标准误。标准误估计了由于随机性所造成的M和μ之间的标准差量。

M的标准误 $= \sigma_M$ = M和μ之间的标准距离

用来表示标准误的符号是σ_M。σ表示我们在估计距离一个平均数的标准差，或者说标准距离；下标M表示我们在估计样本平均数分布的标准差。标准误极其重要，因为它明确了一个样本平均数多准确地估计了总体平均数。也就是说，平均来说，M和μ之间应该有多大误差。记住：选择样本的一个基本原因是要用简单的数据去回答关于总体的问题。

然而，你并不指望一个样本能提供总体的绝对精确的全貌。在样本统计量和相应的总体参数间永远会有误差。现在我们可以计算这个误差究竟是多少了。对于任意的样本大小

- Web Annotation: a genre of information technology that allows a user to annotate information in a shared web document and hereby anchor a discussion to the annotated information.

Social Annotation using *Hypothes.is*

is also tagged with the unique PMID of its related document, so it's also possible to browse and search all comments related to any specific document using a PMID tag, as in this example. And like with all Hypothesis annotations, you can now interact further with these PubMed comments, adding replies or using their unique URLs in other contexts.

Making comments FAIR

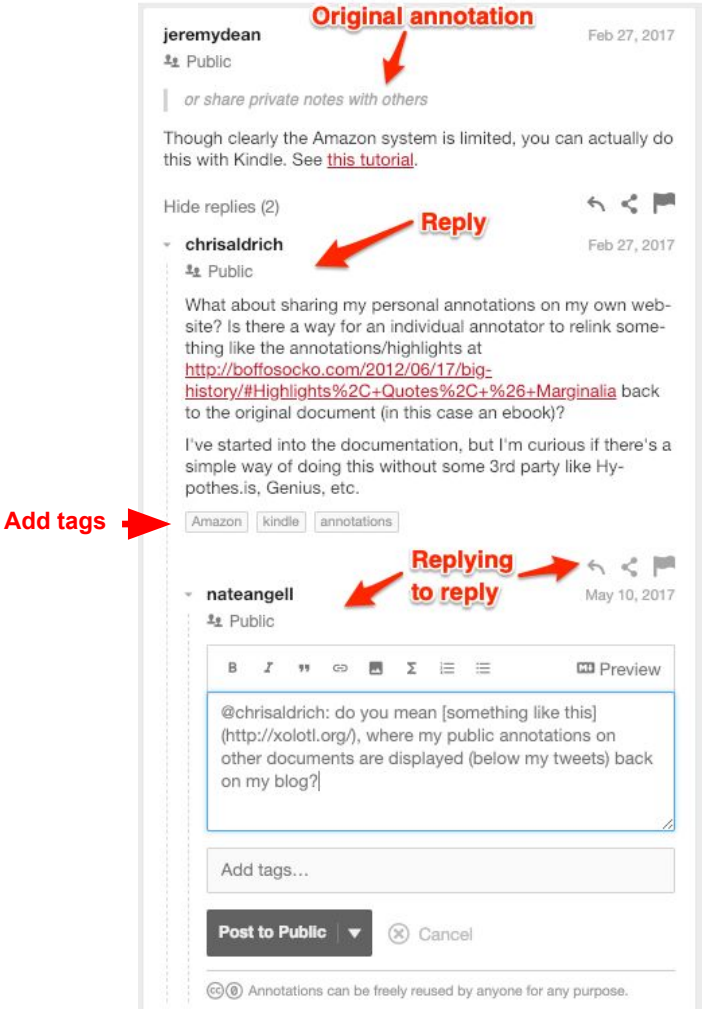
This exercise in preservation surfaced important underlying issues about the status of such scholarly commentary: is it a valuable part of scholarship that deserves more formal status, and if so, how can it be supported and preserved? Towards this end, we and others have been considering how annotations can benefit from adopting FORCE11's FAIR principles, which define four characteristics that data — including comments — should possess in order to fully participate in scholarship: be Findable, Accessible, Interoperable, and Reusable.

Annotate Highlight

Like many comments on the web, those at PubMed Commons were not especially FAIR. They did display a clear license, which helped ensure that they were reusable. But as our screen-scraping and DOI exercises showed, they were not particularly accessible or interoperable. In the process of archiving these comments in Hypothesis, we were able to increase their FAIRness substantially. Each comment now clearly states its provenance, relates in metadata to the unique identifier of the document it addresses, and is available for access and reuse both at its own unique URL and over an open API that matches W3C standards. Before, the comments existed only on PubMed Commons abstracts. Now, they have their own status and a direct relationship to their related documents everywhere those might be published, in any common web format. Learn more about recent conversations to make annotations FAIR.

From comments to annotations

At Hypothesis, we believe strongly that there is a role for community feedback on scholarship. Despite the fact that PubMed Commons struggled, we believe that the kinds of conversation it provided should be ubiquitous capabilities for scientific and scholarly content. Annotation systems like Hypothesis go well beyond typical commenting systems by:



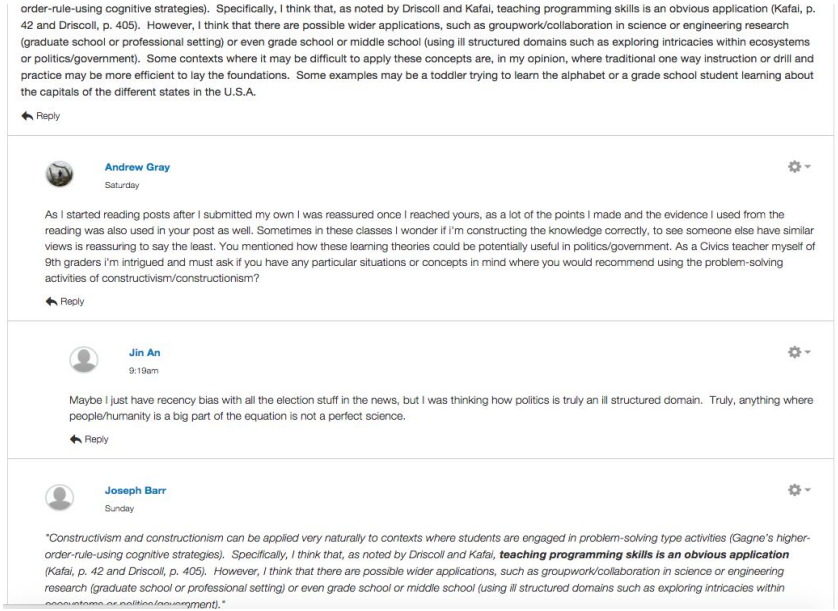
hypothes.is

Web Annotation in Education

- When Covid-19 has forced schools/universities to pivot online/distance learning, teachers face a lingering question:

What online teaching strategies are available to support social reading and group discussion of course materials in the classroom?

Discussion board?



order-rule-using cognitive strategies). Specifically, I think that, as noted by Driscoll and Kafai, teaching programming skills is an obvious application (Kafai, p. 42 and Driscoll, p. 405). However, I think that there are possible wider applications, such as groupwork/collaboration in science or engineering research (graduate school or professional setting) or even grade school or middle school (using ill structured domains such as exploring intricacies within ecosystems or politics/government). Some contexts where it may be difficult to apply these concepts are, in my opinion, where traditional one way instruction or drill and practice may be more efficient to lay the foundations. Some examples may be a toddler trying to learn the alphabet or a grade school student learning about the capitals of the different states in the U.S.A.

Reply

Andrew Gray
Saturday

As I started reading posts after I submitted my own I was reassured once I reached yours, as a lot of the points I made and the evidence I used from the reading was also used in your post as well. Sometimes in these classes I wonder if i'm constructing the knowledge correctly, to see someone else have similar views is reassuring to say the least. You mentioned how these learning theories could be potentially useful in politics/government. As a Civics teacher myself of 9th graders i'm intrigued and must ask if you have any particular situations or concepts in mind where you would recommend using the problem-solving activities of constructivism/constructionism?

Reply

Jin An
9:19am

Maybe I just have recency bias with all the election stuff in the news, but I was thinking how politics is truly an ill structured domain. Truly, anything where people/humanity is a big part of the equation is not a perfect science.

Reply

Joseph Barr
Sunday

"Constructivism and constructionism can be applied very naturally to contexts where students are engaged in problem-solving type activities (Gagne's higher-order-rule-using cognitive strategies). Specifically, I think that, as noted by Driscoll and Kafai, ***teaching programming skills is an obvious application*** *(Kafai, p. 42 and Driscoll, p. 405). However, I think that there are possible wider applications, such as groupwork/collaboration in science or engineering research (graduate school or professional setting) or even grade school or middle school (using ill structured domains such as exploring intricacies within ecosystems or politics/government)."*

Web Annotation in Education

A systematic literature review on the use of web annotation in educational settings. Web annotation has been used across different education levels to help students:

- Process domain- specific knowledge
- Promote argumentation and inquiry
- Improve literacy skills
- Support instructor and peer assessment
- Connect online learning spaces

Zhu, X., Chen, B., Avadhanam, R. M., Shui, H., & Zhang, R. Z. (2020). Reading and connecting: Using social annotation in online classes. *Information and Learning Sciences*.

Research Gaps: Designing Scaffoldings in CSCL Literature

- ***Current literature on web annotation***: Less attention on the how web annotation activities are connected to other learning events.

Annotated, what's next?

- ***Call for research***: Meaningful scaffoldings in web annotation activities

- ***Computer Supported Collaborative Learning (CSCL) Literature***: CSCL has a long-standing interest in designing sophisticated social configurations, grounded in CSCL's recognition of interaction as an important factor of learning along with cognitive factors such as knowledge construction

- ***Bridge the gap***: we proposed a scaffolding framework of participation roles to support collaborative annotation activities.
  - Facilitate a natural space for social interaction
  - Engage knowledge co-construction

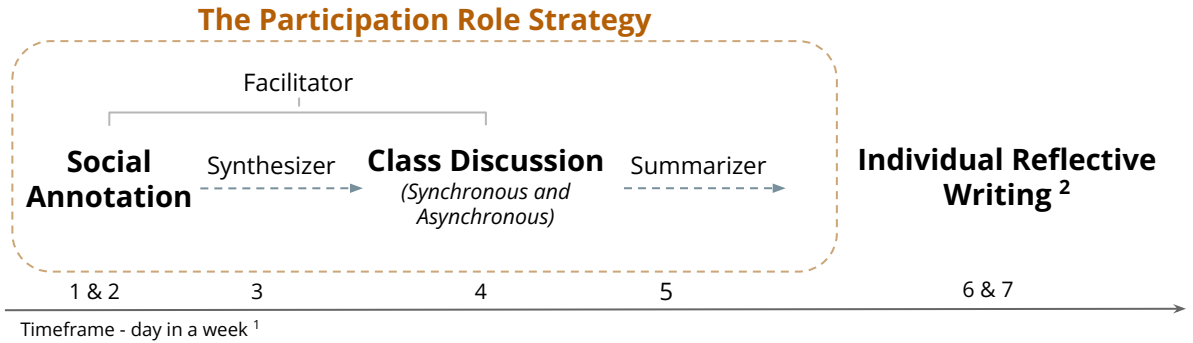
Web Annotation x CSCL

- ***Design the participation roles***: Roles - a fundamental aspect of group dynamics
  - emerging roles
  - scripted/assigned roles

The Design: Scaffolding Roles

The Participation Roles Strategy:

- ***Facilitator***: responsible for stimulating conversations by finding connections, seeking clarifications, and encouraging their peers to consistently tag their annotations for an entire week.
- ***Synthesizer***: who synthesizes the initial ideas, highlights agreement/disagreement, and suggests directions of further discussions in the middle of the week.
- ***Summarizer***: who summarizes group conversations at the end of the week for the whole class.



[1] Example timeframe for the strategies, e.g., synthesizer completes the task on the third day, Instructors may adjust the timeframe accordingly.
[3] Instructors may adjust this accordingly.

Zhu, X., Shui, H., & Chen, B. (2020, December 23). A Scaffolding Framework for Social Annotation in Online Classes. https://doi.org/10.35542/osf.io/zk4vj

Research Questions

- How did the activity design facilitate social interaction? In particular:
  - What were the participation patterns for different participation roles?
  - What were the participation patterns for the whole class and how were they related to patterns of participation roles?
- How did the activity design facilitate knowledge co-construction? In particular:
  - How were the levels of knowledge co-construction reflected in contributions made by different participation roles?
  - How were the levels of knowledge co-construction reflected in contributions made by the whole class each week and how were they related to knowledge co-construction levels of participation roles?

The Study Context

- **Methods**: Co-design between researchers and instructors to design scaffolding roles, and support their implementation with course-specific customization.

- **Tool:** hypothes.is

- **Participants:** Three fully online undergraduate classes in Liberal Arts: *Introduction to Rhetorical Theory (n=73)*, *The Sixties: History & Memory (n=97)*, and *Dance History (n=13).*

- **Reading Activity:**

  - Read 1-2 readings each week; posted annotations on Hypothes.is; replied to each other's annotations.

  - Following the designed scaffolding framework, the instructor assigned the participation roles – i.e., facilitator, synthesizer, and summarizer – to three students for each reading from Week 1 to Week 11. Students rotated across weeks and had the opportunity to assume different roles.

Data Analysis

Data Source: 482 Hypothes.is annotations and 492 replies created by students in 18 readings across 11 weeks.

SOCIAL NETWORK ANALYSIS

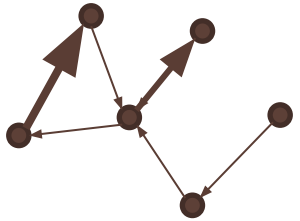
SOCIAL INTERACTION

CONTENT ANALYSIS

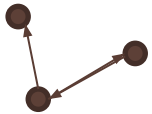
KNOWLEDGE CO-CONSTRUCTION

Social Network Analysis

- Goal: Analyze participation patterns
- Unit of Analysis
  - **Whole-network level**: interaction patterns for whole network
    - each student as a node and their interaction/reply events as edges;
    - this network was temporal (sliced by reading), directed (following the direction of replies), and weighted (based on the number of ties in a particular reading)
    - Conducted whole-network analysis for each reading
    - Network measures: degree centralization, density, reciprocity, and transitivity



  - **Ego-level network**: individual node's interaction pattern
    - one-step ego networks for individual students
    - network measures: ego size, centrality, and constraint



Content Analysis

- Knowledge Co-construction
  - Coding scheme: Revised Interaction Analysis Model (IAM) of Collaborative Annotation
  - Unit of analysis: each annotation

Table 1. *Revised IAM of Collaborative Annotation*

Level	Definition	Examples
Level-1: Initiation	a) Share initial understandings b) Ask questions and share resources without elaboration or critical examination	"Does this sound similar to what is happening in our society today? "
Level-2: Exploration	a) Elaborate on the texts b) Provide additional evidence/information to an argument without critical examination c) Make connections without critical examination	"Do you think this definition of social dance is accurate? What examples of social dance do we see today? How do these dances impact culture?"
Level-3: Negotiation	a) Response to questions through critical reasoning b) Negotiate disagreement c) Connect readings with critical reasoning d) Synthesize meanings e) Create new supporting statements by building on a previous conversation	"This also reminded me of the readings ... This approach to viewing performances seems desirable because it's often nice to just be able to watch a piece for the art that it is, but it is also important not to settle into this mindset and block out the intentions and messages behind a staged performance as well."
Level-4: Co-construction	a) Reach a consensus on a previous question b) Apply the knowledge or way of thinking gained through the activity c) Make a metacognitive statement illustrating their learning outcome	"… before this class began, I only thought of the first description when I considered diaspora. I viewed it as a lonely and isolating thing where people are forced from their homelands and lose all connection with their culture. However, these articles are broadening my view and allowing me to appreciate the connective power of diaspora, which I think is perfectly alluded to in this quote."

Adapted based on Gunawardena's IAM (1997) and Onrubia & Engel's model of collaborative knowledge construction (2009)

Results

Research Question 1: How did the activity design facilitate social interaction?

Facilitator

- The facilitators sent out more replies; reached out to more peers; received more replies.
- They were influential in the collaborative annotation activities.

Synthesizer

- The synthesizers participated more than non-role takers in terms of the numbers of posts they sent out, but not as much as the facilitators did since they tended to focus more on synthesizing the readings and annotations on their own.

Summarizer

- The summarizers participated as same as non-role takers which is also expected since the responsibility for them was to write the weekly summary on their own.

Node-level Measures for Role Takers and Non-Role Takers

Table 2. *Pairwise Comparisons among Groups*

		Mean Differences (A-B)					
Group A	Group B	In Degree	Out Degree	Betweenness	Constraint	Dominance	Ego Size
Facilitator	Synthesizer	0.11	0.03	5.21	-0.07	0.09	0.76
	Summarizers	0.07	0.14	10.13*	-0.05	0.14	1.24
	Non-role	0.11*	0.13*	9.75*	-0.08	0.16*	1.37*
Synthesizer	Facilitator	-0.11	-0.03	-5.21	0.07	-0.09	-0.76
	Summarizers	-0.04	0.11*	4.92	0.02	0.05	0.47
	Non-role	0.00	0.10*	4.55	-0.01	0.07	0.61
Summarizers	Facilitator	-0.07	-0.14*	-10.13*	0.05	-0.14	-1.24
	Synthesizer	0.04	-0.11*	-4.92	-0.02	-0.05	-0.47
	Non-role	0.04	-0.01	-0.38	-0.03	0.02	0.13

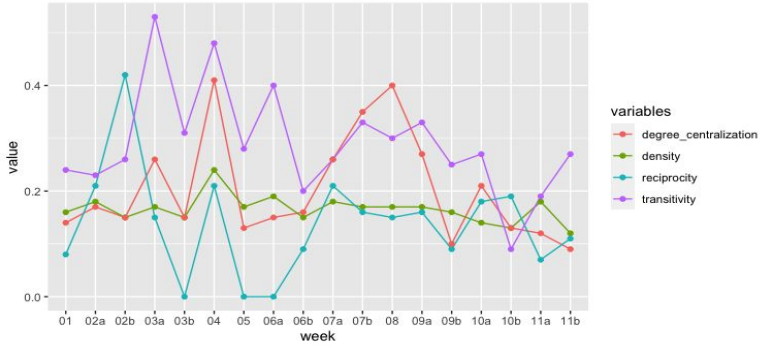
Note. * indicates the mean difference is significant at the .05 level.

Results

Research Question 1: How did the activity design facilitate social interaction?

Network-level Measures Across 11 Weeks

- Conducted for each reading across 11 weeks
- The results do not show discernible trends across weeks. Why?



Pearson Correlation: role takers' node level SNA X network level SNA

- network-level measures (except reciprocity) are significantly correlated with facilitators and synthesizers' node-level measures to some extent.
- Example see table 3
- role takers' participation is associated with the interaction patterns for the whole class. Hence, when different role takers took different strategies to play their roles and interact with peers, it may lead to the variance of interaction patterns across the whole class.

		Density	Reciprocity	Transitivity	Centralization
Facilitator	In-degree	0.32	0.34	0.33	0.68*
	Out-degree	0.83*	-0.02	0.47	0.74*
	Betweenness	0.57*	0.26	0.12	0.53*
	Constraint	-0.45	-0.19	-0.04	-0.28
	Dominance	0.43	0.31	0.50*	0.86*
	Ego size	0.60*	0.18	0.49*	0.67
Synthesizer	In-degree	0.57*	-0.18	0.64*	0.65*
	Out-degree	0.77*	0.13	0.62*	0.53*
	Betweenness	0.64*	-0.08	0.58*	0.45
	Constraint	-0.48	0.27	-0.55*	-0.05
	Dominance	0.48	0.27	0.57*	0.81*
	Ego size	0.75*	-0.13	0.77*	0.53*

Results

Research Question 2: How did the activity design facilitate knowledge co-construction?

Knowledge co-construction levels of role takers

Table 4. *Mean and Standard Deviation of Participation Roles in Four Levels*

	Level-1	Level-2	Level-3	Level-4
Facilitator	0.88 (1.65)	2.24 (1.35)	3.24 (2.17)	0.18 (0.39)
Synthesizer	0.62 (0.81)	2.00 (0.89)	3.06 (1.73)	0.12 (0.50)
Summarizer	0.29 (0.47)	2.06 (1.09)	1.29 (1.05)	0.06 (0.24)

Facilitator

- They generally asked questions or provided answers with elaboration, examples, critical reasoning, etc. to start and push the discussion.
- Knowledge construction level varied across the facilitators in different weeks

Synthesizer

- Their posts were also mostly classified into Level-2 and Level-3 in terms of the knowledge co-construction.

Summarizer

- They on average contributed much less annotations in all levels. Most of their posts were in Level -2. The results were in line with the scripted role in the scaffolding framework, i.e., they focused on the class discussion during Zoom meetings and composed a summary that connected Zoom discussions with annotations.

Results

Research Question 2: How did the activity design facilitate knowledge co-construction?

The Relationship between the Contributions Made by Role-takers and Non-role Takers

- In weeks when role takers posted more higher-level posts, the knowledge construction level from non- role takers tended to be high too.

Table 5. *The Percentage of Posts Contributed by the Role-takers in Each Knowledge Co-construction Level and the Average Knowledge Co-construction Levels of Non-roles*

		Readings															
		02a	02b	03a	03b	04	05	06a	06b	07a	07b	08	09a	09b	10a	10b	11a
Role	Level-1	6%	21%	5%	27%	0	0	0	43%	9%	32%	16%	13%	8%	8%	8%	0
	Level-2	56%	43%	45%	27%	30%	40%	21%	29%	35%	42%	32%	50%	58%	33%	42%	47%
	Level-3	38%	36%	35%	45%	65%	60%	79%	29%	57%	26%	53%	38%	33%	42%	50%	53%
	Level-4	0	0	15%	0	4%	0	0	0	0	0	0	0	0	17%	0	0
Non-role	average	2.24	2.05	2.72	2.05	2.55	2.34	2.54	2.11	2.40	2.33	2.51	2.21	2.42	2.41	2.18	2.56

Results

Research Question 2: How did the activity design facilitate knowledge co-construction?

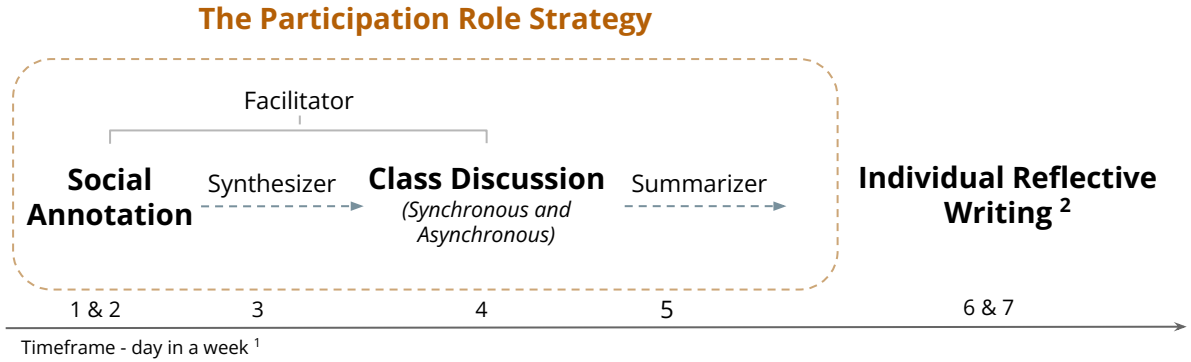
[student A]: Cultural syncretism means the blending of cultures to form something new. This can be in the form of religious practices, architecture, philosophy, recreation, food, etc. I think this back and forth Dunham was experiencing throughout her career is understandable. Was she in search of a right and a wrong answer? Or was she struggling to see how cultural syncretism preserved culture while simultaneously creating something new and different. → Level 3

[facilitator]: Student 110, this is a good thought and a new word for me, too. Student B student C talked about diaspora and assimilation a few paragraphs above. How do you think diaspora and syncretism relate, or maybe they do not relate at all? Do you think one is more beneficial than the other for preserving the culture? → Level 2

[Student A]: In general terms, I interpreted diaspora meaning this shift of cultures due to movement, and the intertwining of different cultures. I think syncretism focuses more on the combination of religious beliefs and an "interfaith". I don't know if one is better than the other, there always seems to be two sides to the story. In my opinion, I think the creation and development of new cultures is beautiful, but I am also someone who likes to hold onto tradition. → Level 3

Conclusion – key findings

- In general, the results indicated that to a great extent the designed activity was enacted by students properly.
- The role assignment was associated with students' social interaction patterns and knowledge construction to some extent.
- Different role takers may have different strategies when playing the roles



Implication of the Design

- We proposed a scaffolding framework for collaborative annotation is applicable to many college-level classes.
- We developed a revised Interaction Analysis Model for collaborative annotation that is more appropriate for analysis of student discussions “anchored” in web documents. This can support teaching as well as a reference for evaluation.
- Finally, results of data analysis have shown promise of the designed scaffolding framework for facilitating productive collaborative annotation in the study context. In particular, the facilitators and synthesizers played roles in deepening collaborative annotation.

Final Words

Rethink the relationship: What can be done as researchers, designers, and teachers?

- Students are not always natural collaborators and need to make intentional efforts to become better collaborators (Borge & White, 2016).
- The instructor needs to provide careful scaffolding and detailed guidelines for students to take various roles.
- The technology needs to connect students and teachers' needs to provide a natural and effective environment for collaboration.

Thank you!

Let's chat more:

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Questions and Suggestions