

Automatically Generating Discussion Questions

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Teamwork!

DA-IICT



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**Bloom suggests that going deep
builds up knowledge students keep**

**Asking questions for reflection
moves learning in a good direction**

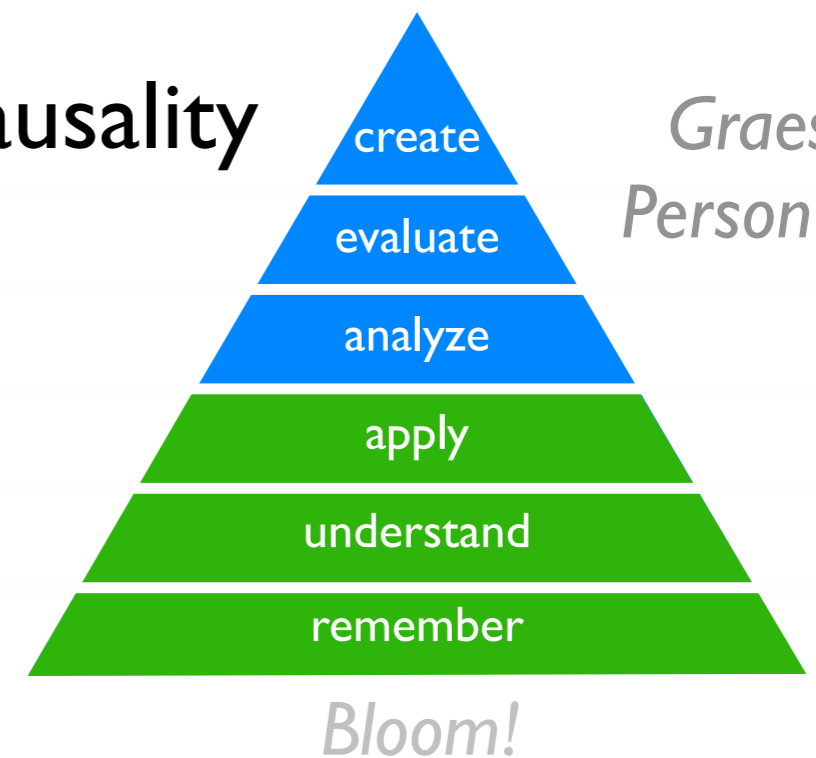
**We'd like to help, we say emphatically -
can we do it automatically?**

Outline

- **Deep Questions & Discussion**
- Generating Questions
- Generating Discussion Questions
- Evaluation & Analysis
- Conclusions & Future Work

Deep Questions

- Comparison, interpretation, causality
- Engage personal perspective
- Allow multiple answers
- Stimulate discussion



*Graesser &
Person 1994*

- Deep discussion questions
& reflective knowledge-building
show positive learning outcomes

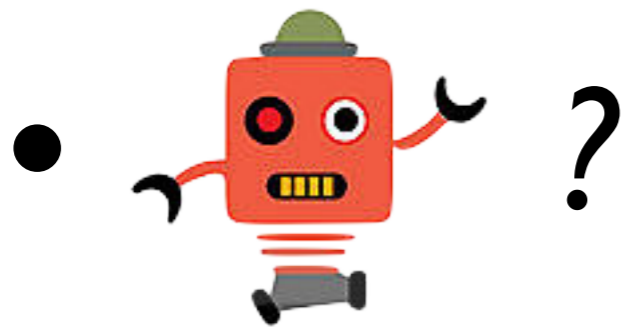
Applebee et al 2003

Craig et al 2006

Roscoe & Chi 2007

Facilitating Depth & Discussion

- Questioning the Author (Beck et al, 1997)
- Reciprocal Teaching (Palinscar & Brown, 1987)
- Collaborative Reasoning (Chinn et al, 2001)
- Accountable Talk (Michaels et al, 2010)



Questions



Can we automatically generate questions suitable for deep discussion?

How can we measure discussion question quality?

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Generating Questions

Heilman (2010) - generating factual questions

- domain-general, off-the-shelf NLP tools
- overgenerates questions
from all sentences in a given text
- ranks/prunes using trained model for
grammaticality, correctness
- great for factual/comprehension questions



- Very little work on generating deep questions.

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Generating Discussion Questions for a Text

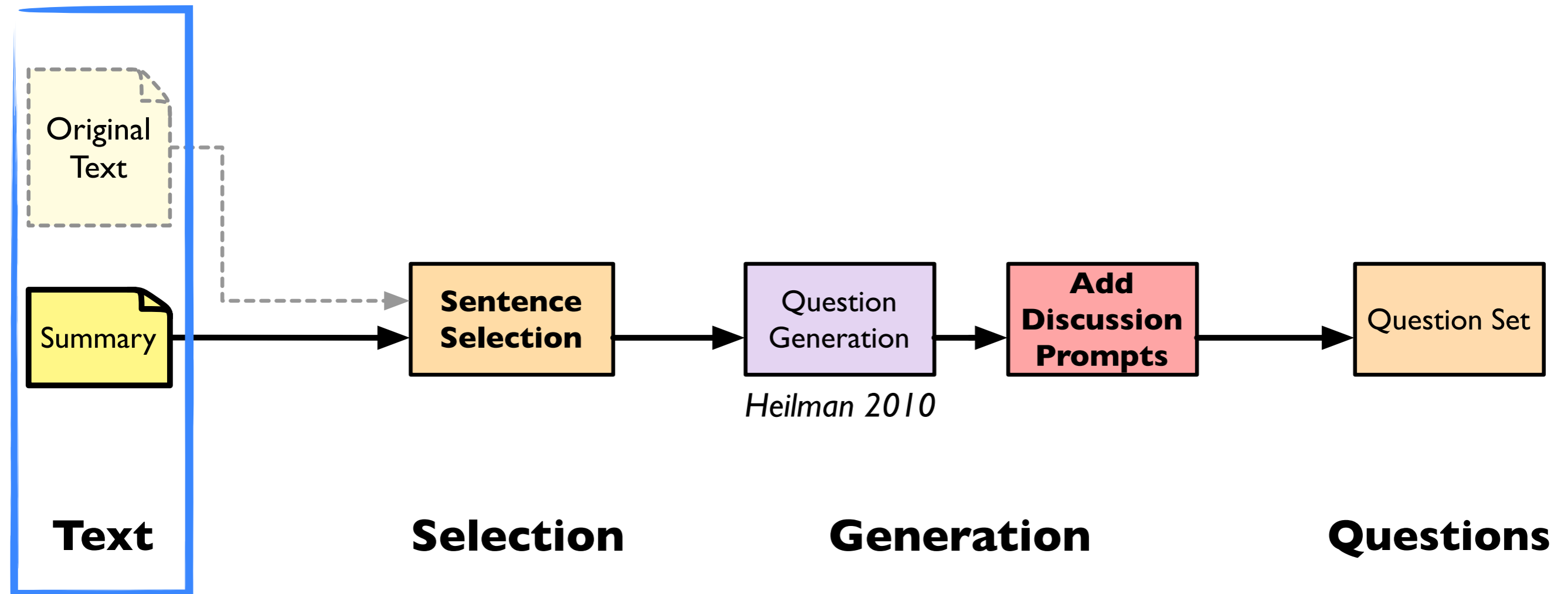
Start with a text and its summary

Pick statements suitable for deep discussion

Transform statements into questions



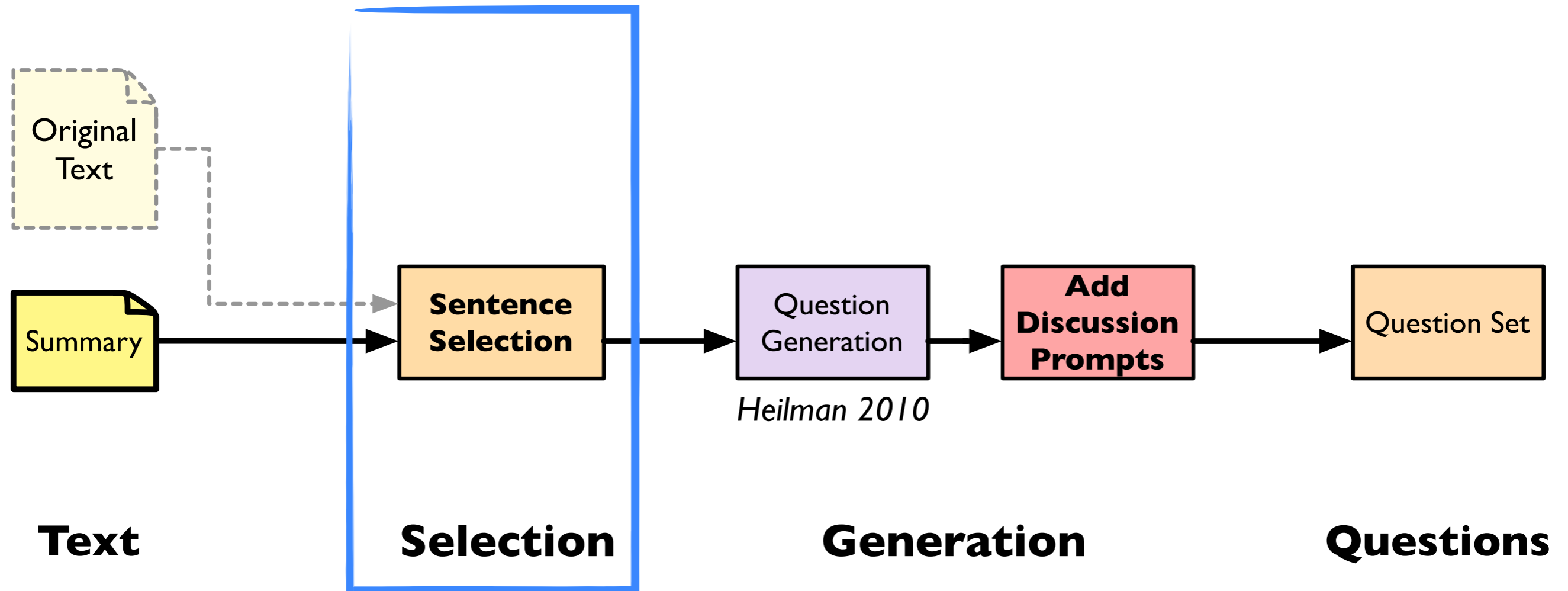
Generating Discussion Questions



Starting with a Summary

- Summaries favor more abstract statements
- Contain synthesized ideas and evaluations
- Eventually powered by automatic summarization?

Generating Discussion Questions



Selecting the Strongest Sentences

What makes a sentence a good candidate for question generation?

- Restatement of ideas within the summary
- Representative of topics from the original text
- New ideas not present in the original text

Selecting the Strongest Sentences

- **Cosine Similarity**
to the preceding sentence in the summary

...they undertake backbreaking labor to build the windmill...

The pigs' declaration that Snowball is responsible for the windmill's first collapse constitutes psychological manipulation...

- **LSA Content Score**
summary sentences with highest value in each “topic” in a model trained on the original text

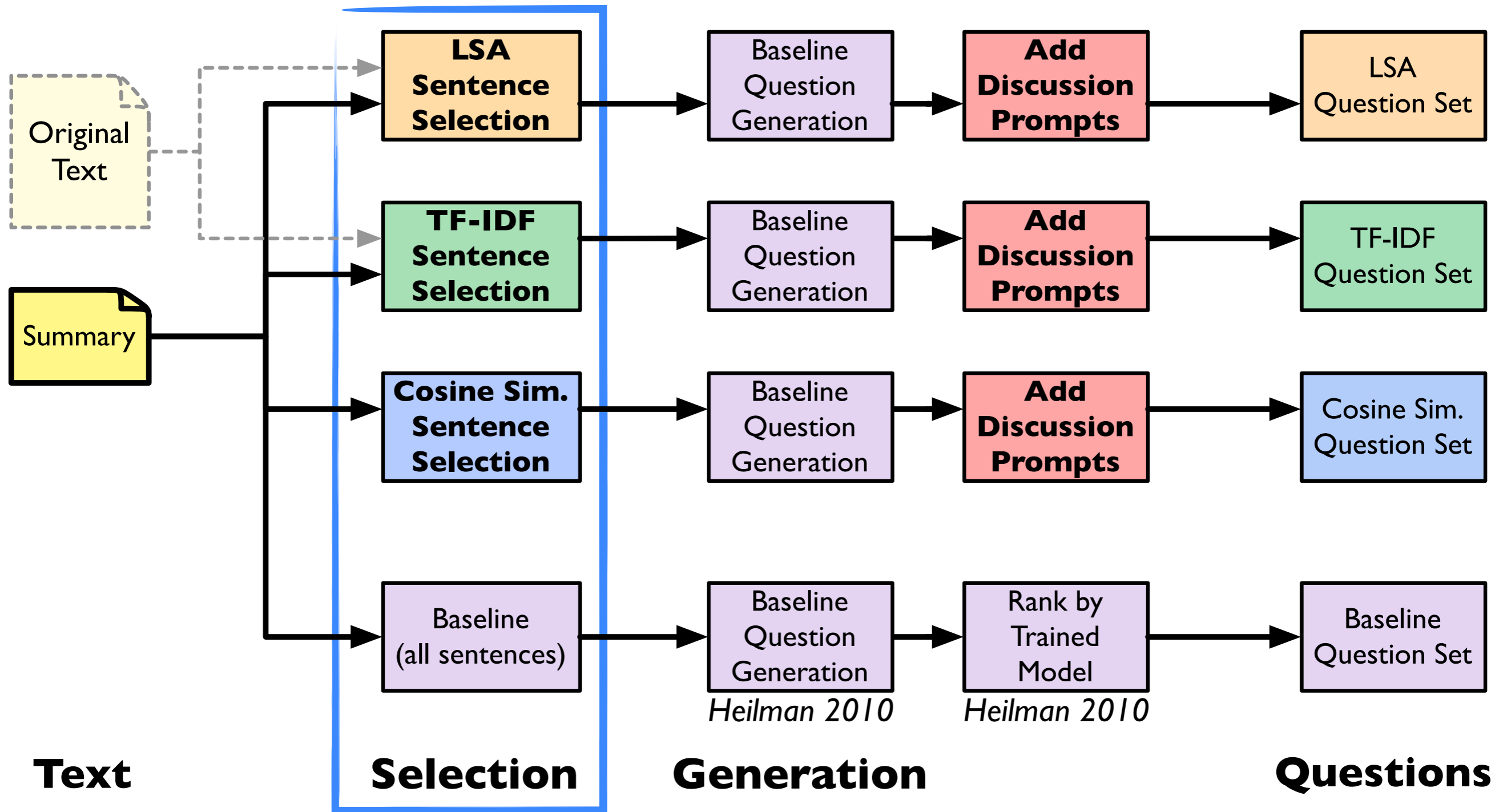
pigs/men Snowball socialism allegory workers

His idealism, however, leads to his downfall.

- **TF-IDF Score**
“uniqueness” of a summary sentence relative to the original text

...the working class becomes ever more reliant on the ruling class to define their group identity and values.

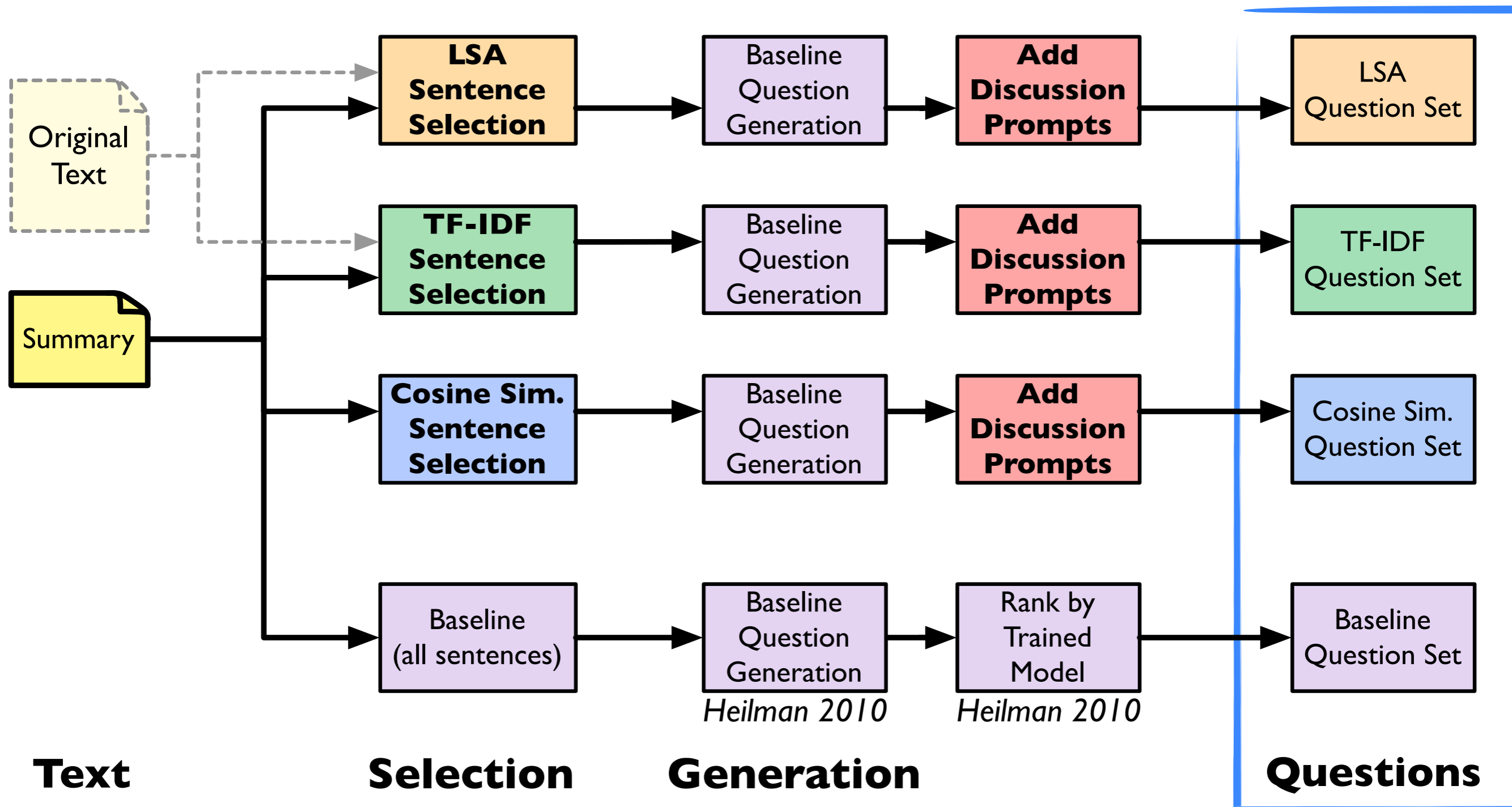
Generating Discussion Questions



Transforming Questions

- Adapt baseline's question templates
- “Is X?” → “Why is X?”
- Simple reframing allows opportunity for analysis, evaluation

Generating Discussion Questions



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Question Evaluation



- Generate 50 questions each from baseline and new methods, using Orwell's *Animal Farm* and its SparkNotes summary.

Generated Questions

Method	Question
Cosine	Why does psychological manipulation unite the animals against a supposed enemy ?
LSA	Whose idealism leads to his downfall?
TF-IDF	What does the increasing frequency of the rituals bespeak? Discuss in detail.
Baseline	Who gathers the animals of the Manor Farm for a meeting in the big barn?

Teacher Evaluation

- 4 teacher judges - 4 to 40 years experience
- Evaluate each question:

x

1

2

3

4

5

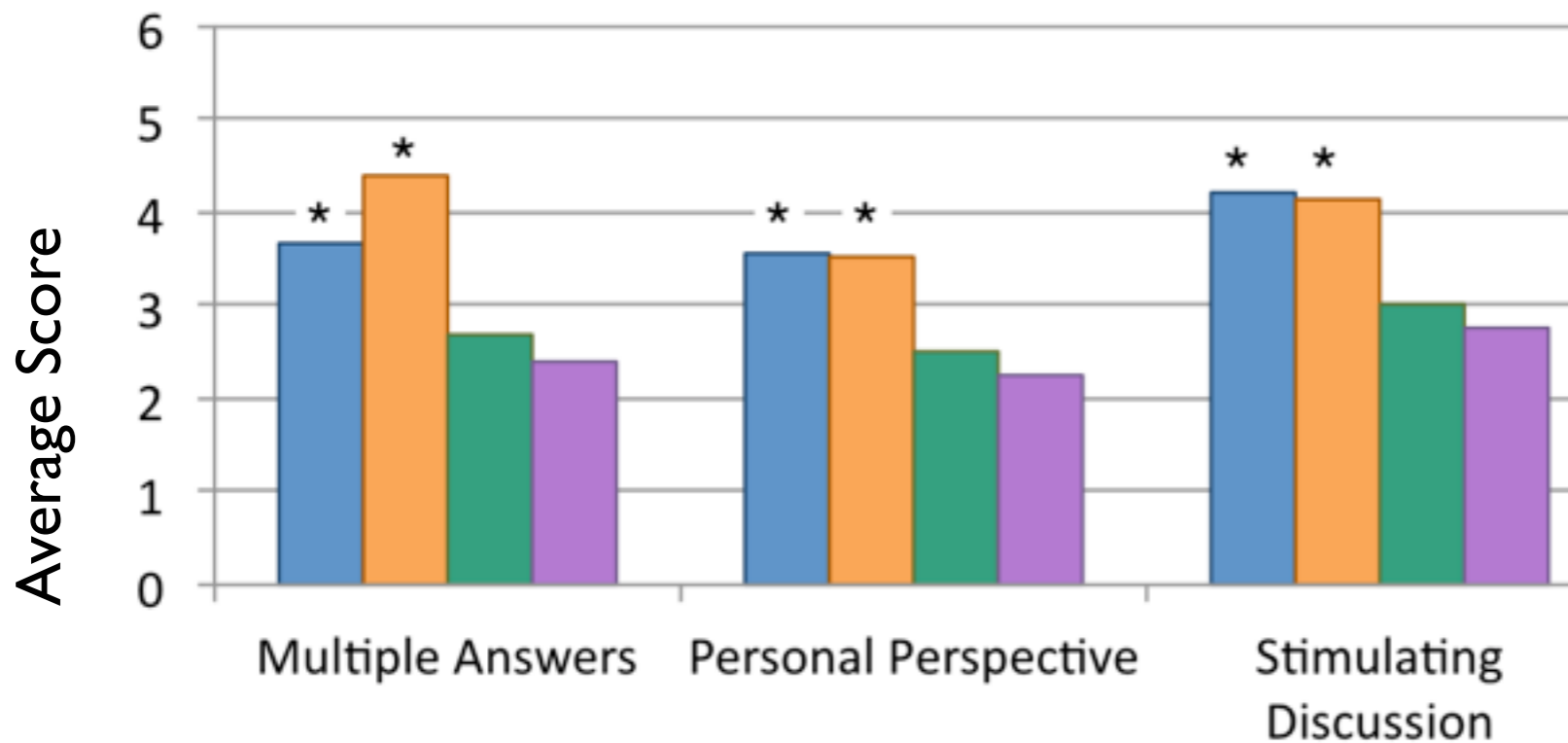
6

7

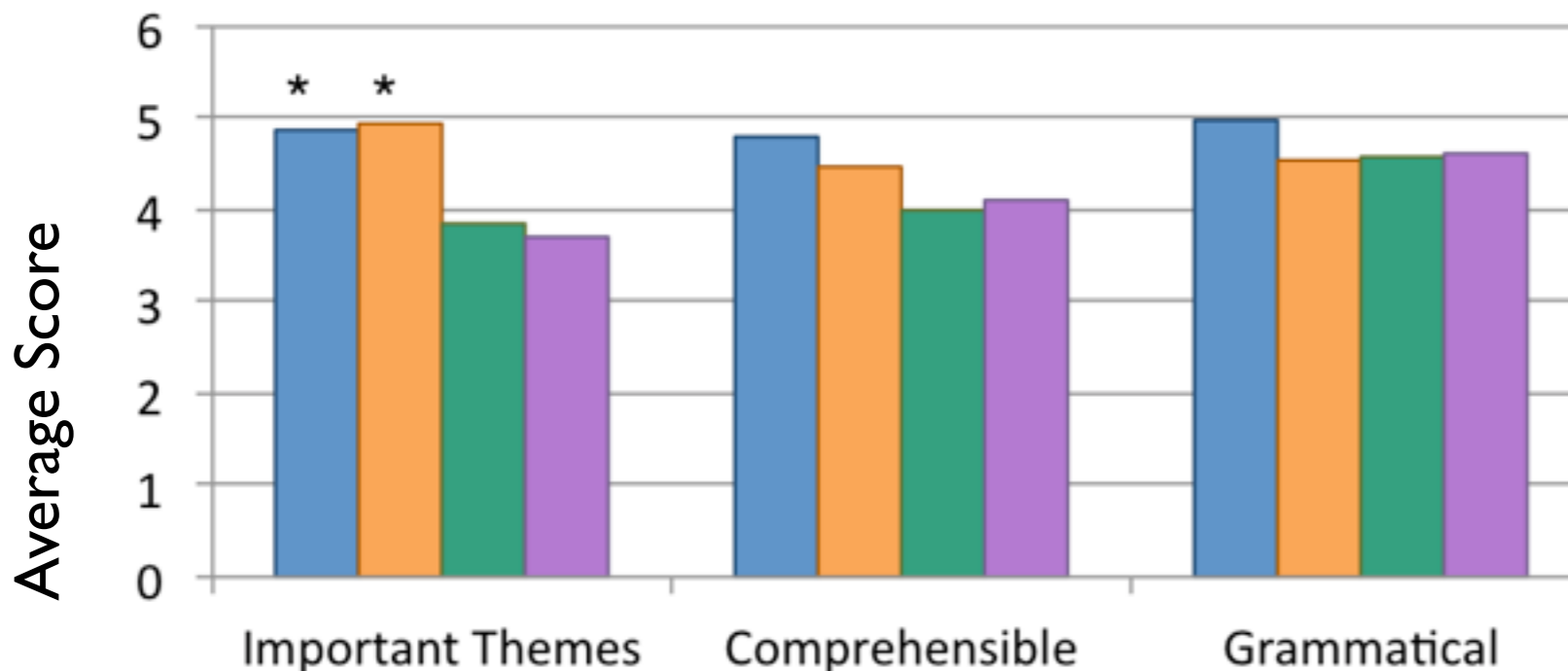
✓

1. This question lends itself to **multiple answers**.
2. Answering this question could engage a student's personal values or **perspective**.
3. This question would be valuable for **stimulating discussion** among students.
4. This question touches upon **important themes** from the story.
5. This question is **comprehensible**.
6. This question is **grammatical**.

Analysis



As a group, the new methods are judged significantly better than the baseline on the first four dimensions.



Legend:
Cosine (blue)
LSA (orange)
TF-IDF (green)
Baseline (purple)

* significantly higher than baseline

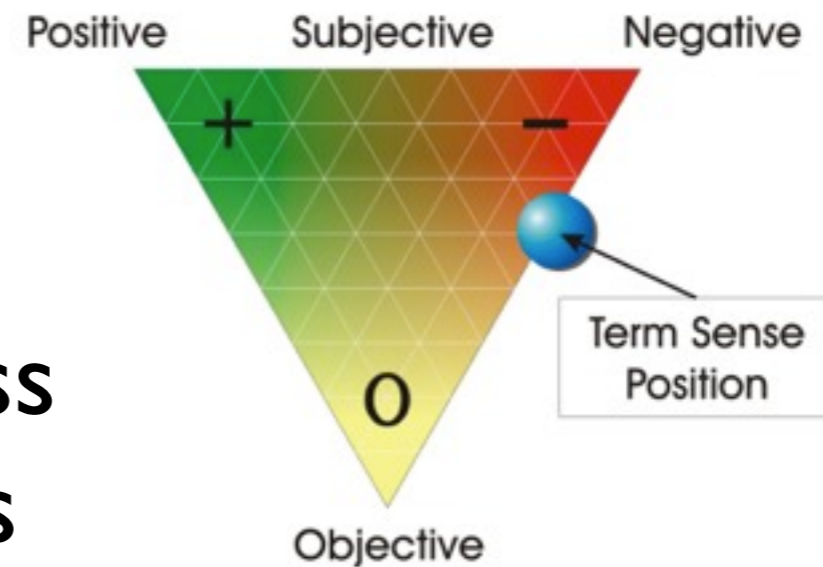
Questions

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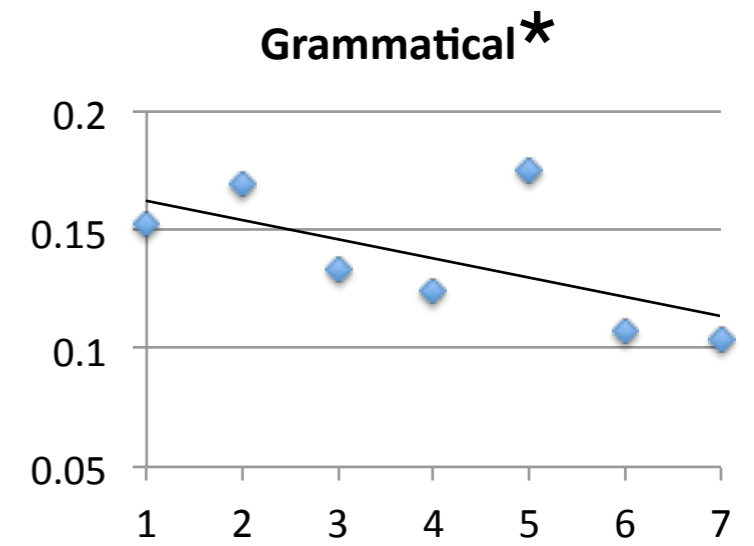
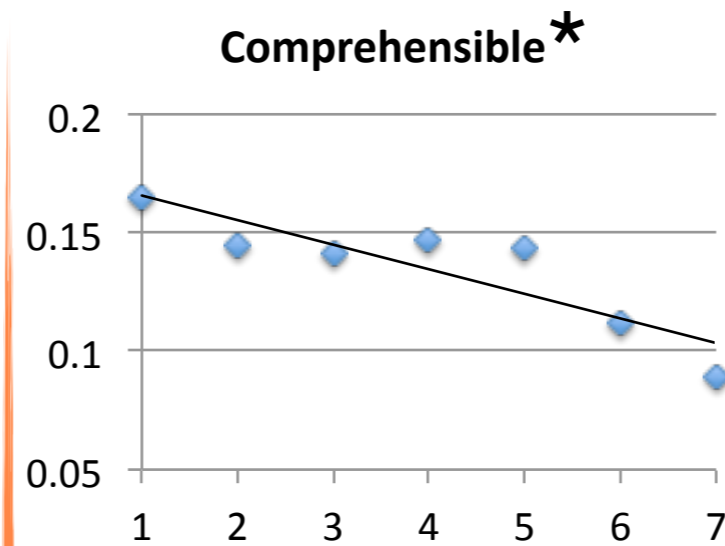
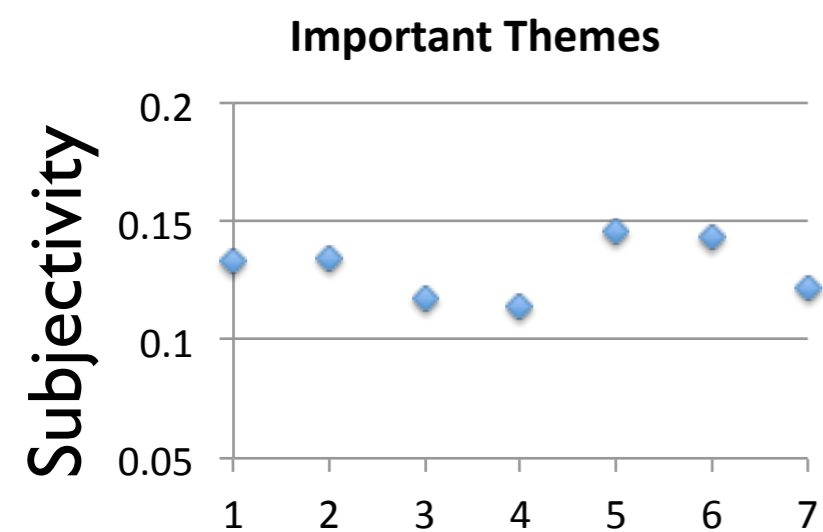
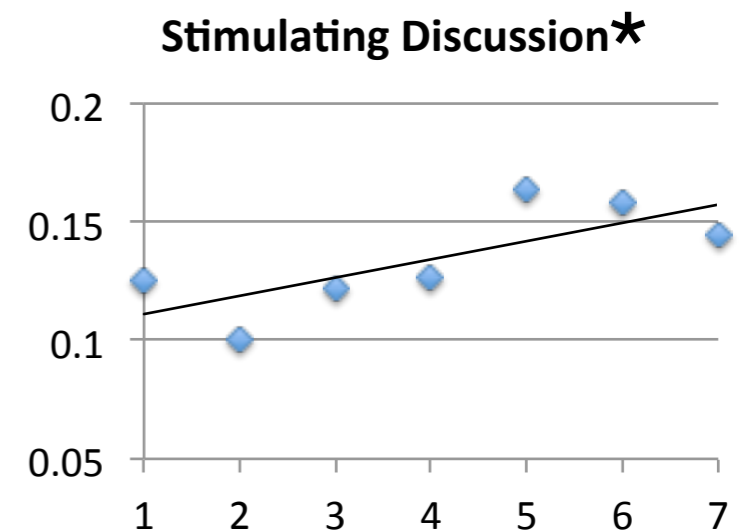
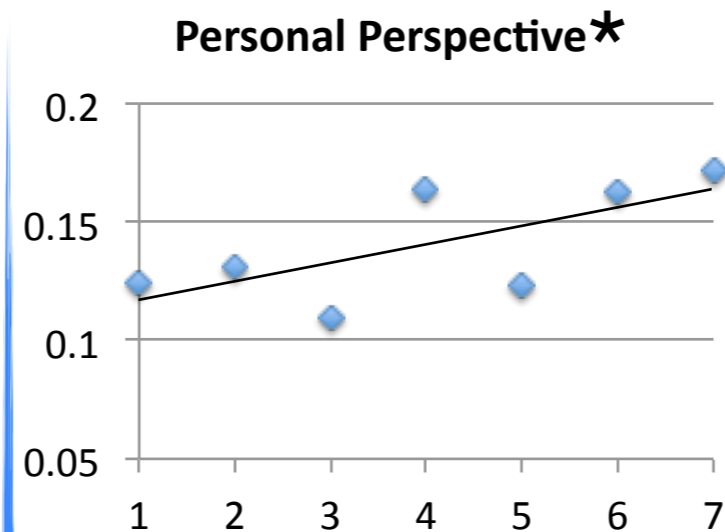
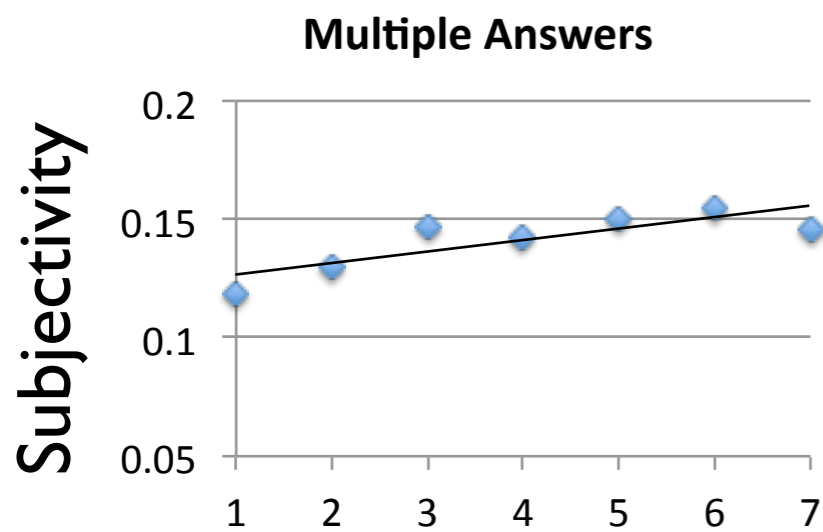
Subjective Questions



- Subjective words express opinions and evaluations
- Question subjectivity = average of words' SentiWordNet subjectivity (Baccianella 2010)
- Subjective questions might allow justification, multiple answers & personal perspective
- Are more subjective questions better for deep discussion?

Subjectivity ~ Discussion

Subjectivity positively correlates with judgements of a question's ability to engage perspective & stimulate discussion.



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Conclusions



- Targeted, transformed questions are judged better for discussion than the baseline
- Subjectivity correlates with teachers' judgements of suitability for discussion
- Contextual & thematic selection models appear to be effective

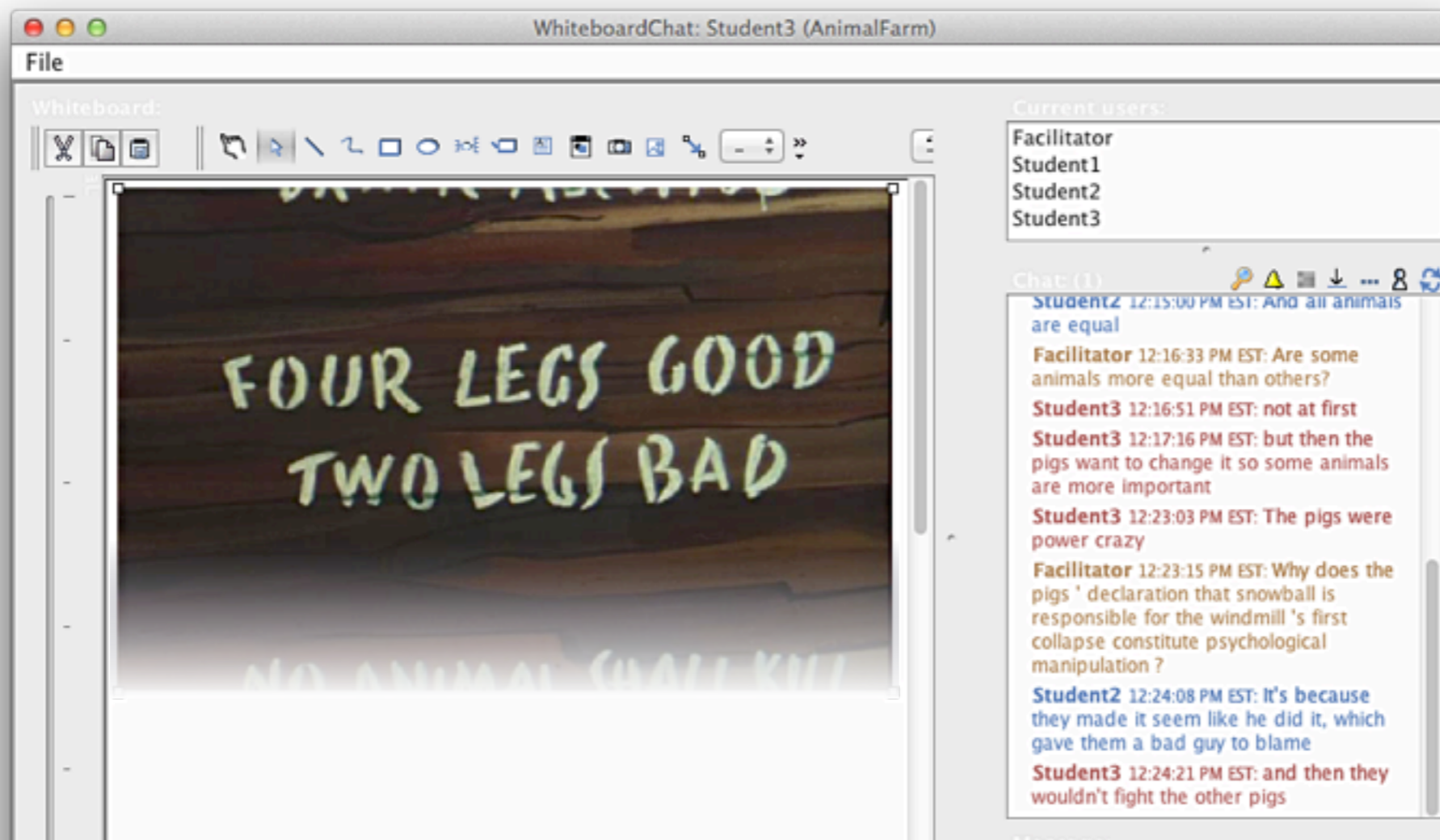
Caveats



- Selection & Transformation are coupled in this evaluation
- Reliant on human-authored summaries
- Subjectivity \neq Readability
- “Shallow” questions are still important

Future Work

- Validation with students
- Ensemble methods for selection and ranking
- Pilot with conversational agent facilitator:



The screenshot displays a web application window titled "WhiteboardChat: Student3 (AnimalFarm)". The interface is split into two main sections. On the left is a whiteboard area with a toolbar containing various drawing tools. The whiteboard itself shows a dark background with the text "FOUR LEGS GOOD" and "TWO LEGS BAD" written in a light green, hand-drawn font. Below this, the text "NO ANIMAL SHALL KILL" is partially visible. On the right is a chat window titled "Chat: (1)". It lists "Current users" as Facilitator, Student1, Student2, and Student3. The chat log shows a conversation about the text on the whiteboard, with messages from Student2, the Facilitator, and Student3 discussing the equality of animals and the role of pigs in the story.

WhiteboardChat: Student3 (AnimalFarm)

File

Whiteboard:

FOUR LEGS GOOD
TWO LEGS BAD

NO ANIMAL SHALL KILL

Current users:
Facilitator
Student1
Student2
Student3

Chat: (1)

Student2 12:15:00 PM EST: And all animals are equal

Facilitator 12:16:33 PM EST: Are some animals more equal than others?

Student3 12:16:51 PM EST: not at first

Student3 12:17:16 PM EST: but then the pigs want to change it so some animals are more important

Student3 12:23:03 PM EST: The pigs were power crazy

Facilitator 12:23:15 PM EST: Why does the pigs ' declaration that snowball is responsible for the windmill 's first collapse constitute psychological manipulation ?

Student2 12:24:08 PM EST: It's because they made it seem like he did it, which gave them a bad guy to blame

Student3 12:24:21 PM EST: and then they wouldn't fight the other pigs

A hand holding a red pen over a document. The hand is positioned in the upper right quadrant, with the pen pointing towards the center. The document is open, showing a page with some faint lines. The background is a light, neutral color.

Audience Generated Discussion Questions?

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